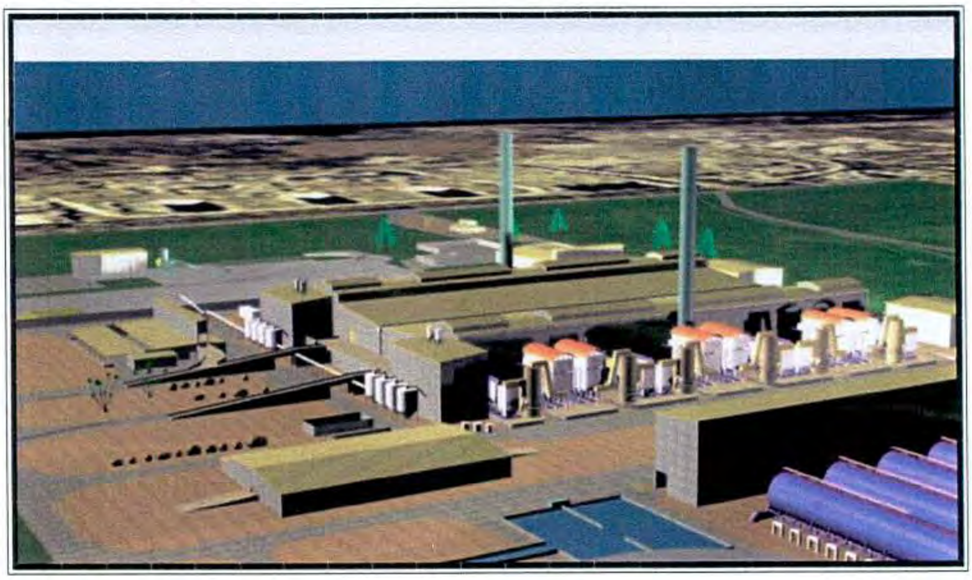
Energy, Water & Materials from Waste & Biomass Resources

# WASTE TO ENERGY & WATER PLANT
# LOT 15 MASON ROAD, KWINANA
# WESTERN AUSTRALIA

## PUBLIC ENVIRONMENTAL REVIEW DOCUMENT



*Prepared for:*

**GLOBAL OLIVINE WESTERN AUSTRALIA**

*Prepared by:*

**BARKER & ASSOCIATES LTD**

**APRIL 2000**

GO Western Australia

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## INVITATION

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

The Public Environmental Review (PER) proposes the development of a Waste to Energy and Water (WTE&W) plant on Lot 15, Mason Road, Kwinana Industrial Estate.

In accordance with the Environmental Protection Act, a PER has been prepared which describes this proposal and its likely effect on the environment.

The PER is available for public review for up to four weeks from 1 April 2000 closing on 1 May 2000.

After receipt of comments from Government agencies and the public, the EPA will prepare an assessment report with recommendations to the 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 your suggested action - including alternative approaches.

It is useful if you can suggest ways to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents and may be quoted in full or in part in each report unless specifically marked: confidential.

Submissions may be fully or partially utilised in compiling a summary of the issues raised or, where complex or technical issues are raised, a confidential copy of the submission (or part of:) may be sent to the proponent.

The summary of issues raised is normally included in the EPA's assessment report.

**Why not join a group?**
If you prefer not to write your own comments, it may be worthwhile joining a group or other groups interested in making a submission on similar issues.

Joint submissions may help to reduce the work for an individual or group while increasing the pool of ideas and information.

If you form a small group (up to 10 people) you may wish to indicate the names of all participants.

If your group is larger, please indicate how many people your submission represents.

**Developing a submission**
You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals.

It helps if you give reasons for your conclusions, supported by relevant data.

You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the review document:

- 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 issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the review document
- if you discuss different sections of the review document, keep them distinct and separate, so there is no confusion about which section you are considering;
- attach any factual information you may want to provide and give details of the source.

Make sure your information is accurate.
Remember to include:

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

The closing date for submissions is: 1 May 2000
Submissions should be addressed to:
Environmental Protection Authority
Westralia Square
141 St Georges Terrace
PERTH WA 6000

Attention: R Sutherland

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## FIGURES

# 1. DEFINITION OF TERMS

| | | |
|---|---|---|
| **ANZECC** | - | Australian and New Zealand Environment Conservation Council |
| **DEP** | - | Department of Environmental Protection |
| **EPA** | - | Environmental Protection Authority |
| **GOA** | - | Global Olivine Australia Limited |
| **GOWA** | - | Global Olivine Western Australia Limited |
| **GWP** | - | Global Warming Potential |
| **IET** | - | Integrated Environmental Technologies Limited |
| **MED** | - | Multiple Effect Distillation |
| **MSW** | - | Municipal Solid Waste |
| **ONZ** | - | Olivine New Zealand Limited |
| **PEM** | - | Plasma Enhanced Melters (Vitrifiers) |
| **UHTC** | - | Ultra High Temperature Combustor |
| **US EPA** | - | United States Environmental Protection Agency |
| **WTE** | - | Waste to Energy |
| **WTE&W** | - | Waste to Energy and Water |

**SCIENTIFIC TERMS**

| | | |
|---|---|---|
| As | - | Arsenic |
| Cd | - | Cadmium |
| Cr | - | Chromium |
| Cu | - | Copper |
| Pb | - | Lead |
| Hg | - | Mercury |
| Ni | - | Nickel |
| Zn | - | Zinc |
| PCBs | - | Polychlorinated biphenyls |
| PAHs | - | Polyaromatic Hydrocarbons |
| TBT | - | Tributyltin, marine anti-fouling agent |

# 2. INTRODUCTION

## 2.1 BACKGROUND

### *2.1.1 Waste Disposal in General*

Most metropolitan regions throughout the world face similar problems to Western Australia with regard to the management of refuse generated by the community. These problems fall into a number of categories but can be summarised as follows:

1. Existing management means (primarily landfills) are quickly approaching capacity, and the availability of future sites, in or near metropolitan areas, become more difficult to locate.
2. Landfill carries with it on-going environmental liabilities and is no longer automatically accepted as the method of choice. Site contamination and liability insurance is becoming very difficult to obtain, hence the community carries the responsibility (see Aon letter attached as Appendix G).
3. Costs associated with new technology landfill options are very high.
4. The effective management of a resource demands recognition of community priorities across a wide base of interests and recognises the value of waste as a biomass fuel and a valuable raw material.
5. A region's interests are best served by a comprehensive refuse scheme that involves all local authorities and relevant commercial interests, taking a global planning view and delivering an integrated solution.

The key inter-related dynamics associated with the refuse issue are;

1. Environmental responsibility.
2. Cost efficiency.
3. Viability (process, system and financial).
4. Flexibility (to facilitate integration with current resources and systems to meet future requirements).
5. Community acceptability.

### *2.1.2 Waste Disposal in Australia*

Currently over 14 million tonnes of domestic, commercial and industrial waste is disposed of in Australian landfills per year. Of this, more than 200,000 tonnes of liquid and solid industrial waste is taken to special landfills and 'treatment' facilities throughout Australia. Overall, Australia's level of waste per head of population is one of the highest in the world. As a result, landfill sites are becoming scarce and there is a growing community debate over waste management issues (Commonwealth Environment Protection Agency). Accordingly, waste disposal is now one of the major concerns of local councils and other government organisations throughout the country.

In response, the Commonwealth has implemented a hierarchy of waste management priorities. In order of importance these are;

1. Waste avoidance;
2. Waste reduction;
3. Waste reuse;

4. Waste recycling or reclamation;
5. Waste treatment; and
6. Waste disposal.

The Commonwealth has also adopted a national target of 50% reduction in waste going to landfill by the year 2000.

The greenhouse impact of fossil fuel electricity production and landfill methane emissions is also becoming an important issue in terms of Australia's commitments under the Kyoto Protocol. Australia's commitment is 108% of the 1990 greenhouse emission level by 2012.

In response its Kyoto Protocol obligations, the Australian Greenhouse Office has issued a goal of producing 4% of national energy production from renewable energy sources. This includes gasification, natural gas, tidal energy and waste to energy.

Within this regional and government context Olivine New Zealand Limited, through its Australian based company Global Olivine Western Australia (GOWA), have selected Perth to locate one of its leading technology waste to energy plants. The plant has potential to fully convert Perth's domestic waste stream through thermal treatment into products such as electricity, industrial chemical compounds, industrial glass, metal ingots, construction aggregate and contaminant free compost. In response to Perth's water shortage problems, GOWA also intend to utilise the waste heat from the combustion process to operate water desalination units to produce fresh water at low cost for the domestic population.

## 2.2 THE CASE FOR WASTE TO ENERGY

In countries without an established Waste to Energy industry such as Australia and New Zealand, the concept of Waste to Energy can be controversial for a range of reasons, which include;

- Perceptions of Waste to Energy as a threat to waste management plans based on the waste hierarchy of reduce, reuse, recycle and dispose.
- Negative environmental perceptions of waste combustion.
- Ash management and disposal.
- Commercial threats to waste industry participants.

Apart from the last one, these issues can raise emotional responses from lobby groups and the community, and require careful management. Careful management includes the gathering and dissemination of information on others' experiences and international trends in these areas. Most importantly, it requires the application of best practice combustion and flue gas treatment technology and ash disposal, all of which are a feature of the Global Olivine Waste to Energy technology.

The major Australian waste industry participants generally have interests in Waste to Energy on the international scene through parent companies activities. The reason for their not introducing Waste to Energy to Australia probably lies with the relative economics of other forms of Waste to Energy technology compared to landfilling.

Following is some information that addresses international experience with some of the issues noted above.

### 2.2.1 *Waste to Energy Internationally*

The international recognition of the importance of energy recovery and the elimination of landfills is increasing. Since the early 1970's waste to energy has become common in countries such as the USA, UK, Germany, France, Denmark, Sweden, Switzerland, Holland, Japan, Canada, Finland and Singapore. The technology has been improved significantly since that time and many of the poor perceptions of Waste to Energy come from the earlier combustors.

Appendix A shows the status of municipal waste management in a range of countries. This shows that internationally, incineration of waste is a significant and growing feature of waste management.

***United States***

There are 103 Waste to Energy plants operating in 31 states throughout the U.S. These plants burn approximately 15% of the municipal solid waste (MSW) generated nation-wide or about 105,000 tonnes each day, and generate over 2,700 MW of electricity. Cumulatively the USA WTE industry serves the waste disposal needs of more than 39 million people and represents a capital investment of more than $10 billion.

A survey conducted in 70 USA cities indicates that almost three quarters of the Americans polled believe Waste to Energy plants are vital components for the nation's environmental and economic future. Respondents also believe that Waste to Energy programs mean cleaner disposal of MSW, less need for landfill space and cost-effective, safe power generation.

By the year 2000, the USA will generate more than 223 million tonnes of MSW annually. The US Environmental Protection Agency (EPA) expects about one-third to be recycled or composted, leaving 156 million tonnes of MSW to be managed. This remaining MSW will be handled using other elements of EPA's integrated waste management approach, primarily Waste to Energy and landfilling.

***United Kingdom and Europe***

Currently in the UK, of the 26 million tonnes of MSW generated each year, approximately 7% is recycled while energy is recovered from approximately 10%. Other European countries achieve recovery rates of 35-80%, of which recycling and composting account for 15-30% and Waste to Energy for the remainder.

The European Union recognises Waste to Energy as a preferred recovery option and has published a target of 12% of power generation from renewable sources, including waste, by 2010.

In Germany, Waste to Energy projects will be the only permitted disposal technology for untreated municipal solid waste from 2005. The UK is supporting Waste to Energy development through landfill taxes and subsidising non-fossil fuelled electricity generation.

Europe's largest combustor is in Rotterdam and produces 15% of the city's electricity requirements and over 6 million cubic metres of water each year.

France has banned landfilling from 2000 and is encouraging environmentally sound forms of energy and materials recovery from waste. Overall in France, existing energy recovery schemes are saving about 450,000 tonnes of oil-equivalent fuels each year by household waste combustion. In Paris the waste produced by 5 million people provides energy that supplies 43% of the Paris District Heating Company's requirements.

Countries like Denmark, Sweden, Germany, Austria and Switzerland have had a "visionary" approach in the past and already operate modern energy recovery plants. In tandem, other countries, such as the Netherlands and Belgium, are already executing a program of "new for old".

By the year 2010 5% of Europe's domestic energy needs could be met by Municipal Solid Waste, which would save approximately half the coal imports to Western Europe. Currently approximately 15% of Municipal Solid Waste is being used in this way, generating around 1% of Europe's domestic electricity needs (Penshaws International Energy Consultants).

### *2.2.2 The Waste Hierarchy and Integrated Waste Management.*

No matter how much we reduce, re-use and recycle there will always be waste left over. If the energy locked in this waste can be utilised in an environmentally sound manner, rather than being lost to landfill, then the process must be considered valuable.

US communities with Waste to Energy plants recycle an average of 32% of their MSW, five percent higher than the national average of 27%.

Waste to Energy plants greatly reduce the need for landfill by reducing the volume of municipal solid waste to be dealt with by 90% and its weight by 70%. The GOWA process effectively has no waste, which eliminates reliance on landfills.

Waste to Energy enables the recovery of materials that would not otherwise be recycled. This material recovery happens after the energy is recovered by combustion. Ferrous and non–ferrous metals remaining in the ash are extracted and recycled. Since these metals are often combined with non-recyclable materials during manufacture, extraction of the metals would not be feasible without combustion.

Nearly 773,000 tonnes of steel is recovered for recycling each year at Waste to Energy plants in the USA. Each year, an additional 460,000 tonnes of other products are recycled on-site at USA Waste to Energy plants.

Waste to Energy is one element of an integrated waste management program and has been designed to reduce waste volume, detoxify it and utilise resources which might otherwise be lost to landfill.

### *2.2.3 Environmental Responsiveness.*

Waste to Energy is environmentally responsible. For example, in the USA, new Clean Air Act rules for municipal waste combustors ensure that Waste to Energy is one of the cleanest sources of power in the world. The U.S. Conference of Mayors, the American Society of Mechanical Engineers and others report in a recent booklet jointly released, that energy from rubbish can be produced about as cleanly as from natural gas.

In 1993, the Los Angeles District Sanitation Department, and the Plant Manager of the Commerce, California Waste to Energy plant, concluded that their local facility created less pollution than the trucks used to haul rubbish to a nearby landfill.

The U.S. Department of Energy has labelled Waste to Energy technology as a major part of a plan to reduce carbon dioxide emissions in the United States. By replacing fossil fuels, Waste to Energy reduces the build-up of carbon dioxide in the air. Combusting biomass, materials such as paper, wood and food waste, does not add to the build-up of greenhouse gases. In addition it prevents the release of methane, a much more potent global warming gas, from decomposition of this material in a landfill.

Burning MSW also effectively destroys waste stream bacteria, pathogens and other harmful elements.

Dioxins, one of the emissions sometimes associated with old-style incineration is far less prevalent at modern Waste to Energy plants. A modern, average-sized Waste to Energy plant emits only 0.25g dioxins a year. Dioxins are widespread in the environment, so they are also found in waste. Efficient Waste to Energy is the only waste management technique that actually reduces the amount of dioxins in waste. Landfill, recycling and composting have no impact on reducing dioxin levels.

Typically over 80-85% of the dioxins in waste are destroyed during combustion. The remainder are stabilised and bound up into the ashes (primarily fly ash). In this way modern Waste to Energy plants act as an effective 'clean-up' method or 'dioxins sink'.

### *2.2.4 Ash Management and Reuse*

The Waste to Energy process reduces the incoming volume by about 90%. The remaining bed ash (being the majority of the ash) is either used as a road-bed material or similar product or landfilled.

Waste to Energy residue ash from high temperature combustion processes is safe for construction. The ash exhibits concrete-like properties causing it to harden once it is placed and compacted in a landfill. This reduces the potential for rainwater to leach contaminants in landfills into the ground. In the USA more than 300,000 tonnes of ash are used annually as daily and final cover in place of soil in landfills and in roadbed construction. Ash is used as a substitute for aggregate in road base materials, building construction and artificial offshore reefs.

## 2.3 THE PROPONENT

Global Olivine Western Australia (GOWA) is a registered Australian company. GOWA is currently owned by Global Olivine Australia (GOA), and Olivine New Zealand Limited.

GOWA, the first of a number of companies which will be formed to develop Australian regional Waste to Energy plants, will develop and manage the Kwinana Waste to Energy and Water (WTE&W) plant in Perth. It is intended that up to 50%

of GOWA will be owned by Australian based investors, Councils and waste management companies.

The parent company, Olivine New Zealand Ltd (ONZ), is a New Zealand public unlisted company with 200 shareholders and 103,700 shares issued as at Jan 31 1999 with total combined assets of $NZ13.8 million.

ONZ owns 100% of an equipment holding subsidiary 'Olivine International Ltd'. This company has assets of around $NZ10 million.

ONZ was incorporated in 1993 expressly to develop Waste-to-Energy projects which use ultra high-temperature combustors that are similar to the original Olivine US combustors. The principals of ONZ have undertaken further independent development of power station design which uses the improved combustors and their extension and integration to energy and water production and materials recovery. These developments are now the subject of a patent application and an independent commercial valuation.

The name of the company reflects the mineral 'Olivine' which occurs naturally in the Cascade Mountains in Western Washington USA. The mine from which this mineral is obtained is owned by Olivine US and a particular grade of Olivine is a key material from which Olivine combustors are constructed.

The mineral has a distinctive ability to withstand very high temperatures with low and uniform expansion and contraction. Olivine US has developed a proprietary method for constructing refractory panels from this material that provides a significant commercial advantage for unique high temperature combustor construction.

The Olivine US material and panel rights have been granted to Warwick Davies of Olivine NZ Ltd for world-wide use in Waste-to-Energy Systems. Negotiations are under way for a merger of Olivine US into ONZ at which point ONZ will own the mining and panel rights. Construction of South East Asia, Asia and Australasian refractory will be undertaken in Kwinana and will become a major export industry for Western Australia.

A summary of company directors and key contractors is attached as Appendix B

## 2.4 TIMING

The final design and detailing of the plant has commenced. The site construction process is expected to take two years until commissioning of the first UHTC units. Based on EPA approval being obtained in early June 2000 and required Works Authority permits being granted in July 2000, it is expected that the plant will be operational by mid 2002.

A gant chart outlining the timing of the construction process is attached as Appendix C.

## 2.5 APPROVAL PROCESS

In West Australia the environmental impact assessment process is aimed at protecting the environment by ensuring development is environmentally sound and well managed. Proponents (such as GOWA) are required to tell the Environmental Protection Authority and the community what the development is, what the expected environmental impacts are, and how they plan to manage the project so the environment will be protected. They also are required to commit to the environmentally responsible implementation of their proposals.

Environmental impact assessment provides a way in which independent environmental advice can be given to the Government so it can properly decide the balance on the basis of a range of advice covering political, environmental, economic, social and cultural issues. Environmental impact assessment is aimed at resolving questions of "how to" manage projects so the environment is protected rather than to say "yes" or "no" to development.

### *2.5.1 Aims of the Process*

Environmental protection in Western Australia is based on a value that captures the hopes and aspirations of most people.
It is:

*"The world should be a good place in which to live, and to make a living, for all of us, and for our children and theirs."*

Environmental impact assessment, therefore, is designed to ensure that the environment is looked after when new development proceeds. The process runs in parallel with project development so that designers and planners can incorporate environmental protection and developers can commit themselves to continuing, responsible environmental management.

The process also is designed to:

- ensure that Governments get timely and sound environmental advice before they make decisions;
- encourage and provide opportunities for public involvement in the environmental aspects of proposals before decisions are made;
- ensure that proponents take primary responsibility for protecting the environment affected by their proposals;
- encourage environmentally sound proposals which minimise adverse environmental impacts and maximise environmental benefits.
- provide for continuing environmental management; and
- promote environmental awareness and education.

### *2.5.2 The Process*

The EPA in Western Australia is an independent environmental adviser that recommends to the Government whether projects are environmentally acceptable. It does not decide whether projects should proceed. That task is properly left with the Government.

The first formal step of environmental assessment is the referral of a proposal to the EPA for a determination as to the level of assessment required. The proposal document includes a brief description of the project, the likely environmental impact and how that impact will be managed. The GOWA proposal document was referred to the EPA on 3 September 1999.

The EPA has several options for dealing with a proposal referred for assessment. It may:

- decline to assess it because it is considered environmentally insignificant;
- assess it "in house" and provide public advice (known as an Informal Review with Public Advice);
- issue a works approval and licence; or
- assess it "formally" as a Consultative Environmental Review, Public Environmental Review, or Environmental Review and Management Program.

Formal assessments require varying degrees of environmental and public review and evaluation. All formal assessments are reviewed and evaluated by the EPA who advise the Government on environmental acceptability. The Government then decides whether to approve. In this case, the Perth WTE&W proposal was set a Public Environmental Review level of assessment with a four week public review period.

### *2.5.3 Public Environmental Review (PER)*

Public Environmental Review is used for proposals with either major public interest or potential for significant environmental impact. In these cases, the EPA issues a detailed, project-specific list of guidelines which should be examined by the proponent in its Public Environmental Review. GOWA has received a comprehensive list of guidelines which are attached as Appendix D.

The PER process is designed to ensure that people are told about development, have a say, and are heard before decisions are made. People having an interest in, or living near, a proposed development often have important local knowledge which can contribute to better environmental management.

The EPA will provide a summary of issues raised during the public review of the PER documents. All submissions received by the EPA will be treated as publicly available unless specifically marked confidential. Proponents then must provide a written response to the issues, including commitments to their management where appropriate. The issues and the proponent's response to them are published by the EPA in its report and recommendations to the Minister for the Environment.

### *2.5.4 EPA Recommendations*

In its assessment of a proposal, the EPA will consider issues raised by the public, specialist advice from Government agencies, the proponent's response to those issues, the EPA's own research and, in some cases, research provided by other expert agencies. The EPA takes about six weeks on average to assess a proposal after the proponent has responded to issues raised during public review. The time varies, of course, depending on the complexity of issues and the level of assessment. At the end of an assessment, the EPA reports and makes recommendations, which include suggested environmental conditions, to the Minister for the Environment. This advice indicates whether the EPA considers the proposal to be environmentally acceptable and, if so, whether environmental conditions should be imposed. The Minister makes the final decision on whether a proposal may proceed.

# 3. THE PROPOSAL

## 3.1 SITE LOCATION AND SETTING

The project involves the establishment of a regional waste processing plant within the Kwinana industrial estate. The site is located on the Swan Coastal Plain, approximately 30 km south-west of the Perth Central Business District and 3 km west to north-west of the town of Kwinana. The western boundary of the site is situated approximately 700 m from the coastline.

The Swan Coastal plain lies between the Indian Ocean and the Darling Range approximately 23 km to the east. The site is located within the Kwinana strip, which forms the main heavy industrial area of Western Australia and was formerly part of the British Petroleum (BP) Refinery.

Under the Metropolitan Regional Scheme 1999, the site and all adjoining land is zoned Industrial. The nearest Residential zoned land is the Town of Kwinana located 2.2km south-east of the site. Land use data under the metropolitan regional scheme for the area is shown on Figure 3-1.

The site of the plant (Lot 15) is a large undeveloped section of land that was originally created to serve a future petrochemical industries plant. The site lies adjacent to BP Oil refinery, Wesfarmers LPG plant, Tiwest Titanium Dioxide plant and the former BHP Steel plant. The general area forms the southern section of the Kwinana Industrial Area and is accessed only by Mason Road. Figure 3-2 shows the site location.

## 3.2 GENERAL OVERVIEW

It is proposed to locate the facility in the position as shown on Plan PL101 attached as Appendix E. The plant has potential to process the majority of Perth's domestic and industrial waste stream (an average of 1.2 million tonnes per annum) into products such as electricity, fresh water, industrial chemical compounds, industrial glass, recycled metal ingots, construction aggregates and contaminant free compost. The project capital is in the order of $520 million (AUS) for the construction phase with an anticipated $150 million annual revenue.

The key components of the Kwinana WTE&W plant are:

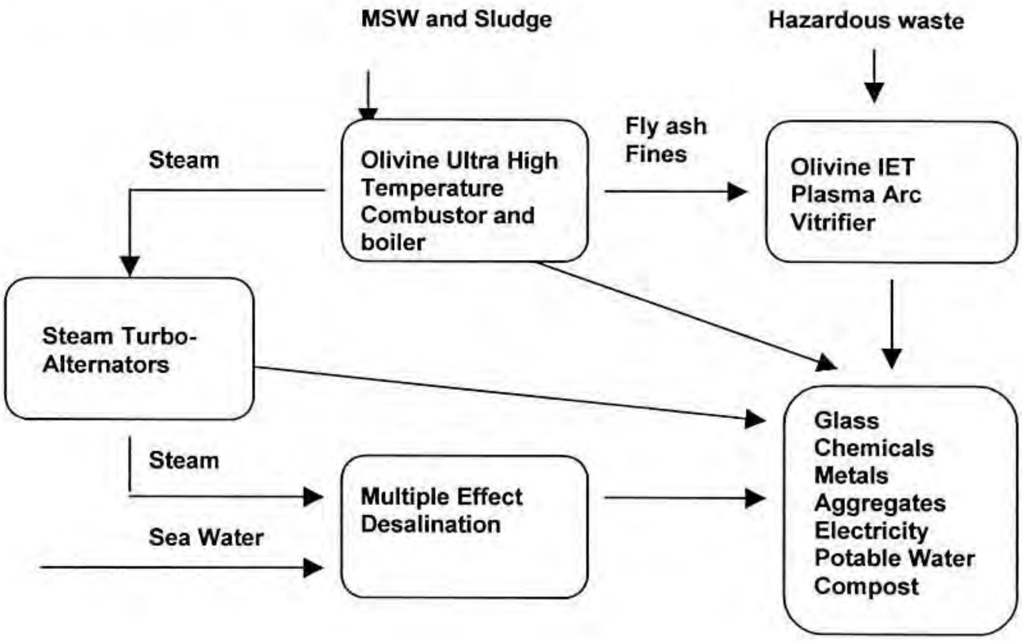
| | |
|---|---|
| 12 Ultra High Temperature Combustors | 1.2 million of MSW tonnes per annum |
| 4 IET Plasma Arc Vitrifiers | 100,000 tonnes per annum |
| 4 Turbo Generators | 780 GWh per annum |
| 8 Desalinator Chains | 29.2 million tonnes of water per annum |
| Water Bottling Plant | 350,000 tonnes of water per annum |
| Compost Plant | 88,000 tonnes per annum |
| Concrete Plant | 80,000 $m^3$ per annum |
| Bed Ash Aggregate Screening Plant | 220,000–260,000 tonnes per annum |

The proposal will also incorporate a metal recycling plant, a concrete plant and olivine panel manufacturing plant. The project components are discussed in detail below.

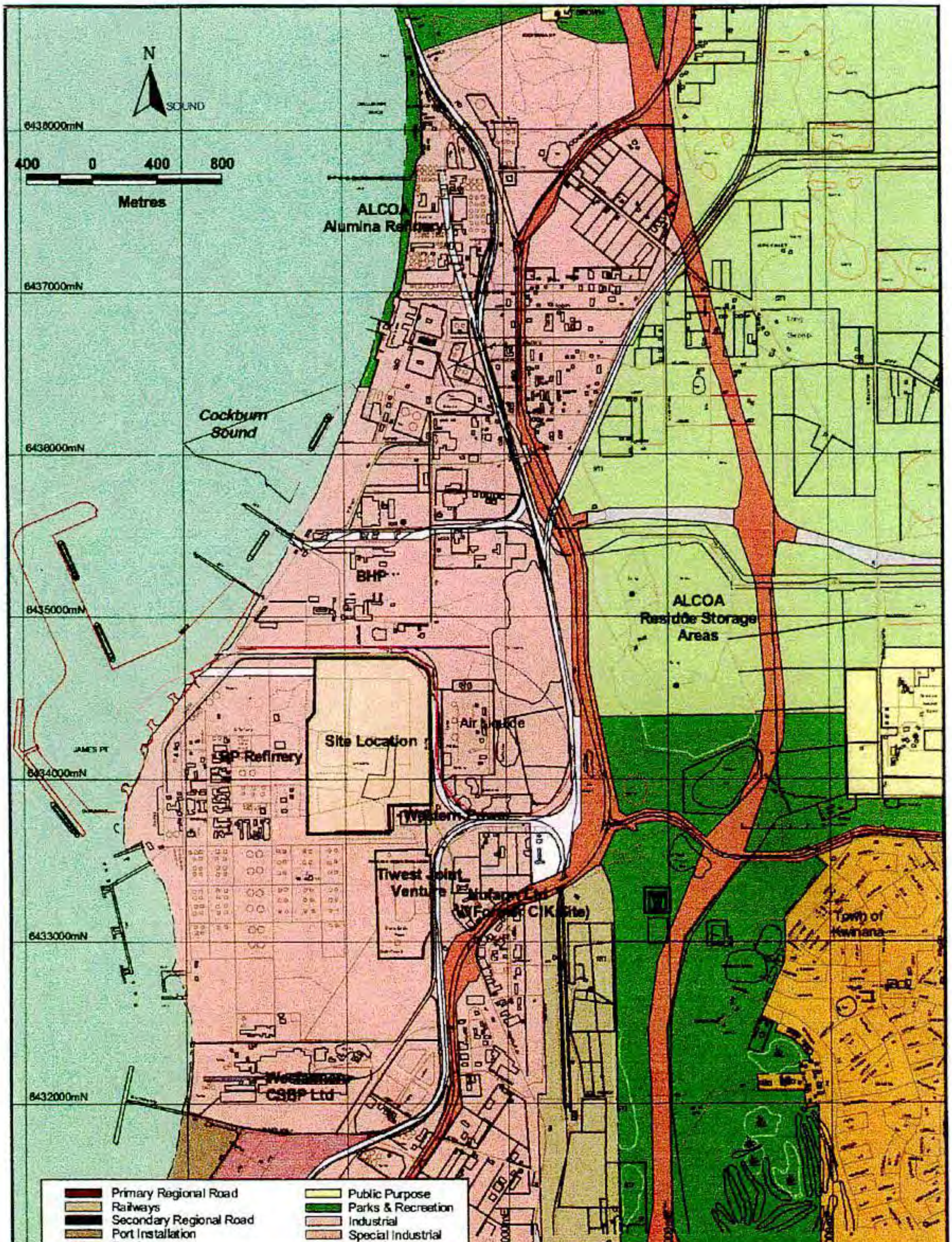
The facility will utilise the entire components of the domestic waste stream as a combustion fuel (60% - 70% of which is biomass) and will also process hazardous waste and soils from contaminated sites by way of vitrification. An overview of the process is as follows:

1. Domestic waste (MSW) is collected in the normal manner and taken to a transfer station where it is either loaded loose or compressed into cylindrical, 10 tonne containers.
2. MSW and de-watered sewage sludge is transported to the Kwinana facility by road. The facility will be designed to accommodate future rail access, although this is not proposed as part of this application.
3. At the facility, the containers and loose MSW is unloaded and stored within the WTE building.
4. Dewatered sewage sludge is also received at the facility in sealed containers (usually baled in plastic). This is fed into a separate containment system and fed into the combustors via a separate mechanism.
5. The fuel (MSW and sewage sludge) is fed into high temperature combustors and combusted. The heat is used to produce stream for driving the turbo generators. The exhaust heat from the turbines is then used to produce distilled water from sea water using the desalination units.
6. Combustion gasses are passed through various scrubbing processes which clean the gasses to meet the most stringent international emission standards.
7. The high temperature combustion process (1150 °C – 1100 °C in the fully mixed zone and 6 – 8 second residence time) produces two types of ash termed 'fly ash' and 'bed ash'.
8. The majority of the combustion ash is in the form of bed ash which settles at the bottom of the combustor. As a result of the high combustion temperatures, the bed ash is in the form a rock and coarse sand product which is screened, crushed and either sold as a low strength aggregate material or manufactured into a concrete construction product.
9. Fly ash is a fine 'flue' ash which is collected during the air scrubbing process and represents a small percentage of the total ash. Fly ash, bed ash fines, air scrubbing materials and dangerous goods are passed into the vitrifier and under extremely high temperature electric arc, are converted into glass which is moulded into useable products. This process also recovers hydrochloric acid, sulphur, mercury, copper, chromium, nickel, lead, zinc cadmium and arsenic.
10. Clean garden greenwaste, collected from transfer stations, is composted on-site via an enclosed composting process to produce a clean, uncontaminated compost product.

The process streams are summarised below:

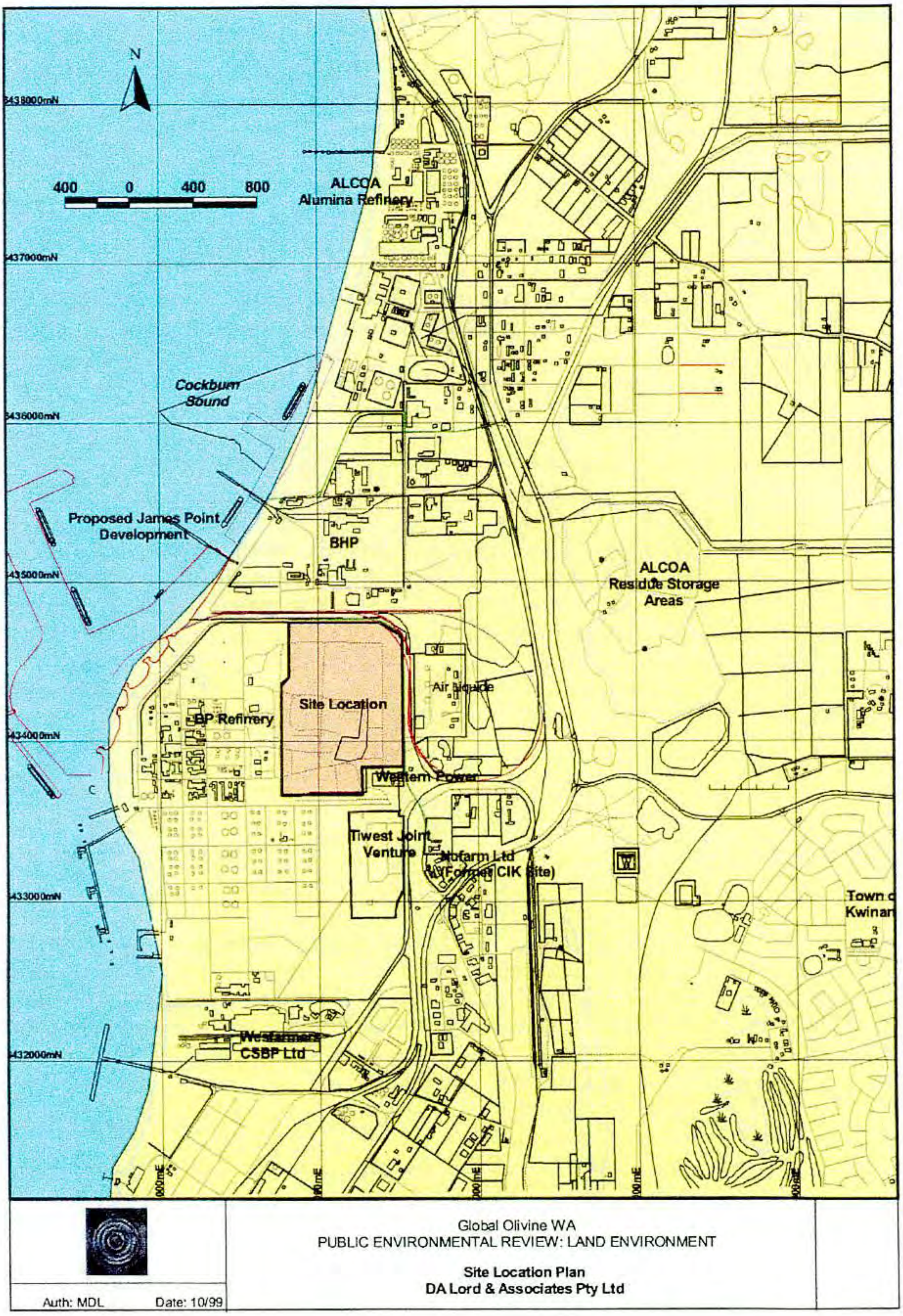


## *Figure 3-1. Land Zoning Metropolitan Regional Scheme 1999*




| | |
|---|---|
| Auth: MDL Date: 10/99 | Global Olivine WA<br>PUBLIC ENVIRONMENTAL REVIEW: WATER ENVIRONMENT<br>**Land Zoning (Metropolitan Region Scheme 1999)**<br>**DA Lord & Associates Pty Ltd** |

## *Figure 3-2. Site Location Plan*



## 3.3 PROJECT COMPONENTS

The key WTE&W project physical components are numbered on Figure 3-11 in numerical order.

### *3.3.1 Waste to Energy and Furnace Cover Building (1)*

A large waste to energy (WTE) building and two appended furnace cover buildings will be constructed within the northern section of the site to house. The attached buildings (combined total floor area of 31,200m$^2$) will house a total of 12 Ultra High Temperature Combustors (UHTC's), and store loose MSW, containerised MSW and belt pressed (off site) sewage sludge. The building will be constructed on a large concrete pad with a sloped floor and internal drainage system to prevent any potentially contaminated liquid escaping outside the building. All walls and roofing will be tightly sealed to prevent rain leakage and air escaping. The structure will also be acoustically designed to comply with the relevant noise regulations.

The building consists of three levels; a lower basement level for the ash rail tunnels and building duct work; an upper basement level for the storage of containerised MSW (see Figure 3-3); and an upper level for the storage of containerised MSW, loose MSW and sewage sludge (see Figure 3-4). The building has been designed to house up to 6,300 tonnes of containerised waste, approximately 6,000 tonnes of loose waste in bins and 900 tonnes of either containerised or plastic bailed sewage sludge. This equates to up to 6 days of waste storage on-site which will provide for any plant failure scenario, apart from a force majeure (see "Plant Duplication" below). The lower basement, upper basement and upper level are shown on Figure 3-5 and on Plan PL200 (attached on Appendix E).

The building is designed to provide direct truck access to the upper basement and upper level to allow containerised MSW, loose MSW and sewage sludge to be unloaded within the building itself. All trucked containerised waste will be unloaded in the upper basement level into specifically designed container storage areas. This containerised waste will be transferred to the upper level storage area by way of one elevator for each UHTC (refer Appendix E, Plan PL201). All loose MSW, tyres and baled or containerised sewage sludge will be unloaded within the upper building level. All waste is fed into the UHTC on the upper level.

Appended to each side of the WTE building are two separate furnace cover buildings which are designed to insulate the UHTC heat from the main receival halls. Each furnace cover building will house one separate plants comprising 6 UHTC's (12 UHTC's in total). This allows for each plant (6 UHTC's) to operate totally independently. Each UHTC is also able to be shut down independently without affecting the plant operation.

Each UHTC within the furnace cover building is connected to the WTE hall via a feed chute. Each UHTC feed chute is located opposite one containerised storage bay (with elevator) and three loose MSW storage bays within the upper level of the WTE building (refer Figure 3-4).

The combustors located within the building require large primary and secondary intake fans which will be in continual operation to ensure a negative internal air pressure which will continually suck air through the main doors into the combustors to preclude odour escape nuisance.

***Figure 3-3. Upper-Basement WTE Building - Garbage Container Unloading Hall***

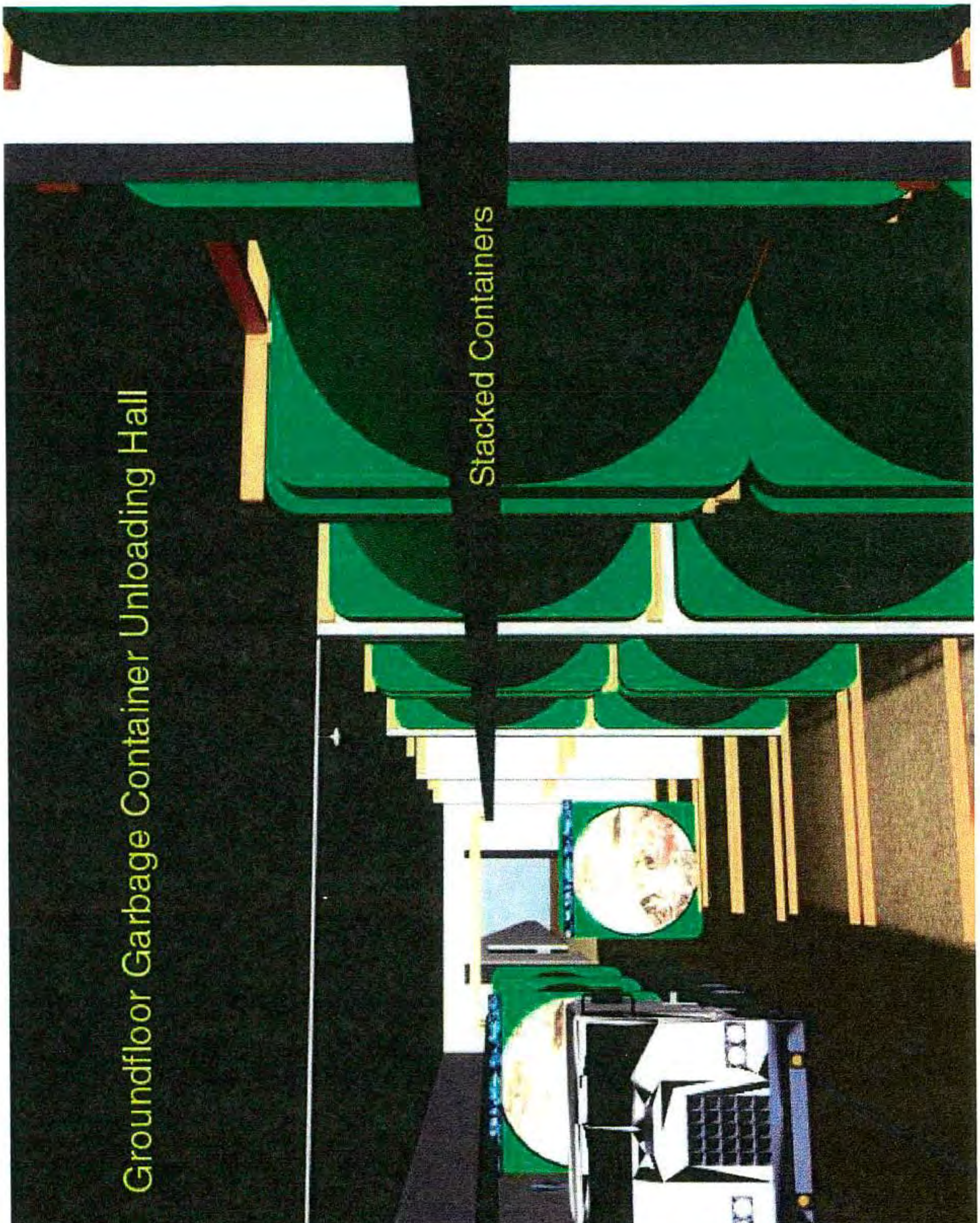


***Figure 3-4. Upper Level WTE Building - MSW Storage and UHTC Feed Hall***

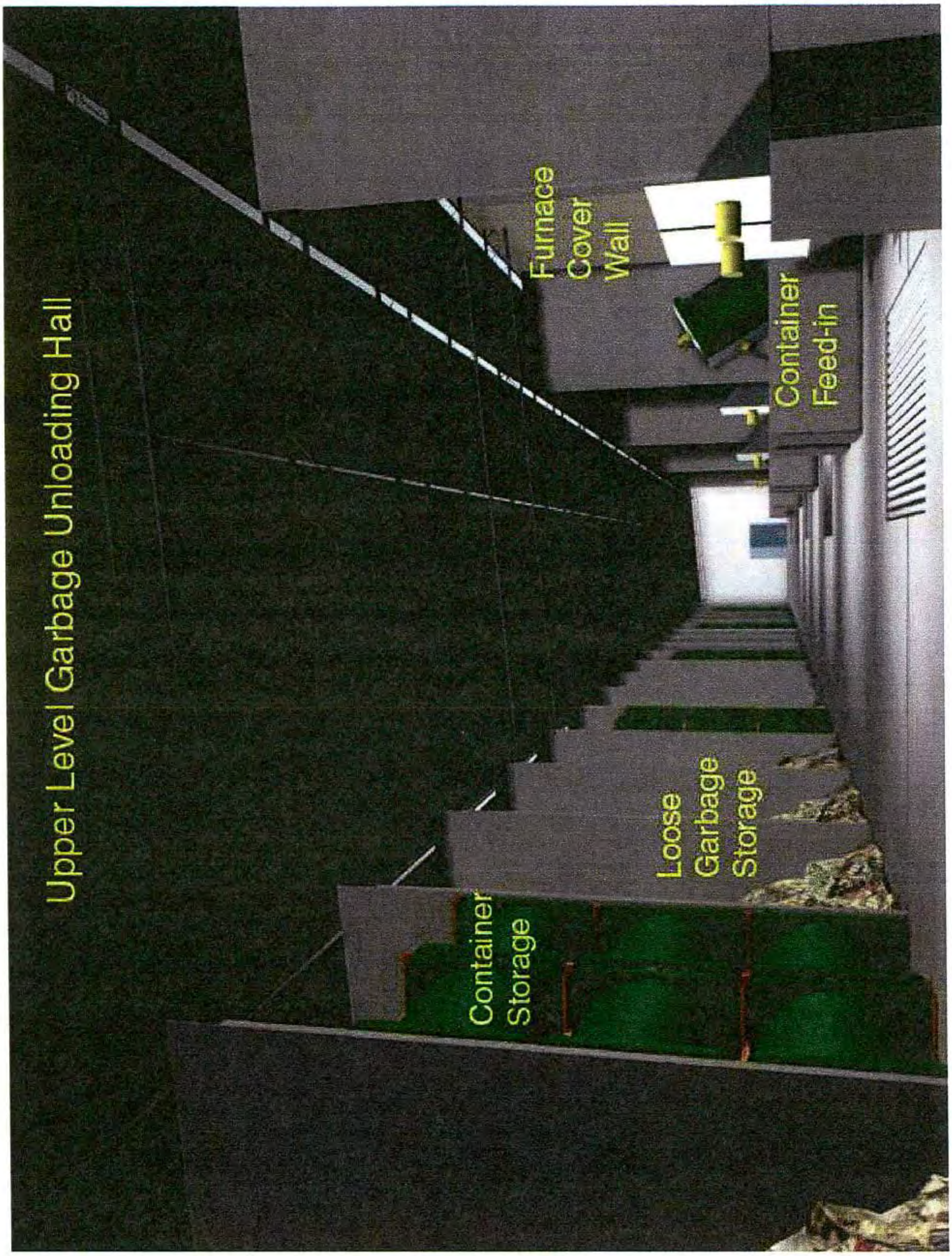
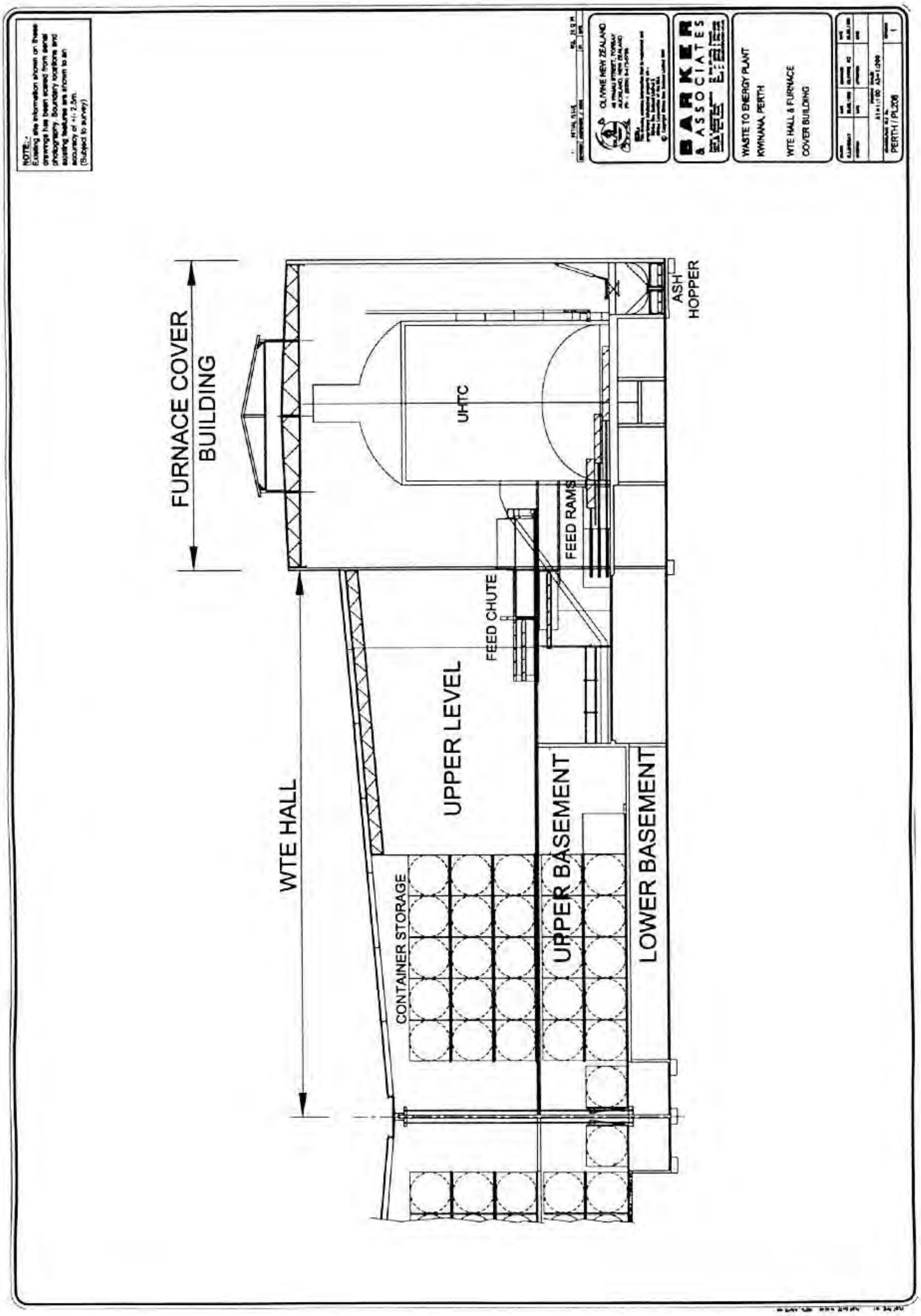


Figure 3-5. Cross Section showing One Side of the WTE Building and One Appended Furnace Cover Building



### 3.3.2 *12 Ultra High Temperature Combustors (2)*

It is proposed to establish a total of 12 Olivine Ultra High Temperature Combustors (UHTC's). Each side of the building is a discreet separate plant with 6 UHTC's. Each plant and each combustor within that plant will operate independently to process the MSW fuel into heat and bed ash aggregate.

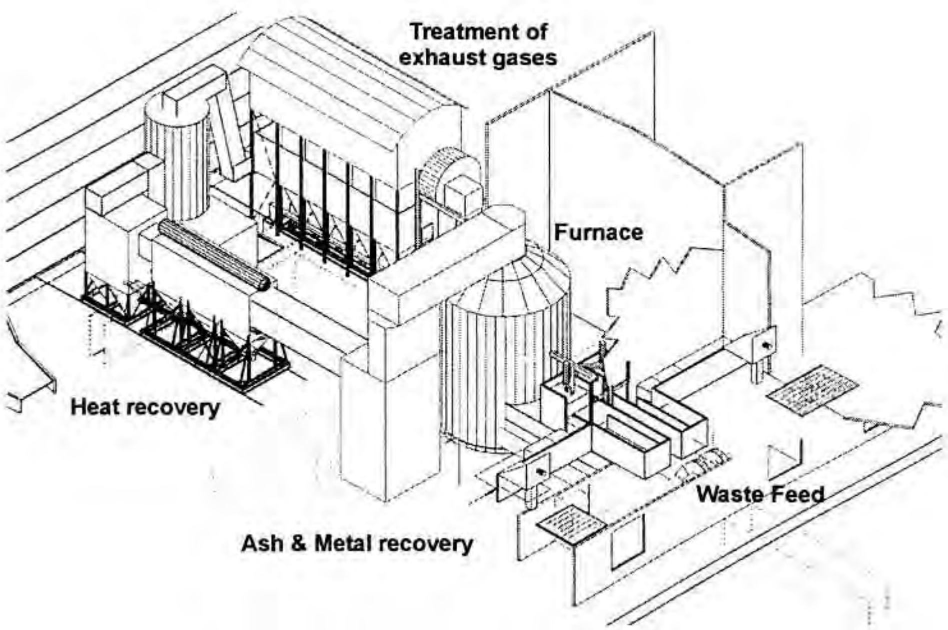
Each UHTC is designed to achieve the following:

- Hourly average capacity of 11.95 tonnes;
- Daily average capacity of 287 tonnes;
- Yearly average capacity of 104,000 tonnes; and
- Hourly average gross electrical output of 7.48 MW per UHTC chain.

Figure 3-6 shows one UHTC including waste feed and gas treatment. A total of 12 UHTC's will process an average of 1.2 million tonnes of MSW per annum. Each unit has the ability to operate at a level 20% higher than average or 20% lower than average. This allows for load following the peak and non-peak power use periods during each day. It also allows for two combustors to be shut down for maintenance without affecting the daily average MSW throughput but with some effect on modulation ability.

Each UHTC will produce an average of 57 tonne of bed ash per day and 5.6 tonne fly ash (and waste lime) per day. Bed ash is transported by underground railcar to the ash screening plant for crushing, washing and screening for use as aggregate. Fly ash will be conveyed by underground rail cars to storage hoppers for vitrification. Plan PL 300 (Appendix E) shows the site tunnel layout.

***Figure 3-6. UHTC***



### 3.3.3 *4 IET Plasma Enhanced Melters(3)*

GOWA is proposing to install four Plasma Enhanced Melters (PEM™) to be supplied by Integrated Environmental Technologies (IET) LLC (USA). IET plasma enhanced vitrifiers are currently in commercial operation in the USA.

Plasma Enhanced Melters, a form of vitrifier, are effectively large molten glass pools which operate at extremely high temperatures to destroy all hazardous organic compounds and melt the residual base elements into a glass and metal melt. Plasma arc technology has been added to the IET vitrifiers to speed up and ensure the destruction of organic material. Plasma arc technology produces extremely high temperatures (6,000°C), reactive radicals and intense ultraviolet light, all of which result in rapid and complete conversion of organic material to its fundamental atomic constituents which then recombine predominantly into hydrogen and carbon monoxide. Once passed through the plasma arc zone, the material is held in a large two layered molten pool comprising glass and a mixed melt of metals for use in making stainless steel. These are then tapped off into glass products and metal ingots.

Each vitrifier will have the capacity to process an average of 70 tonnes of fly ash and hazardous waste per day. Approximately 100,000 tonnes of waste (primarily fly ash) will be processed per annum into useable glass products. The vitrification process will also produce elemental chemicals for recycling and various elemental metals. The vitrifier process has a small off-gas volume compared to the combustion process which will pass through specifically designed cleaning units and this cleaned gas (effectively a high calorific value synthesis gas) is returned to the combustors as a fuel.

Figure 3-7 shows a PEM™ schematic and examples of glass products.

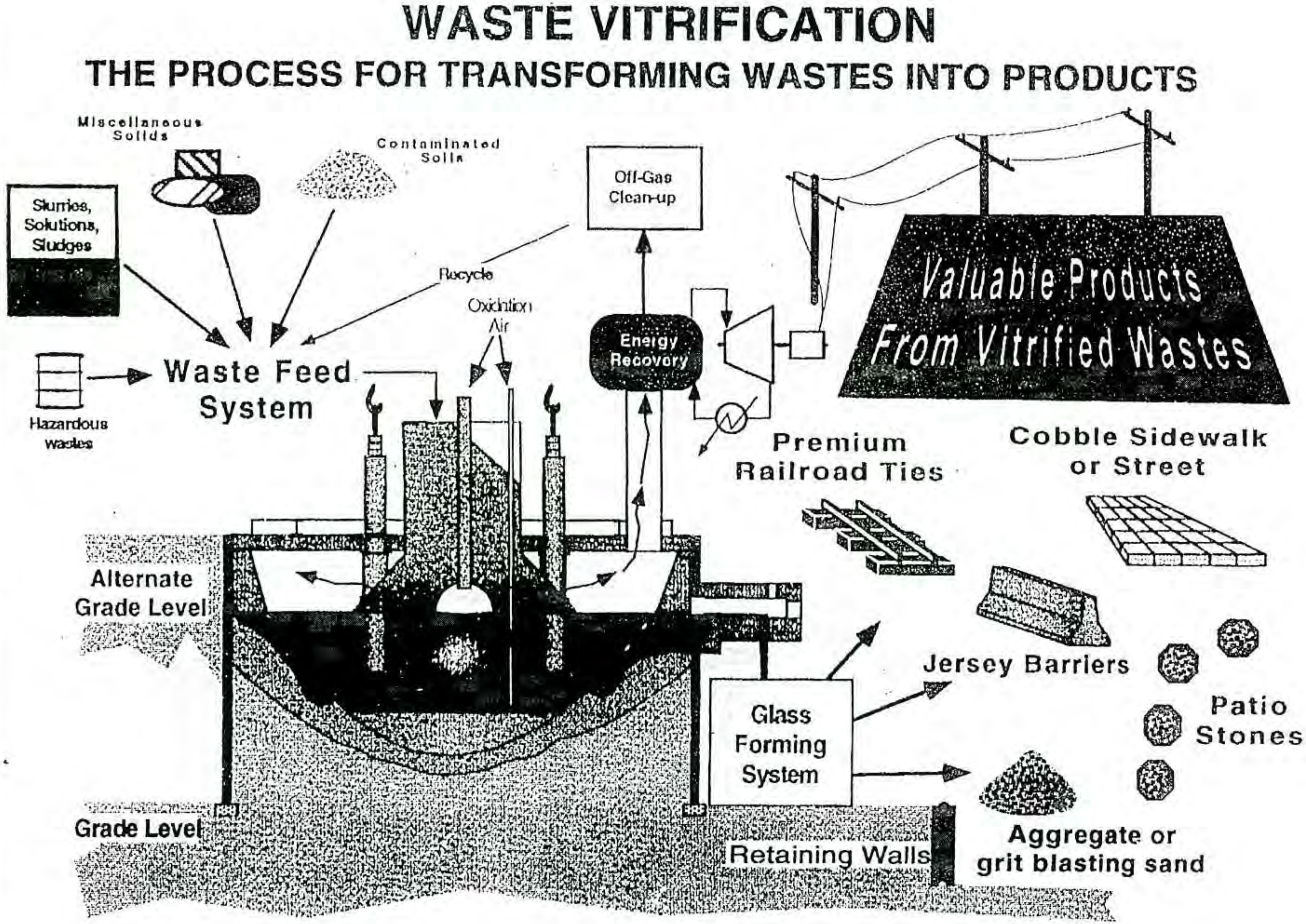



Figure 3-7. Waste Vitrification

Energy, Water & Materials from Waste & Biomass Resources

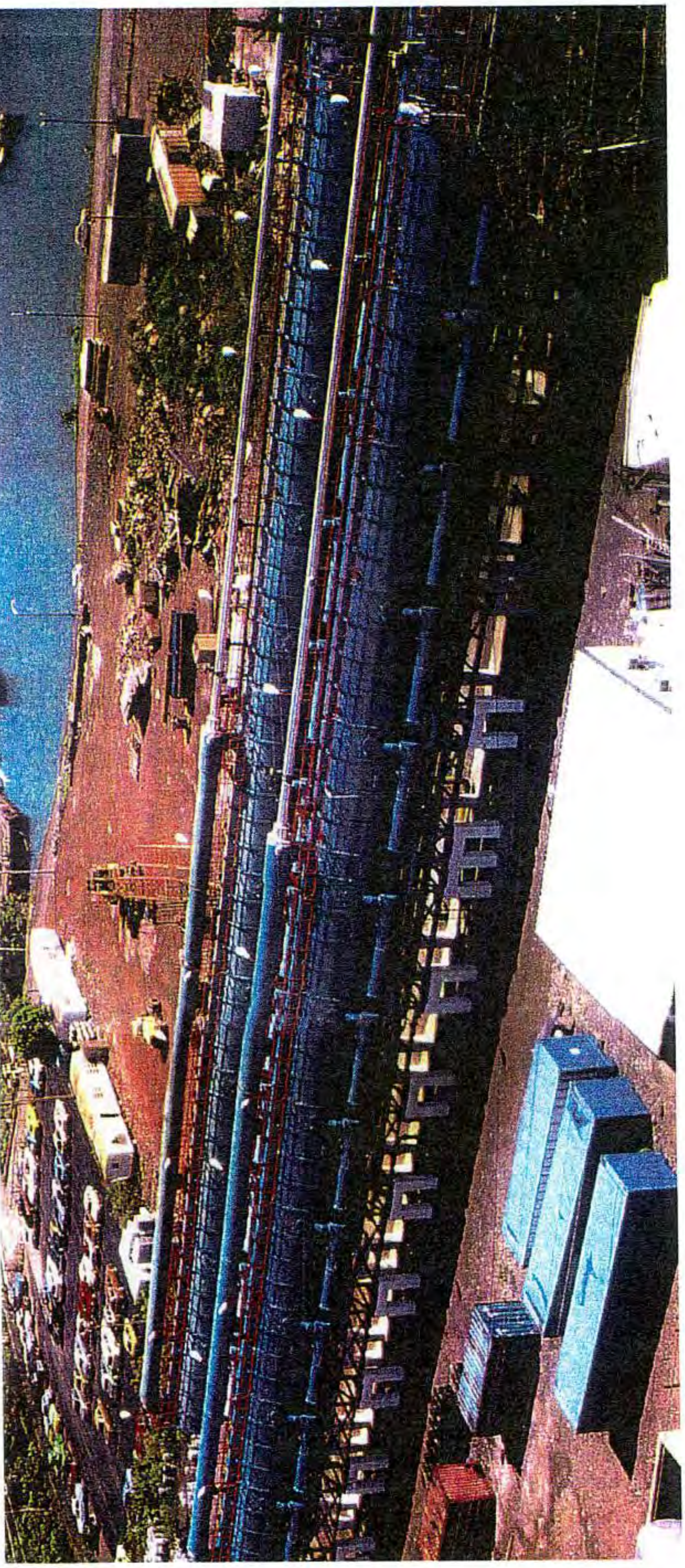
### 3.3.4 *4 Turbo Generators (4)*

Four standard turbo alternators will be established within a separate turbine hall located between the WTE building and the desalination plant. Each alternator has a capacity to produce up to 30 MW providing a peak capacity of 120 MW and a yearly output of 780 GWh. Based on the daily generation gross electrical output of each UHTC (7.48 MW), the four turbo alternators will produce an average of 90 MW with a peak capacity of 120 MW. The waste turbine steam will be tapped directly into the desalination units for the production of water.

### 3.3.5 *8 Multiple Effect Desalinators (MED's) (5)*

It is proposed to establish a total of 8 MED units on-site to utilise the waste heat from the post combustion process. Each MED has the capacity to produce up to 12,500 tonnes of desalinated water per day with an average daily production of 10,000 tonnes. Based on a total of 8 MED's, an average total of 29.2 million tonnes of water could be produced per annum. Figure 3-8 shows a typical MED unit in operation.

*Figure 3-8. Photo of MED Unit*



### 3.3.6 *Water Reservoir (6)*

Two water reservoirs will be constructed alongside the MED units. One as a buffer reservoir from which water is pumped into the mains. This reservoir will have a total capacity of 38,000 tonnes, allowing for one MED chain to be shutdown for three days for maintenance without effecting water supply capacity. The second reservoir will be constructed in four separate compartments to allow for water treatment testing and reservoir cleaning.

### 3.3.7 *Water Bottling Plant (7)*

A water bottling plant will be sited alongside the water reservoirs with the capacity to pack or bottle up to 1000 tonnes of water per day.

### 3.3.8 *Compost Plant (8)*

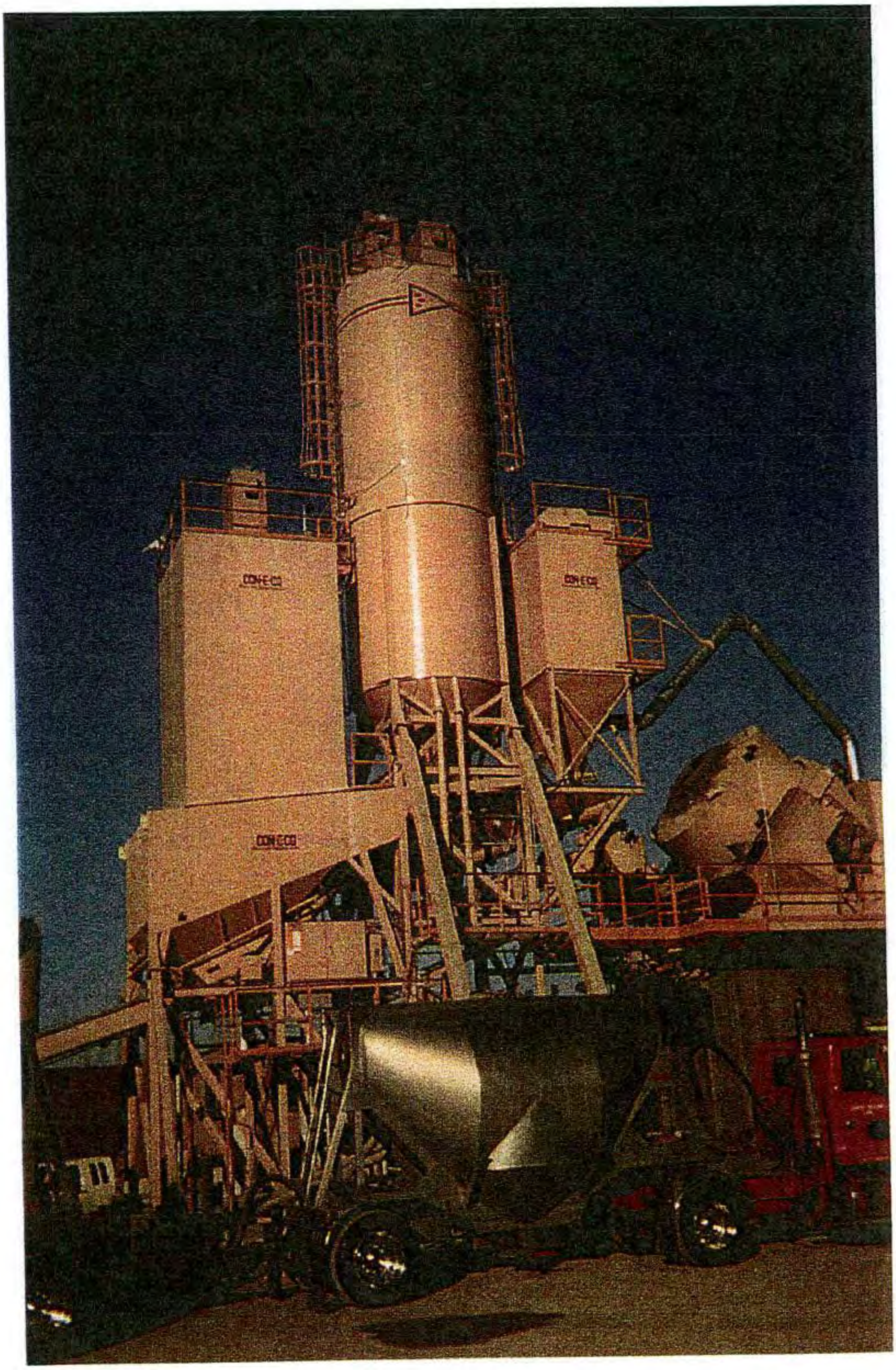
An enclosed composting facility will be constructed on-site to process clean green waste (limited to pure vegetative matter). In the first stage of development, it is expected that up to 56,000 tonnes of green waste per annum will be processed, equating to approximately 30,000 tonne of compost per annum. It is anticipated that the greenwaste volume will increase to approximately 100,000 tonnes per annum after a period and will necessitate the construction of an additional compost building (subject to any necessary further approvals). Figure 3-9 shows an compost plant, similar to that proposed at Kwinana. Plan PL204 (Appendix E) shows the generic compost plant design.

***Figure 3-9. Typical Compost Plant***

### 3.3.9 *Concrete Plant (9)*

A proprietary packaged concrete plant manufactured by CON-E-CO Ltd will be established on-site to provide necessary construction products during the WTE&W plant construction period. Once construction is complete, the plant will be utilised for the construction of concrete products from MSW aggregate and imported basalt. The concrete plant will also be utilised for the construction of Olivine panels using Olivine mineral product imported from the USA. It is proposed that the Olivine mineral will be imported to the site by the back-loading of alumina ships and an on-going refractory business will provide product for all Pacific and Asian plants. It is anticipated that this will be the source of substantial export earnings for Western Australia. A typical CON-E-CO unit is shown as Figure 3-10.

***Figure 3-10. CON-E-CO Unit***



### *3.3.10 Dangerous Goods Store (10)*

A large dangerous goods store will be established on-site to store dangerous materials which will be destroyed in the vitrifier and which are required for plant operation. A conceptual plan of the dangerous goods store and good departments is shown on Plan PL202 attached as Appendix E.

### *3.3.11 Containerisation System*

In order to facilitate the safe, convenient and cost-efficient transportation of bulk refuse, a compaction and containerisation system has been developed as part of this project. It has been designed according to the principles evident in a number of similar systems operational throughout the world.

The WTE&W plant is configured to accept bulk refuse in any form, ie. directly from collection contractors' vehicles (with loads of over 4 tonnes) and compacted containers from transfer stations.

The proposed containers are light steel cylindrical units, able to be transported by rail, barge or road. Each transfer station (including existing facilities, which can be simply modified), will be equipped with a container filling and compacting unit. Each container holds approximately 10 tonnes of MSW. This system makes the scheme available to the total region with an overall net reduction to road transport usage.

The containers have been designed to ensure no loose debris can escape during transportation. The narrow end of each container will be located at the rear of each truck trailer and sealed with a steel rotational flap. The largest end of each container is sealed with metal bars and a tightly fitting locking canvass flap. The container design is shown in a Plan attached within Appendix E.

*Figure 3-11. Plant Components*

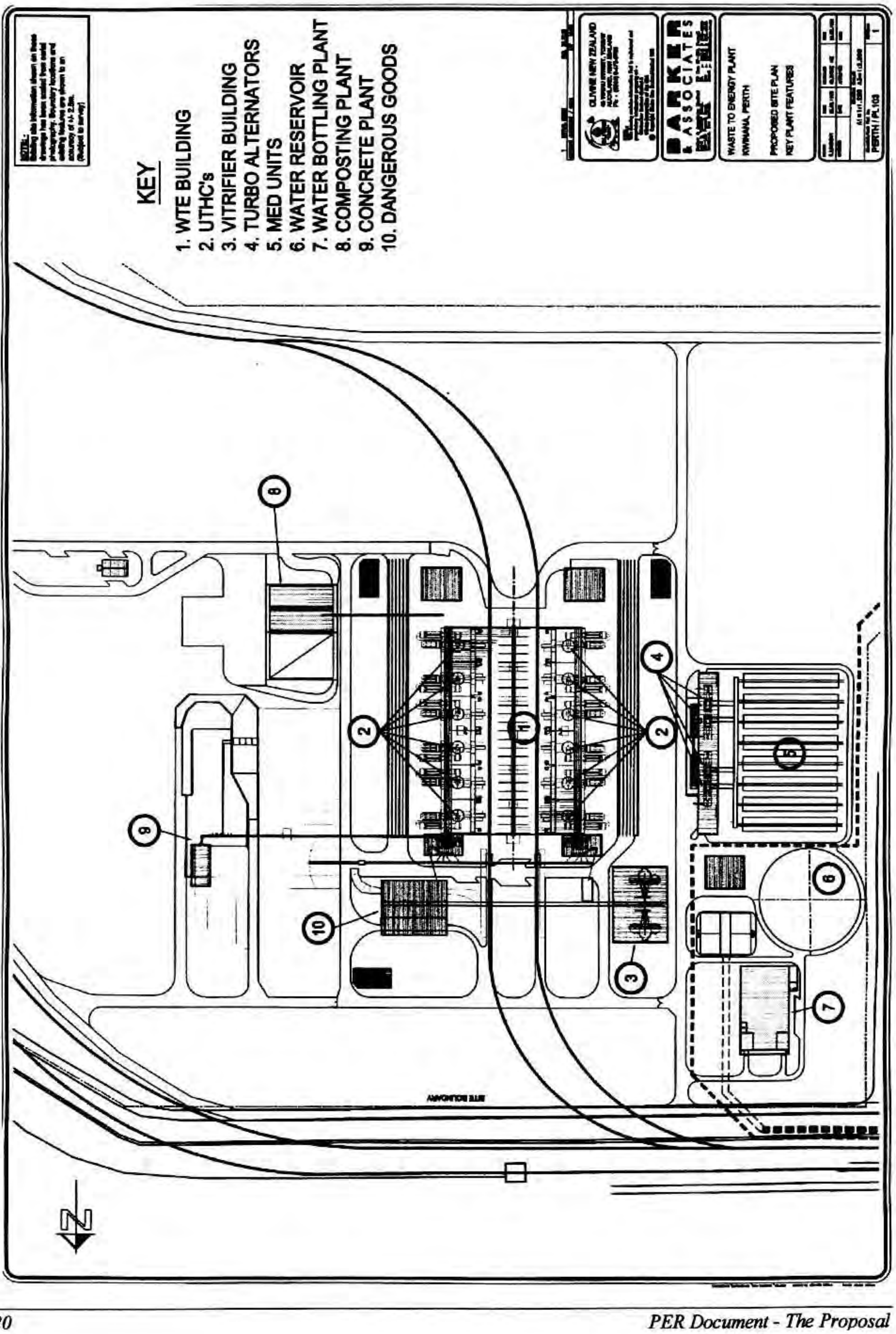


*Figure 3-12. Plant Components Illustration*

### 3.3.12 *Water Intake and Discharge Structures*

The GOWA development will require cooling water drawn from Cockburn Sound at a maximum rate of 4.2 $m^3/s$. Approximately 80% of the water taken will be returned to the Sound via a discharge channel leading to a shoreline discharge, the other 20% will be used by a desalination plant in the production of desalinated water. The return water will be slightly denser than the receiving water of Cockburn Sound.

At this stage there are two options for the proposed water intake. The GOWA development is to be located on the north side of James Point, Kwinana, Western Australia. The preferred option will be to source the intake water by pumping directly from Cockburn Sound. It is envisaged that an inlet will be sited to the north of James Point in a location chosen through negotiations with James Point Pty Ltd (JPPL), possibly under the existing BHP No. 2 jetty as shown on Figure 3-13. If the preferred option is found to be flawed on technical or commercial issues, then GOWA will seek to source intake water from the existing British Petroleum (BP) Refinery intake under agreement with BP. This will be subject to further negotiation between GOWA and BP on commercial aspects.

BP have provided preliminary advice that there should be adequate capacity in their existing intake system to accommodate GOWA's requirements and that they may be amenable to GOWA obtaining cooling water in this fashion. However, preliminary investigations have indicated that the use of BP's cooling water intake may result in technical problems. Any use of the BP inlet will require detailed technical analysis and further negotiation between GOWA and BP on commercial aspects.

GOWA have undertaken extensive inlet design work in collaboration with the University of Waikato, New Zealand for their proposed New Zealand plant. As a result of this work, it has been found that an inlet velocity of 1 $ms^{-1}$ will prevent entrainment of smaller fish species (e.g. whitebait). GOWA will design the intake to meet this lower (0.25 $ms^{-1}$) intake velocity criteria. Furthermore, the inlets will be continually protected through a double screen system, with one screen in place at all times. These screens will be lifted and cleaned on a regular basis.

The intake will lead to a large holding pond onsite, the pumps taking this water from the pond will also be screened. This provides further opportunity to remove any fish entrained.

GOWA will commit to undertaking a post-commissioning study which measures the actual velocities in the vicinity of intake structure. The results of this study will then be presented to the DEP. Should it be found that the velocities are greater than the design criteria, GOWA will prepare and implement a plan to rectify and problems with fish entrainment.

The cooling water will discharge to the shoreline via an open channel running west along the northern boundary of the plant heading directly into Cockburn Sound. There is an existing channel and drain to Cockburn Sound along this route and this will be used if feasible.

JPPL have a proposal (JPPL, 1999) to construct a port in stages at James Point over the next five to fifteen years. At present it is intended that the cooling water discharge scheme shown on Figure 3-14 will be incorporated in the final stage of the port development. The scheme assumes that the GOWA discharge will be combined with the discharge from BP when the development occurs. The final location of the discharge and the combination with BP's discharge will be subject to further negotiation between GOWA, JPPL and BP over the next five to ten years.

*Figure 3-13. Cooling Water Discharge and Inlet Locations (pre-James Point development)*

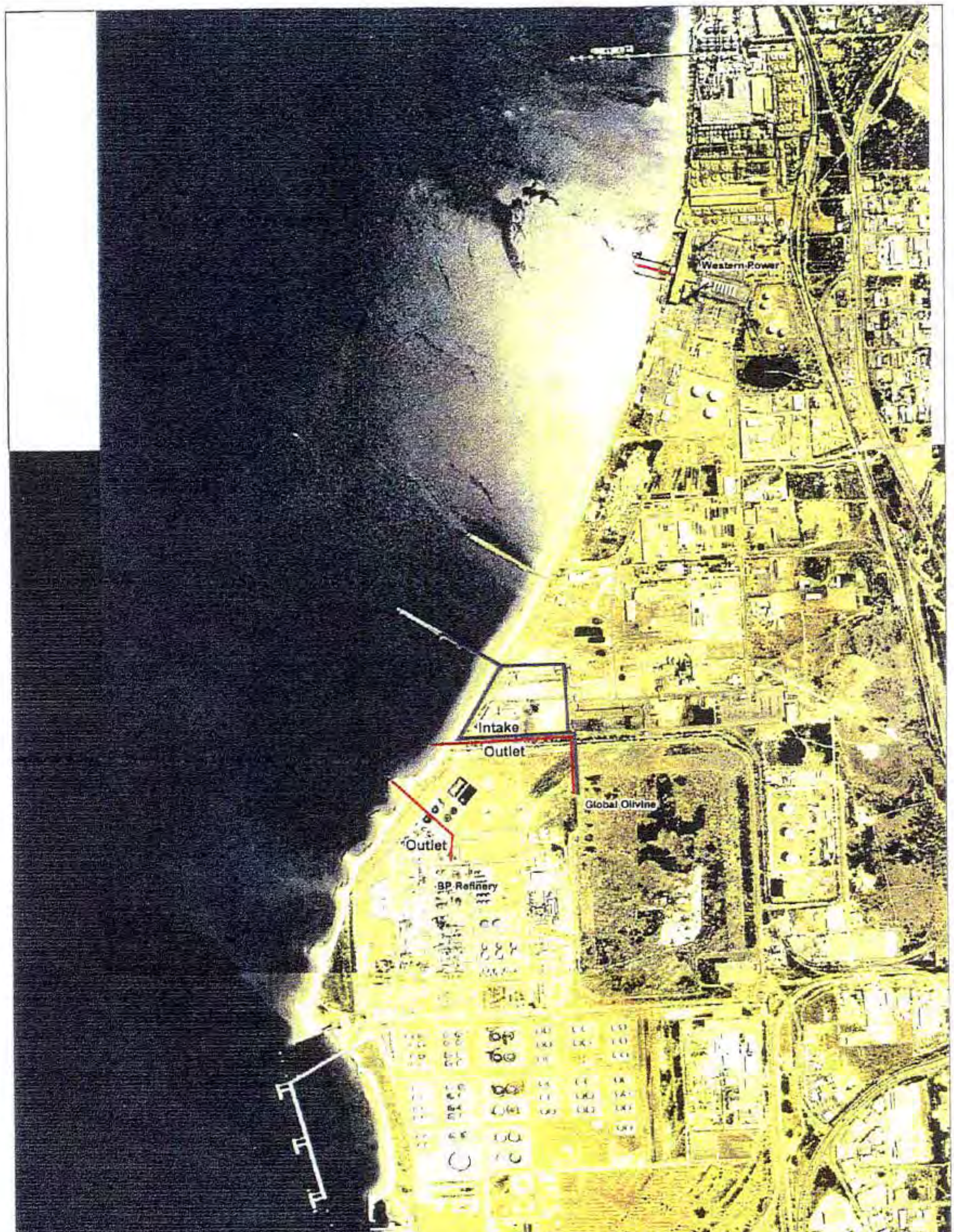
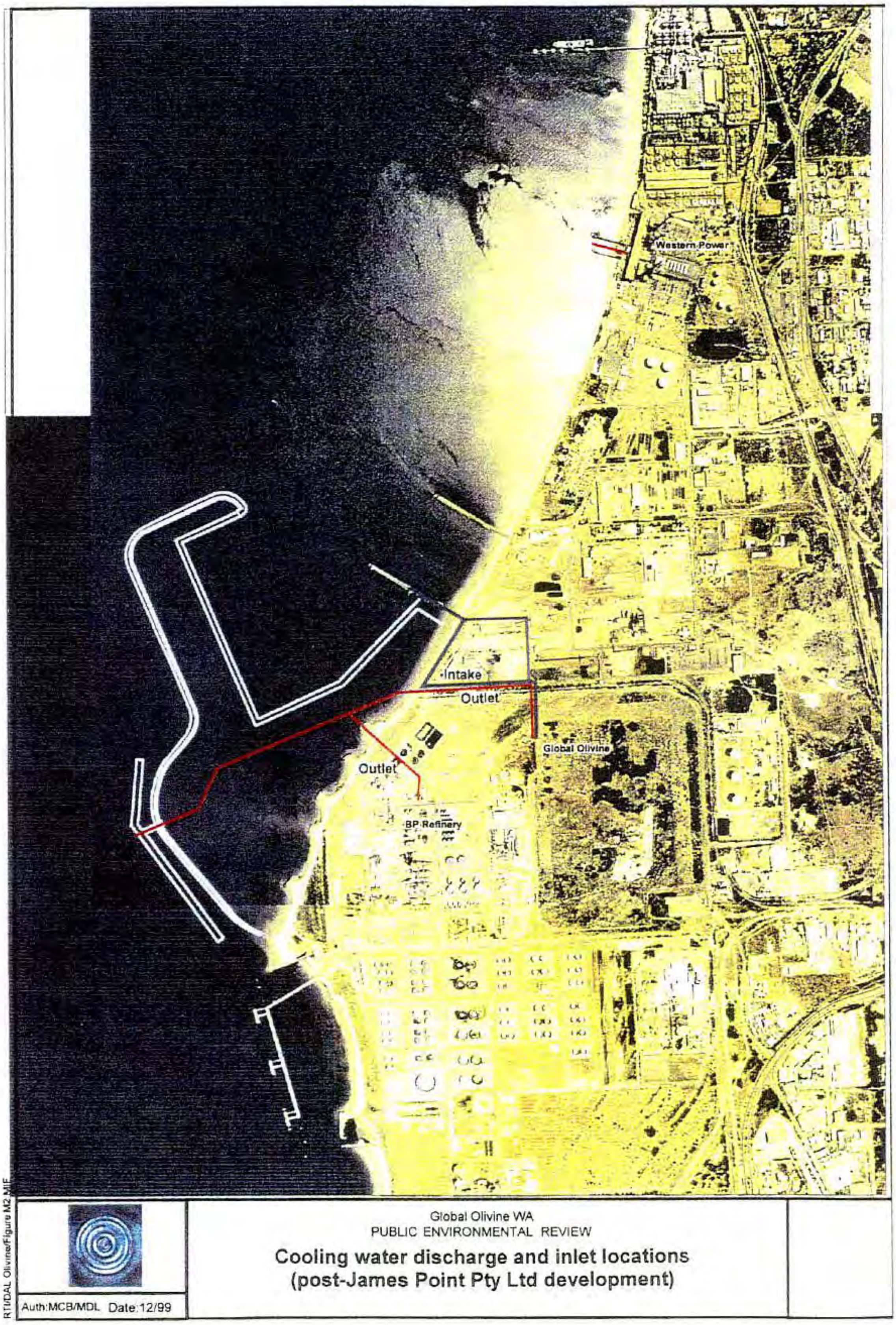


*Figure 3-14. Cooling Water Discharge and Inlet Locations (post-James Point harbour development)*



### *3.3.13 Stormwater Management*

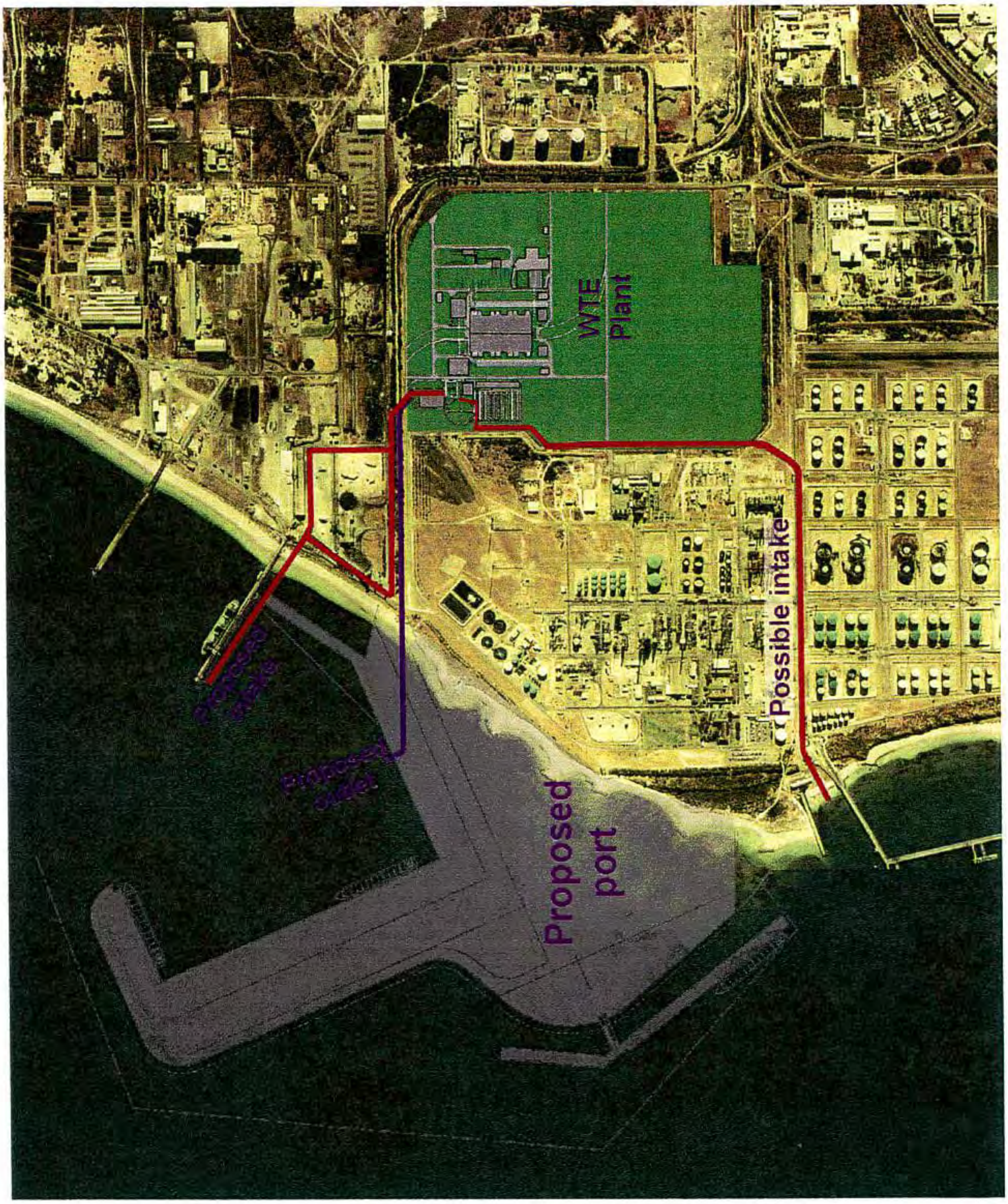
Stormwater drainage systems will be established to ensure that surface water is managed to prevent the discharge of contaminated water from the site or to groundwater. The stormwater management techniques are detailed in Section 10.3.12. Site stormwater management plans are attached as Appendix F.

### *3.3.14 Roading and Access*

For the purpose of this application all MSW deliveries and goods transport will be by way of either single unit, semi-trailer and B-double trucks. The B-double vehicles will be restricted to the declared heavy haulage routes as they make their way from their origin to the plant. A maximum of 169 truck visits per day will be generated by the proposed WTE&W plant as detailed in the site traffic table attached as Appendix L. The main plant access as shown on the general site layout plan (Plan PL101 Appendix E) has been situated a sufficient distance from the curve in Mason Road to provide adequate sight distances. To provide for all traffic movements from the south (into the site) a left turn entry lane will be provided in accordance with the Town of Kwinana and Austroad requirements.

The site layout has been designed to provide for future rail access to the site if required. This will be discussed with the relevant authorities and any necessary approvals will be sought if rail transportation to the site is pursued. The plant layout is shown on Figure 3-15.

*Figure 3-15. Overall site layout post James Point*



## 3.4 PROJECT DUPLICATION

As indicated above, the WTE&W plant has been designed as two separate plants each comprising 6 UHTC's. Both plants have also been designed to allow each UHTC to be operated and shut down separately. In each plant one UHTC is redundant to allow for cycle maintenance. Unplanned maintenance allows for two of the 12 UHTC's to be down at one time while still combusting the contracted MSW and supplying the contracted power by winding the remaining units up to peak capacity.

The plant is also designed to allow any component to be replaced within three days, inclusive of boilers and baghouses. The site contains two permanent boiler workshops with spare boilers and a cross railway to allow for the convenient removal of boilers and baghouses. This allows boilers and baghouses to be removed and replaced with a substitute while maintenance occurs. The baghouses themselves have 10 individual compartments. Each compartment can be isolated to enable replacement of bags without shutting the UHTC down. If more than two units were non-operative for a three day period (force majeure), catch up can be achieved very quickly on restart by winding up all the units (refer Appendix K – Modulation Table)

All fans, electrical systems, bed ash railways, gas scrubbing systems and spray nozzles are duplicated so the maintenance or replacement can be undertaken without requiring to shut down the UHTC. This same principle of duplication applies to the bed ash screening plant and vitrifiers.

The main turbine hall, power reticulation and steam reticulation are all "looped" and "ranged" which allow for the isolation and repair of anyone unit without affecting the plant operation. Each separate plant (6 UHTC's) is also ranged and looped separately to allow for plant isolation.

The turbine hall has been designed so that only three turbines are required to handle the daily capacity of the plant. The fourth turbine is available for required maintenance or load following.

The MED plant consists of eight chains with an average daily production of 10,000 tonnes. To allow for maintenance, the reservoir has three days storage for one MED unit to allow for maintenance without affecting water supply.

A "black start" gas turbine generator will be started in the event of a complete power failure to provide the total auxiliary load of the plant. The MED plant provides a limitless supply of boiler water which would allow for 'steam dumping' in the event of a total grid failure. This enables continued MSW throughput without exporting power.

The vitrifier power use of 7-9 MW may be switched of instantly for periods up to 24hrs without any restarting complications. This allows for surge demand servicing of power to the grid (ie. instant spinning reserve).

In summary, a total failure of both plants is impossible while a failure of more than one individual UHTC unit is highly unlikely. Any failure is unlikely to affect the capacity of the plant to process waste and ensure that emissions comply with all listed commitments (see also 3.15.8 MSW Plant System Safety Features / Breakdown Procedures). For the above reasons the outputs of the plant are completely insurable as confirmed in the letter from Aon International Insurance Brokers attached as Appendix G.

## 3.5 PROJECT INTERGRATION

There is a pressing need for an integrated solution to the region's bulk refuse disposal problems. It requires cooperation by territorial local authorities, a reliable, cost-efficient, environmentally sound bulk disposal method and infrastructure involving strategically located transfer stations and the integration of transportation systems. It also requires the integration of current and future recycling activities and the ability to deal with domestic, industrial and commercial refuse and sewage sludge in a manner that precludes waste, by recycling and using wastes as a raw material and energy source for other valuable marketable products.

The GO Western Australia proposal for the establishment of the WTE&W project addresses these needs with a comprehensive waste management solution which closes human waste stream loops.

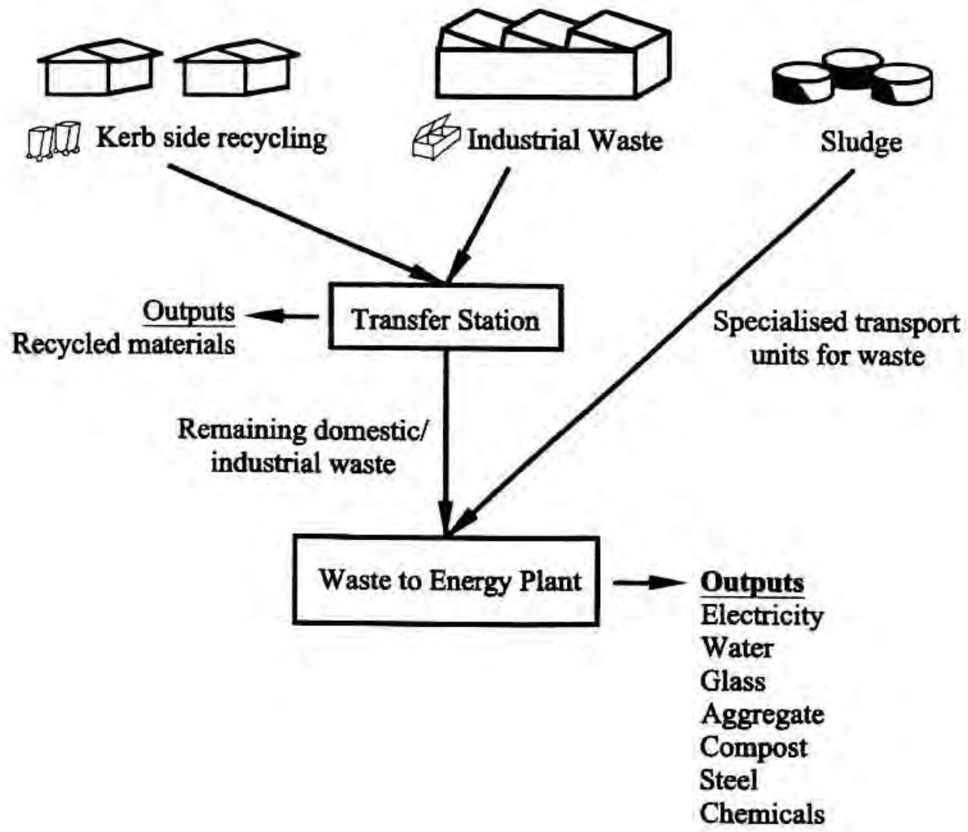
A fundamental principle of the GO Australia WTE& W project is its integration. An assessment of refuse management systems and infrastructure for Western Australia has resulted in the development of a comprehensive development plan. This plan provides for the modification of existing transfer stations and establishment of new transfer stations where required to containerise transportation. Recycling and clean fill operations are also integrated with the operation of these transfer stations. All aspects of the site operation are integrated with associated by-product industries, producing valuable glass products, concrete products, metal and acid recovery along with biomass energy and clean water.

The key components of the integrated scheme are:

- Establishment of the WTE&W plant.
- Institution of a compaction/containerisation system for transfer stations.
- Transportation system.
- Transfer station design assistance for local bodies and waste companies.
- Integration with recycling operations.
- Integration with cleanfill operations and composting.

The integration of the project is summarised below.

*Figure 3-16. Project Integration*




## 3.6 PROJECT TECHNOLOGY

The ONZ system is an integrated cluster of technologies which process municipal and industrial solid wastes, sewage sludges, hazardous wastes and green waste. The outputs from this process are electrical power; potable water from seawater; recovered metals; recovered chemicals, aggregates, glass products and compost.

There are four key technology components being:

- Ultra High Temperature Combustors;
- IET Plasma Arc Vitrifiers;
- Steam Turbo Alternators;
- Multiple Effect Desalinators and water plant; and
- Compost Plant.

All of these basic components are currently in commercial operation internationally. The features of each component are summarised in the following table:

*Table 3-1. Technology Features*

| Technology | Features |
|---|---|
| **Olivine Ultra High Temperature Combustor (UHTC)** | • Very high average gas temperature: 1150 °C – 1100 °C;<br>• Long gas residence time at high temp: 6 to 8 seconds;<br>• Extremely thorough gas mixing in a highly turbulent second combustion zone;<br>• Both high and low temperature gas scrubbing;<br>• Activated carbon flue gas polishing;<br>• Low construction and maintenance cost;<br>• Proven technology: 400 similar combustors world wide;<br>• Waste processing is more than competitive with modern landfill costs;<br>• Ferrous and non ferrous metals recovered;<br>• Graded aggregate recovered; and<br>• Responsible fly ash disposal by vitrification. |
| **IET Plasma-Arc Vitrifier** | • Extremely high processing temperature: 4000°C – 6000 °C;<br>• No direct emissions to air;<br>• Chemicals retrieved from off-gas: Mercury, Sulphur, Hydrochloric acid, Lead, Zinc, Cadmium, and Arsenic;<br>• Metal retrieval: An alloy of nickel, chromium, copper and iron; and<br>• High quality glass output: used for making tiles, etc |
| **Steam Turbo-alternators** | • Standard off-the-shelf technology; and<br>• Generates low cost electricity. |
| **Multiple Effect Desalinator (MED)** | • Uses waste heat from turbo-alternator exhaust;<br>• High quality water output - 20 to 50 ppm dissolved solids; and<br>• Low maintenance costs. |
| **Compost** | • High quality compost from clean green waste. |

The advantage of the Olivine system is the integrated nature of the technology components, which results in a 'closed loop' waste processing system. The major feature is that all physical outputs from the waste treatment process have a market value and consequently there is no need for a landfill. This is summarised in Figure 3-17.

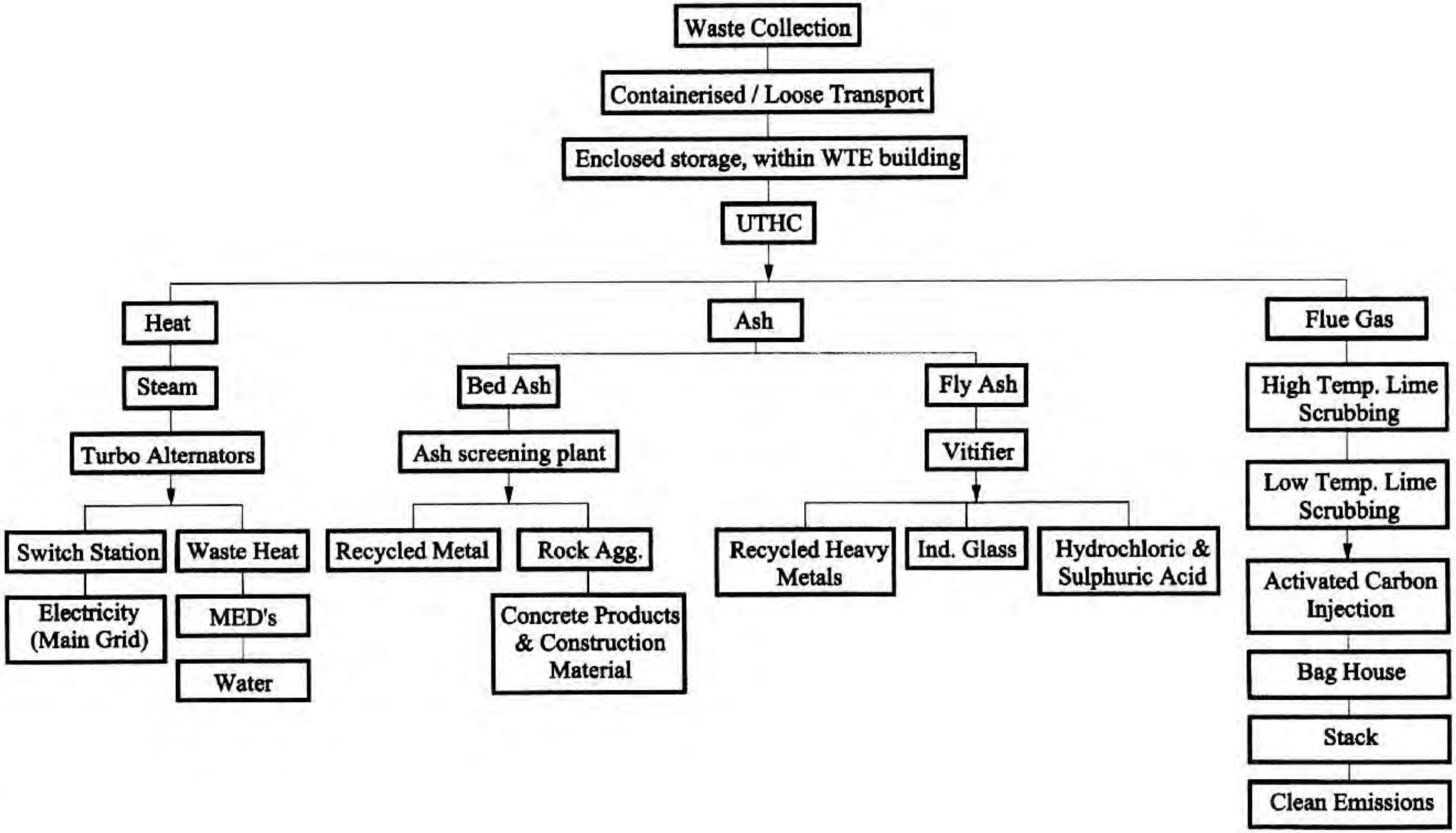



*Figure 3-17. Technology Flow Chart*

Of the technology to be established on-site, the IET Plasma Enhanced Melter™ (PEM™) units and Olivine MSW UHTC's are new to Australia. Turbo alternators and multiple effect desalinators are conventional technologies established throughout Australia.

The plasma enhanced vitrification process was developed jointly by the Battelle Research Institute, Richmond, Washington and Integrated Environmental Technology (USA). The PEM™ process is the latest in vitrification technology and has been granted all necessary US EPA permits. IET Plasma Enhanced Vitrification units are in commercial operation internationally as a safe and effective method of transforming wastes into glass. There is also a current proposal to construct an IET plant in Hawaii which will process over 200 tonne of waste per day. A letter from IET explaining the status of the PEM™ technology is attached as Appendix I.

Olivine combustion technology is proven internationally and currently in commercial operation. The key benefit of the technology is its simplicity due to the ability of the Olivine mineral to absorb and radiate heat. This avoids the need for water walls, common in non-Olivine combustors, which operate at reduced combustion temperatures and allow unburned gases to escape along their cooled waterwall surfaces. Due to the unique simplicity of Olivine combustion systems they are easily modified to meet different design requirements. As a result, there are various forms of Olivine combustors worldwide including over 400 wood waste combustors and several forms of Olivine MSW combustors. There are 18 Olivine woodwaste and rice hull combustors in Australia. Their common denominators are the high temperatures, large thermal mass and long gas retention times in a highly turbulent, high temperature environment.

Olivine New Zealand have over 20 years experience in Olivine combustion designs through an association with Olivine US. The Olivine engineering team has designed proprietary improvements to the standard Olivine combustor which will further improve the thermal efficiency and quality of bed ash. The key improvements are:

- A change in the hearth design;
- Improved plant design;
- Integration of vitrification technology for fly ash and dangerous goods;
- Improved combustion air systems; and
- Installation of a fuzzy logic control system.

These improvements form the UHTC and are currently subject to a pending patent. Two independent engineering companies have undertaken a comprehensive due diligence technical review of the UHTC plant systems and concluded that the technology is well proven and technically viable (refer Appendix J). A detailed report describing the Olivine combustor design principles and detailed engineering plans have been submitted to the DEP on a confidential basis.

The UHTC air scrubbing units and fabric filters are standard "off the shelf" technologies using Olivine panels. The components will be purchased from reputable supply companies.

The plant technologies are further expanded in the description of the general process and plant operation (below).

## 3.7 PROCESS DESIGN AND OPERATION - GENERAL

### *3.7.1 Characteristics of the Global Olivine System*

Olivine, a naturally occurring mineral, is mined in the Cascade Mountains in western Washington in the north west corner of the United States. The Olivine Corporation owns commercially accessible deposits. The mineral is unique with a low coefficient of thermal expansion, which varies little with temperature.

The material has been in general use as superior quality foundry sand and refractory material for decades. It is superior to traditional materials because of its stability and thermal shock resistance.

The refractory qualities of olivine facilitate the unique design of the heart of the system, the combustion chambers. The design benefits from extremely low materials, construction and maintenance costs. The panels, which form the combustion chambers, are created with an olivine base so that they act as both structural units and as high heat retention refractory linings. The completed structure is 90% refractory and only 10% steel.

These materials and the system design contribute to very low maintenance costs. An entire section of the combustion chamber can be replaced in a short time at negligible cost. Maintenance costs are therefore a fraction of those usually associated with such a plant.

The large combustion chamber with resulting high residence times facilitates the treatment of unprepared waste which is placed on a stepped multiple splayed U hearth for batch burning. There are no cool slotted steel grates and moving steel components common in other systems of similar capacity, except for 3 or more staged and stacked hydraulic ash pushes constructed from olivine.

Labour costs are manageable also as the straight-forward, uncomplicated design requires little operator training and few personnel. The system can accept completely unprepared waste so costs associated with preparation of refuse for treatment are low.

The combustion efficiency means that the system can accommodate a wide range of waste composition, making it suitable for integration with recycling and reduction programs.

The reliability and controllability of the system allows stable and efficient generation of heat for the production of steam and electricity as well as potable fresh water.

The system is controlled by a dynamic fuzzy logic control system.

### *3.7.2 Plant Size*

The plant design is based on a average refuse throughput of 1.2 million tonnes per annum (1.45 million maximum). The plant is to consist of 12 identical UHTC and boiler chains which are each capable of operating independently. Normally 90% availability would be planned for this portion of the plant. For extra flexibility it has been sized so that only 10 units are needed at any one time to provide the design throughput. This allows for maintenance without any plant closure. The ability to substantially modulate power production to match peak demands is enhanced by this surplus capacity derived from a large wind up and wind down capability. All plant functions that are common to more than one chain are duplicated. The subsequent design strategy guarantees the ability to handle the contracted waste and produce a guaranteed minimum amount of power with an ability to substantially modulate for load following if required, is illustrated in Appendix K.

### *3.7.3 Fuel and Feed*

The principle types of fuel and feed to be accepted at the WTE&W plant are:

1. Municipal solid waste (MSW) and sewage sludge, which will be the primary fuels for the MSW UHTC's. Other substances, which may be used for supplementary fuel include used rubber tyres and used oil and waste solvents.
2. Potentially hazardous waste materials, which will be passed through the vitrification plant. These include contaminated soils, sludges and waste dangerous goods.

#### *Combustion Fuel Value*

A survey of seven different Auckland waste streams gave as-received calorific values (CV) ranging from 6.3 to 16 GJ/tonne with an average value of 13 GJ/tonne.

For the purpose of this design, we have assumed a mean lower heating value of 11.0 GJ per tonne. This conservative value was suggested by Worley Consultants Ltd for a study done in New Zealand for the Auckland Regional Council on a Waste-to-Energy project.

#### *Assumed MSW Properties*

Raw MSW

| | |
|---|---|
| • Lower heating value | 11.0 GJ per tonnes |
| • Moisture | 25% |
| • Ash | 19% |

Low calorific waste, such as sewage sludge and other wet waste will be modulated with other high calorific value wastes, such as oils, hospital waste, waste solvents and tyres, in order to average the calorific value of the fed in waste stream.

#### *Waste hazardous substances*

Waste hazardous substances destined for vitrification will include banned, disused, contaminated or otherwise not-reusable chemicals which are not prohibited (see below). Examples include:

- Household hazardous waste collected, segregated and repackaged at municipal waste transfer stations;
- Agrochemicals, PCBs; and
- Waste from other storage facilities currently accepting hazardous substances for long-term storage.

Vitrification of these substances will be subject to the pre-approval and verification procedures for acceptance of hazardous waste.

***Prohibited wastes***

The following hazardous waste and hazardous substances will be prohibited for disposal on-site by vitrification:

- explosive substances (dangerous goods Class 1) and waste with explosive properties
- radioactive substances (dangerous goods Class 7) and waste having radioactive properties

Waste known or suspected of being prohibited must be declared and will be prohibited from disposal by vitrification.

### *3.7.4 Waste and Hazardous Substance Delivery*

All MSW deliveries and goods transport will be by way of either single unit, semi-trailer and B-double trucks. The B-double vehicles will, however, be restricted to the declared heavy haulage routes as they make their way from their origin to the plant. A maximum of 169 truck visits per day will be generated by the proposed WTE&W plant as quantified in Appendix L. All MSW will be sourced from waste transfer stations. No private vehicles and trailers will be permitted to access the site.

Waste and hazardous substances transporters and operators wishing to gain entry to the facility, for the purposes of transferral of substances for storage and waste for incineration or vitrification, are expected to transport these materials in a manner that avoids accidental releases and remedies or mitigates the effects of any such releases. Containers will be fit for transporting and containing waste or hazardous substances. No leakage of substances, waste, odour or liquids associated with the waste or substances will be permitted from the transportation container.

Compliance with the relevant sections of the Road Transport Reform (Dangerous Goods) Regulations 1997 and any other relevant codes of practice is expected. Amongst other things, these impose controls on documentation, placarding and labelling, segregation and driver training.

Deliveries of substances and waste will be to the main gatehouse in the northern corner of the facility. The entry will be well signposted indicating the entrance to the facility and directions to the storage areas on site.

An attendant will be at the gatehouse to record the company name and contact details, vehicle operator, truck weight and contents. All deliveries will be accompanied by:

- a completed waste manifest for MSW and waste shipments destined for vitrification.
- dangerous goods declaration form for hazardous substances
- a packing slip or equivalent for non-hazardous substances.

The gatehouse attendant will verify the contents of the shipment and notify the appropriate site attendant(s) of the impending delivery. Further detail on the waste and hazardous substance delivery is contained in Section 10.3 - Water, and Section 10.7 - Social Surrounds – Traffic.

### 3.7.5 *Waste and Hazardous Substance Storage*

The main WTE building and Dangerous Goods Store are designed to allow direct truck access for delivery of waste within the confines of each building. A plan showing the layout of the dangerous goods store is attached as Plan PL202 (Appendix E).

Deliveries of hazardous and non-hazardous substances, which have passed successfully through reception at the gatehouse will be directed to the appropriate storage facility. At the storage facility, they will be greeted by the attendant who will recheck the details of the packing slip or consignment note against the contents of the vehicle. The vehicle will then offload its contents to the storage facility in accordance with the site operating procedure for handling that particular substance. The offloading will be supervised by the vehicle operator and the site attendant at all times.

There will be detailed procedures developed specifically to receive, identify and handle waste materials arriving on site.

#### *Municipal Solid Waste and Sewage Sludge*

To minimise biological hazards during transport and storage at the site, the dewatered sludge will be baled and plastic-wrapped or containerised at the sewage treatment plant. MSW and sewage sludge will be received, handled and stored completely inside the MSW building. Because the MSW and sewage sludge will not be exposed to rainfall or stormwater from outside the building, the volume of liquids draining from the materials will be minor. Any liquids will remain inside the building and will be directed by internal drainage and grading to a sump, the contents of which can be pumped out and directly injected into the combustors. The grade and slope of the floor will be designed to ensure liquids do not escape from the building through doors and other exits. Low nib walls and pumps will be used.

No special provisions are required under the Dangerous Goods Regulations 1992 for storage of MSW and sewage sludge on site. However, good materials handling and storage practices will be adopted.

#### *Hazardous Substances*

All hazardous waste for vitrification will be stored in the Dangerous Goods Store. These materials will include:

- Dry materials including clay and sand, which are the base materials for the preparation of the vitrifier mix. These will be non-hazardous.
- Waste dangerous goods including chemicals and hazardous substances of the following dangerous goods classes: flammable and combustible substances (Class 3), flammable solids (Class 4), oxidising substances (Class 5) poisonous substances (Class 6), corrosives (Class 8). Other hazardous waste materials will include contaminated soils, sludges and other materials having ecotoxic properties (Class 9).

Dangerous goods used on site, such as hydrazine will also be stored in the dangerous goods store. A conceptual drawing of the dangerous goods store is provided as Plan PL202, (Appendix E) and shows the layout of the store along with how the materials will be segregated.

## 3.8 UHTC PROCESS DESIGN AND OPERATION

### *3.8.1 System Flow*

The UHTC process is summarised in Figure 3-18 while Figure 3-19 shows a schematic view of the plant components. Briefly, MSW is fed into the combustion chamber where the oxidising process takes place. The hot off gases are fed via the labyrinth chamber to the boiler. Steam is produced in the boiler, which is expanded through a steam turbine driving alternator, producing electricity. Gases from the boiler are treated by a lime scrubbing and activated carbon absorption process and cleaned by filtration in a baghouse.

Steam is then injected into the turbine units to produce electricity. Exhaust steam from the steam turbine is then ducted to a Multiple Effect Desalinator (MED) and the waste heat used to convert seawater into potable water.

The outputs from the process are clean air emissions, electricity, bed ash aggregate, cement additive, glass products (via vitrification of fly ash), recycled metals and potable water (via the desalination units). Figure 3-20 also shows an isometric view of the plant.

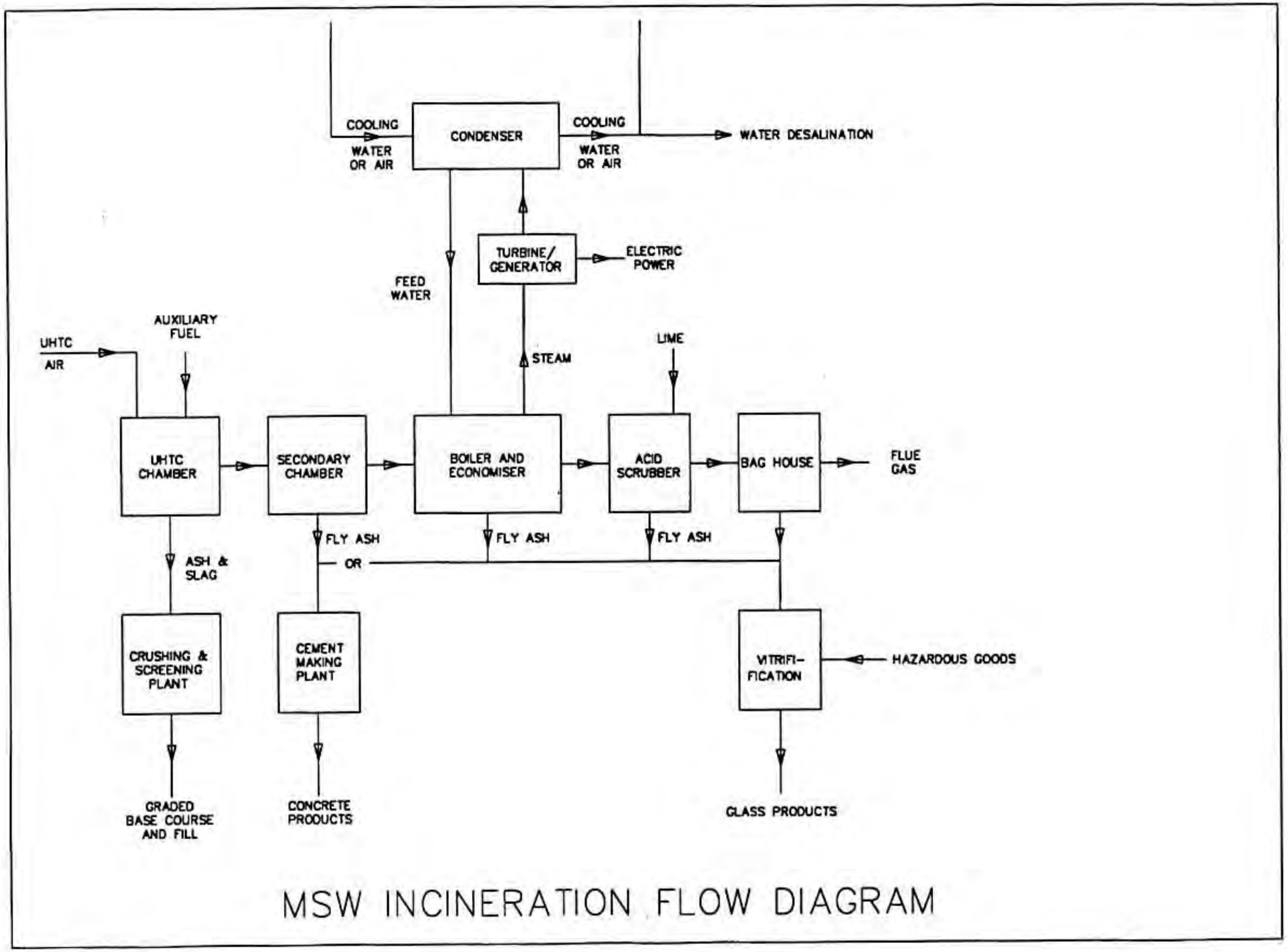
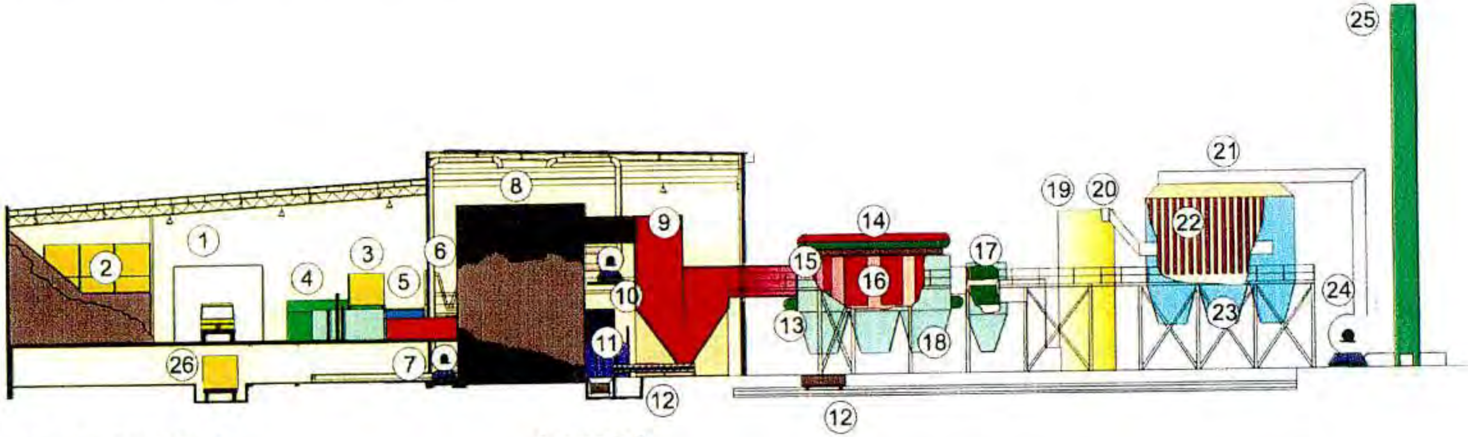



*Figure 3-18. UHTC Process Flow Chart*

Energy, Water & Materials from Waste & Biomass Resources

# OLIVINE WASTE TO ENERGY FACILITY

(Schematic view only, not to scale)




**Technical Data**

| | |
|---|---|
| Waste handling capacity: | 12 t/h |
| Calorific value of waste: | 11.0 GJ/t |
| Gross heat release: | 132 GJ/hr |
| Steam output: | 38 t/h |
| Steam pres. at superheater outlet: | 42 bar |
| Superheated steam temperature: | 455 °C |
| Feed water temperature: | 130 °C |
| Flue gas temperature: | 120 °C |

**Legend**

1 Refuse tipping hall
2 Containerised refuse
3 Container feed-in
4 Tyre feeder
5 Walking floor
6 Feed-in mechanism
7 Primary air fan
8 UHTC
9 Labyrinth
10 Secondary air fan
11 UHTC de-ashing
12 Ash transport system
13 Boiler
14 Feed-water drum
15 Superheater
16 Evaporator
17 Economiser
18 Boiler ash hoppers
19 Flue gas scrubbing (CaO)
20 Activated carbon injection
21 Bag house
22 Bag filters
23 Bag house ash hoppers
24 Main draught fan
25 Stack
26 Railway unloading

*Figure 3-19. Plant Schematic*

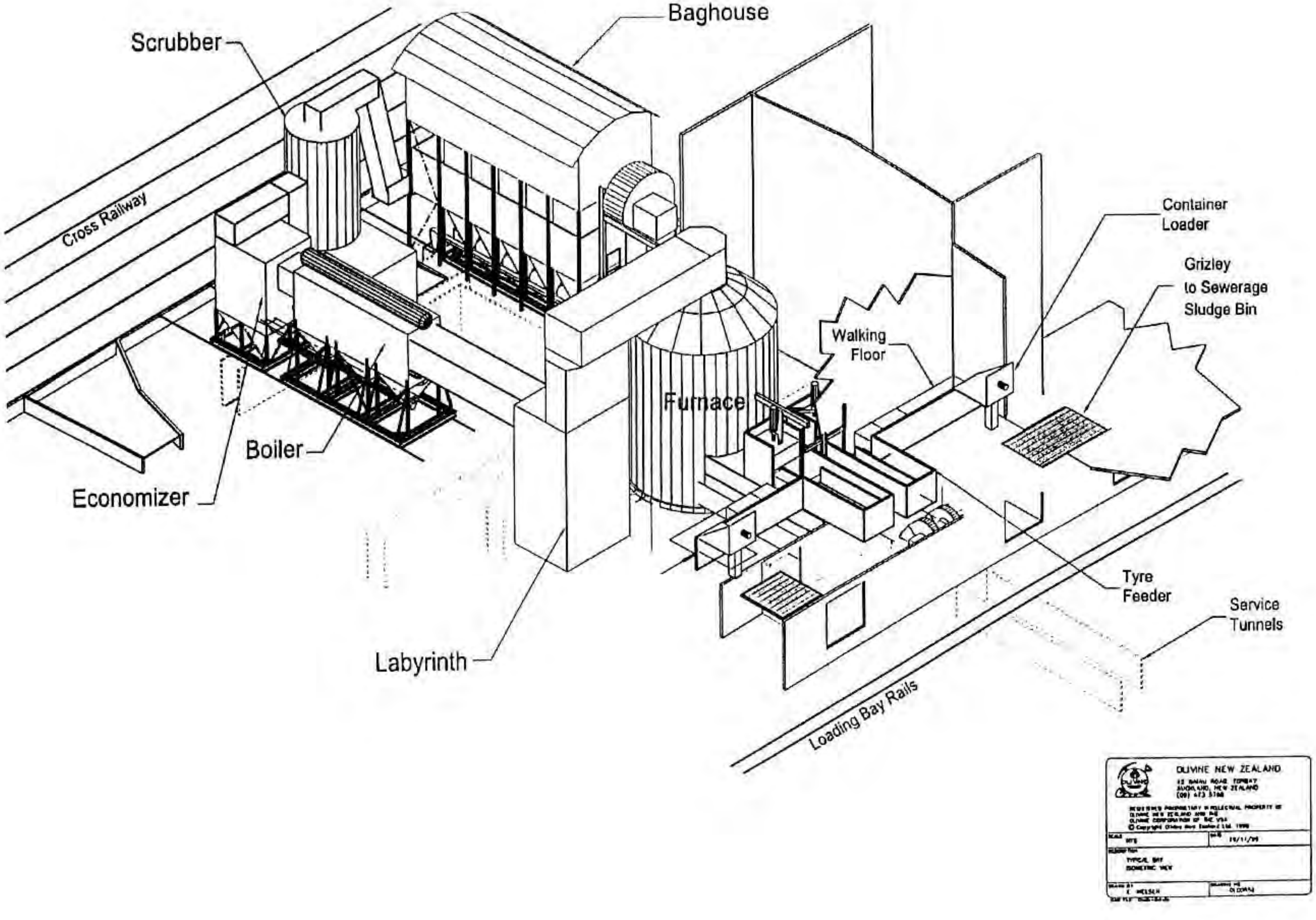



**Figure 3-20. UHTC Isometric View**

Energy, Water & Materials from Waste & Biomass Resources

### 3.8.2 *UHTC Fuel Feed*

Within the enclosed WTE receiving building, two straddle gantry cranes in each plant provide handling facilities to unload incoming trucks onto an indexed multi-storey racking system. When required, each container is lifted to the upper level by way of an elevator. Forklifts then place each container in turn into a cradle and remove the end curtains. The refuse is pushed out of the container with a hydraulic ram onto a 2.4 m wide walking floor conveyor. This enables the plant operator to view the contents on TV monitors before it enters the UHTC. Unacceptable material may then be removed from the floor and diverted to steel recycling bins or the vitrifiers. Any refuse not arriving in containers is tipped directly onto the receiving floor from where it is loaded onto a "walking floor" with the loader. Containerised MSW unloading is shown as Figure 3-21.

The walking floor conveyor is a flat bed in which the floor segments move together in the feed direction and cycle back sequentially. This is a reliable and well-proven low maintenance system.

The MSW feeds off the end of the walking floor conveyor into a automatic series of three isolated locks. The MSW is pushed from one lock to the next by a series of plug rams. These plugs prevent rogue air entering the combustor and also prevent lock fires in the in feed.

Once inside the MSW receiving building at the facility, all handling of the sludge will be mechanical without human contact. Bales will be transferred by loader with an enclosed, air-conditioned cab into a bale breaker and passed into the MSW UHTC via a subfloor sewage hopper. The hopper is then hermetically sealed from the main building floor. The sewage sludge is moved by feed screws from the hopper into the final UHTC feed lock. Air from the hoppers is continually purged and injected into the nearest operating UHTC.

The rubbish receiving building has a forced air ventilation system so that air is extracted from the building and used as primary air in the UHTC preventing the escape of fumes and odours to the outside.

*Figure 3-21. Containerised MSW Unloading*

### *3.8.3 UHTC Combustion*

The UHTC combustor is a mass burn system and this means that like other fuel-bed systems the firing-rate is, within limits, dependant in the short term on the primary air supply.

The combustion process in the bed, while a complex process, is relatively easy to control. The reactions can be characterised as a mixture of pyrolysis (thermal decomposition) and combustion. Evidence for both coal and MSW beds confirms that the off-gas from the bed is a mixture of gases from both burning and pyrolysis and that this mixture, particularly for MSW, is controlled by the water-gas shift equilibrium (Niessen, 1995). This equilibrium describes the relative concentration of the reactants in the following:

$$H_2O + CO \longleftrightarrow CO_2 + H_2$$

The important effect of this equilibrium is that about twice the amount of MSW fuel can be gasified with a given quantity of primary air than that predicted from stoichiometric combustion to $CO_2$ and $H_2O$. This bias towards gasification rather than combustion means that until sufficient primary air to combust the complete bed of MSW is supplied, the bed behaves as a gasifier with the gasification rate being determined by the primary air supply. The combustor is designed so that primary combustion operates in this gasification zone and thus primary air provides a stable and wide-ranging control of firing rate.

### *3.8.4 UHTC Characteristics*

There are five features of the Olivine UHTC's that lead to very efficient and easily controlled destruction of waste material.

- The combustor is built from long-life refractory Olivine panels which can withstand extremely high temperatures without degradation.
- There are no metal components either static or moving inside the combustor.
- There are no water walls or other heat extraction components in the combustor.
- The secondary combustion zone has a large volume of well mixed gas at very high temperature.
- The large volume of the UHTC provides for long gas residence times and good combustion at high temperatures allowing for high temperature acid gas scrubbing with calcium carbonate(calcining temperature of lime is 850 °C).

The lack of metal components (water walls, grates etc) means that the combustor can operate at very high temperatures (1150 °C – 1100 °C) without concern that slag formation will cause problems such as grate or waterwall fouling. In fact slag formation is encouraged by the introduction of either vitrifier gas or back up natural gas fuel into the bed ash just before the ash is discharged. This reduces the ash fines which need to be vitrified and produces a useful clinker.

All internal combustor surfaces consist of the unique Olivine refractory panels which operate at the same high internal gas temperatures of 1150 °C – 1100 °C without degradation. These panels provide a considerable thermal sink or source for high-rate radiative heat exchanges between themselves and the combustor gasses. This heat exchange serves to minimise gas temperature fluctuations due to momentary changes in combustion conditions (drying of new fuel etc) and also assists in maintaining good combustion conditions by ensuring that gasses in the mixed secondary combustion zone are isothermic.

The thermal capacity and therefore thermal stability of a conventional water-wall combustor is relatively low. Process upsets can occur within a matter of minutes or even seconds allowing uncombusted organics to escape from the process. The use of afterburners is largely prompted by this potential. The thermal mass of the Olivine combustor however leads to great thermal stability and simple control.

Olivine's absence of waterwall ensures that no uncombusted gasses can escape from the combustor via a "cold path" up the walls.

### *3.8.5 UHTC Fuel Calorific Value*

As described above, waste delivered to the plant is stored either compressed in transport containers or loosely in storage bins. The selection of containers or bins for the next load of fuel to the combustors is a decision for the loader operator and he/she is guided by the status of each combustor. Each combustor control system continuously calculates the average calorific value (CV) of the current fuel load and displays "High", "OK", and "Low" signals to the loader operator. Based on these signals an experienced operator can select from the stored waste an appropriate "next load" which will maintain the CV as "OK".

The combustor fuzzy logic control system will adjust the firing-rate to maintain a constant heat output and this will normally be sufficient to compensate for CV variations. However if the control system senses that the current fuel load CV is outside present limits, it will then introduce supplementary fuel, either liquids and tyres to increase CV or pressed sewage sludge to lower CV.

### *3.8.6 UHTC Primary Combustion Chamber*

The heart of the UHTC is the primary combustion chamber. The primary combustion chamber consists of a single cylinder, manufactured from panels of olivine refractory material 13.2 m in diameter and 13 m high, standing on end. The cylinder of refractory panels can withstand temperatures of up to 1500 $^{o}$C. The outlet temperature is kept at 1,100 $^{o}$C. This is well above the U.S.A. EPA minimum temperature for MSW combustion (850 $^{o}$C) and well within the capability of the refractory. Oxidation at higher temperatures often leads to high $NO_X$ values and excessive carry over to the boiler of sodium and potassium based slag. The system is designed to encourage slagging of the bed ash to form a rock-like bed ash aggregate.

A SNCR process is installed to reduce $NO_X$ which is already lowered by the partially reducing bed. There is a stepped multiple splayed U-shaped hearth in the bottom of the chamber with the MSW being fed at the top of this hearth. Each hearth has a side angle of 70$^{o}$ and narrows to 550 mm at the bottom. Refuse is piled 1.2 to 2.4 m high on the hearth. This represents approximately 20 tonnes of waste in various oxidising stages in the chamber.

Process air comes from two places. Primary air is introduced along the bottom axis and side walls of each hearth through a series of ports, some of which can be automatically controlled to regulate the air flow.

Secondary air is injected through several ports 3.2 m or more above the hearth in counter rotating layers, equally spaced around the perimeter of the combustion chamber with a sufficiently high velocity to penetrate into the centre of the chamber. It can also be injected in the cross-over duct. The secondary air is computer controlled to better regulate the airflow delivery. This same computer controls the primary air and the waste feed rate.

The primary oxidation chamber has a fully mixed zone extending approximately 9 m upwards from the plane of the secondary air jets. This gives a total residence time in the primary oxidation chamber of approximately 6 - 8 seconds.

This long residence time, with ultra high temperature, good turbulence and high radiated heat from a large thermal mass, gives the chamber excellent performance characteristics especially as there are no cold surfaces collecting radiant heat.

As the waste oxidises, it is reduced in volume (to approximately 8% of the in feed) and in weight (to approximately 20% of the in feed) as an ash residue. This is transferred from the hearth to an ash chamber at the side of the primary combustion chamber by pushing the bottom of the above waste pile with a series of hydraulic rams. This action unsettles the pile, resulting in a momentary increase in the release of combustible gases. Each hearth is pushed sequentially to minimise hearth upset. The pushes tend to roll the waste slowly, which aids drying and gasification.

After the final push, two doors either side of the de-ashing chamber are closed to allow the ash to be removed by opening a hopper and dropping the ash into a rail car, which is winched in an enclosed tunnel to the ash screening plant. The dusty air from the isolated portion of the tunnel is sucked back into the UHTC.

Oxidising gases leaving the bed are further treated in the upper portion of the chamber after contact with secondary air from the secondary air jets. A negative air pressure is maintained in the primary combustion chamber and the ducting system by a fan located after the baghouses.

The combustion process can be demonstrated in entirety with a dynamic model, which overlays the control system. A comparison between the lower and upper mixing levels is contained in Appendix H.

### *3.8.7 UHTC High Temperature Gas Scrubbing*

Limestone is broadcast into the primary combustion chamber above the stepped U-hearths via the secondary air nozzles to limit the levels of acid gases (HCl and $H_2SO_4$) in the gases entering the boiler. At the elevated temperatures existing in the primary combustion chamber the limestone ($CaCO_3$) reacts with the acid gases to form $CaSO_4$, CaO and some CaCl. This reduces the acid gas levels in the flue gases and corrosion problems in the boiler. The removal of $SO_x$ components from the exhaust gas is very effective with experience suggesting that routine removal rates of up to 96% are achievable (Ohio Coal Development Office, 1998), with the residence time of the lime particles in combustion gas that is 200 °C above the calcining temperature of lime.

### *3.8.8 UHTC Secondary Oxidation Chamber (Labyrinth)*

The gases leaving the primary combustion chamber enter a secondary chamber. This chamber consists of an array of refractory panels, which have sufficient thermal mass to smooth temperature variations in the system caused by variations in fuel or surges at ash push.

At the base of the labyrinth the gas passage area suddenly increases and gas velocities are reduced and the gas direction changes through 180°, providing further residence time of 2.1 seconds at high temperature. At this point a large portion of the particulate in the gas stream is collected and discharged in a low velocity region. These units are divided into three sections that can have fly ash removed independently while the UHTC is in operation.

A bank of sacrificial pre-boiler screen tubes are located in the after compartment of each labyrinth section. These allow the temperature to drop quickly below the eutectic slagging temperature of sodium. These tubes can be cleaned by mechanical rapping without shutting down the chain. They can be quickly replaced as they are in a high erosion and corrosion situation.

### *3.8.9 UHTC Boiler and Turbine Operation*

Hot gases from the secondary oxidation chamber, or modulating chamber, pass into the boiler where temperatures are quickly reduced to about 280 °C producing high pressure steam.

The boiler is followed by an economiser where the gas temperature is further reduced to 170 °C and the boiler feedwater temperature is raised from approximately 130 °C to 250 °C prior to entry to the boiler (the feedwater is pre-heated by the high temperature labyrinth screen tubes to avoid acid attack on the economiser). The high-pressure steam raised in the boiler is expanded through a steam turbine, which drives an alternator producing electricity.

Each boiler is designed to be removed and replaced in less than three days due to the plant design which includes boiler workshops and a cross railway system.

### *3.8.10 UHTC Low Temperature Acid Gas Scrubber*

Hydrated lime, or $Ca(OH)_2$, in a fine atomised slurry form is used to treat the acid components of the flue gases. This is added to the gas stream, after the economiser, in an injection chamber. The lime is stored in a silo then metered mixed with water and pneumatically conveyed to the injection chamber.

The variable speed lime feed system is controlled by the $SO_2$ and HCl levels in the exhaust gases. This wet-dry scrubbing system is designed to remove more than 86% of the remaining $SO_X$ and 95% of the HCL. The water content of the slurry and re-injection of cooled flue gas further cools the gases to optimum reaction temperature of 140 °C.

### *3.8.11 UHTC Activated Carbon Injection*

After the wet scrubber and before entering the baghouse activated carbon is injected into the gas stream as a final gas polisher and to absorb the remaining $SO_x$, HCl, heavy metals and any de novo synthesis dioxin.

### 3.8.12 *UHTC Baghouse*

The gases exiting the acid gas scrubber, containing lime particles, activated carbon particles and the absorbed acid gases, pass through a duct system to the baghouse. The baghouse consists of ten compartments and uses woven fibreglass material with an acid resistant finish for the filter bags.

Cake build up on the filter bags is measured by the pressure drop. When this reaches a predetermined level, the compartment is shut off and pulsed to remove the dust cake. The cake drops into a hopper and is removed by a screw conveyor to an enclosed winched rail car, which takes the cake, fly ash and heavy metals to the dangerous goods store and vitrifier.

The baghouse is made from mild steel with a high-quality, acid resistant paint finish. It is insulated to limit the temperature drop in the system and acid condensation on the inside. Baghouse and hopper heaters are provided to prevent caking in the baghouse during shutdown. The clean gases leave the baghouse and exit the plant via the stack.

The baghouse is, like the boilers, designed to be easily removed and replaced for maintenance on a cross railway. Both boilers and baghouses can be removed and replaced within three days.

### 3.8.13 *UHTC Exhaust Fan and Stack*

Gas from the baghouse finally passes through two induced draught fans and on to the stack. The induced draught fans are designed to provide a small negative pressure throughout the gas passages to contain any tendency for gas leaks to atmosphere. Both fans are sized to provide 80% of the rated duty required so they run at 62% power on normal load. By reducing the combustion rate by 20%, each chain will run on one induction fan while the other is replaced or repaired. At the base of the stack, emission-monitoring equipment continually samples and logs the constituents of the stack gasses.

### 3.8.14 *UHTC Ash Management*

The high temperature incineration process (1150 °C – 1100 °C) produces two types of ash termed 'bed ash' and 'fly ash'. The majority of the combustion ash is in the form of bed ash which settles at the bottom of the combustor. The very high combustion temperatures form a rock product which is screened, crushed and sold as a low strength aggregate material.

Fly ash is a fine 'flue' ash which is collected during the air scrubbing process and represents a small percentage of the total ash. Fly ash, scrubbing materials and dangerous goods are passed into the vitrifier.

#### *UHTC Bed Ash*

The bed ash from the combustion of MSW and sewage sludge within the UHTC comprises the non-combustible fraction of MSW and sewage sludge. The amount of bed ash from the incineration plant is directly related to the content of non-combustible materials. The bed ash retrieved from the MSW and sewage sludge combustor is between 20 and 25% of the weight (inclusive of metals) of the input stream and 8 to 10% by volume. The bed ash contains non-combustible components such as scoria-like slags (aggregate material), masonry, glass and steel not already recovered for recycling.

The resultant bed ash is transferred to an ash chamber at the side of the hearth by pushing the bottom of the burning waste pile with the hydraulic powered refractory ram. After the ram push, the door between the hearth and the ash chamber is partially closed and a door either side of the ash house in the active tunnel is closed which allows the ash to be loaded into an ash car using a rotating hopper. The dust from this operation is sucked back to the UHTC with a controlled influx of air. The ash car travels on rail tracks to the ash screening plant in an enclosed concrete channel to avoid dust emissions. At the end of the channel the rail car is lifted and tipped into a large bunker through a grizzly with a magnet above. The bunker is located within the ash screening plant. The concrete channel and ash plant is equipped with an extraction fan which will recover the dust for vitrification.

The purpose of the ash screening plant is to screen the ash into useable and non-useable grades and to recycle ferrous and non-ferrous metals. Once the ferrous and non-ferrous metals are separated, the majority of the ash will be in the form of a slag (similar to scoria) which, if appropriately sized, maybe sold as roading aggregate. The screening and end use of MSW ash can be summarised as follows:

| ***Fraction*** | ***Final Usage*** |
|---|---|
| Coarse fraction (> 200 mm) | Crushed and rescreened |
| Large fraction (200 – 60 mm) | Use as a filler or construction material |
| Medium fraction (60 – 8 mm) | Use as filler or construction material or concrete aggregate |
| Course Sand (8 – 0.6 mm) | Concrete |
| Fine fraction (< 0.6 mm) | Vitrified as required for good quality glass |
| Steel (13 – 15% of bed ash) | Sale to metal recycler or on site smelting (subject to future required approvals). |
| Other non-ferrous metals (1–2%) | Sale to metal recycler or on site smelting (subject to future required approvals). |

This summary shows that the ash is screened to grades and ferrous and non-ferrous metals are separated out.

The first screen separates material over 200 mm in any dimension and then a large magnet extracts a good portion of the steel. Material over 200mm in any dimension is fed into a spall-breaking bin. The clinkers are re-broken daily and fed into the primary screening plant. The day shift then processes the ash from the holding hopper in the following manner. Firstly the ash passes through a dry screed to separate the dust and sand into two different fractions. The residual clinkers then pass under another belt magnet, for steel removal, then through a crusher, then under another belt magnet for further steel removal. The clinker then passes through an eddy-current separator to extract non-ferrous metals, then through a wet screen to separate the aggregates into three sizes. The aggregates are washed on the screen at the same time. The sediment from the wash water is sent to the vitrifier daily. Top up water is used from the stormwater sediment ponds.

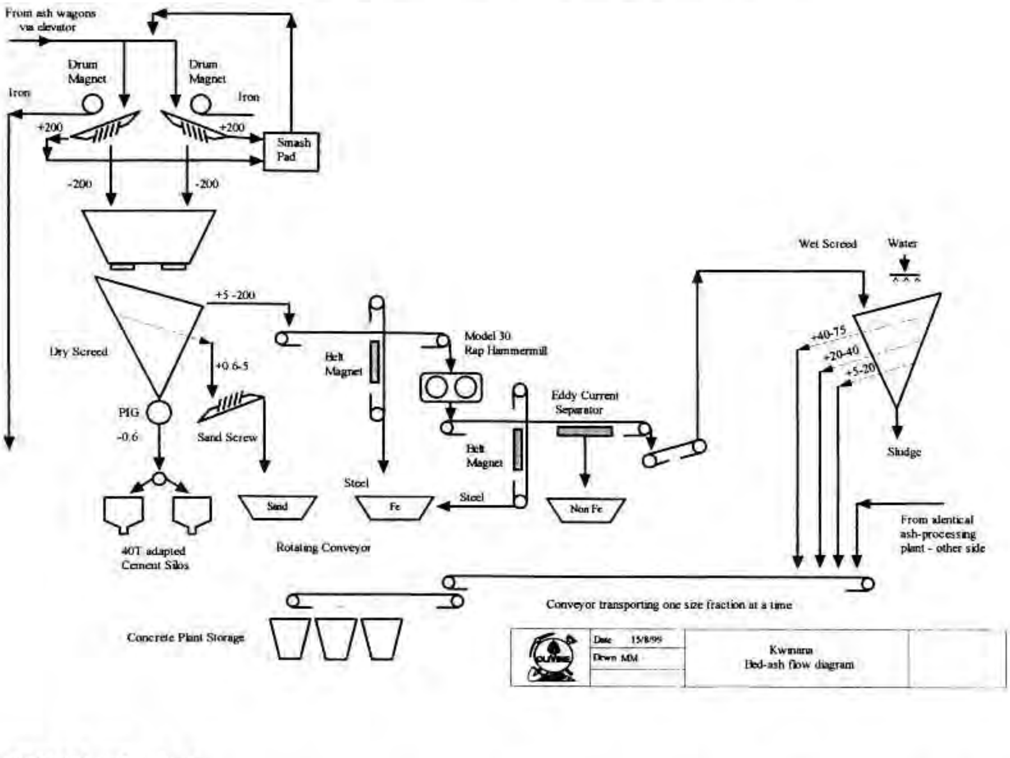
The bed ash fines that pass through the last screen are collected in a hopper and air conveyed to the vitrification plant, where they get vitrified into a glass matrix at high temperatures.

Tunnel, hoist and screening plant are all enclosed within buildings. The over fire air fans of the MSW chains suck the over fire air through dust extraction units, which remove any dust emissions from the ash plant. The air is filtered before entering the combustors and the filter dust is vitrified.

The bed ash will be crushed and screened for disposal as roading base course or other metal. This material is largely inert and contains minimal leachable materials as discussed in Section 9.15.

A bed ash flow diagram is shown as Figure 3-22. Plan Perth/PL203 (Appendix E) shows the ash screening plant configuration.

***Figure 3-22. Bed Ash Schematic***




### *UHTC Fly Ash*

Fly ash from MSW incineration plants comprises the fine fraction of the non-combustible components from the waste input as well as reaction products from the flue gas cleaning system. Fly ash and bag filter products contain high levels of heavy metals and toxic materials. This material is stabilised physically and chemically through vitrification into glass.

Fly ash from the plant is collected from three different sources, as follows:

- Fly ash from the labyrinth which falls out of the gas stream because of reduced gas velocities in the labyrinth. This high temperature ash contains no dioxin and is comprised of silica, calcium trialumina silicate, calcium oxide, calcium sulphate and some insoluble oxides of heavy metals.
- Boiler fly ash which comprises particles dropping out of the gas stream in the heat recovery boiler and economiser. This ash will be vitrified.
- Fly ash retrieved from the baghouse filter at the end of the flue gas cleaning system. This ash will be vitrified.

The three different types of fly ash will be collected in hoppers underneath the labyrinth, boiler and baghouse filter. From the hoppers, the retrieved fly ash will be discharged into silos or transported to the vitrification unit by underground rail. The fly ash from the baghouse filters will be discharged into stainless steel rail dollies which will be winched in an enclosed concrete tunnel to the storage area of the vitrification plant for further treatment. Fly ash from the MSW plant will be turned into glass in the vitrification units on site which will also recover mercury, hydrochloric acid, and sulphur in good commercial grades and heavy metal sludge suitable for recovery.

### *3.8.15 UHTC Control System*

The control concept for the UHTC plant has two levels:

1. Local single variable set-point PID controllers. The set points for variables such as temperature, air-flow etc to be controlled can be set manually by operating staff but are normally set by:
2. A multi-variable adaptive supervisory control system employing fuzzy control principles. The supervisory system allows for many more system measurements to be included in the control strategy to optimise combustion and emission control. In the event of a failure of the supervisory system the plant is left in a safe "status quo" mode and can then be monitored and controlled by operating staff.

#### *Set Point Controls*

The top level control for the MSW UHTC plant is a total energy (steam) demand from all on-line boilers required to meet a programmed electrical energy demand at the power station. This total steam demand is in turn proportioned over all on-line MSW boilers into a steam demand for each boiler that is translated into a required firing-rate for each combustor. The proportioning is modified by computed values for the average calorific value of the fuel in each unit so that secondary control limits on each unit are avoided.

#### *Firing Rate Control*

The firing rate or heat release of a combustor depends on:

- Primary air supply
- Amount of fuel in the combustion chamber
- Calorific value of that fuel
- Secondary air supply

The primary control for meeting a steam demand is primary air. Adjustment of primary air will lead to a consequent secondary adjustment of fuel feed rate and secondary air and these changes are anticipated by the supervisory control system by simultaneously changing the set points for primary and secondary air and fuel feed rate based on an assumed value for fuel CV. The set points are then subject to trimming to reflect the actual fuel CV and to meet other operating requirements.

***Primary Air Control***

Primary air is normally supplied by two variable-speed primary air fans discharging into a common manifold. In the event of a fan failure each fan has the capacity to provide all the primary air. The practical limits to the control of the primary air supply ( and thus the ultimate firing rate) are :

1. *A minimum exhaust excess $O_2$ requirement of 5% or low secondary air.*

   The minimum excess air requirement provides a buffer to ensure that no unburned gasses escape the combustor. At the same time an 1100 °C design exhaust temperature is required for primary gas scrubbing. As the primary air supply and the combustor heat rate are reduced, the fixed combustor heat losses become predominant and the excess secondary air must be reduced to maintain the required exhaust temperature of 1100 °C. There is also a minimum secondary air supply limit required to maintain effective mixing of the bed off-gas. A low primary air supply limit is reached when either the exhaust excess $O_2$ reaches 5% or the secondary air limit is reached.

2. *A minimum mean residence time for MSW fuel or excess primary air.*

   The pyrolysis time for solid wastes is controlled by the rate at which they are heated and this is a function of the size of the MSW components and the heat energy incident on those components. Telephone directories are typical of bulky objects requiring a long residence time at high temperatures to completely burn out, typically about one hour.

   The residence time of the fuel in the combustor is a function of the fuel feed rate and the average volume of fuel in the bed and for a given fuel feed rate there will be a desired minimum bed volume to give the required residence time. The upper limit to this volume is determined by the hearth and fuel feed design and this in turn sets an upper limit to the fuel feed rate if the residence time criterion is to be met.

   As the primary air supply is increased and the firing rate increases, the bed fuel consumption rate increases and the fuel feed rate increases to maintain the bed volume. The upper limit to the fuel feed rate finally limits the primary air supply (and hence heat rate).

   If during this increase in primary air there is insufficient calorific value in the bed to meet the steam demand requirements the primary air supply will eventually create excess $O_2$ in the primary exhaust gas zone. This is detected by laser spectroscopy gas analysis (LSA) and causes supplementary fuel (liquids and tyres) to be injected into the combustion chamber. This fuel maintains heat output to meet steam production demand until either the calorific value of the bed is increased or the steam demand is relaxed.

***Secondary Air Control***

Secondary air is normally supplied by two variable-speed secondary air fans discharging into a common manifold. In the event of a fan failure each fan has the capacity to provide all the secondary air.

A lower limit to secondary air supply is required to maintain effective penetration of the secondary air jets and thus ensure that mixing of the bed off-gas is maintained.

If this lower limit is reached there is insufficient calorific value in the bed to meet the steam demand requirements and supplementary fuel (liquids and tyres) is injected into the combustion chamber. This fuel maintains heat output to meet steam production demand and allow normal secondary air input until either the calorific value of the bed is increased or the steam demand is relaxed.

***Fuel Feed Control***

Fuel feed is controlled to maintain a bed volume that will give the required fuel residence time in the bed. Bed volume is indicated by the mean height of the bed above the hearth base. This height is measured by laser distance measuring sensors in the combustor roof. Bed volume is limited at the low end by the need to fully cover the primary air ports, and at the upper end by the height of the fuel feed port.

***Ash push Control***

The three ash pushes in each of the two hearths serve to distribute the incoming fuel across each hearth and to move the ash to the ash exit ports. It is essential that the material in the hearth at the final ash push is mainly ash so that unburned fuel is not ejected at the ash port. This means that fuel is distributed so that it moves across the hearth at a rate that will allow complete combustion. This rate is controlled indirectly by controlling the slope of the bed so that a constant height is maintained at the ash port regardless of the required bed volume. Each push is independently controlled by roof mounted height sensors to maintain the desired bed slope which has been determined from bed volume requirements.

The final ash pushes in each hearth discharge sequentially into two ash hoppers which, in turn, unload into a pair of ash rail cars. There are two ash rail car systems with only one system in operation at any time, the other acting as a backup for maintenance purposes.

***Ash Rail Control***

The sequencing of the twin ash rail cars under normal conditions is controlled so that the rail cars visit each combustor in turn every hour. The arrival of a car at a combustor activates that combustors hopper unloading. This sequence can be modified to account for combustors out of service and the state of the ash hoppers on each MSW unit. The normal ash unloading sequence is designed so that a hopper only becomes half full before being emptied. Should a hopper become more than half full, the frequency of the rail car return cycle will be increased.

***Primary Dry Scrubbing Control***

This injection rate is controlled by Differential Optical Absorption Spectroscopy (DOAS) which measures sulphur dioxide concentrations from the MSW bed.

***Secondary Wet Scrubbing Control***

The injection of $Ca(OH)_2$ slurry is controlled by DOAS of the gas stream into the baghouse which measures sulphur dioxide, hydrogen chloride and temperature. Additional water is injected with the slurry and is separately controlled to maintain an optimum gas scrubbing temperature of 140 $^{o}$C.

***SNCR $NO_x$ Scrubbing Control***

The urea injection rate is controlled by the DOAS in the cross over duct between the combustion chamber and the labyrinth. The DOAS measures $NO_x$ concentrations and ammonia concentrations of the gas stream into the baghouse. The injection rate is controlled to give maximum $NO_x$ removal combined with negligible levels of ammonia residual.

***ID fan Control***

Induced draught is provided by two variable speed ID fans operating in parallel. Each fan is capable of full ID duty in case of a fan failure. The fans are controlled by a smoothed pressure measurement in the combustor chamber to maintain a 5 millibar depression below atmospheric pressure in the chamber. This control eliminates any gas leaks to atmosphere.

***Supervisory Control***

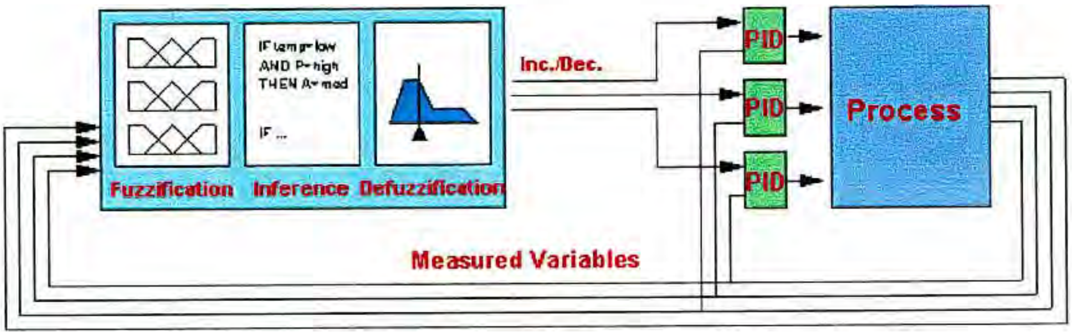
The use of a fuzzy-logic supervisory control system allows for effective and stable multi-variable control of what is usually a complex non-linear process without requiring an exact mathematical description of that process (Von Altrock, 1996).

In contrast to older conventional design techniques, fuzzy-logic enables the design of multi-variable control strategies directly from human operator experience or experimental results. In addition such designs can be adaptive i.e. they can be updated on-line to accommodate new operational and experimental experience.

A typical application uses fuzzy-logic supervisory control to measure a large number of process parameters and to control the set points of standard single variable Proportional-Integral-Differential (PID) plant controllers.

Increasingly many modern Programmable Logic Controllers (PLCs) with PID functions are able to incorporate fuzzy logic software as part of their capabilities so that the functions of supervisory and plant control become merged (eg. Foxboro's I/A Series automation system ).

*Figure 3-23. Control System*




## 3.9 VITRIFIER PROCESS DESIGN AND OPERATION

A total of four 70t/day vitrifier Plasma Enhanced Melters (PEM™) supplied by Integrated Environmental Technologies LLC (USA), will be installed on-site. These units will be used for the vitrification of fly ash from the MSW combustors, and for destruction of organic and inorganic hazardous wastes. Integration of the PEM™ technology with waste to energy combustors and downstream product processing offers substantial operational, economic and environmental advantages, compared with operation of either technology in isolation.

After extensive development and demonstration of vitrification technology, vitrification is now gaining commercial acceptance for a variety of waste types (refer Appendix I).

### *3.9.1 PEM™ Process*

The PEM™ combines plasma and vitrification technology into a system which can take essentially any type of solid or liquid (apart from dilute aqueous solutions) hazardous waste with extremely high levels of destruction of organic contaminants. Toxic elements are either incorporated into leach-resistant glass or recovered in a concentrated form suitable for recycling, depending on the waste composition and element volatility. Metallic iron, chromium, copper and nickel in wastes is recovered in ingot form.

The process chamber of the vitrifier is lined with three or more layers of high performance refractory and insulating materials to withstand the extreme temperatures (1350 °C for the vitrified product) and to retain heat during idle periods to minimise maintenance heating requirements. Energy is supplied to the process chamber in two forms: a DC (direct current) arc plasma, and AC (alternating current) joule heating of the glass pool. The process can be operated in the standard (un-enhanced) mode by turning off the arc plasma.

The DC arc plasma is created by applying a DC voltage across three graphite arcing electrodes to create a stable plasma arc. A further three electrodes submerged in the glass melt are supplied with an AC voltage, creating a current flow through the glass, which acts as a resistor and consequently heats up.

The feed into the vitrifier is introduced into the plasma zone, where it is subject to temperatures in the range 3,000-6,000 °C, extremely intense ultraviolet light and extremely active radicals, including hydrogen, oxygen and hydroxyl radicals. This results in extremely rapid and complete pyrolysis and steam reforming of the organic materials to produce hydrogen, carbon monoxide, carbon dioxide (minimal), hydrochloric acid and hydrogen sulphide. If any organic material escapes the plasma zone, it is pyrolised by the high temperature of the glass melt and chamber. Inorganic constituents either decompose into the vapour phase (relatively volatile elements) or are dissolved into and become part of the chemical structure of the melt.

The strongly reducing conditions ensure that formation of dioxins at any stage, including during cooling of the off-gas, is effectively eliminated. A small-scale trial using MSW ash showed an extremely low concentration (0.002 ng/m$^3$ I-TEQ, of which 0.0014 ng/m$^3$ I-TEQ was accounted for by "non-detects") of dioxin/furans in the off-gas including the solids (metal fume etc). This concentration is low enough to ensure negligible contamination of product recovered from the off-gas.

The endothermic plasma assisted synthesis gas reaction results in small off gas volumes compared with combustion processes, which facilitate clean-up of the off-gas and recovery of useful components. Hot off-gases from the vitrifier are initially water-quenched to less than 80 °C, and then pass through a mercury polishing unit before entering a catalytic process for conversion of hydrogen sulphide to elemental sulphur. The cleaned gas (effectively synthesis gas) is then available for use as a fuel in the combustors. The water quench, wet scrubbers, mercury polishing units and hydrogen sulphide removal system are all well-established, off-the-shelf technology.

The scrubber solutions contain hydrochloric acid, metal particulate, and mercury condensed from the off-gas. After filtration, the particulate removed from the scrubber solution is distilled in a retort combustor to recover mercury, and the remaining particulate material is returned to the vitrifier. The filtered solution is distilled to recover hydrochloric acid, and metals in solution are precipitated electrochemically.

Both the ingot metal and glass are tapped from the vitrifier periodically. The typical residence time for glass inside the vitrifier is 30-60 hours. Strong convection cells within the glass melt ensure that the pool is always well mixed. The high temperatures (the glass cannot be poured below 1000 °C), and long residence time ensure the absence of any organic contamination.

Leachability of toxic elements from the glass is extremely low. All investigations to date have reported the concentrations of all toxic elements sought as below detection limits.

### *3.9.2 Vitrifier Off-gas Treatment*

The Plasma-Arc boosted vitrifier operates without the feed/supply of oxygen and therefore a reducing atmosphere is established in the vitrifier and the subsequent off-gas cleaning system. The major advantage of the reduced atmosphere process in comparison to an oxidising atmosphere which involves an active supply of oxygen/air, is the much smaller volume of off-gas generated for vitrifier feed materials with a low content of carbon such as MSW fly and bed ash and contaminated soils. The main gas constituents are hydrogen and carbon monoxide as a result of the reducing, atmosphere, nitrogen from the nitrogen purge of the feed systems, suspended particulate (carry over), hydrochloric acid (HCl), hydrogen sulphide ($H_2S$). Additionally, volatile heavy metals such as mercury, cadmium, zinc and lead which are not incorporated in the vitrified matrix are present in the off-gas stream and require removal.

### *Gas Cooling*

The temperature of the off-gas from the Plasma-Arc boosted vitrifier is expected to be between 600 to 1,000 °C. For subsequent gas cleaning the temperature of the gas is required to be below 80 °C. This is achieved by injection of water into the gas stream (otherwise termed "water quench").

### *Off-Gas Scrubbing*

The presence of hydrochloric acid (HCl) in the vitrifier off-gas is a result of the thermal decomposition of calcium chloride contained in the fly ash from the MSW chain gas cleaning system. Under the plasma arc and glass bath condition (high temperature) and the reducing atmosphere the conversion of calcium chloride into hydrochloric acid is approximately 100%. The hydrochloric acid in the off-gas is removed via a 2 stage wet scrubber using a 2% (by weight) hydrochloric acid as scrubbing agent. The scrubbing solution enriches with hydrochloric acid until a concentration of 10% is achieved. The concentrated hydrochloric acid is retrieved from the bottom of the scrubber and the system replenished with fresh scrubbing solution (2% HCl) with an expected scrubbing liquid consumption of up to 3 cubic metres per hour. Two staged hydrochloric acid scrubber achieve HCl removal efficiencies of over 99% at operating temperatures of 60 to 75 °C. The raw acid (10% HCl) contains additionally recovered particulate from the off-gas and volatile heavy metals (Hg, Cd, Zn, Pb). The further treatment of the raw acid is described below.

### *Removal of Particulate Matter and Mercury Recovery from Scrubber Solution*

Any particulate matter leaving the vitrifier with the off-gas is recovered in the wet scrubber system for HCl removal (see below) and suspended in the raw acid. Additionally the raw acid will contain suspended elemental mercury. Under reducing conditions approximately 100% of the mercury present in the off-gas exists as elemental mercury. Suspended particulate and elemental mercury are separated by filtration. The retained solids are fed into a small retort distillation process to separate the elemental mercury from the non-metallic solids. The separation of mercury via distillation is a common process used for mercury separation and purification. The solid residue from the distillation process is recycled back into the vitrifier and incorporated into the glass. The retrieved mercury is sold as a product with purity in excess of 99%.

### *Recovery of Hydrochloric Acid and Heavy Metals*

The raw hydrochloric acid is treated further for particulate, mercury and removal of other heavy metals and finally distilled to a 22% technical grade hydrochloric acid. In the first step the acid is filtered to remove suspended particulates including elemental mercury. The filtrate free of suspended particulate is then fed into a distillation process to produce a 22% technical grade hydrochloric acid. Distillation of hydrochloric acid is a common process to purify and increase the final HCl concentration in a commercial product. During the distillation process the feed acid is depleted in HCl and the water concentration increases until the initial 2% concentration is achieved. Subsequently, the acid is fed into an electrochemical cell to recover and precipitate the heavy metals in elemental form as a dark grey powder on the electrode surface. The product is scraped off periodically and the powder stored and marketed as a product. The purified 2% hydrochloric acid is then recycled for re-use in the wet scrubbing process.

***Removal of Sulphur Compounds***

The off-gas from the vitrifier after hydrochloric acid, particulate and heavy metal removal contains as impurity, predominantly hydrogen sulphide and traces of elemental mercury vapour. Prior to removal of hydrogen sulphide ($H_2S$) an activated carbon polishing device will be installed to remove mercury and traces of hydrochloric acid to ensure a high quality sulphur product from the following treatment step. The spent activated carbon is recycled back into the vitrifier periodically.

The off-gas is then conveyed into a LO-CAT scrubber to remove the hydrogen sulphide producing sulphur (S) by oxidation with a water based iron system ($Fe^{2+}/Fe^{3+}$). The LO-CAT process is flexible in terms of hydrogen sulphide ($H_2S$) concentration and the quantity of off-gas requiring treatment and is the ideal process for the proposed vitrification process. The elemental sulphur (S) is sold as a product.

***Cleaned Off-Gas***

The cleaned off-gas purified from particulate, hydrochloric acid (HCl), hydrogen sulphide ($H_2S$), mercury and other volatile heavy metals consists predominantly of carbon monoxide (CO) and hydrogen ($H_2$) and is a useful fuel. The gas is fed into the MSW combustor where it contributes to electricity generation. Any residual hydrogen sulphide ($H_2S$) will be immediately oxidised in sulphur dioxide ($SO_2$) and traces of other compounds such as hydrochloric acid will be removed from the MSW combustor flue gas in the lime scrubbing system. No emissions from off-gas to atmosphere will result from this operational procedure.

***Organic Compounds***

The combination of extreme temperatures, high reactive radical concentrations, and intense ultraviolet light resulting from the plasma, destroy dioxins and any other organic contaminants with extremely high efficiencies. The strongly reducing atmosphere in the vitrifier and off-gas also ensures negligible re-formation of dioxins or other organic contaminants, and negligible contamination of products recovered from the off-gas.

***Quantities of Gas Cleaning Products***

The products from the vitrifier off-gas treatment system can be summarised into the following categories:

1. Hydrochloric Acid (22%)
2. Elemental Sulphur
3. Particulate
4. Mercury
5. Other heavy metals

Hydrochloric Acid (HCl)

The expected chlorine content of MSW and sewage sludge is approximately 0.6%. Ash from 12 MSW chains used as feedstock for the vitrifier will result in a maximum HCl recovery from the off-gas cleaning system of 50 tonnes of 22% HCl per day. As other wastes, other than MSW, sewage sludge and fly ash, will be processed in the vitrifier, the total quantity of 22% HCl per day will be approximately 75 tonnes.

Elemental Sulphur (S)

Based on the Auckland regional Waste Report of 1995 the average sulphur content in MSW is approx. 0.2% the maximum output of daily sulphur serving 12 MSW incineration chains is 6.6 tonne of elemental sulphur per day (the sulphur content in Perth MSW is likely to be similar). However, this assumes no removal of sulphur in the high temperature scrubbing, which is likely to decrease the ultimate elemental sulphur production from fly ash processing to approximately 2 tonne per day from the processing of fly ash.

The processing of other hazardous and non hazardous wastes in the vitrifiers may eventually increase the maximum daily output of elemental sulphur to 10 tonne per day.

Particulate

Particulate from the off-gas treatment system will not end up as a by-product but recycled back into the vitrifier for incorporation into the glass. The particulate is 2% of the feedstock which amounts to 100 kg per day for recycle back into the vitrifier.

Mercury

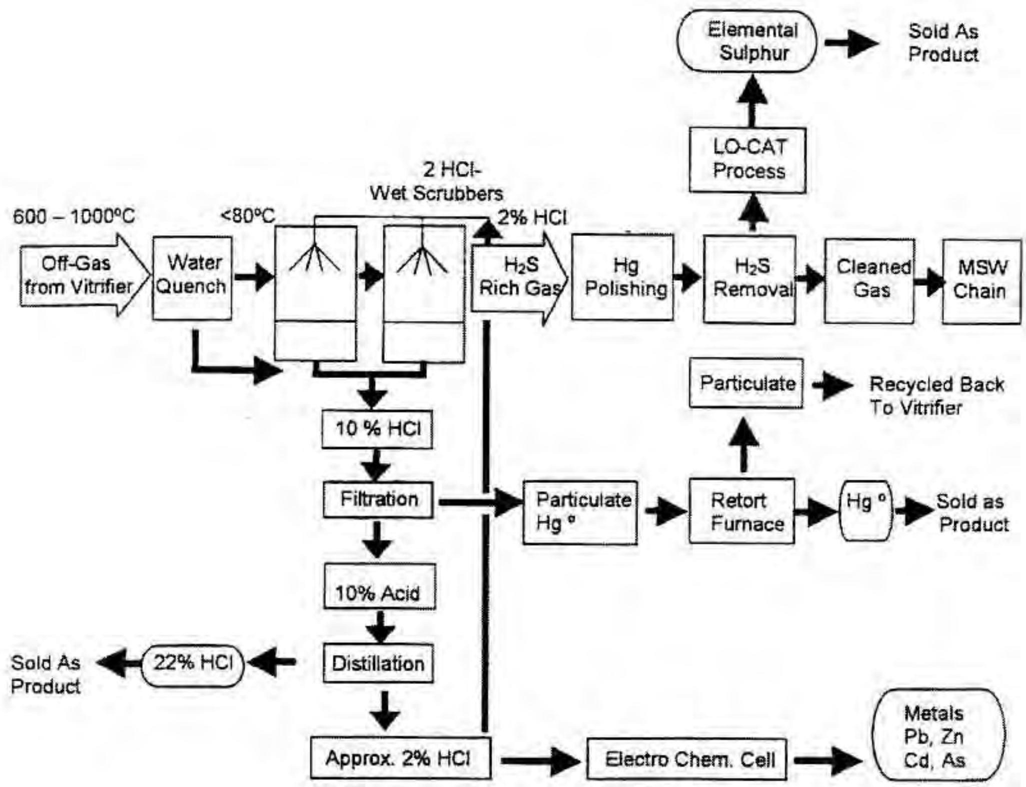
With a maximum expected mercury content of 10 gram per tonne of MSW the amount of mercury retrieved from the off-gas treatment system is approx. 34 kg per day.

Other Heavy Metals

The amount of other, heavy metals, less volatile than mercury, is expected to be in a similar range of output per day due to reduced volatility, a higher incorporation ratio into the glass but potentially higher concentrations than mercury especially for zinc (Zn) and lead (Pb).

A summary of the off-gas treatment system is shown below.

***Figure 3-24. Vitrification Gas Scrubbing***




## 3.10 MED PROCESS DESIGN AND OPERATION

### *3.10.1 Design*

MED units comprise a train of evaporative-condensers with a heat rejection condenser at the end. The low temperature differential allowance on each evaporator (effect) in the train allows a large number of effects to be utilised while maintaining a low brine discharge temperature, thus significantly increasing the Gain Output Ratio (GOR - a measure of energy efficiencies). MED units are powered by heat from the very low-pressure turbine exhaust steam (0.25 to 0.35 bar). Each MED unit has a capacity of 12,500 $m^3$/day and an average volume of 10,000 $m^3$/day. There are two units per turbine (total 8 units).

The inherent load-following capability of the MED allows regulation of output, automatically and proportionally to variations in motive steam input. In dual purpose installations (power and water production), the system will produce maximum quantities of fresh water during peak demand periods - up to 120% of the nominal rated output. During non-peak hours of electrical production, the MED can turn down to as low as 80% of nominal capacity without operator intervention.

MED plants utilise horizontal tube, falling-film evaporative-condensers in a serial arrangement, to produce through repetitive steps of evaporation and condensation,

# 4. JUSTIFICATION

As set out in Section 2.2, waste to energy is quickly becoming the preferred method of waste disposal worldwide. With this in mind, waste disposal is now one of the major concerns of local councils and other government organisations throughout Australia. The following table shows the status of existing landfills within the Perth Region indicating that four landfills are due to close by 2005 and that after that time only three landfills will be available to take MSW for the entire Perth Region. The Perth community are therefore at the point where a decision must be made as to whether to continue the current ultimately unsustainable landfill practices or opt for the use of new technological advances to ensure the wellbeing of future generations.

***Table 4-1. Status of Existing Landfills – Perth Region***

| Landfill | Approximate Closure Date[1] |
|---|---|
| Tamala Park | 2003 |
| Cardenup | 2020 |
| Red Hill | 2005 |
| Rockingham | 2020 |
| Cockburn | 2003 |
| Canning | 2002 |
| Quins Rock (Class 1 and 2) | 2020 |
| Kwinana (Class 1 and 2) | 2020 |
| Armadale | 2013 |
| Atlas Facility | - |

Within this context, the directors of GOWA have selected Kwinana as one of its leading waste to energy sites[2] for four key reasons:

1. Environmental Benefits;
2. Government Policy Support;
3. Economic and Social Benefits; and
4. Site Suitability.

## 4.1 ENVIRONMENTAL BENEFITS

The environmental benefits of the WTE&W proposal for Perth and Australia can be divided into five broad categories:

- Sustainable alternative to landfills;
- Greenhouse gas benefits;
- Safe disposal of hazardous waste;
- Recycling; and
- Site Location Synergies.

### *4.1.1 Sustainable Alternative to Landfills*

High temperature "Waste-To-Energy" provides a sustainable alternative to current landfilling practices. It is becoming an increasingly acceptable method of disposing of bulk refuse internationally. The primary reasons for this are:

1 Kwinana Town Council
2 Other proposed sites are located within New Zealand, Singapore and Kuala Lumpur

- Superior environmental performance when compared to landfill. All emissions can be effectively controlled and monitored. No waste management risks remain for future generations.
- The ability to recover energy, thereby contributing to the reduction of the use of fossil fuels to produce electricity. Mitigation of landfill gas, a serious potential global warming gas.
- The ability to totally combust all organic material and control emissions and by-product quality.
- Low impact on the immediate plant environment and community.
- Cost efficiency.

The use of effective combustion technology and state of the art air scrubbing and 24hr monitoring equipment removes any environmental liability. In contrast, the on-going liability of landfills is well documented.

### *4.1.2 Greenhouse Gas Benefits*

Over the last two centuries, methane's concentration in the atmosphere has more than doubled (IPCC 1996). Landfills are the largest single source of methane emissions in the United States accounting for 37% of yearly emissions.

Landfill gas is approximately 52% methane ($CH_4$) and 46% carbon dioxide ($CO_2$). While both are "greenhouse effect" gases, $CH_4$ is 21 times as "effective" as $CO_2$ (and can be up to 73 times more effective depending on the time scale which the release of methane is measured) as a global warming potential gas (GWP). Waste-to-Energy using UHTC produces more $CO_2$ than landfill, but prevents the release of the more potent $CH_4$ and is hence results in a substantial greenhouse credit (refer also Section 9.13).

Further, when the energy generated by Waste-to-Energy is applied to the production of electricity a corresponding reduction of the use of fossil fuels can be achieved, further benefiting the greenhouse balance.

### *4.1.3 Safe Hazardous Waste Disposal*

At present, Australia and many other countries do not have access to cost-effective and environmentally sound hazardous waste treatment facilities. The proposed vitrification facility fulfils this need. This vitrification process was developed jointly by the Battelle Research Institute, Richmond, Washington and Integrated Environmental Technology Ltd and is in commercial operation (refer Appendix I).

As described in Section 3.9, the vitrification process is used internationally as a safe and effective method of transforming wastes into glass. When soils and rock or inorganic oxides, are heated to temperatures greater than 1300 °C, the materials melt. In the high temperature, molten state, the liquid has a non-consistent crystalline structure and is vitreous. When the molten material cools, this non-crystalline, vitreous state is frozen into a solid glass. This creates an inert safe material which can be manufactured into a variety of products. The proposed vitrifiers also comprise a plasma arc enhancement which completely destroys all organic compounds.

### 4.1.4 *Recycling*

The WTE&W plant provides an additional tier of recycling beyond Council initiated recycling programs and waste transfer stations. The project incorporates the recycling of glass, metals, green waste and chemicals. Glass will be stored on-site and vitrified into valuable useable glass products. Metals will be recovered from the bed ash through the magnetic ash screening plant which will separate the steel clinker from the ash aggregate. An enclosed composting facility will also be established which will process 240 tonnes of compost per day on a 21 day cycle. Furthermore, metals will be recovered from the vitrifier and vitrifier off-gas together with sulphur and hydrochloric acid.

An integrated approach of composting, recycling and "Waste-To-Energy" results in environmental benefits. This is demonstrated in European countries, which combine high levels of energy generation from combustion of waste with high recycling and composting rates (refer Section 2.2.2).

### 4.1.5 *Site Location Synergies*

The location of the WTE&W plant on Lot 15 Kwinana Industrial Estate provides for a number of synergies with positive environmental benefits:

- Site Decontamination
- Reduction of Industrial Airborne Wastes
- Utilisation of Existing and Proposed Infrastructure
- Proposed Port Facility Benefits

#### *Site Decontamination*

Both the incineration and vitrification processes provide the opportunity for the remediation of Lot 15, Kwinana. Contaminated groundwater will be drawn from the ground and used in the high temperature gas scrubbing (SNCR) process, allowing for the destruction of any hydrocarbon or organic contaminants. Clean water will then be returned to the groundwater system. On-site contaminated soils and stored wastes will be processed in the vitrifiers into useable and safe valuable glass products. A long-term site decontamination program will be developed once current site contamination investigations are complete.

### 4.1.6 *Reduction of Kwinana Industrial Wastes*

The facility has potential to contribute to an overall improvement in the air quality of the Kwinana industrial area, by taking industrial wastes such as flare off gas from BP Kwinana. The plant will also process industrial wastes (through vitrification) created by existing industries within the Kwinana area, thereby reducing the risk to the local environment.

### 4.1.7 *Utilisation of Existing and Proposed Infrastructure*

The project will utilise existing power transmission, gas transmission and roading infrastructure. There is also future potential to use the existing rail Kwinana rail line, which does not form part of this application.

James Point Pty Limited (JPPPL) has a proposal to construct a new port in stages at James Point over the next five to 15 years. The port facility will benefit the site by facilitating the convenient export of by-products.

## 4.2 GOVERNMENT POLICY BENEFITS

The Perth WTE&W project will advance the following State Government policy objectives:

- Hierarchy of waste priorities;
- Reduction of waste going to landfill;
- Production of electricity using biomass; and
- Reduction of greenhouse emissions.

### *4.2.1 Hierarchy of Waste Priorities*

Waste disposal is the last option in the Commonwealth's Hierarchy of Waste Management Priorities. The Perth WTE&W project will reduce the current reliance on waste disposal in Western Australia, reusing approximately 75% of Perth's MSW as electricity, aggregate (from bed ash) and compost (from greenwaste). The vitrifiers also provide for the reuse of hazardous/contaminated wastes by production of glass and extraction of mercury, metals, hydrochloric acid and sulphur. The WTE&W project will also provide for further recycling (beyond current recycling programs and the transfer station) with the removal of non-ferrous and ferrous metals within the bed ash screening plant.

### *4.2.2 Reduction of Landfilled Waste*

A recent survey established that approximately 1.5 million tonnes of waste was disposed to landfill during 1997 (DEP, 1997-98). Once fully operational, the Perth WTE&W project will reuse and recycle 1,200,000 tonnes of solid waste per annum, representing approximately 70% of waste currently going to landfill. This will achieve the government objective of a 50% reduction in waste going to landfill by the year 2003 within the Perth region.

### *4.2.3 The Production of Electricity Using Biomass*

The total WA South West annual electricity energy sold in 1996/97 was around 17,000 GWh. The Perth WTE&W project will generate approximately 600-650 GWh of biomass electricity per annum[3] which represents 3.5-3.8% of the West Australia State electricity. The project therefore contributes substantially towards meeting the Energy Minister's biomass electricity production target of 4.5% before 2010.

### *4.2.4 Reduction of Greenhouse Gas Emissions*

The proposed WTE&W project will significantly reduce the emissions of methane in the Perth Region by reducing landfilling. The biomass electricity produced by the project will also offset the burning of an equivalent amount of fossil fuels to produce electricity, thereby further reducing the emission of greenhouse gases. The project will therefore assist in meeting Australia's commitment of 108% of the 1990 greenhouse emission level by 2008 to 2012.

## 4.3 ECONOMIC AND SOCIAL BENEFITS

The proposed WTE&W project will result in significant economic and social benefits for the Perth region. In economic terms, the project represents a $520 million (AU) investment in the Kwinana area with an anticipated $150 million per year annual revenue.

[3] Based on 62% – 72% biomass energy content in MSW (see Greenhouse Environmental Impacts – Section 9.13)

Socially, the project will result in increased employment opportunities for the local population. The construction period is anticipated to take two years and employ up to 300 people at any one time. Once fully operational, the WTE&W plant will employ up to 50 people full time, half of which will be unskilled.

## 4.4 SITE SUITABILITY

Another key reason for selecting Perth to locate one of GOWA's waste to energy and water plants is the ideal location and suitability of the site at Kwinana for such a development. Like many projects of a regional scale, there are specific location and operational requirements of any site to provide for efficiencies and environmental considerations.

### *4.4.1 Site Location Requirements*

A WTE&W plant should be sited to meet the following location criteria.

- Location within close proximity to a large refuse generator (i.e. major industry and/or town/city);
- Preferably separated from any residential area to provide a noise buffer;
- Within close proximity to a large water body for cooling water and possible water desalination (sea);
- Close to main regional roads to provide for direct truck access;
- Close to main rail corridors to allow potential rail access;
- Close to the main electricity grid;
- Preferably close to other industries which provide synergies with the plant operation; and
- Must be near port, rail and road infrastructure to accommodate the large tonnage throughputs and the water desalination.

### *4.4.2 Site Operation Requirements*

Any WTE&W plant site should meet the following operational criteria:

- Must be of a sufficient size to allow for the integration of all technologies, and convenient truck and possible rail access and manoeuvring.
- Must be of sufficient size to provide a buffer between the plant and surrounding development in order to meet all dangerous goods and health and safety requirements.
- Should be relatively flat to facilitate rail and truck manoeuvring.
- Must be geotechnically stable with minimal potential for earthquake risk.
- Must be devoid of any significant vegetation, habitat or any significant cultural site.

In this case, Lot 15, Kwinana Industrial Estate provides for the following location and operational advantages which make the site ideally suited for the WTE&W industry.

- The site is located on the fringe of the wider Perth metropolitan area providing for the efficient receival processing of the wider metropolitan area's waste.
- It is well separated from any residential area allowing for an effective noise buffer;

- The plant will be located within 700 m of Cockburn Sound allowing for the direct intake of cooling and desalination water.
- The site is located close to the Fremantle – Rockingham Highway, providing for direct truck access. The northern site boundary is also located within 400 m of the proposed Anketell Road extension which will potentially improve vehicle access.
- The eastern site boundary adjoins the Kwinana Industrial area rail line allowing for direct rail transport, subject to necessary future approvals.
- The site will be located close to a future port facility allowing for the import and export of Olivine mineral and export of by-products by ship.
- The area contains high voltage lines currently used as part of the BP Oil generation plant. These lines can be easily upgraded to meet the requirements of the WTE&W facility.
- The proposal will provide for the decontamination of Lot 15.
- The plant has various synergies with surrounding industries including the use of BP flare gas as fuel, piped supply of nitrogen from Liquid Air and the ability to treat waste from surrounding industry.
- The 70 ha site, is of sufficient size to allow for the development of all existing and future technologies and convenient truck and rail access.
- The site also is of sufficient size to provide a buffer between surrounding industries, particularly the BP refinery, in order to meet hazardous zone requirements.
- The site is flat and geotechnically stable.
- It is devoid of any significant vegetation, habitat or cultural site.

each at a lower temperature and pressure, a multiple quantity of distillate from a given quantity of low grade input steam.

Any number of evaporative-condensers (effects) may be incorporated in the plant's heat recovery sections, depending on the temperature and cost of the available low-grade heat, and the optimal trade-off point between investment and steam economy.

Technically the number of effects is limited only by the temperature difference between the steam and seawater inlet temperatures (defining the hot and cold ends of the unit) and the minimum temperature differential allowed on each effect.

### *3.10.2 Process*

The incoming seawater is de-aerated and preheated in the heat rejection condenser, and then divided into two streams. One is returned to the sea as the coolant discharge, and the other becomes feed for the distillation process.

The feed is pre-treated with a scale-inhibiting additive and introduced into the lowest temperature group of heat recovery effects. A spray nozzle system distributes it over the top rows of tubes in each effect where it flows in thin films down each bank of tubes, and part of it vaporises as it absorbs the latent heat released by steam condensing inside the tubes.

The remaining feed, now slightly concentrated, is pumped to the next group of effects, which operate at higher temperatures. There, the spray and evaporation procedure is repeated. The remaining feed is pumped onward again until it leaves the hottest group of effects as concentrated brine.

The input steam is fed into the tubes of the hottest effect. There it condenses, giving up its latent heat to the saline water flowing over the outer surface of the tubes. While condensation is taking place on the inside of the tubes, a nearly equal amount of evaporation occurs on the outside. After passing through the brine droplet separator, to maintain distillate purity, the vapour is drawn into the tubes of the next effect, which operates at a slightly lower temperature and pressure.

The evaporation-condensation process is repeated along the entire series of effects, each of which contributes a significant amount of additional distillate. The vapour from the last effect is condensed by seawater coolant in the heat rejection condenser.

The condensate from the first effect is collected, and part of this distillate is returned to the steam generator; the excess above the original quantity of motive steam flows into the first of a series of special chambers, each of which is ducted to the cooler condensing section of the next effect. Part of the distillate flashes off, cooling the remaining product stream, while returning the heat given off to the main body of heat recovery effects.

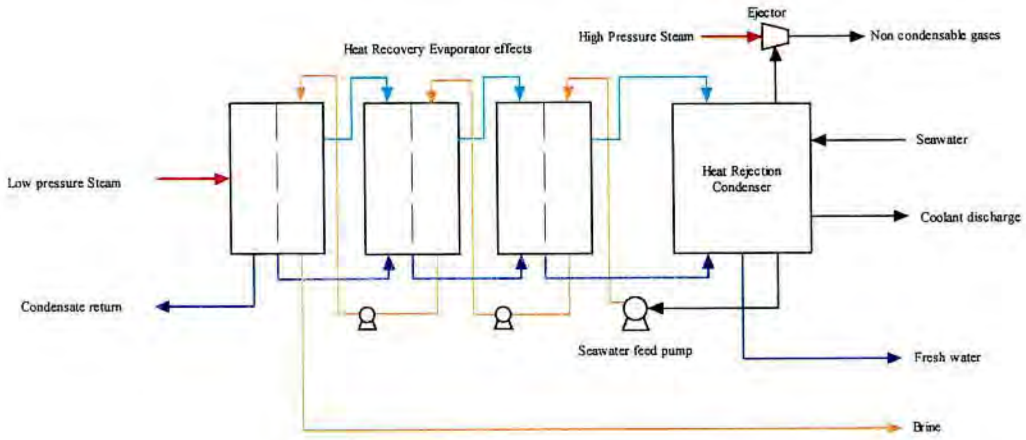
The flowing product steam is thus cascaded and flash-cooled in stages. The heat which is given off increases the total efficiency of the process. The cooled distillate is finally discharged to storage by the product delivery pump. The product is totally pure water. It is fresh, potable and soft, averaging less than 10 ppm TDS.

The concentrated brine from the hottest effect is, like the distillate, cascaded through a series of brine flash tanks and flash-cooled to recover its heat. After cooling, it is returned to the sea via the brine pump.

Non-Condensable Gases (NCG) are bled from each tube and flow collectively from one effect to the next. They are eventually concentrated at the coolest end of the heat rejection condenser, and evacuated by a steam jet ejector or mechanical vacuum pump.

The MED process is summarised in Figure 3-25 and Figure 3-26. A photo of a MED unit is also shown as Figure 3-8.

***Figure 3-25. MED Process***



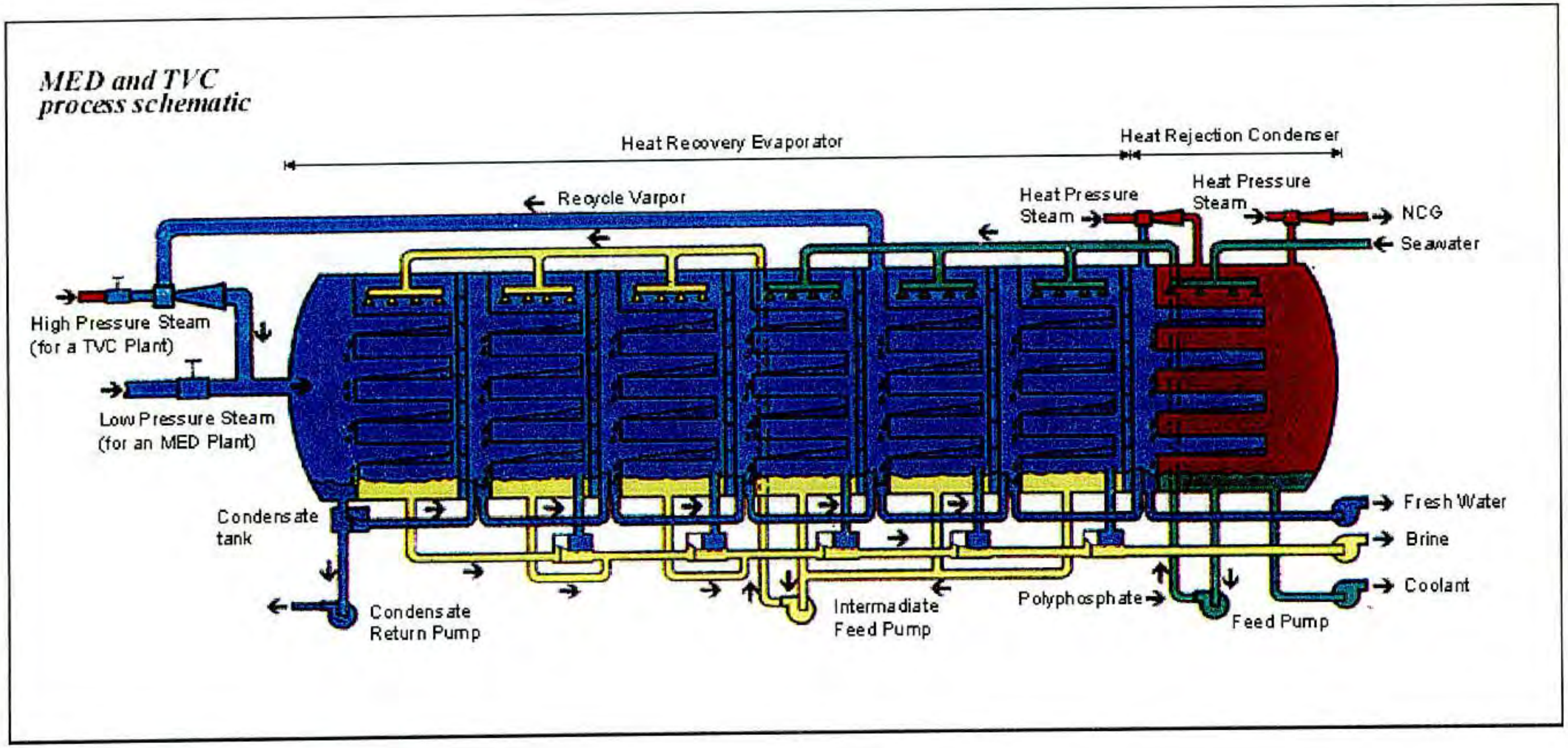



Figure 3-26. MED Schematic

Energy, Water & Materials from
Waste & Biomass Resources

## 3.11 COMPOST PLANT PROCESS DESIGN AND OPERATION

### *3.11.1 Design*

The composting plant is designed to accept up to 56,000 tonnes per annum of green waste. This greenwaste is typically about 20% woody material and 80% soft green material. Overall the moisture content is about 50% on a wet basis.

In the first stage of development, it is expected that up to 56,000 tonnes of green waste per annum will be processed. It is envisaged that this volume will increase to approximately 100,000 tonnes per annum after about 2 to 3 years, and will necessitate the construction of an additional compost building, subject to any necessary further approvals. Ventilation requirements for the second building will be addressed when it is required.

### *3.11.2 Process*

Raw material is shredded and placed into 45 m long windrows that are 3 m wide. The bays are made up of concrete slabs placed 3 m apart that allow the compost to be built up to 3 m in height at the intake end of the windrow. After 21 days composting, these windrows will generally decrease in height to about 2 m. The average height in the windrow is thus 2.5 m.

The compost remains in the windrows for about 21 days until the initial rapid thermophilic stage one composting phase has been completed. During this time the windrow is turned approximately once per two to three days depending on the degree of compaction that takes place in the windrow. The turning assists with aeration mainly by ensuring that the windrow mass retains an open structure so that air can pass easily through.

The preferred method of composting for this plant is the aeration assisted static pile system in which air is provided by means of an under-windrow ventilation pipe system.

Ventilation air is needed for the following reasons;

- To maintains aerobic conditions in the composting mass;
- To remove excess heat and maintain a temperature of about 55 °C; and
- To dry the compost from about 100% to 40% on a dry basis

The most significant of these requirements is the need to remove heat and maintain the temperature at about 55 °C. To achieve this, the forced aeration is controlled by temperature sensors in the compost mass. The aeration fans are activated when the temperature of the compost mass exceeds the set point of a few degrees above 55 °C.

Ventilation air is drawn from inside the building and supplied to the compost at an average rate of 1.2 $m^3$ $min^{-1}$ per tonne or 1.5 $m^3$ $min^{-1}$ per cubic meter of compost.

Air that has passed through the compost contains a mixture of gases, some of which are odorous. These gases include water vapour, ammonia, carbon dioxide, and trace quantities of other gases such as hydrogen sulphide, higher order sulphides, and organic acids and aldehydes. These are vented directly into the composting building from where they are extracted to the main MSW hall and combusted in the combustors. There will be no continuous discharges directly to the outside ambient air.

The final phase involves the curing of the compost product over a 2 week period. Compost from the plant will be stored in large outdoor tilt slab wall bins which will drain to a sealed bunded area into a specifically designed catch basin. In line with conventional practice, the collected leachate will be spread back over the curing compost. No disposal of leachate will be required. Compost and leachate during this final phase is non-odorous.

## 3.12 PLANT WATER EMISSIONS

The GOWA development will require cooling water drawn from Cockburn Sound at a maximum rate of 4.2 $m^3$/s. Approximately 80% of the water taken will be returned to the Sound via a discharge channel leading to a shoreline discharge, the other 20% will be used by a desalination plant in the production of desalinated water. The return water will be slightly denser than the receiving water of Cockburn Sound.

At this stage there are two options for the proposed water intake. The preferred option will be to source the intake water by pumping directly from Cockburn Sound. It is envisaged that an inlet will be sited to the north of James Point in a location chosen through negotiations with James Point Pty Ltd (JPPL), possibly under the existing BHP No. 2 jetty. The structure would be designed to keep inlet velocities at around 1 m/s to minimise any potential harm to pelagic marine life. The design of the inlet will be undertaken in consultation with the Department of Environmental Protection (DEP). If the preferred option is found to be flawed on technical or commercial issues, then GOWA will seek to source intake water from the existing British Petroleum (BP) Refinery intake under agreement with BP. This will be subject to further negotiation between GOWA and BP on commercial aspects.

The cooling water will discharge to the shoreline via an open channel running west along the northern boundary of the plant heading directly into Cockburn Sound. There is an existing channel and drain to Cockburn Sound along this route and this will be used if feasible.

JPPL have a proposal (JPPL, 1999) to construct a port in stages at James Point over the next five to fifteen years. At present it is intended that the cooling water discharge scheme will be incorporated in the final stage of the port development. The scheme assumes that the GOWA discharge will be combined with the discharge from BP when the development occurs. The final location of the discharge and the combination with BP's discharge will be subject to further negotiation between GOWA, JPPL and BP over the next five to ten years.

The intake and discharge option are shown as Figure 3-13 and Figure 3-14.

### 3.12.1 *Cooling water discharge characteristics*

The GOWA proposal will impact on the marine environment through the discharge of warm, hyper-saline cooling water which will be approximately 32 °C at the point of discharge and at a salinity of 48 ppt in summer and 60 ppt in winter. It is intended that the cooling water be discharged to the Sound at a rate of between 1.42 $m^3$/s in winter and 3.34 $m^3$/s in summer with all flows to be gravity driven.

The desalinator design will be such that the water volume requirements for desalination feed and for cooling will be independent of seawater feed temperature. The equipment will be designed to run with a feed temperature of 24 °C. At lower feed temperatures a heat exchanger will transfer heat from the brine and coolant discharge back to the incoming feed water to maintain a feed temperature of 24 °C.

An anti-scalant will be added to the feed water at 5 ppm. The chemical data for the anti-scalant (ID-204) is included in Appendix M. ID-204 meets stringent specifications. Its active ingredients appear on the approved list of the United States Food and Drug Administration Section 173.310. Furthermore, the ingredients also have the approval of the United States Environmental Protection Authority (US EPA) for use in potable water-producing evaporators.

## 3.13 PLANT AIR EMISSIONS

### *Approach to assessment of emissions from the proposed WTE&W plant*

Assessment of the level of emissions from the proposed Waste-to-Energy and Water plant at Kwinana is based on comprehensive assessments by the US EPA of the emission levels achieved by operating MSW combustors, hazardous waste combustors and medical waste combustors in America and elsewhere, as a basis for establishment of the US emission standards for these facilities. The EPA follows a rigorous procedure of data collection and analysis to arrive at the most stringent reasonable emission limits which it is confident can be achieved by facilities using specified technology. It assumes that the critical components of facilities will be well designed and properly operated, but not to unusually high standards. The emphasis is on defining emission limits which will definitely be achievable, given reasonably good design and operation. The procedure followed by the US EPA gives a very good assurance that any facility using the technology specified as the basis for the EPA emission standards can be expected to meet those standards.

For Municipal Waste Combustors, the US EPA has determined that the emission controls required to achieve its emission standards for new facilities are:

- selective non-catalytic reduction (SNCR)for $NO_x$ control
- spray dryer, typically using lime, primarily for control of acid gases and dioxins emissions
- activated carbon injection, primarily for control of dioxins and mercury emissions
- fabric filter, for control of particulate material, dioxins, mercury, and heavy metals emissions.

Olivine ultra high temperature combustors incorporate all of the technologies specified by the US EPA as their MACT (Maximum Achievable Control Technology) floor controls which, in well designed and competently operated combustors can confidently be expected to meet the US EPA emission standards for new combustors. The Olivine combustors also incorporate a number of enhancements, in addition to the US EPA MACT floor controls, summarised below:

- Unusually long residence times for combustion gases in the primary and secondary combustion zones, at unusually high temperatures (1050-1150 °C), maximising burn-out of organic materials, including precursor compounds and carbonaceous catalytic materials which contribute to formation of dioxins via de-novo synthesis.

- A high degree of temperature "buffering" of combustion zone temperatures by the thermal mass of the Olivine panels making up the unusually large combustion chambers.
- The absence of possible "cold paths" associated with combustion zone water walls.
- An oxygen-deficient bed of burning MSW and oxygen-deficient primary combustion zone, combined with a very rapid transition between the primary and oxygen-rich secondary combustion zones, giving unusually low $NO_x$ concentrations in the untreated flue gases.
- High temperature lime scrubbing made possible by the high temperature of secondary combustion zone, which, unlike lower temperature processes, accommodates the calcining of limestone. This, together with the long residence times at high temperatures optimises the production of gypsum from the sulphur gases. This lime addition ahead of the boilers is also expected to decrease dioxin formation in the boilers by de-novo synthesis.
- Extensive monitoring of critical parameters at key points through the combustion and pollution control systems, with the data being used for process optimisation through a fuzzy logic system.
- A multiple unit, modular approach to overall combustion facility design, minimising the scale of possible effect from any process malfunction, providing the ability to switch loads quickly between units in the event of malfunction, and for any repairs to be carried out with minimum disruption of overall plant operation.

The combination of the US EPA MACT floor control technology with a substantial number of enhancements provides a very good assurance that the Kwinana ultra high temperature combustors will achieve emissions in comfortable compliance with the US EPA and the similar European Commission (EC) emissions standards for municipal waste combustors.

Operating data from the Olivine USA combustor at Bellingham, indicates emission concentrations in compliance with the US EPA standards for new combustors for sulphur dioxide, hydrogen chloride, oxides of nitrogen ($NO_x$), particulates and carbon monoxide. The Bellingham combustor did not use activated carbon, and dioxin emission concentrations were within the ranges expected on the basis of the US EPA data for combustors without activated carbon injection. Data presented by the US EPA shows that, for plants achieving the Bellingham plant dioxin emission concentrations (or significantly above) without activated carbon, addition of activated carbon injection can be confidently expected to result in dioxin emissions concentrations in compliance with the US EPA standards.

### *Emission Limits*

GOWA proposes that the Kwinana Plant be subject to emission limits established for municipal waste combustors by the European Commission (EC) in December 1998 for total particulates, hydrogen chloride, hydrogen fluoride and dioxins. These EC emission limits are slightly more stringent than the corresponding US EPA limits. It is proposed that the US EPA limits for new combustors for lead, cadmium and carbon monoxide apply to the plant.

Because of the importance of minimising sulphur dioxide emissions into the Kwinana airshed, it is proposed that each of the two stacks of the WTE&W plant be subject to the EC maximum half-hour average sulphur dioxide concentration limit, and a combination of other limits not to be exceeded for specified percentages of time as set out in Table 3-2. Because it is very unlikely that both stacks would be at maximum sulphur dioxide emission rates simultaneously, the proposed half-hour average limits are approximately equivalent to half of the EC emission limit applying to the combined discharges from the two stacks. The other percentage limits are approximately equivalent to 60% of the EC 24-hour average limit for the combined discharges from the two stacks.

Further, because final sulphur dioxide concentrations are controlled predominantly by the rates of lime dosage into the scrubber systems relative to sulphur content of the waste feed, sulphur dioxide emissions can be controlled, as demonstrated in plants such as that at Spokane (Washington State), to substantially lower concentrations than half the European limits. GOWA is proposing that, after the first year of operation of the Kwinana plant, the sulphur dioxide emission limits be reviewed, with a view to substantial reductions of the emission limits in light of what is realistically achievable for the plant and local waste streams.

There is also a possibility of the Kwinana WTE&W plant receiving high sulphur waste streams from the adjacent refinery, which would result in a overall decrease in sulphur dioxide emissions to the Kwinana airshed. This would result from removal, in the air pollution control systems of the combustors, of the sulphur dioxide from combustion of the refinery waste streams, followed by recovery as elemental sulphur after treatment of fly ash in the vitrifiers. The sulphur is recovered from the vitrifier off-gas cleaning system. This will occur for all sulphur dioxide removed in the wet/dry scrubber of the ultra high temperature units.

GOWA recognise that emissions of oxides of nitrogen ($NO_x$) should be minimised to the greatest extent practical in view of their possible contribution to photochemical smog in the Perth region under some conditions. It is proposed that the plant be subject initially to the EC emission limits for $NO_x$. Operating data from the Olivine Bellingham plant indicates that the Olivine design approach gives significantly lower concentrations of $NO_x$ in untreated flue gas than in MSW combustors of other designs. This provides a basis for achieving the lowest possible $NO_x$ emission levels after SNCR treatment. GOWA proposes that the $NO_x$ emission limits be reviewed after one year of operations with a view to decreasing these emission limits.

Table 3-2 sets out the proposed emission limits for the WTE&W plant together with estimates of probable average concentrations for contaminants whose concentrations are likely to be significantly below the emission limits. Probable average concentrations for hydrogen chloride, hydrogen fluoride and particulates are at least a factor of two lower than the 24 hour average limits given.

***Table 3-2. Proposed emission limits for the Kwinana WTE&W plant.***

| Emission concentration | Emission rates per stack at plant loading: Average | Emission rates per stack at plant loading: Maximum | Emission rates for whole plant at plant loading: Average | Emission rates for whole plant at plant loading: Maximum | |
|---|---|---|---|---|---|
| $mg/m^3$ at 11% $O_2$, $0^oC$, dry | g/sec | g/sec | g/sec | g/sec | |
| **Sulphur dioxide ($SO_2$)** | | | | | |
| 200 | 26 | 31 | * | * | Each stack not to exceed 98% of time |
| 100 | 13 | 15 | | | Each stack not to exceed 95% of time |
| 50 | 6 | 8 | | | Each stack not to exceed 85% of time |
| 25 | 3.2 | 3.9 | | | Each stack not to exceed 70% of time |
| 15 | 1.9 | 2.3 | | | Each stack not to exceed 50% of time |
| **Oxides of nitrogen ($NO_x$ expressed as $NO_2$)** | | | | | |
| 400 | 51 | 62 | 103 | 123 | Half hour average limit |
| 200 | 26 | 31 | 51 | 62 | 24-hour average limit |
| 100 | 13 | 15 | 26 | 31 | Probable average |
| **Hydrogen chloride (HCl)** | | | | | |
| 60 | 8 | 9 | 15 | 18 | Half hour average limit |
| 10 | 1.3 | 1.5 | 2.6 | 3.1 | 24-hour average limit |
| **Hydrogen fluoride (HF)** | | | | | |
| 4 | 0.5 | 0.6 | 1.0 | 1.2 | Half hour average limit |
| 1 | 0.13 | 0.15 | 0.26 | 0.31 | 24-hour average limit |
| **Particulates** | | | | | |
| 30 | 3.9 | 4.6 | 8 | 9 | Half hour average limit |
| 10 | 1.3 | 1.5 | 2.6 | 3.1 | 24-hour average limit |
| **Carbon monoxide (CO)** | | | | | |
| 90 | 12 | 14 | 23 | 28 | 4 hour average |
| 20 | 2.6 | 3.1 | 5.1 | 6.2 | Probable average |
| **Mercury (Hg)** | (Concentrations $\mu g/m^3$ and emission rates mg/sec) | | | | |
| 50 | 6 | 8 | 13 | 15 | Any test or average of triplicate test |
| 25 | 3.2 | 3.9 | 6.4 | 7.7 | Probable average |
| **Cadmium (Cd)** | (Concentrations $\mu g/m^3$ and emission rates mg/sec) | | | | |
| 14 | 1.8 | 2.2 | 4 | 4 | Any test or average of triplicate test |
| 1 | 0.13 | 0.15 | 0.26 | 0.31 | Probable average |
| **Lead (Pb)** | (Concentrations $\mu g/m^3$ and emission rates mg/sec) | | | | |
| 140 | 18 | 22 | 36 | 43 | Any test or average of triplicate test |
| 12 | 1.5 | 1.8 | 3.1 | 3.7 | Probable average |
| **Dioxins/furans** | (Concentrations ng I-TEQ/$m^3$ and emission rates $\mu g$ I-TEQ/sec) | | | | |
| 0.1 | 0.013 | 0.015 | 0.026 | 0.031 | Any test or average of triplicate test |
| 0.01 - 0.05 | 0.001 - 0.008 | | 0.002 - 0.015 | | Probable average |

* See probabilistic assessment following.

A probabilistic assessment indicates that the sulphur dioxide emissions regime will result in the following emission rates from the whole plant:

- not to exceed 28 g/sec for at least 98% of time
- not to exceed 18 g/sec for at least 95% of the time
- not to exceed 12.2 g/sec for at least 90% of the time
- not to exceed 8.5 g/sec for at least 80% of the time
- not to exceed 4.6 g/sec for at least 50% of the time

It is not proposed that emission limits be established for heavy metals other than lead cadmium and mercury. Although the EC gives limits for combined total emissions of cadmium and thallium, and for antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel and vanadium, the air quality and health effect basis for these combined limits is obscure and questionable. The US EPA have targeted their heavy metal emission limits to mercury, cadmium and lead, because these are the heavy metals most likely to give elevated emissions if present at high concentrations in the waste feed. If the emissions of these elements do not exceed their respective limits, the emission concentrations of other heavy metals and toxic elements are very unlikely to be of concern. Regular emissions testing will be undertaken to confirm that emissions of all heavy metals levels are low.

Table 3-3 sets out the proposed emission limits for the WTE&W plant, together the relevant European Commission (EC, 1998), US EPA (US EPA, 1998), NHMRC (AEC/NHMRC, 1985) and Victoria emission limits. . The proposed limits are the more stringent of the EC and US EPA limits for each contaminant.

The NHMRC and Victoria Schedules no not specify the %oxygen to which the emission limit should be referred for several of the pollutants, and this is assumed to be 7% in those cases. Conversion to 11% oxygen for comparison with the proposed limits for the WTE&W plant then gives a more stringent interpretation than may be appropriate. Some of the limits are expressed at 12% $CO_2$, which is taken as equivalent to 7% oxygen, the relationship which normally applies for combustion sources. Figures in Table 3-3 given for the NHMRC and Victoria limits are expressed at both the original concentrations, and at 11% oxygen for comparison with the proposed limits for the WTE&W plant. For particulates, the two lower limits for Victoria are calculated from the process weight and emission rate limits for particulate matter, as these would apply to the WTE&W plant.

In all cases, the proposed emission limits are substantially more stringent than the NHMRC limits, which are of limited relevance to the project. The only Victoria limit which may be more stringent than those proposed is for oxides of nitrogen, for new sources in Air Quality Control Regions, which is about 10% lower than that proposed for the WTE&W plant. However, whether this is more stringent in practice depends on exactly how the Victoria limits are applied, in terms of such matters as averaging times.

For antimony, arsenic, nickel and some of the miscellaneous heavy metals, NHMRC and Victoria give limits where none are proposed for the WTE&W plant. However, as discussed above, the limits of lead and cadmium will provide control on the emissions of the other heavy metals. Also, the NHMRC and Victoria limits are so high that there is no prospect of the WTE&W plant emissions ever approaching them.

### *Table 3-3 Proposed emission limits and limits from regulatory agencies*

| Proposed limits | Averaging time | EC | US EPA | NHMRC | | Victoria | | |
|---|---|---|---|---|---|---|---|---|
| mg/m$^3$ at 11% $O_2$, 0°C, dry | | | | 11% $O_2$ | 7% $O_2$ | 11% $O_2$ | 7% $O_2$ | a |
| **Sulphur dioxide ($SO_2$)** | | | | | | | | |
| 200 (98%)$^{+}$ | 1/2 hour$^{++}$ | 200 | - | | | | | |
| 100 (95%) | 24-hour$^{++}$ | 50 | 60/80%$^{\#}$ | | | | | |
| 50 (85%) | | | | | | | | |
| 25 (70%) | | | | | | | | |
| 15 (50%) | | | | | | | | |
| **Oxides of nitrogen ($NO_x$ expressed as $NO_2$)** | | | | | | | | |
| 400 | 1/2 hour | 400 | - | 571 | 800 | 357 | 500 | H |
| 200 | 24-hour | 200 | 220 | | | 713 | 1000 | G |
| **Hydrogen chloride (HCl)** | | | | | | | | |
| 60 | 1/2 hour | 60 | - | | | | | |
| 10 | 24-hour | 10 | 29/95% | 285 | 400 | | | |
| **Hydrogen fluoride (HF)** | | | | | | | | |
| 4 | 1/2 hour | 4 | - | 36 | 50 | 36 | 50 | |
| 1 | 24-hour | 1 | - | | | | | |
| **Particulates** | | | | | | | | |
| 30 | 1/2 hour | 30 | - | 178 | 250 | 178 | 250 | H |
| 10 | 24-hour | 10 | 17 | | | 357 | 500 | G |
| | | | | | | 32 | | H |
| | | | | | | 36 | | G |
| **Opacity** | | | | | | | | |
| 10% | 6 minute | - | 10% | 20% | | | | |
| **Carbon monoxide (CO)** | | | | | | | | |
| 90 | 4-hour | - | 89 | 713 | 1000 | 1783 | 2500 | H |
| µg/m$^3$ at 11% $O_2$, 0°C, dry | | | | 11% $O_2$ | 7% $O_2$ | 11% $O_2$ | 7% $O_2$ | |
| **Mercury (Hg)** | | | | | | | | |
| 50 | Any test* | 50 | 57/85% | 2140 | 3000 | - | - | |
| **Cadmium (Cd)** | | | | | | | | |
| 14 | Any test* | 50$^{\#\#}$ | 14 | 2140 | 3000 | | 3000 | B |
| **Lead (Pb)** | | | | | | | | |
| 140 | Any test* | | 140 | - | - | 7133 | 10000 | B |
| **Nickel (Ni)** | | | | | | | | |
| | - | - | - | 14265 | 20000 | 14265 | 20000 | B |
| **Antimony (Sb)** | | | | | | | | |
| | - | - | - | - | - | 7133 | 10000 | B |
| **Arsenic (As)** | | | | | | | | |
| | - | - | - | - | - | 7133 | 10000 | B |
| **Miscellaneous heavy metals** | | | | | | | | |
| | Any test* | 500$^{\#\#\#}$ | | 7132** | 10000 | 7132^^ | 10000 | B |
| ng I-TEQ/m$^3$ at 11% $O_2$, 0°C, dry | | | | | | | | |
| **Dioxins/furans** | | | | | | | | |
| 0.1 | Any test* | 0.1 | 0.14 | - | - | - | - | |

$^{+}$ % figures are percentages of time emissions are not to exceed stated concentration

$^{++}$ applies to EC and US EPA limits only. Proposed percentage of time limits for WTE&W plant are more stringent than either EC or US EPA limits

a. Schedule of Victoria Emission Limits
G Emission limits for stationary sources
H Emission limits for new stationary sources in Air Quality Control Regions
B Both of the above Schedules

\# concentration/optional % removal from raw flue gas

* any test or average of triplicate test

\#\# total of cadmium plus thallium

\#\#\# total of antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel and vanadium.

** total of arsenic, cadmium, lead, mercury and vanadium

^^ total of antimony, arsenic, cadmium, lead and mercury

Table 3-4 sets out estimated extreme maximum and probable average emission concentrations and emission rates for heavy metals of possible concern.

The **extreme maximum** emissions estimates are set at either the proposed emission limit for the WTE&W plant (dioxins, mercury, lead, cadmium) or corresponding to the maximum reliable emission concentration found for information gathered for a number of MSW combustors (arsenic, beryllium, chromium, copper, nickel, and selenium and zinc).

It is not realistically possible to maintain the emissions concentrations continuously at emissions limits, as the extreme emissions estimates imply, because this would inevitably result in exceedances of the legal limits applying to the plant. These extreme estimates are included in the assessments undertaken to indicate that, even in the case of impossibly high emissions, the risks presented by the project emissions are negligible.

The **probable average** emission rates are set to correspond to about the average of the emissions concentrations found for the MSW combustors referred to above, with allowance in some cases for additional air pollution control technology which will be installed at Kwinana, but was not installed at the combustors for which emissions data was available.

These probable average emissions estimates are the most reliable indication of the likely long-term levels of emissions from the project. GOWA is committed to achieving the lowest practical emissions from the WTE&W plant, both as a matter of ensuring no effects on the surrounding community and ecosystems, and for commercial reasons.

The multi-pathway assessment of possible health effects of the emissions of these heavy metals indicates negligible contribution to existing exposure levels for all realistic exposure scenarios at either the extreme maximum or probable average emissions (refer Section 9.8). Accordingly, any realistic uncertainties in the emission concentrations would not affect the conclusion of the risk assessment.

Table 3-4 also includes an estimate of the emission rates for these heavy metals and dioxins from a 1000 MW coal-fired power station fitted with electrostatic precipitators, to give a point of context for consideration of the significance of the estimated emission rates from the WTE&W plant.

***Table 3-4. Emission concentration estimates for heavy metals***

| | Concentrations | | Emission rates | | |
|---|---|---|---|---|---|
| | Extreme maximum | Probable average | Extreme maximum | Probable average | 1000MW coal power station |
| | μg/m$^3$ at 11% $O_2$, dry, 0°C | | mg/sec | | |
| Arsenic | 5 | 0.5 | 1.3 | 0.11 | 7 |
| Beryllium | 0.14 | 0.08 | 0.04 | 0.02 | 0.5 |
| Cadmium | 14 | 1 | 3.5 | 0.3 | 2 |
| Chromium Total | 14 | 5 | 3.5 | 1.1 | 25 |
| Copper | 44 | 8 | 11.0 | 1.9 | 10 |
| Lead | 140 | 12 | 35.2 | 3.1 | 25 |
| Mercury | 50 | 25 | 12.6 | 6.3 | 26 |
| Nickel | 100 | 23 | 25.1 | 5.7 | 20 |
| Selenium | 0.2 | <0.4 | 0.05 | <0.1 | 4 |
| Zinc | 150 | 31 | 38 | 8 | 196 |
| | ng I-TEQ/m$^3$ at 11% $O_2$, dry, 0°C | | μg I-TEQ/sec | | |
| Dioxins | 0.1 | 0.01 - 0.05 | 0.025 | 0.002 - 0.01 | 0.05 |

In order to provide an on-going assurance of low levels of emissions of a wide range of heavy metals, it is proposed to monitor the concentrations of these contaminants in the baghouse cake, which contains essentially all of the heavy metals leaving the combustion zone in the flue gas. Increases in emissions of these contaminants would inevitably increase their concentrations in the cake, and in the event of significant increases, a trace-back exercise will be instigated, to identify the source of the contaminant, and arrange more appropriate management of the relevant waste.

The combination of the US EPA MACT floor control technology with a substantial number of enhancements incorporated into the most recent Olivine design provides a very good assurance that the Kwinana ultra high temperature combustors will achieve emissions in comfortable compliance with the US EPA and EC emissions standards for municipal waste combustors. Achievable emissions are confidently expected to be far below the EC limits for sulphur dioxide, and will almost certainly be well below both the US EPA limits for all other contaminants.

## 3.14 MONITORING SYSTEMS

The Perth WTE&W plant involves three tiers of monitoring systems:

1. Plant Control Monitoring Systems; and
2. Environmental Monitoring Systems
3. Environmental Monitoring Systems

Some of the plant control monitoring also provides emission monitoring information.

### *3.14.1 Plant Control Monitoring Systems*

Control of the combustion and air pollution control systems is based on continuous monitoring of a suite of key parameters at critical points through the UHTCs. The data from this monitoring is sent to duplicated PC computer-based fuzzy logic systems on each UHTC, which control the settings and operation of the equipment. A manual control system is also available in the extremely unlikely event of failure of the duplicated PC system.

Inputs from the process monitoring system to the process control system include:

On the primary air supply:

- temperature
- flow
- pressure

On the combustion bed:

- bed level

At the top of the primary combustion zone, below the secondary air jets:

- oxygen
- temperature
- carbon monoxide
- sulphur dioxide

On the secondary air supply:

- temperature
- flow
- pressure

In the middle of the secondary combustion zone:

- temperature
- hydrocarbons

At the outlet from the secondary combustion zone:

- flow
- pressure
- oxygen
- temperature
- carbon monoxide
- sulphur dioxide
- oxides of nitrogen ($NO_x$)

At the boilers:

- steam flow
- steam temperature
- steam pressure

At the entrance to the scrubber:

- temperature
- moisture
- sulphur dioxide
- hydrogen chloride

- ammonia

Across the baghouse:

- pressure drop

Induction fans to stacks:

- flow
- temperature
- pressure

In the stacks:

- flow
- temperature
- oxygen
- opacity
- carbon monoxide
- sulphur dioxide
- oxides of nitrogen ($NO_x$)
- hydrogen chloride

TV monitors mounted in the combustion chamber wall also enable the operator to view conditions in the chamber.

The gas monitoring system used for both plant control and emissions monitoring is based on Differential Optical Absorption Spectroscopy (DOAS). Equipment for this monitoring is in widespread use in various industries including power stations, waste to energy plants, cement plants and chemical plants.

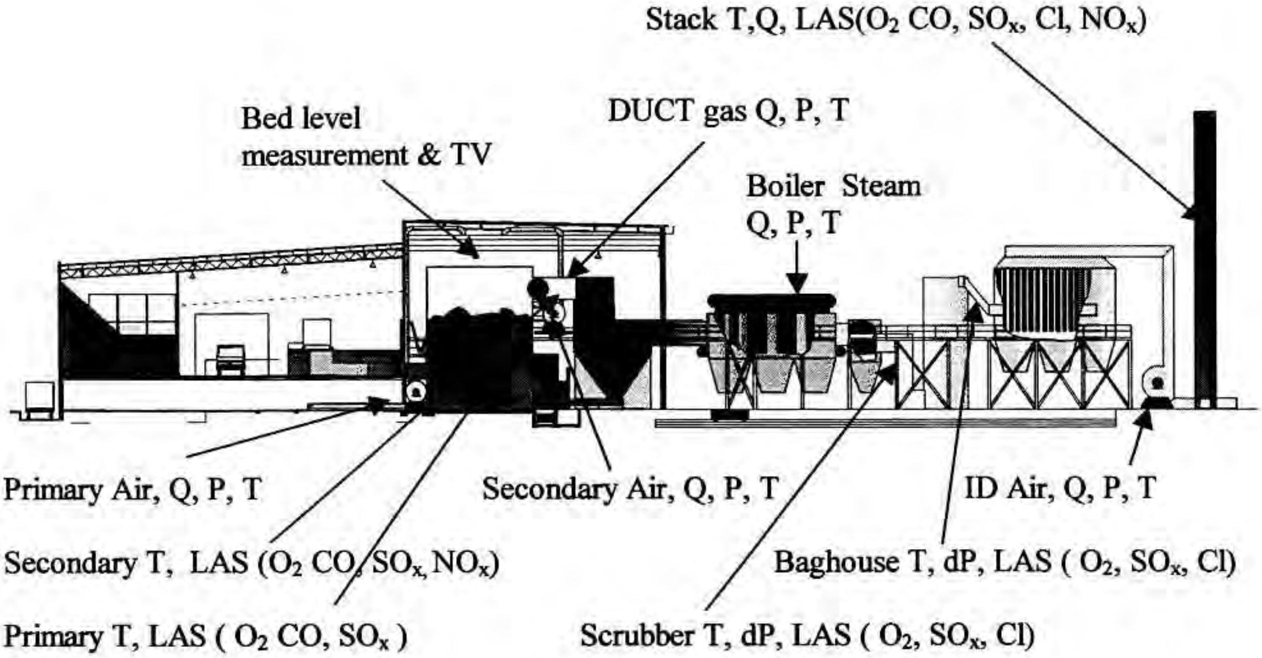
The duplicated PC computer based fuzzy logic system will control a range of functions, including:

- MSW feed rate.
- primary air.
- secondary air.
- auxiliary fuel to correct transient low temperature spikes.
- limestone ($CaCO_3$) injection for high temperature scrubbing and to moderate overheat spikes.
- tyre feed to compensate for low calorific MSW.
- dosage and dosage point of urea for SNCR $NO_x$ scrubbing
- lime dosage to the scrubber
- activated carbon dosage

The process control system will control both combustion conditions, to ensure excellent destruction of organic contaminants, and heat flows, to maintain a constant rate of steam and electricity production. Controlling the heat flow to compensate for variations in the calorific value of the MSW feed is the more demanding of these, so that the commercial, power production requirements will ensure a level of control assuring excellent combustion conditions.

Plant monitoring and control systems are summarised in Figure 3-27. The DOAS instruments are referred to as LAS or laser and UV spectroscopes in this Figure.

***Figure 3-27. Principal Measurement Locations***




Index:

| | | |
|---|---|---|
| T | = temperature measurement | |
| Q | = Flow | " |
| P | = Pressure | " |
| dP | = Pressure drop | |
| LAS | = DOAS | |

### *3.14.2 Emission Monitoring Systems*

The above section on plant control monitoring indicates that continuous monitoring of flow, temperature, oxygen, opacity (an indicator of particulate emissions), carbon monoxide, sulphur dioxide, oxides of nitrogen ($NO_x$) and hydrogen chloride will be undertaken on the emissions from each UHTC to the stacks. In addition to this continuous monitoring, GOWA proposes the following periodic emissions testing program:

*Within 2 months of start-up of each UHTC unit, and annually thereafter, on the emissions from each UHTC to the stacks:*

Particulates, hydrogen fluoride, mercury, arsenic, antimony, barium, boron, cadmium, chromium, copper, lead, manganese, nickel, selenium, silver, vanadium, zinc and dioxins.

*Weekly, on a composite sample of baghouse filter cake:*

Mercury, arsenic, antimony, barium, boron, cadmium, chromium, copper, lead, manganese, nickel, selenium, silver, vanadium and zinc.

The purpose of this sampling and analysis is to provide an on-going measure of the potential for heavy metal emissions. Provided filter cake concentrations remain similar to those obtained when emission tests are undertaken, there is a good assurance that the levels of emission will remain similar to those determined in the emissions tests. Significant increases in heavy metal emissions will only occur when there are significant increases in these metals in the gas stream entering the scrubber, which will result in marked increases in heavy metal concentrations in the filter cake. In the event of such increases above the normal range, trace-back will be initiated to identify the source of the offending waste, so that more appropriate arrangements can be made for its treatment, such as by feeding directly to the vitrifiers.

Prevention of increased heavy metal emissions resulting from failure of a fabric filter bag is achieved by

(a) monitoring of pressure drop across the bag house compartments and

(b) continuous monitoring of opacity.

In the event of a filter bag fault prompt action would be taken to repair the fault.

### *3.14.3 Environmental Monitoring Systems*

As detailed in the dispersion modelling and health risk assessment (Sections 9.7 and 9.8) the emissions to air from the waste-to-energy plant will cause very small changes in existing environmental levels of any of the contaminants. This means that there is very little prospect of even the most sophisticated monitoring program being able to demonstrate any change between existing levels and those after establishment of the plant, with one possible exception, discussed in the following paragraph.

The existing ambient air monitoring undertaken at sites in the Kwinana area covers almost all monitoring which might be appropriate for sulphur dioxide, oxides of nitrogen and $PM_{10}$. Monitoring of oxides of nitrogen concentrations at the Abercrombie road monitoring site is not done currently, but would be desirable. GOWA is proposing a commitment to provide the instrumentation necessary for this monitoring.

In relation to other monitoring, GOWA recognises that, because of the perception some people may have of potential effects from old WTE plants, it is appropriate that some further monitoring be undertaken both to confirm the estimates of existing levels used in the health risk assessment for other contaminants, and to demonstrate, as appropriate, no detectable changes after start-up of the plant. GOWA have committed to the following environmental monitoring (refer Section 1 - Commitments).

***During Construction Phase***

The air dispersion modelling shows that if emissions from the plant result in significant increases in contaminant concentrations in rain anywhere, they will be most clearly evident in rain falling on the plant site. In order to establish a baseline before start-up GOWA are committed to a program of collection and analysis of rain over the two year construction period. This will cover toxic metals and dioxins.

Dispersion modelling shows that the Hope Valley area will be subject to the highest (although still very minimal) annual average concentrations of contaminants emitted from the plant. GOWA are committed to program of ambient air particulate sampling, preferably at the present DEP Hope Valley ambient air monitoring site, for determination of the concentrations of toxic metals in air. Sampling for dioxins in ambient air will also be undertaken.

***Monitoring Post-Start-Up***

GOWA are committed to continued rain water monitoring on the plant site and the ambient air monitoring at Hope Valley, until effects of the plant have been established as negligible to the satisfaction the EPA. The period of continuation will be determined by whether the results obtained fit with the expected absence of any detected changes. The largest difficulty is likely to be the existing variability in air quality, which is likely to make it possible to detect changes, only if they were considerably larger than those predicted. There are likely to be changes in air quality as measured between the "before" and "after start-up" sampling resulting from changes entirely unrelated to the WTE plant.

The primary emphasis in monitoring will be on monitoring of emissions, because confirmation of the levels of emissions used in the dispersion modelling and health risk assessment monitoring is almost certainly the best way of confirming the complete absence of effects predicted.

## 3.15 PLANT SPECIFICATIONS

### *3.15.1 UHTC Primary Combustion Chamber*

12 UHTC units designed as two separate plants (6 UHTC's per plant). Up to 2 UHTC's are able to be shut down at any one time without effecting MSW processing rate or power output (will effect modulation ability).

| | |
|---|---|
| Internal Diameter: | 9.6 m |
| Height: | 13.0 m |
| Hearth Area: | 82 $m^2$ |
| Design Oxidising Rate: | 11 t/hour @ 11.5 GJ/t (126 GJ/hr) |
| Primary Air: | 20 $Nm^3$/sec @ 2.5 kpa |
| (Operating range: 70 – 80%) | |
| Secondary Air: | 14 $Nm^3$/sec @ 9 kpa |
| (Operating range: 70 – 80%) | |
| Duct Outlet Area: | 7 $m^2$ |
| Refractory Material: | Cast refractory using Olivine aggregate. Maximum operating temperature 1,500 °C. |

### *3.15.2 UHTC Secondary Chamber*

| | |
|---|---|
| Length: | 6 m |
| Width: | 5 m |
| Height: | 12.5 m |

### 3.15.3 Boiler

The boilers are stand-alone watertube convective type waste heat boilers, shown in Figure 3-29. A total of 12 boilers (one per UHTC) will be operation with a maximum of two boilers able to be shut down without impacting plant operations. Two spare boilers will be stored on-site within the boiler workshops.

The units have the following features:

- Wide spaced square pitched tubes for optimum cleaning and access.
- The exterior walls consist of easily removed olivine refractory panels to allow access.
- Tubes are arranged with a 'screen' bank of tubes to rapidly reduce flue gas temperatures to avoid high temperature corrosion in the superheater section.
- All tubes are unfinned to facilitate cleaning.
- Boiler capacity is 33 t/hour at 40 bar + 440 °C.

***Process Summary Sheet***

**HEATING SIDE:**

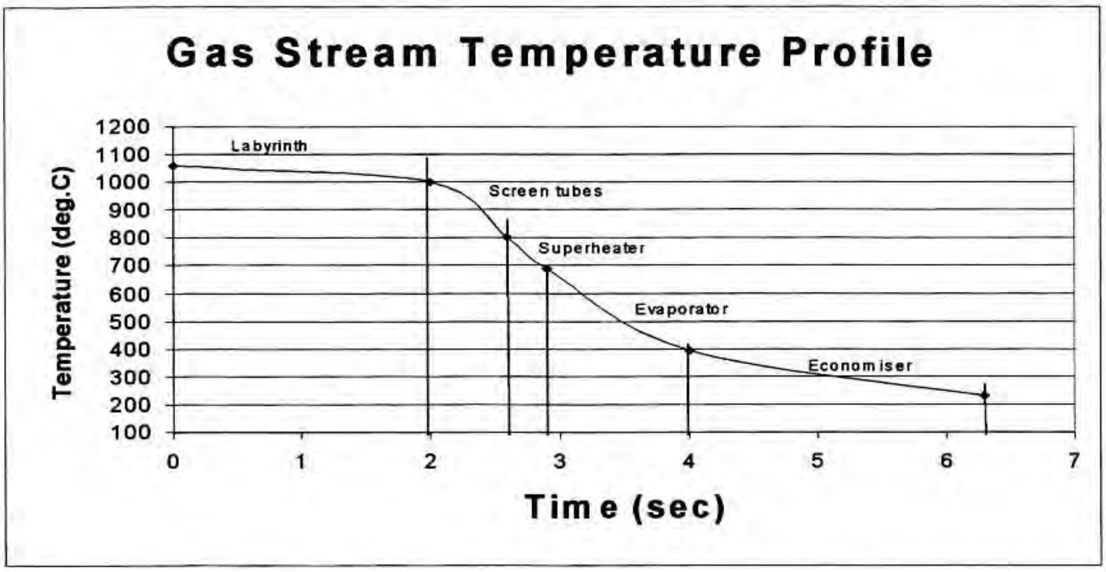
| | SCREEN | SH | EVAP | ECONO |
|---|---|---|---|---|
| Flow Rate, lb/hr | 185 000 | 185 000 | 185 000 | 185 000 |
| Inlet Temp., °F | 1830 | 1485 | 1274 | 740 |
| Outlet Temp., °F | 1485 | 1274 | 740 | 450 |
| Fouling Factor | .01 | .01 | .01 | .01 |
| Heat Los | 2 | 2 | 2 | 2 |
| Heat Exchange, mmbtu/hr | 19.50 | 11.50 | 27.70 | 14.50 |
| Pressure Drop in W.C. | 0.5 | 0.6 | 1.50 | 2.5 |

**HEATED SIDE**

| | | | | |
|---|---|---|---|---|
| Design Press., psig | 940 | 940 | 940 | 1000 |
| Operating Press., psig | 855 | 840 | 855 | 868 |
| Inlet Temp., °F | 806 | 830 | 506 | 320 |
| Outlet Temp., °F +- 10 °F | 530 | 750 | 530 | 506 |
| Blowdown % | 5 | - | 5 | - |
| Fouling Factor | .001 | .001 | .001 | .001 |
| Flow Rate, lb/hr | 67 300 | 67 300 | 67 300 | 70 600 |
| Pressure Drop | - | 15 | - | 12 |
| Heating Surface, ft sq. | 1 393 | 1319 | 5826 | 9913 |

Flue Gas Analysis provided -% Vol. $CO_2$=8.45, $H_20$=13.00, $N_2$=69, $0_2$=9.46, $SO_2$=0.01, HCL= 0.09

*Figure 3-28. Gas Stream Temperature Profile*

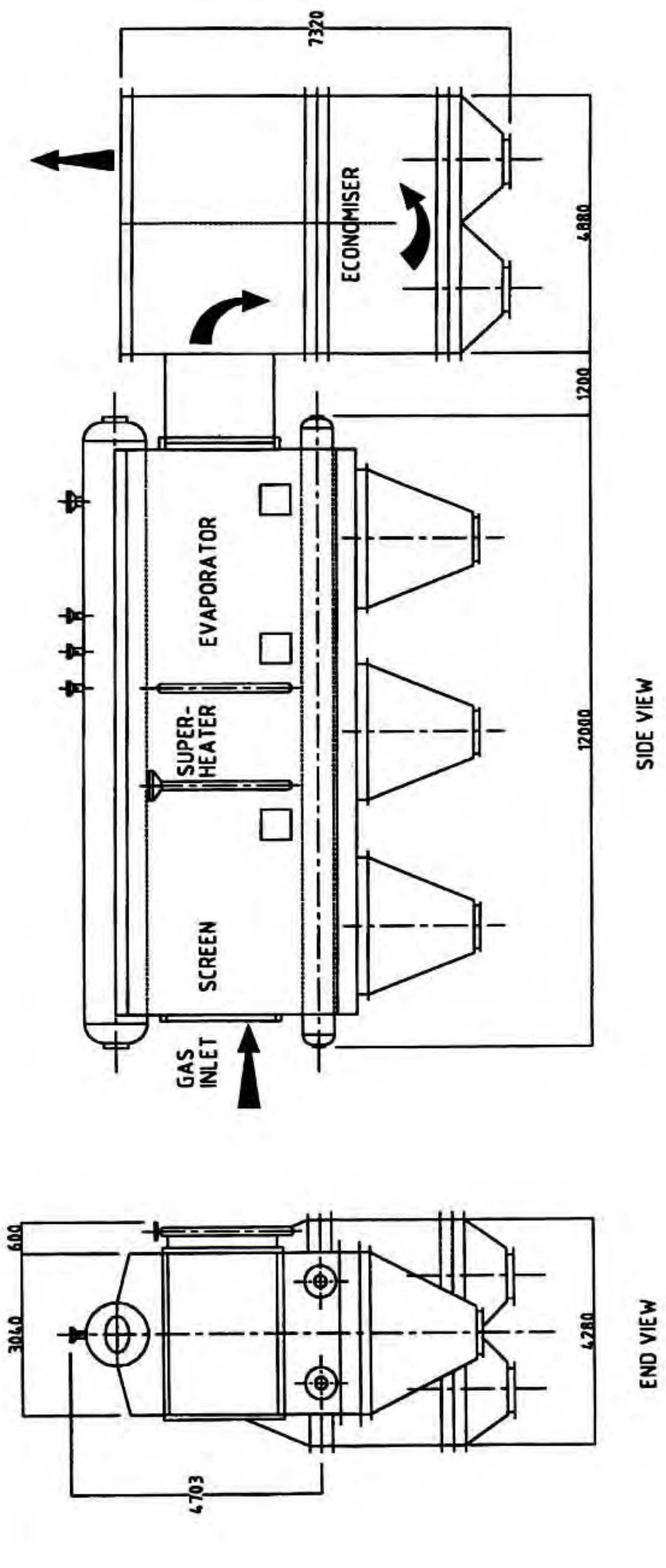



### *Mechanical Design Data*

| ITEM NO. | SCREEN | SH | EVAP | ECONO |
|---|---|---|---|---|
| | | | | |
| **TUBES** | | | | |
| O.D., in. | 2.0 | 1.75 | 2.0 | 1.75 |
| Min. Thickness, in. | 0.135 | 0.135 | 0.135 | 0.135 |
| Material | SA192A | T11 | SA192A | SA192A |
| Effective Length, ft | 11 | 7.5 | 11 | 14 |
| No. Tubes/Row | 11/22 | 24 | 22 | 30 |
| Trans. Spacing, in. | 8.5/4.5 | 5 | 4.25 | 3 |
| No. of Tube Rows | 12/5 | 16 | 46 | 48 |
| Long. Spacing, in. | 4 | 4 | 4 | 3 |
| Arrangement | Inline | Inline | Inline | Inline |
| **FINS** | | | | |
| Height, in. | Bare | Bare | Bare | Bare |
| Thickness, in. | | | | |
| No./In. | | | | |
| Material | | | | |
| **STEAM DRUM** | | | | |
| Diameter, In | 48 | 6 | | 4 |
| Thickness, in. | 2.75 | - | | - |
| Length, ft. | 38 | 10 | | 16 |
| Material | SA516-70 | P11 | | SA106B |
| Outlet, in. | 4 | 6 | | 3 |
| Inlet, in. | 3 | 4 | | 3 |
| Manways | 12x16 | - | | - |
| **LOWER DRUM** | | | | |
| Diameter, in. | 2-24 | 6 | | 4 |
| Thickness, in. | - | - | | - |
| Length, ft. | 38 | 10 | | 16 |
| Material | SA106B | SA106B | | SA106B |
| Manways | 12x16 | | | |

Economiser has 10 streams.
Superheater has 24 streams, and is parallel flow configuration.

*Figure 3-29. Waste Heat Boiler*



### *3.15.4 Turbo Generator*

Four turbines and alternator units will operate, each producing a maximum output of 30 MW. Based on the daily gross electrical output per hour of each UHTC (7.48 MW, 90 MW total) one alternator will remain available in case of breakdown or power modulation requirements.

| | | | |
|---|---|---|---|
| Inlet conditions | 41 BAR | | 454 °C. |
| Outlet conditions | 0.35 BAR | | 75 °C. |
| **Alternator** | **11 kV** | = | **30 MW** |

The WTE&W plant will have a central steam and boiler feed looped water range running the length of the station. This allows a simple looped interconnection to the MSW chains for boiler feed water supply and means steam from the MSW waste heat boilers can be used in any of the steam turbines.

### *3.15.5 Multiple Effect Desalinators (MED)*

Each turbo-alternator will feed exhaust steam to a MED unit.

The specifications for each unit will be:

| | |
|---|---|
| Exhaust steam pressure | 0.35 bar |
| Exhaust steam /unit | 120 tonnes/hr |
| Sea water salinity | 3.6% |
| Sea water temp | 26 °C |
| Desalinated water output | 1200 tonnes/hour |
| Economy ratio | 7.9 |

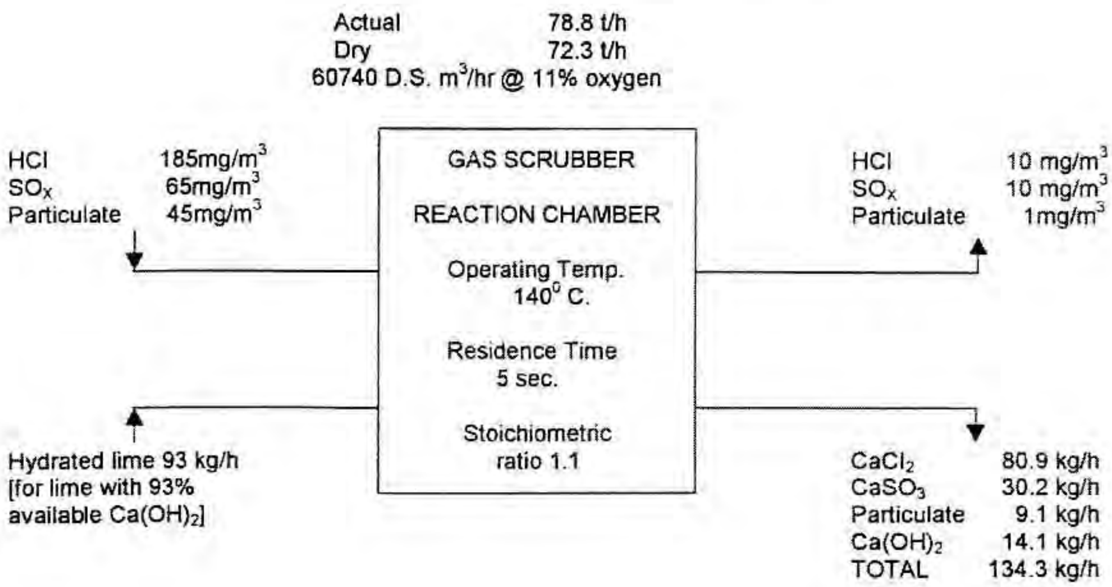
### *3.15.6 Acid Scrubber*

Each UHTC will contain a low temperature wet/dry scrubbing system and a high temperature limestone scrubbing system. Acid removal from the gas stream is achieved by injecting atomised slurry of $Ca(OH)_2$ into the flue-gas. This reacts with the acid pollutants (HCl, HF and $SO_X$). Other substances, including heavy metals, are accumulated on the particulates of the reagent. This process is favoured by low temperatures of the flue-gas, (140°C optimum), high humidity, correct amount of reagent fully distributed and a large specific surface area of reagent.

Commercially available hydrated lime will be used. This material has 91% of particles less than 75 micron in diameter. The reactor has a residence time of 5 seconds. The normal operating temperature is 140 °C.

The expected levels of HCl and $SO_X$ based on overseas experience with this Waste-to-Energy & Water plant and their subsequent treatment is shown schematically below with flow rates of reagent and product:

*Figure 3-30. Gas Flow (per chain)*




Note:
Fluorides in plastics or other portions of the MSW can appear as HF in the air stream but concentrations are usually low, in the order of 15 mg/m$^3$ and they will not materially affect the quantity of lime required.

Individual reaction chambers are located directly after the economiser. The lime dosing rate is controlled by $SO_X$ sensors in the incoming gas stream. A 40 tonne silo provides a three-day storage on-site. Lime is metered and fed pneumatically to the slurry mixer and then to the injector nozzles which use compressed air for dispersion.

High temperature lime ($CaCO_3$) scrubbing is effected in the combustion chamber as a preliminary scrub, in order to reduce acid gases passing through the boiler.

### *3.15.7 Baghouse*

Each UHTC will contain a baghouse system (12 in total) while two spare baghouses will be kept on site to allow quick replacement. The baghouse consists of ten compartments, which are isolated and pulsed separately to remove cake.

Removal of acid gases and particulates depends on contact with the layers of material on the bags. Pressure sensors control the pulsing so that cake is removed only when pressure loss becomes too high.

Early warning of any failure or other control problems in the baghouse is provided by both the constant emission monitoring of the exhaust stack particulates and the sensing of pressure drop across each bag compartment

The baghouse specifications are:

| | |
|---|---|
| Compartments: | 10 with 120 bags each. |
| Bags: | Diameter: 150 mm<br>Length: 3.6 m<br>Material: 16 oz woven acid resistant fibreglass<br>Connections: Snap rings |
| Design Filtration Velocity: | 0.8 m/min (1.0 m/min on 4 compartments) |
| Design Pressure Loss: | 1.50 kpa. |

The baghouse is insulated and equipped with heaters to maintain operating temperature when the chain is not running. The baghouse has an epoxy based protective paint system.

### 3.15.8 *MSW Plant System Safety Features / Breakdown Procedures*

| System | | Duplication or safety features | Breakdown procedure/comment |
|---|---|---|---|
| UHTC | | Explosion doors | UHTC has 2 counterweighted panels which open with a pressure excursion to limit structural damage in case of explosion. |
| | Feed system | Each UHTC has 2 discrete feed systems with separate hydraulic supplies. | Each UHTC will run on 1 feed system with auxiliary fuel while other is repaired. No shut down required. |
| | Ash push systems | Each UHTC has 2 discrete hearths and ash push systems. The hydraulics are duplicated and rams are external to facilitate maintenance while UHTC is in operation | Each UHTC can run on 1 hearth with auxiliary fuel while external push rams are replaced. No shut down required. |
| | Primary air | Duplicate fans<br>Individual controls on each entry port. | Run at 20% reduced load while fan or actuator is replaced. |
| | Secondary air | Duplicate fans<br>Individual controls on each entry port | Run at 20% reduced load while fan or actuator is replaced. |
| Labyrinth | | Multiple screw de-ashing. | Repaired while UHTC in operation. Screws are externally replaceable. |

| | | | |
|---|---|---|---|
| Boiler | | No in-line duplication. Two replacement boilers to be stored on-site for 3 day removal and replacement using the cross railway system. | Boiler failure requires UHTC shutdown. Plant has 12 boilers plus 2 spares stored in two boiler workshops (1 per chain). 2 chains can be shut down at one time and still process contracted MSW and power.<br><br>Feedwater for the boilers is provided from a central range. Any extra water requirement caused by a tube failure can be met from this range. MED plant provides ample boiler water for any emergency. |
| Lime treatment | | Multiple injection nozzles are used with two in reserve capable of automatic switch on. | Nozzle replacement is a quick and easy operation (1 hr). Flow indicators give early detection of nozzle blockage allowing replacement.<br><br>Nozzles may be replaced without shutdown |
| Over temperature control | Water spray nozzles | Multiple injection nozzles are used with two in reserve capable of automatic switch on. | Nozzle replacement is a quick and easy operation.<br><br>Nozzles may be replaced without shutdown |
| Activated carbon | | Twin feed nozzles with flow sensors. | Reduced to 50% feed rate if one blocks. Blocked nozzles may be repaired without shutdown. |
| Baghouse | | 12 baghouses (1 per chain). Ten compartments each can be isolated.<br><br>Baghouse has automatic auxiliary heaters | Isolate individual compartments for bag replacement on line. Baghouse maybe removed and replaced for major maintenance within 3 days (2 spare baghouses stored on-site). |
| Forced draft fan | | Dual fans on each UHTC. | Reduce output 20% while replacing fan (1 hour). |
| Control systems | | The control system is a sophisticated fuzzy logic system with built-in duplication and a large range of diagnostic features, which includes continuously checking primary sensors. Each unit will run manually in the event of breakdown (see control description) | |
| Electrical supply | | MSW plant supply is from the 11 kV station bus. Multi-fuelled gas turbine generation to handle total auxiliary load for the entire plant. Power supply is a looped main with individual transformers for each chain. | |
| Vitrifier | | Each vitrifier can be individually shut down for maintenance. All vitrifiers can be shut down for up to 24hrs while still remaining molten. This will be used to provide peak power surges (spinning reserve) to the grid. The duty requirements of only 70% easily accommodate this load following. | |

# 5. EVALUATION OF ALTERNATIVES

## 5.1 ALTERNATIVE DISPOSAL METHODS

The only current alternative to the disposal of large volumes of MSW is landfilling. The status of landfilling internationally is well documented and described in Section 2.1 of this report.

## 5.2 ALTERNATIVE WASTE-TO-ENEREGY TECHNOLOGIES

There are various alternative technologies within the WTE industry with over 500 WTE plants worldwide owned by various companies. Some of the major companies involved in the industry are described below.

### *5.2.1 Ogden USA*

Ogden, from the USA, is a major developer and operator of large-scale Waste to Energy facilities, operating more of these than any other company in the world. They have 28 Waste to Energy facilities processing more than ten million tonnes of waste per year and have a combined generating capacity of 857 MW serving more than 17 million people.

### *5.2.2 Wheelabrator*

Wheelabrator, which is associated with Waste Management, operates 13 facilities similar to the Spokane example, see case study below, in the U.S.A.

### *5.2.3 American Ref-Fuel*

American Ref-Fuel Company is a partnership formed by subsidiaries of Browning-Ferris Industries, Inc., Duke Energy Power Services (a business unit of which is Duke Power the power company from Charlotte, North Carolina illustrating the potential for the commercial relationship between electricity generation and Waste to Energy), and United American Energy Corp. Its primary objective is to develop, own and operate advanced Waste to Energy facilities. American Ref-Fuel offers waste disposal and related services and owns and operates six Waste to Energy facilities in the USA dealing with both non-hazardous and hazardous waste. It has two subsidiary companies, one to secure the waste streams and one to market the by-products.

### *5.2.4 Chemcontrol*

Chemcontrol is a Danish toxic and hazardous waste consulting and engineering company established in 1979 as a subsidiary of the Central Hazardous Waste Treatment Plant in Denmark. Chemcontrol operates the Kommunekemi plant, an integrated centralised treatment plant for toxic, hazardous and difficult wastes, complete with a collection system servicing the entire country of Denmark. Kommunekemi is owned by all the Danish municipalities and commenced operation in 1973 and has an installed treatment capacity of above 100,000 tonnes per year.

### *5.2.5 ABB Enertech Ltd*

ABB Enertech is a subsidiary of ABB and is based in Switzerland. They are engineers and suppliers of turnkey Waste to Energy facilities throughout the world. They have an extensive reference list of Waste to Energy projects, which includes complete plants and components of plants, particularly the environmental control components. ABB Enertech publish literature on their capabilities and four of their waste to Energy Plant case studies are:

- Bordeaux, France, 255,000 tonnes of waste per year, 1998;
- Basel, Switzerland, 240,000 tonnes of waste per year, 1998;
- AVA Augusburg, Germany, 225,000 tonnes of waste per year;
- AVI Amsterdam, Netherlands, 840,000 tonnes of waste per year;

illustrating the acceptance of Waste to Energy in major European centres and near sensitive agricultural areas.

### 5.2.6 *Case Study: Spokane (USA) Regional Solid Waste System*

Spokane is a community in the USA that chose to install a Waste to Energy facility as part of an integrated waste management program. An outline of the selection process, the waste management program and the Waste to Energy facility in included in Appendix N. This case study illustrates how Waste to Energy can be effectively integrated into an overall waste management program for a region.

## 5.3 BEST AVAILABLE TECHNOLOGY - OLIVINE WASTE TO ENERGY

A comparison of the major differences between currently available waste to energy systems and the ONZ technology is summarised in Table 5-1. This illustrates the improvements and benefits of ONZ Waste to Energy technology over and above other systems which are deemed to be best technology in Europe and the USA. Given that the ONZ system can match, or in most cases better, the competition's ability to effectively manage all waste streams and emissions, the single biggest factor which will allow its successful introduction into Australia and New Zealand is that of capital cost.

***Table 5-1. Differences between Current WTE Systems and ONZ Technology***

| | Olivine | Conventional |
|---|---|---|
| **Combustion** | | |
| 1 | Very high average gas temperature 1100 - 1150 °C | Average Gas temperature 850 °C 900 °C |
| 2 | Long gas residence time at high temp - 6 to 8 seconds | Quickly decaying gas temperature - 2-3 seconds |
| 3 | Extremely thorough gas mixing Symmetric secondary air injection | Asymmetric air injection – problems with wall effect. |
| 4 | Both high temperature and low temperature acid gas scrubbing | Low temperature acid gas scrubbing only |

| Ash Disposal | | |
|---|---|---|
| 5 | High temperature slagging produce graded aggregates for sale | Slagging discouraged – low quality aggregates – in some cases ash landfilled. |
| 6 | Fly ash containing heavy metals vitrified to recover metals and chemicals and to produce saleable glass products | Fly ash landfilled. |
| **Emissions** | | |
| 7 | Betters the most stringent standards for air emissions | Meets the most stringent standards for air emissions |
| 8 | No by products to landfill | Ash needs to be landfilled. |
| **Reliability** | | |
| 9 | Modular plant design with redundancy. Units designed for three day repair. Guaranteed to meet contractual obligations on waste processing and power output. | Usually one or two large units. Long repair time. Guarantees? |
| **Cost** | | |
| 10 | Low maintenance cost<br>Low maintenance time | High maintenance cost<br>High maintenance time |
| 11 | Low capital cost | High Capital Cost |

### *5.3.1 Combustion*

The Olivine ultra high temperature combustors are designed to provide excellent combustion conditions which are robust in respect of variations in the quantities and characteristics of the waste feed. The key to the design is its simplicity which effectively eliminates "cold paths" by which some of the combustion gases can partially bypass the high temperature combustion zones. This is achieved by constructing the combustors with a large thermal mass in the form of cast panels of the mineral olivine, which has very good resistance to high temperatures and a near-linear coefficient of thermal expansion. These panels act as temperature buffers, absorbing heat from the combustion gases during heat spikes and re-radiating heat back into the gases during cooler periods, which occur during the cycle of introduction of new MSW "pushes" and the ram-induced "rolling" of the burning MSW as it progresses across the hearth.

The most common, currently conventional, approach to MSW combustors is to extract heat from the combustion zone by installation of complex "water walls", which precludes effective temperature buffering and provides possible "cold paths" for combustion gases as well as relatively short high temperature gas residence times.

As Olivine combustors do not require waterwalls, heat is not extracted from the combustion zones (except for conduction through the insulating olivine panels). Olivine combustors can therefore maintain both very high temperatures

(1100-1150 °C) throughout the large primary and secondary combustion zones and high oxygen concentrations (above 7%) for any MSW composition normally encountered in Westernised countries.

The large primary and secondary combustion zones, together with the large "labyrinth" results in comparatively long residence times for combustion gases in the range 6-8 seconds at temperatures above 1100 °C. This gives excellent overall combustion and maximises burn-out of residual carbonaceous material on particulates. This carbonaceous material can act as a catalyst for "de-novo" formation of dioxins in the boiler, after any dioxins in the waste feed have been completely destroyed in the combustion zones. Conventional combustors using waterwall systems typically have gas residence times of 2-3 at temperatures of 850 °C - 900 °C.

### *5.3.2 Ash Disposal*

A feature of the combustor design is that there is no requirement for moving steel grate components that could be subject to fouling and failure from molten ash. Instead, ash slagging is encouraged in the design by supplementary gas firing of the ash in the bed. This results in a very low proportion of ash fines and a molten ash product which can be crushed to produce various grades of useful aggregates. The fines themselves are vitrified so that no ash landfill is required.

### *5.3.3 Emissions*

The Olivine ultra high temperature combustors incorporate all of the technologies specified by the US EPA as their MACT (Maximum Achievable Control Technology) floor controls (and a number of enhancements, listed below) which, in well designed and competently operated combustors can confidently be expected to meet the US EPA emission standards for new combustors. These MACT floor emissions controls are:

- Selective non-catalytic reduction (SNCR) for $NO_x$ control.
- Spray dryer, using lime, primarily for removal of acid gases, heavy metals and dioxins.
- Activated carbon injection, primarily for removal of dioxins and mercury, but also contributing to removal of most other contaminants.
- Fabric filter for particulate material, dioxins, mercury, and heavy metals, incorporated in the baghouse cake.

The Kwinana units will include additional features which can be expected to contribute to improved emissions performance compared with the US EPA MACT floor controls. These include:

- Unusually long residence times for combustion gases in the primary and secondary combustion zones, at unusually high temperatures (1050-1150 °C).
- A high degree of temperature "buffering" of combustion zone temperatures by the thermal mass of the Olivine panels making up the unusually large combustion chambers.
- The absence of possible "cold paths" associated with combustion zone water walls.
- A oxygen-deficient bed of burning MSW and oxygen-deficient primary combustion zone, combined with a very rapid transition between the primary

and oxygen-rich secondary combustion zones, giving unusually low $NO_x$ concentrations in the untreated flue gases.

- High temperature lime scrubbing made possible by the high temperature of secondary combustion zone, which, unlike lower temperature processes, accommodates the calcining of lime. This, together with the long residence times at these high temperatures optimises the production of gypsum from the sulphur gases.
- Extensive monitoring of critical parameters at key points through the combustion and pollution control systems, with the data being used for process optimisation through a fuzzy logic system.

### *5.3.4 Reliability*

An Olivine WTE plant is modular with each UHTC able to operate independently. This approach to overall combustion facility design minimises the scale of possible effect from any process malfunction, providing the ability to switch loads quickly between units in the event of malfunction, and for any repairs to be carried out with minimum disruption of overall plant operation (see Section 3.15.8).

### *5.3.5 Cost*

The best available technology is not of much interest if it is uneconomic. Table 5-2 is a compilation of capital costs and capacities for a number of European and American plants for which data is available. It is evident that ONZ costs are a fraction of those in the USA or Europe. Processing charges are largely determined by capital servicing charges and ash disposal costs. Given the low capital costs of the Olivine system the processing charges are able to be low enough to compete with current landfill charges.

***Table 5-2. Comparison of Olivine Technology with other Waste to Energy plants***

| Plant | Capacity Tonne per year | Capital Cost | Cost in $AU (1999) 2% cpi | Cost per annual tonne | Equivalent Olivine Cost per annual tonne |
|---|---|---|---|---|---|
| Spokane WA USA | 252,000 | US$197m (1990) | $197m | $780 | $245 |
| Ingolstadt Germany | 166,000 | DM 300m (1996) | $260m | $1566 | $245 |
| Mainz Germany | 254,000 | DM 150m (1996) (no turbines) | $130m | $511 | $166[2] |
| Kempten Germany | 74,460 | DM 150m (1996) (No boilers or turbines) | $130m | $1745 | $133[3] |
| Coberg Germany | 192,000 | DM 100m (1988) | $125m | $651 | $245 |
| Olivine Kwinana Plant | 1,200,000 | $AU294m ( no desalination or by- product processing plant)[1] | $294m | $245 | |

1. Additional capital cost at Kwinana includes vitrifiers, desalination plant and by product processing plant. This capital is serviced by income from sales of by products and therefore this capital is not included in the above table.
2. This is the equivalent cost per tonne without turbines.
3. This is the equivalent cost per tonne without boilers or turbines.

Current wholesale tipping charges in Perth range between $42 to $50 and are steadily rising. GOWA processing charges which will provide for reasonable profits to the developers will be $43 per tonne reducing to $35 per tonne for investing waste suppliers. This can be compared to the processing charge at the Spokane Waste to Energy plant (Appendix N) of US$97 per tonne.

# 6. COMMUNITY CONSULTATION

## 6.1 GENERAL

The Global Olivine project team have been involved in consultation over the past 12 months. Over this time a number of parties have been approached and briefed. Global Olivine view in-depth, ongoing consultation as being of primary importance to both the PER process and the future operation of the waste to energy plant.

The lodgment of this final documentation will not end the consultation exercise. GOWA intend to facilitate on-going consultation with interested persons and parties throughout the public notification process (see consultation strategy below). After the granting of consents, consultation will continue with local community groups and interested parties to explain consent conditions and monitoring results.

For the purpose of detailing the consultation undertaken, the following groupings have been identified:

- Government
- Regional and Local Councils
- Community Groups
- Nearby existing or Potential Landowners
- Commercial
- Other parties.

Under the above headings, a number of groups or agencies were identified and consulted with. Below is a summary of that consultation.

## 6.2 GOVERNMENT

Consultation has been undertaken with a number of central government agencies over the past 12 months. Further, a large number of Ministers have been briefed on the project.

### *6.2.1 Department of Resources Development*

Consultation with the Department of Resources Development (DRD) has been on-going since the initial stages of the project. Discussions have focused on the operational and location requirements of the project in terms of the significance of the Kwinana site and the commercial aspects of the project. Consultation is on-going and will continue throughout the PER process.

### *6.2.2 Landcorp*

Landcorp representatives have been briefed on the project in conjunction with DRD representatives.

### *6.2.3 Commerce and Trade*

Commerce and Trade representatives have been briefed on the project in conjunction with DRD representatives.

### *6.2.4 Mainroads*

Global Olivine's traffic engineering team have had various discussions with Mainroads regarding the proposed upgrade of the Mason Road/Paternson Road/ Rockingham Road intersection. Mainroads have confirmed that at this stage the upgrade is programmed for 2008. It is also acknowledged however, that the increased traffic as a result of the WTE&W plant is less than the annual industrial traffic growth in the area.

### *6.2.5 The Department of Health*

Discussions have been held with representatives of the Department of Health regarding the Health Risk Assessment. A draft copy of the Health Risk Assessment has been sent to the Department of Health for Review.

### *6.2.6 Water Corporation of Western Australia*

Meetings have been held with representatives of the Water Corporation since May 1999. GOWA have been included in the water desalination study investigating costs associated with technologies used in conjunction with desalination systems. The final PER documentation will be forwarded to the study coordinator at our earliest convenience.

### *6.2.7 Legislative Assembly*

All members of the assembly have been sent information packs to bring them up to speed with the project and what it has to offer to Perth.

### *6.2.8 Environmental Protection Agency and Department of Environmental Protection*

Several meetings have been held with representatives regarding the PER process. Further meetings will be held as required.

### *6.2.9 Office of Energy*

A meeting has been held with the coordinator of energy to discuss the project in detail.

### *6.2.10 The Greenhouse Office*

The Greenhouse Office of Australia have been supplied a file on the project in relation to renewable resource energy.

## 6.3 REGIONAL AND LOCAL COUNCILS

The following Regional Councils have been briefed on the project:

- Eastern Metropolitan Regional Council
- Western Metropolitan Regional Council
- Southern Metropolitan Regional Council
- South Western Metropolitan Regional Council
- Mindarie Metropolitan Regional Council.

A presentation has also been made to Western Australia Municipal Waste Association, representing all individual councils. A total of 26 councils have also been individually briefed.

## 6.4 COMMUNITY GROUPS

Consultation has been undertaken with various community groups by way of a series of meetings:

### *6.4.1 Conservation Council/ Pollution Action Network*

A presentation was made to the Conservation Council on $15^{th}$ July 1999. The response to the meeting was generally positive and the outcomes of the meeting were discussed at the Pollution Action Network.

A second meeting was held with a representative of the Conservation Council on $15^{th}$ September 1999. The project was presented and various general questions were answered. Information was also left with the representative who indicated that the proposal would need to be discussed with other key members of the group.

### *6.4.2 Other Community Groups*

On 8 September 1999 a meeting with representatives of the following groups was held in the Kwinana Arts Centre.

*Kwinana Watchdog Group*
*Casuraina Wellard Progress Association*
*Hope Valley Progress Association*
*Wandi Progress Association*
*West Byford Peel Estate Conservation Committee*
*Leda Progress/Watchdog Group*
*Wattleup Citizens Association*

A video and overhead presentation was given by GOWA. A detailed question and answer session was held (2 hours). The issues raised focused on:

- The nature of the plant process and by products;
- Plant failure and community risks;
- Air emissions and impact on the health of nearby residents;
- Impact on Cockburn Sound and ecology;
- Project Economics; and
- Community Employment.

At the completion of the presentation and question session company representatives mingled with the group to discuss any further issues. At the completion of the meeting there was a general consensus that all questions had been answered satisfactorily.

### *6.4.3 Wandi Progress Association*

On 10 November 1999 a meeting was held with the Wandi Progress Association in the Wandi Community Hall. Approximately 30 people attended the meeting. A detailed question and answer session was held after the meeting with the majority of questions answered to the satisfaction of the group. Response sheets were handed around and the group were asked to list any concerns. All response sheets received provided generally positive comments on the project.

## 6.5 NEARBY EXISTING OR POTENTIAL LANDOWNERS

Consultation has been undertaken with a number industries located near the site over the past 12 months.

### *6.5.1 BOC Gases and Air Liquid*

Representatives of BOC Gases and Air Liquid have been briefed on the project. The response was very positive, particularly towards developing synergies between both industries (such as piped supply of nitrogen from Air Liquid and purchase of power).

### *6.5.2 BP Refinery*

Various meetings and discussions have been held with representatives of BP. Their response to the project is neutral, provided the project does not interfere with the operation of the BP refinery. BP have offered the use of their existing intake, subject to meeting design specifications and are prepared to enter into discussions for a combined discharge once the James Point port is underway. BP have also kindly made available some recent information on the status of existing site contamination.

### *6.5.3 Alcoa World Alumina Australia*

Alco representatives have been briefed and are generally supportive of the project. Alcoa have agreed to enter into further discussion regarding the possibility of back-loading ore ships in the USA to ship olivine mineral back to the site for manufacturing of Olivine panels for export.

### *6.5.4 James Point Pty Limited*

Representatives of James Point Pty have been briefed and are generally very supportive of the project. Discussions have focussed on site synergies including the possible use of desalinated water in live export ships.

### *6.5.5 Western Australia Consolidated Power*

Representatives have been briefed on the project and are willing to enter into further discussions regarding purchase of power.

## 6.6 CONSULTATION STRATEGY

As set out above, Global Olivine views on-going consultation, particularly with local community groups, as essential to both the PER process and the future operation of the waste to energy plant.

The consultation strategy post lodgement of the PER involves the following:

1. Letters will be sent to all community groups advising that the PER is soon to be notified and offering further meetings with each group during the notification period.
2. An invitation will be sent out to all community groups, councils and relevant government agencies advising of a project open day to be held during the second weekend of the notification period.
3. On-going consultation with government departments.

# 7. RELEVANT POLICIES AND GUIDELINES

## 7.1 MARINE ENVIRONMENTAL QUALITY OBJECTIVES AND ENVIRONMENTAL QUALITY CRITERIA

As a result of studies on Cockburn Sound and adjacent waters, the DEP Southern Metropolitan Coastal Waters Study (SMCWS) concluded by proposing that the Environmental Protection Authority (EPA) develop an Environmental Protection Policy (EPP) for Perth's coastal waters (DEP, 1996). Once approved by the Minister for the Environment the EPP will have the full force of law as though it is part of the Environmental Protection Act. The DEP also proposed draft Environmental Quality Objectives (EQOs) and Environmental Quality Criteria (EQC) for inclusion in the EPP. The EQOs have been revised and finalised in extensive discussions with community/user groups (CSIRO, 1998), and are expected to be released by the EPA soon.

EQOs represent the goals of an environmental management program and relate to both ecological (i.e. maintenance of biodiversity and ecosystem integrity) and cultural values (i.e. maintenance of community uses and aspirations) of natural systems. Ecological EQOs are fundamental management goals whereas cultural EQOs are, by definition, negotiable and generally derived from a balance between existing and future uses after due consideration of economic, social or political factors.

The revised EQOs are as follows:

1. Types and rates of ecological processes vary naturally in all of Perth coastal waters except designated zones.
2. Biodiversity, as measured on a regional basis, remains at natural levels in Perth coastal waters.
3. Abundance and biomass of marine life vary naturally in all of Perth coastal waters except designated zones.
4. Sediment quality varies naturally in all of Perth coastal waters except designated zones.
5. Water quality varies naturally in all of Perth coastal waters except designated zones.
6. Seafood, including molluscs and other filter-feeding animals, is safe to eat when taken from anywhere in Perth coastal waters except designated zones.
7. Swimming and other forms of primary contact recreation are safe and attractive in all of Perth coastal waters except designated zones.
8. Boating and other forms of secondary contact recreation are safe and attractive in all of Perth coastal waters except designated zones.
9. Enjoyment of an attractive and natural environment is possible in all of Perth coastal waters except designated zones.
10. Industry can safely use water from Perth coastal waters except in designated zones.

EQC are the benchmarks upon which a decision or judgement may be made concerning the ability of the environment of a given quality to maintain a designated EQO. The criteria for ecological EQOs and some cultural EQOs (eg. maintenance of aquatic life for human consumption) are determined on the basis of technical information. Criteria for other cultural EQOs, such as the maintenance of aesthetic values, are determined in a more subjective manner.

Environmental quality management zones are agreed geographic zones in which EQC are applied to meet the management goals set by agreed EQOs for the zone. The boundaries around a zone are defined in accordance with what changes are seen to be acceptable. This involves two major steps: i) defining what constitutes *change*, and ii) determining limits for *acceptability*.

The four proposed environmental quality management zones are:

1. Pristine Zones; completely natural areas, where no waste discharges or human impacts are allowed and human access may be strictly controlled. Such areas are likely to be small and rare in Western Australia (and in fact anywhere in the world), because humans have some impact on most coastal waters.
2. High Quality Zones; which represent the majority of Perth's coastal waters, and where the quality of the environment is sufficiently high for people to enjoy recreation, fishing and an attractive environment.
3. Buffer Zones; areas of environmental quality intermediate between multiple use zones and limited quality zones, and therefore of potential concern, so that close monitoring is required.
4. Limited Quality Zones; areas such as harbours, wastewater discharge areas and boat marinas, where activities occur that prevent some or all of the EQOs being met. Limited Quality Zones should mark a conservative estimate of the where a given activity will have a significant effect (eg. area encompassing the near-field, mid-field and part of the far-field dilution of wastewater discharges as distinguished by hydrodynamic modelling).

### 7.1.1 *Proposed environmental quality management zone*

Specifically, for this project it is proposed that:

- change in median water temperature and salinity constitute the primary indicator of *change*; and
- that these changes in median water temperature and salinity beyond the Limited Quality Zone are less than those stipulated in the relevant guidelines will constitute *acceptability*.

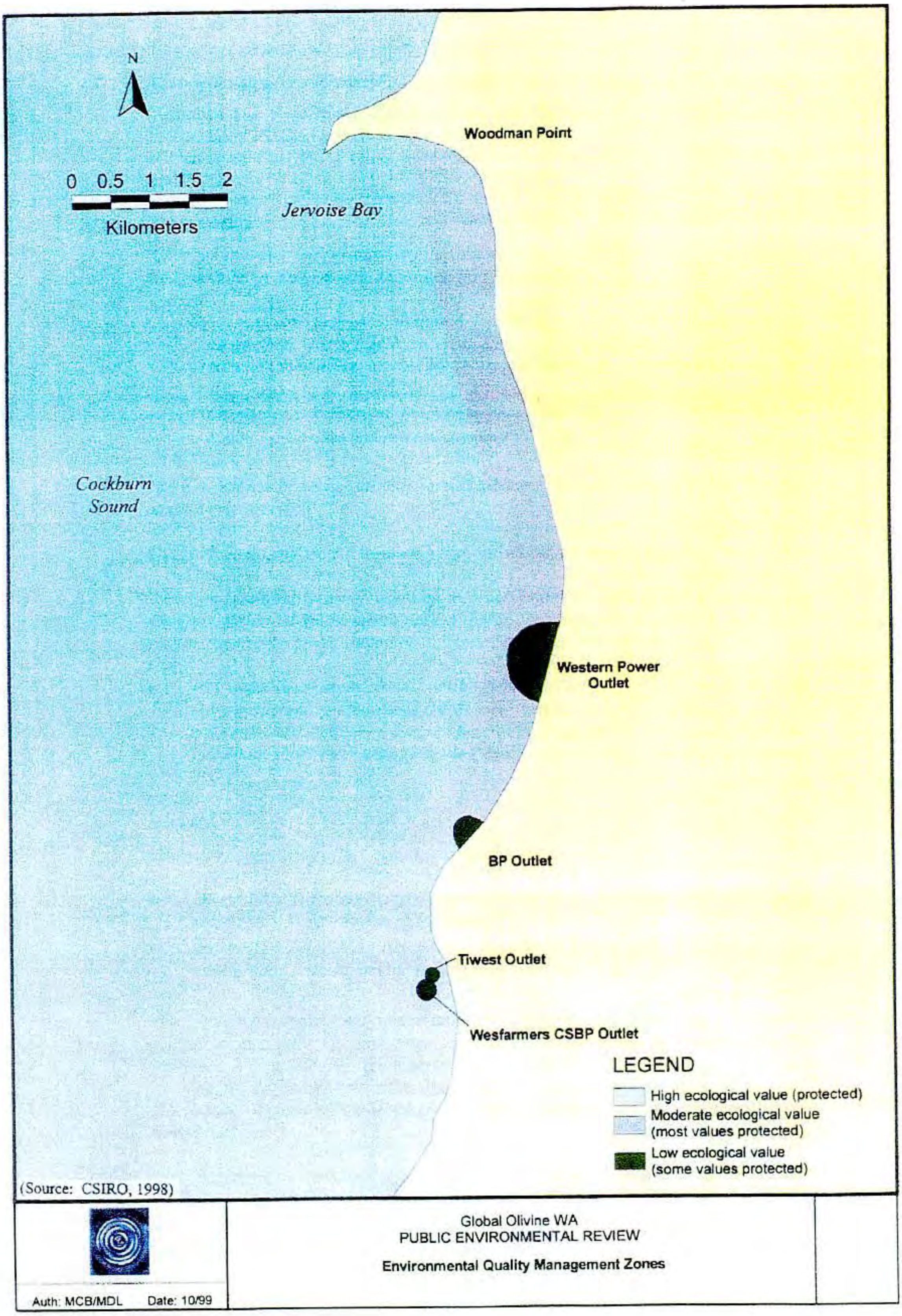
It is proposed that a Limited Quality Zone be established in the region of the discharge into Cockburn Sound.

The zones currently proposed for Cockburn Sound (CSIRO, 1998) are shown in Figure 7-1. The derivation of the extent of the Limited Quality Zone for the project is discussed in Section 10.1.

## 7.2 GUIDELINES FOR TEMPERATURE AND SALINITY CHANGE

The discharge will be at higher temperature and salinity than the surrounding waters. The relevant guideline trigger values relating to increased temperature and salinity in marine waters are as follows.

*Figure 7-1. Environmental Quality Management Zones*



### 7.2.1 *Australian and New Zealand guidelines for fresh and marine water quality*

Australian and New Zealand Environment and Conservation Council (ANZECC) have recently released a draft set of water quality guidelines (ANZECC, 1999) which will soon be finalised. These guidelines replace the previous ANZECC (1992) guidelines.

***Temperature***

*'Changes in water temperature can have a substantial effect on aquatic ecosystems, the effects being conveniently separated into two groups:*

- *Influences on the physiology of the biota (eg. growth and metabolism, reproduction timing and success, mobility and migration patterns, and production may all be altered by changes to the ambient temperature regime); and*
- *Influences on ecosystem functioning (eg. through changes in the rate of microbial processes and altered oxygen solubility).*

*There is little information on the thermal tolerance of Australian and New Zealand aquatic organisms.'*

The guidelines propose the following approach for derivation of trigger levels.

*'For significant ecosystems, where appropriate reference systems are available, and there are sufficient resources to collect the necessary information for the reference system, the trigger levels should be determined as follows:*

- *Hot water discharges should not be permitted to increase the temperature of the aquatic ecosystem above the 80 %ile temperature value obtained from the seasonal distribution of temperature data from the reference system. The maximum short term change caused by effluent discharge should be less than 2 °C.'*

***Salinity***

*'Salinity changes may affect aquatic organisms in two ways:*

- *Direct toxicity through physiological effects—both increases and decreases in salinity can have adverse effects; and*
- *Indirectly by modifying the species composition of the ecosystem and affecting species that provide food or refuge.'*

*'For significant ecosystems, where an appropriate reference system(s) is available, and there are sufficient resources to collect the necessary information for the reference system, the low-risk trigger concentrations for electrical conductivity (or salinity) should be determined as the 20 %ile or 80 %ile of the reference system(s) distribution, depending on whether low salinity or high salinity effects are being considered.'*

It is important to note that the salinity and temperature trigger level criteria are applied to the 'aquatic ecosystem' as a whole, leaving some doubt as to the usefulness of the criteria when dealing with a small flow into a large system such as Cockburn Sound.

### 7.2.2 *Western Australian water quality guidelines for fresh and marine waters*

These guidelines specify that the increase in temperature should be less than 2 °C if the levels of impact are likely to be acceptable (EPA, 1993). With respect to salinity, the change in median salinity is to be less than 5% from background (which in marine environments is a change of approximately 1.8 ppt).

***Criteria adopted***

The adoption of trigger levels for indicator parameters introduces a mechanism under which further investigation of environmental impacts should be undertaken if the trigger levels are exceeded.

Given that the Australian guidelines uniformly specify an increase in median temperature of greater than 2 °C as a trigger value, this criterion will be adopted.

The recent ANZECC (1999) guideline for salinity increase, that post-impact median salinity should be below the 80 %ile of background values, will be adopted. The background salinity of Cockburn Sound varies on a consistent seasonal cycle between ca. 34 ppt and ca. 37 ppt with an upper 80 %ile value of ca. 36 ppt.

In the case of a point source discharge to the marine environment there is the requirement to delimit an agreed mixing zone in which the guideline criteria are not met. This zone usually encompasses the near-field and mid-field regions of dilution to allow for the plume to mix through the water column (refer Section 3).

There are no set guidelines for sizing a mixing zone around a discharge, nor are there guidelines for setting trigger levels within the mixing zone. The proposed mixing zone size is established as part of the numerical modelling study described in Section 9.1.1.

## 7.3 POLICIES AND GUIDELINES RELATING TO AIR QUALITY

### 7.3.1 *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy*

The Environmental Protection (Kwinana) (Atmospheric Wastes) Policy, known as the Kwinana EPP:

- sets air ambient standards and limits for sulphur dioxide and total suspended particulates for three defined areas within the policy area, namely an industrial area (Area A), a buffer area (Area B) and the rural residential area (Area C) beyond the buffer area;
- provides for setting enforceable limits on emissions from industrial sources to ensure that the ambient standards and limits will be met; and
- provides for ongoing monitoring, assessment and, if necessary, redetermination of the emissions limits.
- provides for redetermination of emission limits to accommodate a new source of emissions or a change within an existing industry.

Sulphur dioxide emission limits are determined via a computer model which the DEP has progressively developed and tested. This model has been used to assess the effect of the proposed emissions from the WTE&W plant on air quality in the Kwinana airshed.

Figure 7-2 shows the air quality areas defined under the Kwinana EPP, together with the approximate location of the WTE&W plant, within Area A.

***Figure 7-2. Air quality areas defined under the Kwinana EPP.***

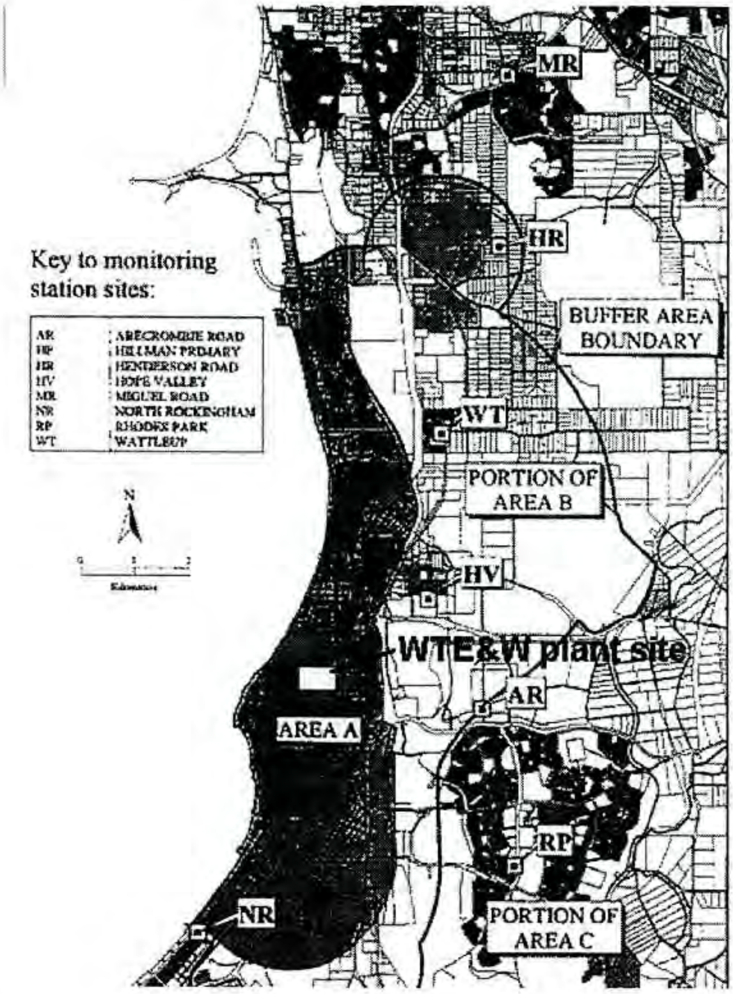



***Table 7-1. Air quality standards for sulphur dioxide in the Kwinana EPP Areas***

| | ***Standard (Level Desirable not to Exceed) (µg/m³)*** | ***Limit (Not to be Exceeded) (µg/m³)*** |
|---|---|---|
| 1-Hour Average Sulphur Dioxide Concentrations | | |
| Area A | 700 | 1,400 |
| Area B | 500 | 1,000 |
| Area C | 350 | 700 |
| 24-Hour Average Sulphur Dioxide Concentrations | | |
| Area A | 200 | 365 |
| Area B | 150 | 200 |
| Area C | 125 | 200 |
| Annual Average Sulphur Dioxide Concentrations | | |
| Area A | 60 | 80 |
| Area B | 50 | 60 |
| Area C | 50 | 60 |

### 7.3.2 *National Environment Protection Measure for Ambient Air Quality (NEPM)*

The National Environment Protection Measure for Ambient Air Quality (hereafter NEPM) was approved by the National Environment Protection Council (comprised of Commonwealth, State and Territory nominated Ministers) in June 1998. The NEPM sets standards for six common air pollutants (carbon monoxide, nitrogen dioxide, photochemical oxidant (as ozone), sulphur dioxide, lead, and particles) and requires the monitoring and reporting of concentrations of these pollutants according to a protocol under development.

The NEPMs do not specify what air quality management programs should be put in place in order to achieve and maintain compliance for each pollutant, but establishes a goal of compliance with its standards within ten years. The National Environment Protection Council (Western Australia) Act 1996 includes a commitment to implement each NEPM "by such laws and other arrangements as are necessary".

Where NEPM standards are available, they are used for assessing the acceptability of concentration increases predicted to result from the discharges from the proposed WTE&W plant.

### 7.3.3 *State Air Environmental Protection Policy*

Within Western Australia some effective air quality management programs are already in place, such as the Kwinana EPP. Work has commenced on the development of the Perth Air Quality Management Plan which will address, among other things, strategies for the control of photochemical smog, fine particulate matter and air toxics. A key initiative of the EPA and Government will be to develop an EPP addressing air quality across the State (State Air EPP); this has implications for the Kwinana EPP.

It is envisaged that the State Air EPP will:

- reference the NEPM standards for general application to air quality management programs and the assessment of development proposals in WA; but also
- exclude application of the standards within industrial areas and residence-free buffer areas around industrial estates; and
- for circumstances where the standards are not being achieved due to existing emissions, enable attainment and/or management programs to be established.

### 7.3.4 *Review of the Kwinana EPP, and relationship to State Air EPP and FRIARS study.*

Three developments or reviews have some bearing on air and environmental quality in the Kwinana area:

- Review of the Kwinana EPP
- Development of the Fremantle Rockingham Industrial Area Regional Strategy (FRIARS) study
- Development of the State Air EPP (discussed above).

The FRIARS study examines options for land use and infrastructure within the existing buffer area, as defined by the EPP, in response to growing development pressure in the Fremantle-Rockingham area. Options range from maintaining residential areas in the Kwinana buffer (Area B)), to the wholesale removal and replacement of residential areas within the buffer with light and heavy industrial uses.

The likely timeframe for completion of both the FRIARS study and the State Air EPP is the end of 2000. In light of this, the EPA has concluded that the Kwinana EPP should be renewed, unchanged until the State Air EPP is established. At this stage it would be appropriate to modify the Kwinana EPP to properly reflect the provisions of the State Air EPP or, more likely, repeal the Kwinana EPP and subsume it within the State Air EPP.

The proposed Waste to Energy and Water project will have very small effects on air quality or other components of the environment resulting from its emissions, as discussed in the dispersion modelling and multi-pathway health risk assessment sections. There appears to be little likelihood either for limits placed on emissions to require review resulting from these developments, or for emissions from the project to have any potential implications for them. GOWA has proposed, however, that the emission limits for sulphur dioxide and oxides of nitrogen ($NO_x$) applying to the project be reviewed one year after commissioning of the plant, with a view to decreasing the limits to the lowest practical levels in light of operational experience of the practical emission levels achievable.

### *7.3.5 Section 51, Environmental Pollution Act 1986.*

Section 51, Environmental Pollution Act 1986 makes it an offence not to take all reasonable and practicable measures to prevent or minimise the discharge of waste. As discussed in the emissions estimates section, the GOWA Ultra-High Temperature Combustors incorporate both design and operational features which will minimise the discharge of all pollutants to the maximum extent practical. Emissions are expected to be, routinely, well below both European and USA standards for MSW combustors. As noted above, GOWA has proposed a review of emission limits for sulphur dioxide and oxides of nitrogen ($NO_x$), with the intention of decreasing these to the lowest practical levels.

## 7.4 POLICY AND GUIDELINES RELATING TO GREENHOUSE EMISSIONS

### *7.4.1 Kyoto and Australian Greenhouse Office*

The greenhouse impact of fossil fuel electricity production and landfill methane emissions is becoming an important issue in terms of Australia's commitments under the Kyoto Protocol. Australia's commitment is 108% of the 1990 level by 2012.

In response its Kyoto Protocol obligations, the Australian Greenhouse Office has issued a goal of producing 4% of national energy production from renewable energy sources. This includes gasification, natural gas, tidal energy and waste to energy.

The Australian Greenhouse Office has also adopted a system of co-operative agreements between government and industry called the "Greenhouse Challenge". The Greenhouse Challenge encourages best practice in industry to reduce greenhouse emissions (refer Section 9.13.3).

*EPA Interim Guidance No 12*

The EPA Interim Guidance No 12 requires proponents to use the methodology developed and periodically updated by the National Greenhouse Gas Inventory Committee to:

- estimate the gross emissions of greenhouse gases that may be emitted from the proposed project for each year of its operation in absolute and in carbon dioxide equivalent figures;
- estimate the gross removals of greenhouse gases from either sink enhancement programs or carbon dioxide stabilising techniques and loss of sink through land clearing, linked to the proposed project for each year of its operation in carbon dioxide equivalent figures;
- indicate the intended measures and efficient technologies to be adopted to minimise total greenhouse gas emissions in the proposed project, including appropriate abatement measures;
- compare the greenhouse gas emissions of this proposed project (per unit of product and/or other agreed performance indicators) with other similar established projects using the same and different technologies; and
- as a matter of information, indicate whether the proposed project will be entered into the Commonwealth Government's "Greenhouse Challenge" voluntary cooperative agreement program (whether on a project-specific basis, company-wide arrangement or within an industrial grouping, as appropriate).

These matters are addressed in the greenhouse gas Section 9.13 of this document.

## 7.5 GUIDELINES RELATING TO WATER

### *7.5.1 Groundwater*

*WA State Groundwater Protection Policy*

A draft Environment Protection (State Groundwater) Policy was published by the EPA in December 1997 (EPA, 1997). The draft policy recognises beneficial uses of groundwater to be protected, consistent with the following broad categories:

- The maintenance of groundwater dependent ecosystems;
- Human drinking water;
- Domestic purposes and commerce;
- For Industrial purposes;
- For Irrigation;
- For Livestock use; and
- For recreational use.

Environmental quality objectives for groundwater are to be consistent with EPA (1993), as well as NHMRC/ARMCANZ (1990), ANZECC (1992) and NHMRC/ARMCANZ (1996). The draft policy does not contain specific details regarding protection measures to maintain water quality.

***Victorian State Groundwater Protection Policy***

Victoria is currently the only State with a developed groundwater protection policy. This is reviewed briefly, since it may form the basis for future WA policy. The goal of the policy is to 'maintain and improve groundwater quality sufficient to protect existing and potential beneficial uses of groundwater'. Segments of the groundwater environment are defined, based on the existing (background) total dissolved solids (TDS) content, as summarised in Table 7-2.

***Table 7-2. Segments of the groundwater environment***

| SEGMENT | TDS RANGE (mg/L) | EQUIVALENT EC (µS/cm) |
|---|---|---|
| A1 | 0–500 | 196–840 |
| A2 | 501–1,000 | 841–1,483 |
| B | 1,001–3,500 | 1,483–4,700 |
| C | 3,501–13,000 | 4,701–16,923 |
| D | >13,000 | >16,924 |

*Note: EC = Electrical conductivity*

Beneficial uses of groundwater to be protected in each segment are proposed, based on the historically accepted uses of groundwater, as summarised in Table 7-3.

***Table 7-3. Protected beneficial uses of the groundwater segments***

| BENEFICIAL USES | SEGMENTS (mg/L TDS) | | | | |
|---|---|---|---|---|---|
| | A1 (0–500) | A2 (501–1,000) | B (1,001–3,500) | C (3,501–13,000) | D (>13,000) |
| 1) Maintenance of ecosystems | √ | √ | √ | √ | √ |
| 2) Potable water | | | | | |
| —desirable | √ | | | | |
| —acceptable | √ | √ | | | |
| 3) Potable mineral water | √ | √ | √ | | |
| 4) Agriculture, parks, gardens | √ | √ | √ | | |
| 5) Livestock rearing | √ | √ | √ | √ | |
| 6) Industrial water use | √ | √ | √ | √ | √ |
| 7) Buildings and structures | √ | √ | √ | √ | √ |

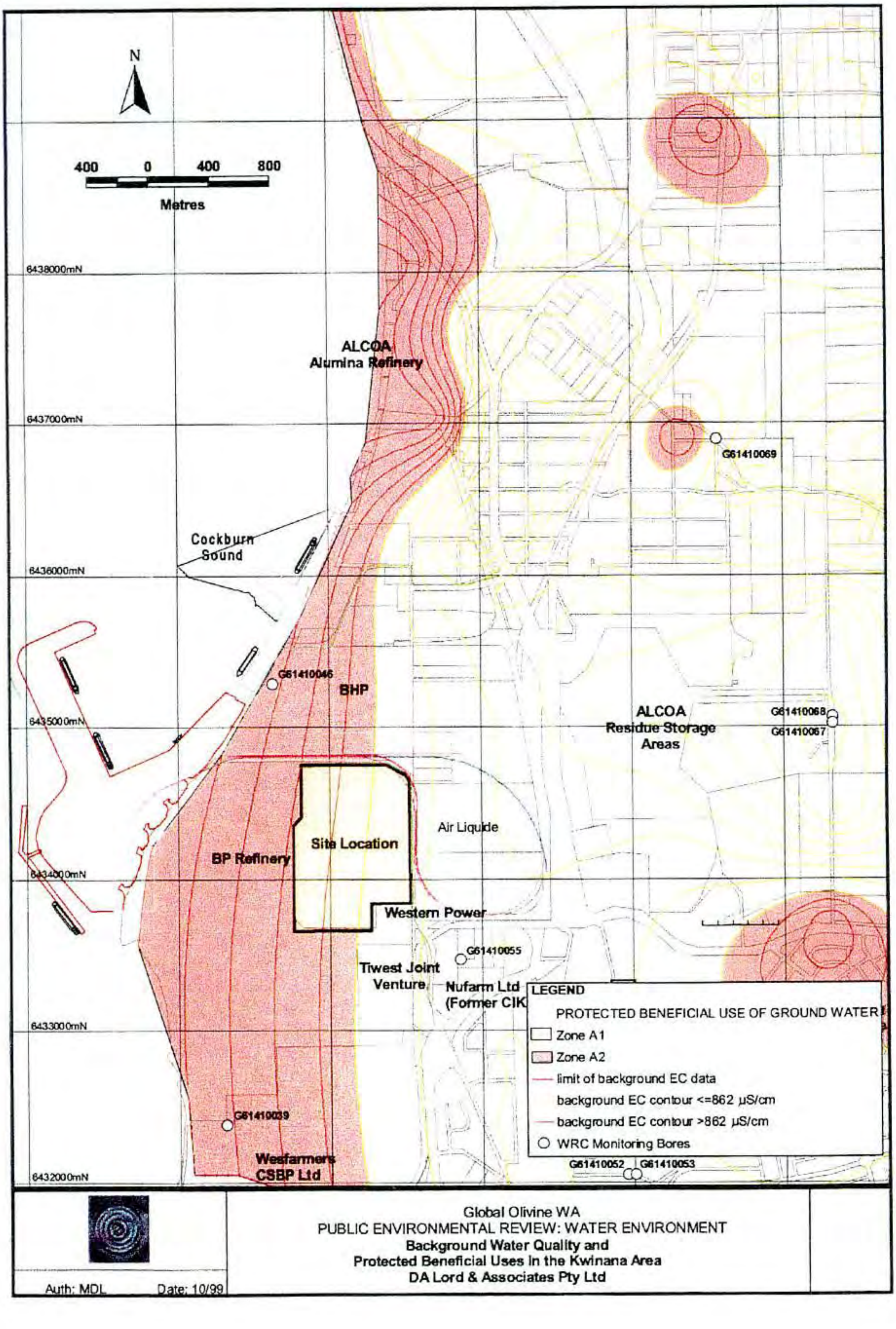
It may be determined that a beneficial use is not applicable under a variety of circumstances, including location within a designated groundwater pollution zone or attenuation zone. Groundwater Quality Objectives define the water suitability for a beneficial use, based on the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992).

***Water quality objectives for the Kwinana area***

On the basis of Table 7-3 only, the site overlies segment A2 groundwater to the west, and segment A1 groundwater to the east of a line running north to south centrally beneath the site (refer Figure 7-3). However, defining beneficial use segments based on probable background salinity only ignores other naturally occurring or introduced chemicals that may render the groundwater unfit for a particular usage. It has been recognised recently by the DEP that existing groundwater contamination may render the concept of protected beneficial use inappropriate.

Informal advice was obtained from the Water and Rivers Commission (WRC) relating to likely water quality objectives for the Kwinana area under forthcoming amendments to the Cockburn Groundwater Area Management Plan. It was indicated that the protection of groundwater quality for use for industrial purposes (e.g. cooling water) and an on-site source of irrigation/landscaping water may be applicable. The use of shallow groundwater as drinking water is not recommended by the WRC or DEP anywhere within the Perth metropolitan area and therefore there is no loss of this beneficial use.

***Figure 7-3. Background Water Quality and Protected Beneficial uses in the Kwinana Area.***



### *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) (NEPC, 1999)*

Groundwater Investigation Levels are provided, based on the ANZECC (1992) Australian Drinking Water Quality Guidelines and the NHMRC/ARMCANZ Australian Drinking Water Guidelines (1996), for groundwater quality at the point of use, and as response levels at the point of discharge, (Australian Water Quality Guidelines (AWQG)) for:

- Aquatic ecosystems (Fresh and Marine);
- Drinking water; and
- Agricultural use:
  - Stock watering; and
  - Irrigation.

### *Hazardous goods*

The handling and storage of hazardous substances is covered in Western Australia by the Explosives and Dangerous Goods Act (EDGA) 1961 incorporating subsequent amendments. Nine classes of Dangerous Goods are defined, including:

- Class 1: Explosives;
- Class 2: Compressed gasses (including liquefied petroleum gases (LPG), chlorine);
- Class 3: Flammable liquids;
- Class 4: Flammable solids (including spontaneous combustible and dangerous when wet);
- Class 5: Oxidisers (including organic peroxides);
- Class 6: Poisonous and Infectious Substances (including chronic hazard substances);
- Class 7: Radioactive (substances);
- Class 8: Corrosives; and
- Class 9: Miscellaneous.

The regulations cover the following:

- Packaging and Bulk Container requirements;
- Labelling requirements;
- Storage of Dangerous Goods:
  - Licensing of premises;
  - Requirements of storage premises;
  - Management procedures; and
  - LPG, liquid chlorine, flammable and combustible gases, cyanides.
- Firefighting equipment;
- Pipeline operations; and
- Offences.

### *DEP secondary containment policy*

The DEP operate a secondary containment policy (SCP) for the storage of hazardous liquids (DEP, 1997). The policy provides appropriate environmental design parameters for above ground storage of liquid chemicals, consistent with conditions set for licensed premises by the Pollution Prevention Division, Licensing Branch under part V of the Environmental Protection Act (1986). The policy sets additional conditions to those specified under the EDGA 1961 and amendments, which are intended to contain releases of environmentally hazardous chemicals. The policy stipulates maximum permeability and minimum volumes for storage compounds, resistance to chemical attack, the segregation of reactive chemicals, inclusion of valve/transfer apparatus, and maintenance requirements for storage areas.

### *7.5.2 Surface water*

Water discharges to surface water courses will be subject to the guidelines for the protection of freshwater aquatic ecosystems (EPA, 1993). Neither the DEP nor the WRC have specific policies relating to the discharge of surface waters from industrial sites to drains (other than natural watercourses) providing that the water is 'clean' and uncontaminated. Discharges of contaminated stormwater would be subject to license conditions to be set by the DEP on maximum acceptable contaminant concentrations.

Advice from WRC (H. Tan, *pers. comm.*) indicates that an overflow from soakwells to existing drainage channels would be required. The Town of Kwinana is responsible for the maintenance of surface water drains in the site area. The engineers department has indicated that discharges to surface water drains from the site development should be minimised or prevented, and that incidental water should be retained within the site through the use of soakwells or other infiltration mechanisms (K. Singh, *pers. comm.*).

## 7.6 POLICIES RELATING TO WASTE

The Commonwealth has implemented a hierarchy of waste management priorities. In order of importance these are;

1. Waste avoidance;
2. Waste reduction;
1. Waste reuse;
2. Waste recycling or reclamation;
3. Waste treatment; and
4. Waste disposal.

This strategy reflects an international objective to landfill waste only as a last option. As set out in Section 3, the WTE&W plant effectively recycles or reclaims all waste by removing directly recyclable products (ferrous and non ferrous metals) and creating useable by-products (aggregate, compost, industrial chemicals, glass, electricity, potable water). The proposal will not impact on Council and government driven waste avoidance and reduction measures.

The Australian and New Zealand Environment Conservation Council (ANZECC), of which Western Australia is a member, has also adopted a national target of 50% reduction in waste going to landfill by the year 2000. This goal has now been incorporated into the Waste Reduction and Recycling Policy Statement which also highlights the importance of waste reduction and recycling. The Government's waste reduction and recycling policy is based on the following principles:

- The environment and economic impact of waste should be kept to a minimum;
- Society should be responsible for managing its own waste today, rather than leaving it for future generations to deal with;
- State government, local government and industry should co-operate in reducing waste;
- Those responsible for generating waste should pay for its treatment or disposal; and
- The community should be closely consulted in the development of policy.

## 7.7 GUIDELINES AND CRITERIA RELATING TO RISK MANAGEMENT

### *7.7.1 Risk Management Objectives*

The overall objectives in the management of hazardous industrial plant are:

- To minimise the risk (i.e.: individual, societal and environmental) associated with new developments.
- To ensure that hazardous industry and land-use planning in the vicinity meet acceptable criteria for individual fatality risk and that separation distances are established in the planning process.
- To ensure the plant continues to operate in such a manner that the emissions and risks are managed within the accepted criteria and licence conditions.

### *7.7.2 Risk Criteria*

The Environmental Protection Authority(EPA) have published the criteria which they use to assess the acceptability of a major hazards industry in their Bulletin 611, "Criteria of the Assessment of Risk from Industry", (EPA, 1992). These criteria have been augmented by subsequent guidance note, the most recent being EPA Bulletin 728 (EPA, 1998).

### *7.7.3 Risk Criteria for New facilities*

The EPA has established the following criteria for off-site individual risk for fatalities from hazardous industrial plants:

- A risk level in residential zones of one in a million (1x10-6) per year or less, is so small as to be acceptable to the EPA.
- A risk level in "sensitive developments", such as hospitals, schools, child care facilities and aged care housing developments of one half in a million (0.5x10-6) per year is so small as to be acceptable to the EPA.
- Risk levels from industrial facilities should not exceed a target of fifty in one million (5x10-5) per year at the site boundary for each individual industry, and the cumulative risk level imposed upon an industry should not exceed a target of one hundred in a million (1x10-4) per year.
- A risk level for any non-industrial activity located in buffer zones between industrial facilities and residential zones of ten in a million (1x10-5) per year or lower, is so small as to be acceptable to the EPA.

- A risk level for commercial developments, including offices, retail centres and showrooms located in buffer zones between industrial facilities and residential zones, of five in a million (5x10-6) per year or less, is so small as to be acceptable to the EPA.

### 7.7.4 *Cumulative Risk Criteria*

The criteria would not only apply to new facilities, but also to existing facilities whose contribution must be incorporated into the cumulative risk. The EPA state that "no extra risk would be acceptable where the cumulative risk of existing industry, combined with assessed risk of the proposed new industry, exceed the risk levels proposed for new industry". Hence if additional hazardous facilities are proposed in the area, this study will provide essential information regarding risk levels which will facilitate the assessment of such proposals.

### 7.7.5 *Existing Industry*

The quantitative criteria specified in Bulletin 611 apply to proposed industrial developments. Where risks from existing industries are found to exceed the criteria, the EPA suggests that "a program should be developed to alter the land use or reduce the risks so that the current criteria can be met".

## 7.8 GUIDELINES AND REGULATIONS RELATING TO NOISE

Environmental Protection (Noise) Regulations 1997 govern both construction and operational noise.

***Construction Noise***

The Environmental Protection (Noise) Regulations 1997 stipulate maximum allowable external noise levels determined by the calculation of an influencing factor which is then added to the base levels shown below. The influencing factor is calculated for the usage of land within the two circles, having a radius 100 m and 450 m from the premises of concern.

***Table 7-4. Baseline Assigned Outdoor Noise Level***

| Premises Receiving Noise | Time of Day | Assigned Level (dB) | | |
|---|---|---|---|---|
| | | $L_{A\,10}$ | $L_{A\,1}$ | $L_{A\,max}$ |
| Noise sensitive premises | 0700 – 1900 hours Monday to Saturday | 45+ if | 55+ if | 65+ if |
| | 0900 - 1900 hours Sunday and Public Holidays | 40+ if | 50+ if | 65+ if |
| | 1900 - 2200 hours all days | 40+ if | 50+ if | 55+ if |
| | 2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and Public Holidays | 35 + if | 45 + if | 55+ if |

*Note: if - influencing factor*

The above levels are conditional on no annoying characteristics existing in the noise of concern, such as tonality, amplitude modulation or impulsiveness. If such characteristics exist then any measured level is adjusted according to Table 7-5.

***Table 7-5. Adjustments To Measured Levels***

| Where **tonality** is present | Where **modulation** is present | Where **impulsiveness** is present |
|---|---|---|
| +5 dB(A) | +5 dB(A) | +10 dB(A) |

*Note: these adjustments are cumulative to a maximum of 15 dB.*

The above criteria are the assigned levels in accordance with Regulation 8. In accordance with Regulation 13, construction noise is exempt from Regulation 8 if that work is only carried out between the hours of 0700 to 1900 on any day except Sundays and Public Holidays. Also, the following management practices are adhered to:-

- Work is carried out in accordance with Section 6 of AS2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites.*
- The equipment used on site is the quietest reasonably available.
- If a noise management plan is to be prepared that:

1. The noise management plan (NMP) was prepared and given in accordance with the requirement, and approved by the Chief Executive Officer; and
2. The construction work was carried out in accordance with the management plan.

In assessing noise from construction activities, Regulation 8 should be used as the level of noise that ideally should be sought. Further where the construction noise is significant for a relatively long period then a management plan should be prepared.

When work is carried out outside of the above hours, Regulation 8 does not apply providing the above is adhered to and;

- A noise management plan is prepared and given to the CEO at least seven days before construction commences and is approved by the CEO.
- Written notice is given to the occupiers of all premises at which noise emissions received are likely to exceed those levels specified under Regulation 8 of the proposed construction work
- It was reasonably necessary for the construction work to be carried out at that time.

### *7.8.2 Operational Noise*

Operational noise must comply with the Environmental Protection (Noise) Regulations 1997. The base levels are shown above in Table 7-4. Due to the influencing factor, the assigned level varies depending upon a residences location with respect to industrial land, commercial land and major and secondary roads.

The following locations are used in this assessment as they are the closest residences with the lowest influencing factor.

Residence on Garden Road in Hope Valley.

Residence on Corner of Tucker Street and Derbel Street in Medina.

The influencing factors for these locations have been calculated and the assigned levels shown below in Table 7-6 for Monday to Saturdays, day time and night time.

All locations are influenced by Area B of the Kwinana Policy Area within the meaning of the *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy Approval Order 1992.* Only the $L_{A10}$ value is shown as it is considered that the $L_{A1}$ and $L_{Amax}$ values will not be significant.

***Table 7-6. Assigned Outdoor $L_{a10}$ Noise Level***

| Location | Time of Day | |
|---|---|---|
| | Day time (0700 - 1900 hrs) | Night time (2200 - 0700) |
| 1 | 55 | 45 |
| 2 | 50 | 40 |

As these locations are within close proximity of other industries, the introduction of a new industry must not "significantly contribute" to an excessive level at the residences as per Regulation 7(1)(a). The noise emission is considered to not significantly contribute when its emission is 5 dB(A) below the assigned level. This effectively reduces the assigned levels in Table 7-6 by 5 dB(A).

## 7.9 LAND

### *7.9.1 Relevant policies*

A number of relevant guidelines and policies can be used for the assessment of site contamination in WA. These are:

- ANZECC/NHMRC (1992) Guidelines for the assessment and management of contaminated sites;
- Dutch Guideline Levels (Assink *et al.*, 1986 and van den Berg *et al.*, 1994);
- DEP Indicative Guidelines for Industrial Sites; and
- National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), (NEPC, 1999).

The ANZECC/NHMMRC (1992) guidelines were superseded by the final NEPM document in December 1999, however these guidelines are still referenced under certain specific circumstances. Each of the relevant guidelines is described below.

***ANZECC/NHMRC guidelines for the assessment and management of contaminated sites***

The guidelines aim '*to provide a systematic framework for the prevention, assessment, clean-up and management of existing and future contaminated sites*'. Background ('A') and environmental investigation ('B') guidelines for soils are provided. Concentrations at or above the 'B' guidelines may indicate the need for detailed site investigation and/or risk assessment to determine the need for remedial works. Where 'B' guidelines are not quoted, reference to the Dutch 'B' values (Assink *et al.*, 1986) is recommended.

Wherever human health or the off-site environment is at risk, a contaminated site should be cleaned up to the extent necessary to minimise short and long term risks. Where no threat to human health or the environment is apparent, it may be appropriate to clean up the site to some lesser degree. Acceptable options may include containing chemicals on site or using planning controls to limit site use. The document lists preferred options for clean up, ranging from on-site destruction to materials left *in situ* with appropriate management.

***Dutch guideline levels***

The Dutch guideline levels are commonly cited international guidelines for contaminated site assessment. The original guidelines (Assink *et al.*, 1986) provided reference 'A' (background), further investigation 'B', and clean-up 'C' values. These criteria have been superseded by the Dutch environmental quality objectives (van den Berg *et al.*, 1994) which provide a (remedial) target value, and an intervention value. Concentrations at or above the intervention value imply the need to remediate in principal, although the priority should be determined using risk assessment methodologies.

***DEP indicative guidelines***

The DEP formerly used an Industrial Site guideline, based on the original Assink *et al.*, 1986 Dutch 'C' guidelines. Concentrations at or above the guideline imply the need for further investigation. Where no site specific risk assessment data are available, the DEP previously compared contaminant concentrations to the Dutch 'C' values to assess the requirement for remediation.

***National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) (NEPC, 1999)***

The National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) was finalised, following receipt of comments in December 1999. This document proposes a nationally consistent approach to contaminated site assessment, effectively superseding the ANZECC/NHMRC (1992) guidelines.

The NEPM provides investigation levels (ILs) for soil and groundwater, for the assessment of groundwater contamination and for health and ecological risk assessment, based on land use. Investigation levels are defined as '*the concentration of a contaminant above which further appropriate investigation and evaluation will be required*' (ANZECC/NHMRC, 1992). Response levels are defined as the '*concentration...for which some form of response is required...to protect public health and ecological values*'.

(Human) Health-based Investigation Levels (HILs) are provided based on land use and a series of potential human exposure scenarios, including:

- 'A', standard residential with garden/accessible soil, with a resident child as the most sensitive receptor, home grown produce contributing less than 10% of fruit and vegetable intake (also applicable to daycare centres, kindergartens, preschools and primary schools).
- 'B', Residential, with substantial vegetable garden and/or poultry contributing to dietary intake. HILs will need to be developed from a site-specific risk assessment.
- 'C', Residential, with substantial vegetable garden, excluding poultry, contributing to dietary intake. HILs will need to be developed from a site-specific risk assessment.

- 'D', Residential, with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high rise apartments and flats.
- 'E', Parks, recreational open space and playing fields; includes secondary schools.
- 'F', Commercial/Industrial; includes premises such as shops and offices, as well as factories and industrial sites.

Where ILs are exceeded, an appropriate site-specific assessment, and health and ecological risk assessment should be conducted for a proposed or current landuse. A risk assessment will lead to the development of site-specific Response Levels.

The DEP have commented that HILs will be adopted, although only as threshold levels above which further characterisation and/or risk assessment is warranted.

***Clean-up levels***

Clean-up levels to be adopted depend on the risk posed to either human health, or ecological risk to the groundwater environment. Where a risk is posed to groundwater, the DEP have indicated that clean-up to the ANZECC 'B' (Environmental Investigation) guideline will be required. However, where no risk is apparent to groundwater quality, the NEPM HIL appropriate to the site usage, in this case the 'F' (commercial/industrial) level should be used as clean-up level/s, in the absence of site specific clean-up levels derived from a health or ecological risk assessment.

# 8. DESCRIPTION OF EXISTING ENVIRONMENT

## 8.1 MARINE

### *8.1.1 Background*

Cockburn Sound developed environmental problems in the 1970s due to large inputs of nutrients and contaminants from industrial and domestic wastewater. Two major environmental problems in this period were loss of seagrass (due to shading by increased growth of epiphytic algae on the seagrass, and increased growth of phytoplankton) and deteriorating water quality (due to phytoplankton blooms). These effects were attributed to a massive increase in nitrogen loading to the Sound. High levels of heavy metals in sediments and marine biota were also found.

Diversion of domestic wastewater out of the Sound and improvements in industrial wastewater treatment processes have considerably decreased direct discharges of nutrients, trace metals and other contaminants into Cockburn Sound since the 1970s. However, large amounts of nitrogen and phosphorus still enter the Sound via groundwater (DEP, 1996).

This Section describes the environment in the vicinity of James Point as it relates to GOWA's development.

### *8.1.2 Coastal processes*

***Wave climate***

The wave climate of Cockburn Sound is characterised by low wave energy, with winter storms responsible for contributing the most significant wave energy. The wave climate is dominated by short period (<8 s) wind waves. Garden Island provides a considerable barrier to incident swell waves, and as little as 5% of the swell wave energy penetrates to southern Cockburn Sound (DEP, 1996). However, the degree of shelter is highly dependent on the incident wave direction and the location within Cockburn Sound. At James Point the attenuation of the prevailing south-westerly swell is considerably greater than the attenuation of north-westerly waves.

***Beach stability***

Prior to 1953, the coastline near James Point was in a natural state, however, significant shoreline modifications have occurred since this time as a result of industrial growth at Kwinana. Construction of the BP Oil Refinery began in 1953 and these works included a large trestle jetty, a small boat haven, a solid cooling water intake jetty which extended 200 m beyond the shore and a cooling water outlet north of James Point. The cooling water intake jetty intercepted the predominantly southward longshore sediment transport, and from 1963–1973 the beach immediately north of the intake prograded at a rate of approximately 6 m year$^{-1}$. By the mid-1970s the shoreline progradation to the north of the intake was of sufficient concern to BP that they constructed three breakwaters to north of the cooling water intake.

These breakwaters rapidly accumulated sediment and were saturated within 5-10 years, which prompted the construction of an additional three breakwaters.

Presently all six groynes are saturated and the shoreline to the north of the intake is continuing to prograde. Currently the beach face is approximately 40 m east of the intake; however, recent aerial photographs suggest significant shallowing near the intake mouth.

Examination of aerial photographs indicates that the shoreline has remained relatively stable immediately north of James Point, where GOWA propose to construct their discharge. BHP constructed two open jetties to the north of James Point (the northern jetty between 1953 and 1963 and the southern jetty between 1963 and 1973). These jetties have had minimal impact on the shoreline position.

***Longshore sediment transport***

Longshore sediment transport occurs due to the development of a longshore drift by obliquely incident waves. Along the Perth metropolitan coast the longshore transport direction is typically northwards, particularly in summer under the influence of swell and sea breeze generated waves (Masselink, 1996). Occasional storms in winter result in southward longshore sediment transport. Along the eastern shore of Cockburn Sound, and particularly in the vicinity of James Point, it appears that combined effects Garden Island and the causeway results in a net southward longshore sediment transport. Examination of the shoreline accretion to the north of the BP cooling water intake between 1963 and 1973 suggest that the net longshore sediment transport is directed southward with a rate of approximately 1,000-2,000 $m^3$ $year^{-1}$ (JPPL, 1998).

### *8.1.3 Circulation and mixing in Cockburn Sound*

Comprehensive reviews of the hydrodynamics of Cockburn Sound are provided by Hearn (1991), D'Adamo (1992) and DEP (1996). These studies examine the hydrodynamics of Cockburn Sound and much of the information is relevant to processes in the vicinity of James Point. An understanding of these processes is important in determining the anticipated level of impact of the GOWA discharge within Cockburn Sound.

Currents in Cockburn Sound are primarily a result of wind forcing (DEP, 1996). The synoptic wind climate of Perth is controlled by the annual variation in the location of the mid-latitude anticyclonic belt. The influence of local-scale effects are also of considerable importance, in particular the diurnal sea breeze cycle which occurs during summer. During summer the winds are typically quite persistent and 50% of winds occur in the 5–9 $ms^{-1}$ range. In winter, winds are more variable with occasional calms and strong storm winds, and 50% of winds have a velocity of 2-7 $ms^{-1}$. During summer the dominant wind direction is south to south-west, whereas in winter the dominant wind direction is westerly, though northerly winds frequently occur.

The tidal range in the vicinity of Cockburn Sound is between 0.1 and 0.9 m but is typically around 0.5 m and the tides are predominantly diurnal. Sea level is also influenced by the passage of anticyclonic pressure systems, storm surges and other long period forcings, including seiching and continental shelf waves (DEP, 1996).

Density effects are important in the main basin of Cockburn Sound (depth ca. 20 m) where lateral density differences can typically be up to 1 kg $m^{-3}$, and in the absence of strong vertical mixing (typically driven by winds), vertical density differences can be up to 0.5 $kgm^{-3}$.

Three distinct hydrodynamic regimes have been identified in Cockburn Sound (DEP, 1996): 'winter-spring', 'summer' and 'autumn'.

During the winter-spring period, the dynamics of the Sound are strongly influenced by the passage of storm systems and buoyant discharge from the Swan River. Using available wind data, D'Adamo (1992) suggested that vertical stratification could occur in the deep central basin 85% of the time during the 'winter-spring' period. During the winter storm events the wind magnitudes are sufficient to fully mix the water column in the main basin of Cockburn Sound. During the winter, water temperatures in Cockburn Sound are typically around 16 °C to 18 °C and salinities are around 34 ppt to 35 ppt (DEP, 1996).

During summer, wind is the dominant mechanism governing circulation within Cockburn Sound and waters are generally well mixed and the net flow direction in the Sound is northwards. Modelling of Cockburn Sound indicated that the strongest wind driven currents occur on the shallow bank immediately offshore of James Point (DEP, 1996). During the summer, water temperatures in Cockburn Sound are typically around 23 °C to 25 °C and salinities are around 36 ppt to 37 ppt (DEP, 1996).

During the autumn period the waters are less well mixed vertically due to the reduced energy input from winds. During this period the waters of Cockburn Sound are typically denser than the adjacent coastal waters and are therefore confined by the presence of bathymetric barriers.

Immediately offshore of James Point is a wide shoal which extends north from James Point to Woodman Point. This shoal has a water depth of approximately 10 m and moderate wind events are sufficient to fully mix these inshore waters. Historical field data indicate that the shallow shoal north of James Point was typically well mixed even during periods when the central basin was vertically stratified (D'Adamo, 1992). Maximum vertical stratification along the eastern shoreline of Cockburn Sound generally occurred during periods of high Swan River discharge in late winter (D'Adamo, 1992).

In the vicinity of James Point the net drift is northward during summer in response to the south to south-westerly winds that prevail. Current velocities are up to 0.2 $ms^{-1}$ during average conditions and are strongest near James Point. During winter, and periods of calm the current velocities drop to below 0.1 $ms^{-1}$. The shallow inshore region is expected to have strong depth-averaged wind-driven flows, however, the increased influence of bottom friction would result in relatively rapid reduction in flows after the onset of calm conditions (Hearn, 1991). These decay times are estimated to be around 12–24 hours and are an important consideration when assessing circulatory response due to the onset of calm conditions.

Submarine groundwater discharge occurs along the eastern coastline of the Sound at an estimated rate of 2.5 $m^3$ day per metre of coastline (Appleyard, 1994). While groundwater was not considered important to the overall circulation within Cockburn Sound it has been noted that it may be of importance locally in the nearshore regions

(D'Adamo, 1992). Previous conductivity-temperature-depth (CTD) surveys conducted in the nearshore have shown localised patches of water with salinities up to 1.5 ppt lower than sea water (Halpern Glick & Maunsell Pty Ltd, 1997).

### *8.1.4 Habitats*

Previous habitat mapping of Cockburn Sound includes Cambridge and McComb (1984), Hillman (1986), LeProvost Dames and Moore (1996) and the SMCWS (DEP, 1996). The work of Cambridge and McComb (1984) and Hillman (1986) found patches of mussels on old seagrass fibre on the shallows off James Point, with the nearest patches of live seagrass (predominantly *Posidonia sinuosa*) more than 2 km north to north-west of James Point on shallow areas to the north of the BHP shipping access channel. The SMCWS habitat mapping exercise also distinguished patches of seagrass meadow in the same area as the two earlier studies, although these areas were not covered by any groundtruthing sites (DEP, 1996). Total habitat areas in Cockburn Sound estimated in the SMCWS are shown in Table 8-1. The patches of seagrass north of the BHP shipping access channel are classified under the habitat defined as 'sand (including sparse seagrass)' rather than 'seagrass'.

***Table 8-1. Areas of main habitat types in Cockburn Sound***

| BENTHIC HABITAT | AREA (ha) | AREA (%) |
|---|---|---|
| Silt | 6940 | 60 |
| Fine sand and silt | 2 | <1 |
| Sand (including sparse seagrass) | 3725 | 32 |
| Seagrass | 750 | 7 |
| Subtidal reef | 68 | <1 |

*Note: (DEP, 1996).*

LeProvost Dames and Moore (1996) surveyed six shoreline sites between the BHP and BP jetties, seven sites in the shallows north of the BHP shipping access channel, and three sites along a north to north-west alignment between the latter site and James Point. Patches of seagrass (*Posidonia sinuosa*) were only found in the shallows north of the BHP shipping access channel.

There are no patches of seagrass in the vicinity of the proposed initial and final locations of the GOWA outfall.

### *8.1.5 Water quality*

The background to the water quality issues relevant to the likely impacts of the proposal are discussed below. The issue of nutrient enrichment is not discussed as, although of primary concern in the Sound, it will not be impacted by the GOWA proposal as the development will not release nitrogen to the Sound or alter the hydrodynamics.

#### *Contaminant inputs*

Estimates of total contaminant inputs to Cockburn Sound in 1997 are shown in Table 8-2, but must be used with some caution as they are subject to an unknown degree of error (Muriale and Cary, 1995). Not all industrial discharges are regularly tested for a full suite of metals (attention is usually focussed on contaminants of concern), and estimates for some metals in groundwater (eg. arsenic, cadmium, chromium, mercury, polycyclic aromatic hydrocarbons [PAHs]) are not included at all. Conversely, overestimation is also possible for some discharges, as some load estimates are calculated using contaminant measurements that are at or near detection limits (in which case the accepted protocol is to use a concentration of one half of the detection limit) multiplied by very large flows (eg. in the case of the BP Refinery outfall).

***Table 8-2. Estimated total annual inputs of chemicals into Cockburn Sound in 1997***

| CHEMICAL | 1997 LOAD (kg pa) |
|---|---|
| Arsenic | 29 |
| Cadmium | 20 |
| Chromium | 108 |
| Copper | 827 |
| Iron | 3,821 |
| Lead | 649 |
| Mercury | 15 |
| Zinc | 5,279 |
| Phenol | 481 |
| Total oil | 3,177 |
| Fluoride | 651,330 |
| Suspended solids | 78,320 |
| Total dissolved solids | 4,300,000 |

*Note: (Muriale and Cary, 1995).*

Industrial wastewater is discharged south of James Point from the Wesfarmers-CSBP outfall and the Tiwest Joint Venture outfall. The BP Refinery (Kwinana) Pty Ltd cooling water outfall discharges from James Point and the Western Power cooling water discharges north of James Point.

The SMCWS found that levels of cadmium, chromium, lead, nickel and mercury in filter feeding mussels throughout Cockburn Sound were below detection limits, and although concentrations of aluminium, arsenic, copper, iron, manganese, and zinc were slightly higher in mussels harvested along the eastern shore of Cockburn Sound than in other areas of Cockburn Sound, they were still well below draft EQC proposed for EQO 3 (Maintenance of aquatic life fit for human consumption) (DEP, 1996). It is noted that the draft EQCs for contaminants in aquatic life fit for human consumption are equal to (arsenic, antimony, copper, selenium and zinc) or more stringent (cadmium, lead, mercury) than the Australian and New Zealand Food Authority guidelines (1996).

### *8.1.6 Sediment quality*

Levels of contaminants in sediments in the region are shown in Table 8-3, along with national interim sediment quality guidelines (ISQGs) (ANZECC, 1999). Values of contaminants in Fremantle Harbour sediments found during the SMCWS (Burt *et al.*, 1995) are also shown as a guide to the level of contaminants that can occur in a busy harbour. The contaminants listed in Table 8-3 include arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), zinc (Zn), PAHs, polychlorinated biphenyls (PCBs) and the marine anti-fouling agent tributyltin (TBT).

***Table 8-3. Contaminant levels in sediments in the vicinity of James Point***

| SITE NO. | % silt/ clay | As | Cd | Cr | Cu | Pb | Hg | Ni | Zn | Total PAH | Total PCB | TBT * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ISQG-Low** | - | **20** | **1.5** | **80** | **65** | **50** | **0.15** | **21** | **200** | **4** | **0.023** | **0.005** |
| **ISQG-High** | - | **70** | **10** | **370** | **270** | **220** | **1.00** | **52** | **410** | **45** | - | **0.070 *** |
| H2, Fremantle Harbour | 4.8 | 68 | 0.9 | 25 | 32 | 52 | 0.12 | 8.7 | 94 | 2.3 | 0.005 | 0.268 |
| BHP No. 2 jetty | 30.8 | 6.4 | 0.25 | 36 | 100 | 14 | 0.19 | 9.2 | 55 | <1.2 | - | < 0.001 |
| 100 m west of BHP No. 2 jetty | 58.2 | 4.6 | 0.21 | 30 | 34 | 15 | 0.12 | 8.2 | 46 | <1.2 | - | 0.035 |
| 500 m west of BHP No. 2 jetty | 21.9 | 3.8 | 0.12 | 21 | 14 | 7.3 | <0.10 | 5.5 | 23 | <1.2 | - | < 0.001 |

*Note: (DEP, 1996) * ppm of TBT present as tin. All data in ppm. Values that exceed ISQG-Highs are shown shaded.*

The ISQGs are largely based on guidelines originally developed by Long and Morgan (1991) and subsequently refined by Long *et al.* (1995), from data on estuarine and coastal sediments in the USA. Long and his coworkers derived an effects range low (ERL) (= 10th %ile of effects range data) and effects range median (ERM) (= median, or 50th %ile of effects range data) for each chemical. The ISQG-Lows equate to ERLs, values below which toxicity effects are highly unlikely; and the ISQG-Highs equate to ERMs, values above which toxicity effects are likely to occur. The DEP have also used the values of Long *et al.* (1995) for sediment EQC in Perth's coastal waters: ERL values for multiple use zones, and ERMs for buffer zones (DEP, 1996). The ISQG-Lows and ISQG-Highs differ slightly from the ERLs and ERMs of Long *et al.* (1995), but the ANZECC (1999) guidelines are shown in Table 8-3 as it is expected that Western Australia will adopt the national guidelines when they are finalised.

The data in Table 8-3 indicate that the degree of sediment contamination in the vicinity of James Point is minor, and the draft EQCS for buffer zones (= ISQG-Highs) are easily met. The sandy nearshore sediments in the James Point region have even lower levels of contaminants than the silty sediments off the BHP No. 2 jetty (Burt *et al.*, 1995).

### *8.1.7 Fisheries*

There are three main commercial fisheries in the Cockburn Sound region: crabbing, wild catch mussel harvesting and beach bait fish netting. Crabbing is the largest commercial fishery in Cockburn Sound and catches have been growing since the late 1970's. In addition to the mussel aquaculture farms within Cockburn Sound there are three wild catch commercial licences for the collection of mussels (*Mytilus edulis*) within Cockburn Sound. The beach bait fish netting principally targets three species of bait fish: pilchards (*Sardinops sagax neopilchardus*), anchovies (*Engraulis australis fraseri*) and white bait (*Hyperlophus vittatus*). Commercial fishing is not permitted in the restricted waters offshore of James Point.

## 8.2 AIR

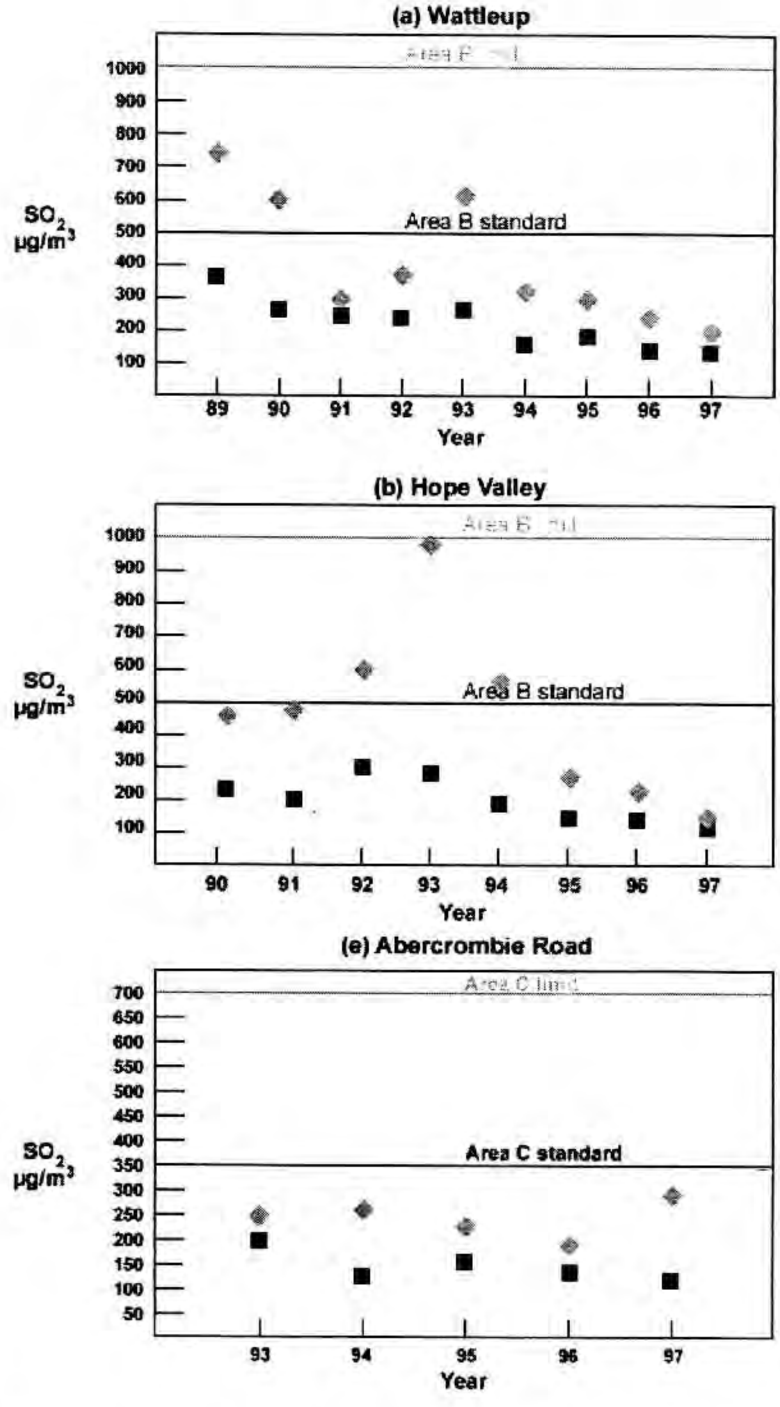
### *8.2.1 Sulphur dioxide*

The principal concern in relation to air quality in the Kwinana area is sulphur dioxide concentrations. In the past, these have been very high, and the Kwinana Environmental Protection Policy was established to control them. There has been a very marked decrease in sulphur dioxide concentrations over the years. In 1979 and 1980 there were about 250 hours each year when the sulphur dioxide concentrations exceeded 500 $\mu g/m^3$ at the Wattleup monitoring site. During the late 1980s, the highest year gave 6 hours above 500 $\mu g/m^3$, and during the 1990s the maximum number of such hours in any year (1999) was three.

As detailed in Figure 9-6, worst case sulphur dioxide emissions from the WTE&W plant produce their greatest increment in the 1 hour average ambient air concentration in the vicinity of the Abercrombie Rd monitoring site. For longer-term averages, the maximum effect is close to the Hope Valley monitoring site, with lesser effects at the Wattleup site. Figure 8-1 shows 1-hour average sulphur dioxide concentrations for these three monitoring sites from 1990-1997. These indicate a general decline in the sulphur dioxide concentrations, particularly for the 99.9 %ile, with the maximum hour showing significantly higher concentrations in some years. Generally, the data indicate comfortable compliance with the standards applicable in Area B, with rare, very high concentration peaks. The Abercrombie Rd site showed no concentrations exceeding 350 $\mu g/m^3$, the standard relevant to the Area C location of the site, over the full period for which data is currently available (1993-1998).

In Figure 8-1, the pale diamonds are 1 hour maximum concentrations, and the black squares are 99.9 %ile concentrations.

*Figure 8-1. 1-hour average sulphur dioxide concentrations in the Kwinana airshed.*




Longer-term average sulphur dioxide concentrations are well below the standards for the relevant Kwinana EPP Areas. The maximum 24-hour average concentration in the data available since 1990 was 71% of the Area standard for Wattleup, 51% for Hope Valley, and 37% for Abercrombie road. The maximum annual average concentrations were 22% of the standard for Wattleup, and 12% for each of Hope Valley and Abercrombie Rd.

### 8.2.2 *Nitrogen dioxide*

Nitrogen dioxide data is available for the Hope Valley and Rockingham sites. This shows a maximum 1-hour average concentration for Hope Valley over the 1990-1999 period of 40% of the NEPM standard. For Rockingham, excluding one extraordinary value at 79% of the NEPM standard, the highest 1-hour average concentration over the 1995-1999 period was 36% of the NEPM standard.

### 8.2.3 *Particulate material ($PM_{10}$).*

Data available for the Abercrombie Road site for $PM_{10}$ shows a few 24-hour averages exceeding the NEPM standard, by up to 34%. There were only two 24-hour periods exceeding the NEPM standard by more than 10%, and a total of 6 hours exceeding the NEPM standard during 1997 and 1998, the two years for which data is currently available. The particulate emissions from the WTE&W plant are very small, and at the emission limit make a negligibly small contribution (less than 1%) to the existing concentrations of $PM_{10}$ at the Abercrombie Rd site, as discussed in the dispersion modelling section.

### 8.2.4 *Ozone*

Ozone is not emitted directly via emissions, but is formed in photochemical reactions in the atmosphere after discharge. Accordingly, maximum ozone concentrations resulting from emissions usually occur at substantial distances from the original emission point, some hours after emission.

Because there is a natural background level of ozone, the principal health concern and focus in monitoring is the frequency and length of periods during which ozone concentrations exceed levels above which health effects are likely for at least some of the population. The NEPM standards for ozone are 100 ppb as a 1-hour average, and 80 ppb as a 4-hour average.

Perth has an extensive network of ozone monitoring stations, of which the Caversham station generally gives the most frequent high concentrations. At Caversham, there were 9 hours over the period 1989-1995 during which the ozone concentrations exceeded 100 ppb, and 5 4-hour periods (on separate days) when the ozone concentrations exceeded 80 ppb. The Perth Photochemical Smog Study estimated that, Caversham, a 10% increase in ozone concentrations would double the frequency of occurrence of both 1-hour periods during which ozone concentrations exceeded 100 ppb and 4-hour periods during which the concentrations exceeded 80 ppb. Increasing the ozone concentrations by 20% would quadruple the frequency of occurrence of these levels.

These observations indicate that elevated concentrations of ozone do occur in the Perth region, and that modest increases in ozone concentrations would substantially increase the frequency of occurrence of levels exceeding standards.

As discussed in the dispersion modelling report, the most likely effect on ozone concentrations resulting from WTE&W plant emissions is a decrease in ozone concentrations resulting from oxides of nitrogen in the plume down-wind from the plant. However, oxides of nitrogen also have the potential to increase ozone concentrations if more time is available during hours of strong sunlight for photochemical reactions to occur, and there is some uncertainty about the effect of such emissions on ozone concentrations.

## 8.3 WATER

### *8.3.1 Groundwater*

Groundwater is present beneath the site at shallow depth within superficial geological units, which are summarised in Table 8-4.

***Table 8-4. Stratigraphic sequence***

| AGE | FORMATION | LITHOLOGY | THICKNESS (m) |
|---|---|---|---|
| Quaternary | SBS | Medium grained sand with shell debris | 15–19 |
| | TLst | Variably cemented lime sand | 6 |
| Tertiary | Rockingham Sand | Very coarse grained sand with clay beds | 1.8 |
| Cretaceous | Osborne Formation | Glauconitic siltstone, shale and sandstone | 260 |

Unconfined groundwater is present at a depth of between 2.23 m and 4.69 m within the Safety Bay Sand (SBS). Groundwater levels are tidally influenced. Groundwater flow occurs to the north-west at a hydraulic gradient of approximately 0.001. Hydraulic conductivity values measured on site are between 0.65 to 1.5 m/day, which are low in comparison to values quoted in Davidson (1995) of between 10 to 50 m/d (average 15 m/d), with an unconfined storage of between 0.1 to 0.3. Natural groundwater discharge from the site will occur into the marine environment of Cockburn Sound, approximately 700 m to the north-west. The natural groundwater velocity is estimated at between 1.4 m/annum to 210 m/annum (average 31 m/a), with an estimated time to reach the coast of between 3.4 years to 507 years (average 22 years).

Groundwater within the underlying Tamala Limestone (TLst) is semi-confined by the basal silty clay of the SBS. Downward leakage occurs from the SBS to the TLst aquifer. The TLst comprises cavernous (karst) limestone and lime cemented sands, and is highly permeable, with a quoted hydraulic conductivity of 100 to >1,000 m/d, (with an average of 800 m/d) and an unconfined storage of 0.3 (Davidson, 1995). The natural groundwater velocity is estimated at between 140 m/annum to 1,400 m/annum (average 1,110 m/annum). The estimated time to reach the coast is between six months to five years (average eight months).

Groundwater within underlying aquifer units is confined by low permeability formations and will not be affected by the site development.

Groundwater is abstracted under licence from 61 locations within a 3km radius of the site, to a total allocation of 11.5 megalitres per annum. In decreasing order, this is utilised for industrial (87.6%), irrigation (11.6%) and domestic purposes (0.8%). There are no licensed abstractions located downgradient (north-west) of the site (Figure 8-2) that may be impacted by the site development. At present, groundwater resources are understood to be fully committed under licensing within the Cockburn Groundwater Area.

Groundwater quality within the superficial aquifers is generally fresh, becoming brackish near the coast. Groundwater quality in the Kwinana area has been impacted by industrial development, with in excess of 35 known or inferred sites of groundwater contamination located within a 3 kilometre radius of the site (GSWA, 1988). Approximately 15 of these sites are located up hydraulic gradient to the south-east (refer Figure 8-3) and may therefore impact groundwater quality beneath the site. These include landfill sites, former steel production, chemical, gas production and transmission manufacturing sites.

***Site specific conditions***

The site has a long and complex history of waste disposal operations that have given rise to groundwater contamination in several different areas and associated with a variety of sources. The history of waste disposal operations is summarised in Section 8.4.1 and reviewed in detail in DAL, 2000. A number of site investigations assessing groundwater have been undertaken by various consultants since 1988, including Soil and Rock Engineering (1988, 1989), Rockwater (1989), British Petroleum (1988, 1999) and Dames and Moore (1998), which are reviewed in detail in DAL, 2000 and 2000.

Former waste disposal areas and monitoring bore locations are shown on Figure 8-4. Groundwater conditions identified by Rockwater in 1989 may be summarised as:

- Phase separated hydrocarbon (PSH) was recorded in three bores (PICL5B, PICL20 and BP bore 482) in the southwest of the site at between 0.36 m and 0.61 m in thickness. Leaded petroleum contamination of the water table identified had resulted from leakage and migration from a storage tank on the BP Refinery site to the southeast of the site boundary;
- Arsenic contamination was present in the majority of investigation bores adjacent and downgradient of former arsenic trioxide waste storage areas (E, J and N), to a maximum concentration of 0.4 mg/L (bore PICL4A);
- Lead contamination was present in the majority of bores adjacent and downgradient of the former Tetraethyl Lead (TEL) storage areas (B, M and P), to a maximum of 0.54 mg/L (bore PICL10);
- Oil and grease, and Total Organic Carbon (TOC) contamination was present in bores adjacent and downgradient to the waste oil landfarm areas (1, 2, 3 and 4) and former waste oil lagoon area (H);
- Fluoride contamination was present in bores adjacent and downgradient of the former calcium fluoride disposal areas (ALK1-4). The maximum concentration (46 mg/L) was recorded in bore PICL9; and
- The SBS aquifer was contaminated by arsenic, lead, fluoride, oil and grease and TOC for distances of up to 500 m downgradient of known waste disposal areas.

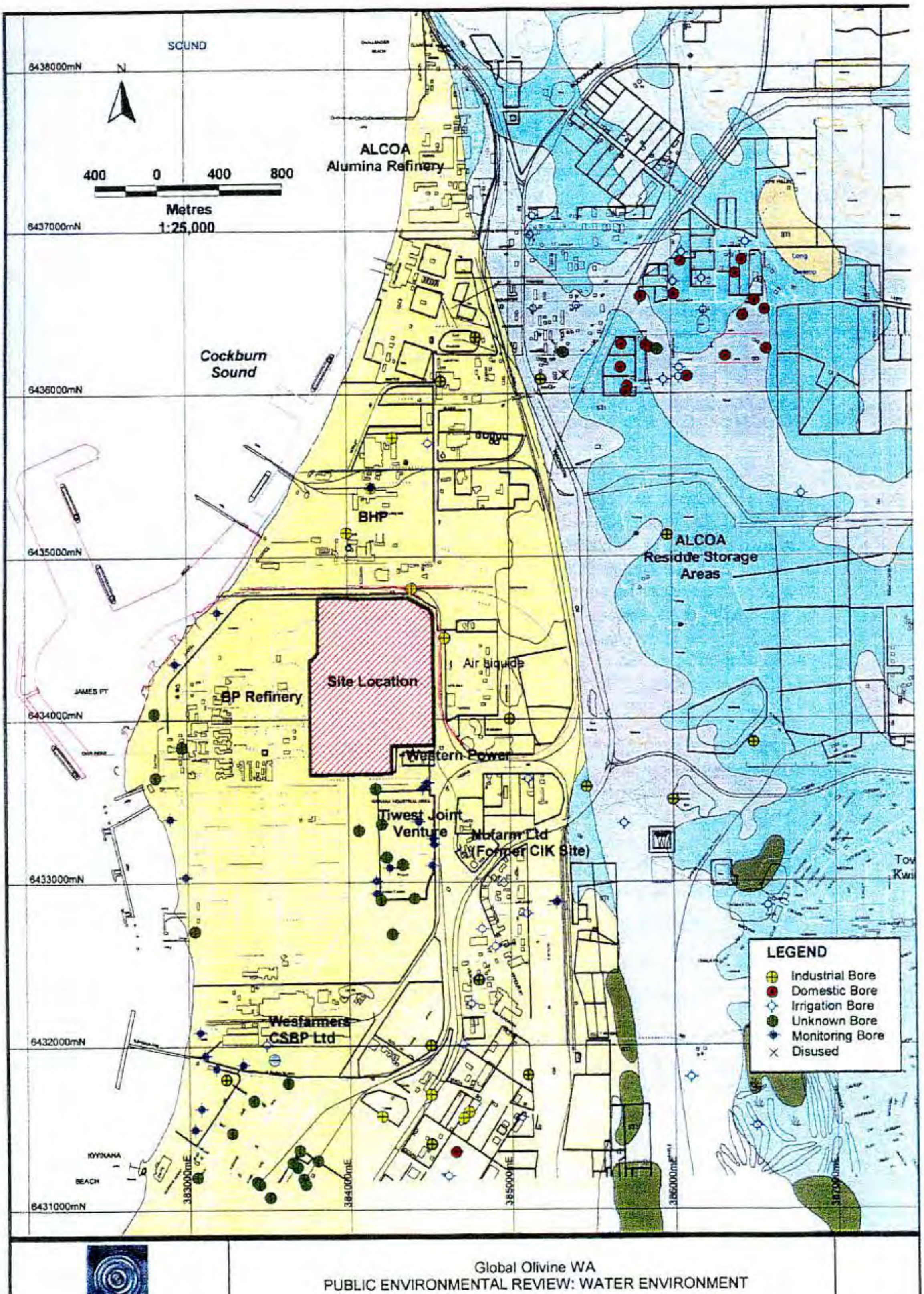
It must be noted that these data are more than ten years old (by 2000), and groundwater conditions are likely to have changed substantially in the intervening period from those identified at the time of sampling.

Groundwater conditions were reassessed more recently by Dames & Moore in 1998. The results are included in Table 8-5 and Table 8-6.

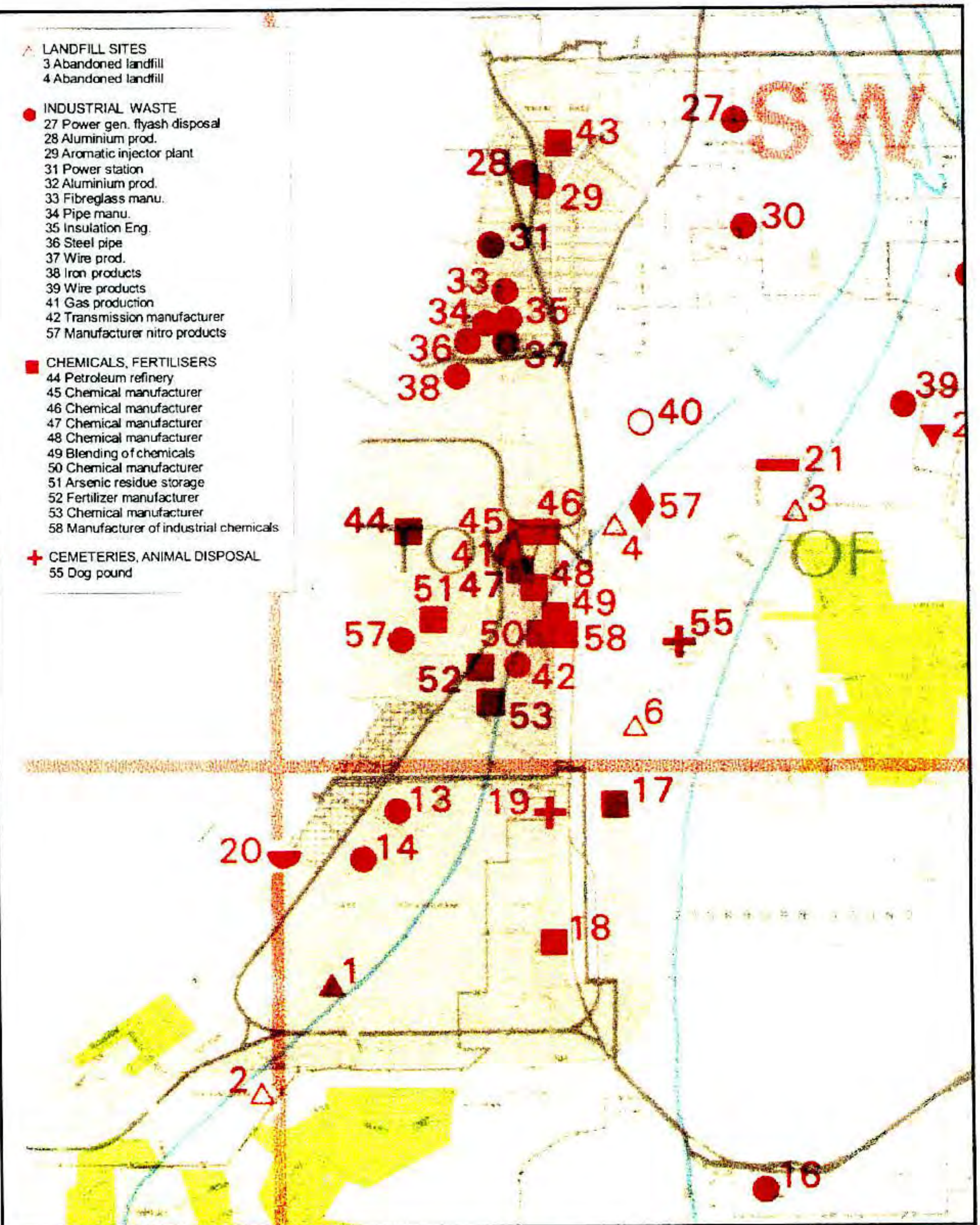
The results may be summarised as:

- A plume of dissolved phase hydrocarbon, including TPH and BTEX compounds originating from the BP Refinery extends from the southern site boundary with BP for a distance of approximately 320 m to the western site boundary, with concentrations greatly exceeding relevant environmental guidelines. PSH is present within 30 m of the site boundary. The plume is likely to migrate from the site across its western boundary back onto BP land.
- Groundwater beneath the northern site area in the vicinity of bore MW3 (PICL3) has an elevated EC, although no other contaminants were detected in the available analysis. Possible explanations for this may be due to the thinning or absence of fresh groundwater overlying saline groundwater at this location due to groundwater abstraction, or it may be consistent with historical practices on the former Australian Iron and Steel Mill to the east of the site. The EC of the groundwater at this location renders it unsuitable for irrigation purposes. The extent of the elevated EC groundwater has not been determined at present.
- A plume of arsenic contamination may be present, originating from the former disposal of arsenic wastes on-site. The extent of the plume has been inferred, based on analysis of bore MW7 in 1998 by Dames & Moore, and the previous analyses from 1989 by Rockwater. Confirmation of the existence and extent of the plume is not possible with certainty due to limited bore coverage.
- A plume of fluoride contamination may be present, originating from the former calcium fluoride disposal pits (ALK1–4). The extent of the plume has been inferred, based on analysis of bore MW9 in 1998 by Dames & Moore, and the previous analyses from 1989 by Rockwater. Confirmation of the plume is not possible with certainty due to the limited bore coverage.
- Monitoring of bores on the downgradient (western) boundary indicates that no contaminant levels of concern are migrating from the site.
- The arsenic and fluoride concentrations in bores MW7 and MW9 are at or marginally exceed the irrigation water guidelines.
- Low concentrations of the organo-chlorine pesticides 2,4D and 2,4,5T were detected in bore MW1 on the south-eastern boundary, consistent with the migration of the contaminant plume from the former CIK site, located approximately 500 m south-east of Lot 15 (refer Figure 8-4).

*Figure 8-2. WRC Groundwater Monitoring and Licensed Abstraction.*

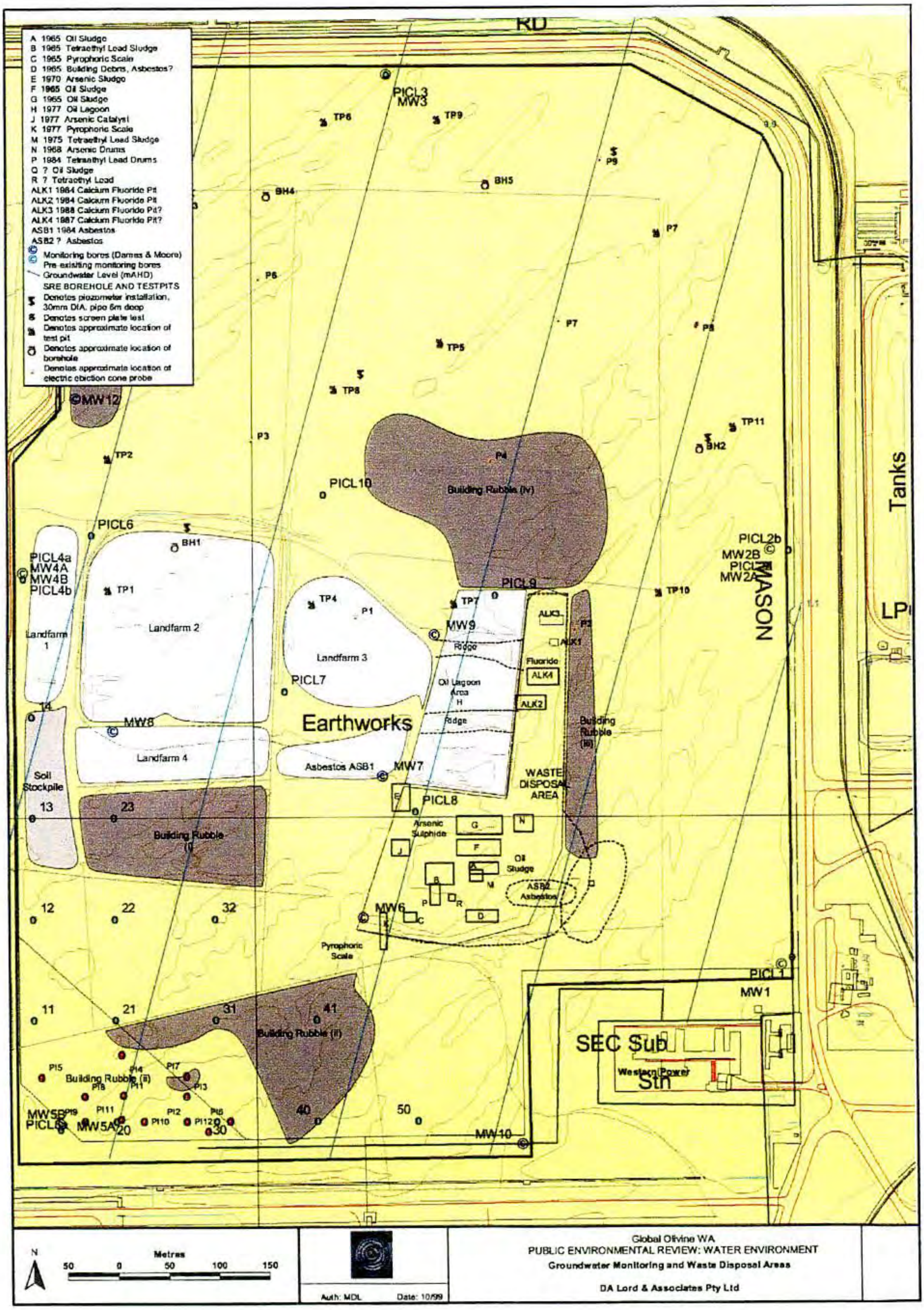


## *Figure 8-3. Groundwater Contamination in the Business Area*




| | |
|---|---|
| Auth: MDL     Date: 10/99 | Global Olivine WA<br>PUBLIC ENVIRONMENTAL REVIEW: WATER ENVIRONMENT<br>**Groundwater Contamination in the Kwinana Area**<br>**DA Lord & Associates Pty Ltd** |

*Figure 8-4. Groundwater Monitoring and Waste Disposal Areas*



## Table 8-5. Summary of groundwater TPH/BTEX/pesticide analyses from Dames & Moore (1998)

| BORE | $C_6$-$C_9$ | $C_{10}$-$C_{14}$ | $C_{15}$-$C_{28}$ | $C_{29}$-$C_{38}$ | BENZENE | TOLUENE | ETHYLBENZENE | XYLENES | 2,4D | 2,4,5T | TOTAL PHENOLS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MW1 | <0.02 | <0.02 | <0.04 | <0.04 | - | - | - | - | 0.00002 | 0.00001 | 0.03 |
| MW2A (deep) | <0.02 | <0.02 | <0.04 | <0.04 | - | - | - | - | - | - | - |
| MW2B (shallow) | <0.02 | <0.02 | <0.04 | <0.04 | - | - | - | - | - | - | - |
| MW3 | <0.02 | <0.02 | <0.04 | <0.04 | - | - | - | - | - | - | - |
| MW4A (deep) | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | <0.001 | <0.002 | <0.001 | - | - | - |
| MW4B (shallow) | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | <0.001 | <0.002 | <0.0012 | - | - | - |
| MW5A (deep) | 12 | 26 | 0.90 | <0.04 | 12.2 | 0.4 | 1.6 | 5.1 | - | - | - |
| MW5B (shallow) | 150000 | 470,000 | 17,000 | <50 | 2800 | 9500 | 12000 | 54000 | - | - | - |
| MW6 | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | <0.001 | <0.001 | <0.002 | - | - | - |
| MW7 | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | <0.001 | <0.001 | <0.002 | - | - | - |
| MW8 | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | <0.001 | <0.001 | <0.002 | - | - | - |
| MW9 | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | 0.004 | <0.001 | <0.002 | - | - | - |
| MW10 | <0.02 | <0.02 | <0.04 | <0.04 | - | - | - | - | <0.00002 | <0.00001 | <0.01 |
| MW12 | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | <0.001 | <0.001 | <0.001 | - | - | - |
| SA3 | <0.02 | <0.02 | <0.04 | <0.04 | <0.001 | <0.001 | <0.001 | <0.001 | - | - | - |
| EPA Bulletin 711 Protection of Freshwater Ecosystems | N/a | N/a | N/a | N/a | 0.3 | 0.3 | N/a | N/a | N/a | N/a | 0.3 |
| EPA Bulletin 711 Irrigation Water Guidelines | N/a | N/a | N/a | N/a | N/a | N/a | N/a | N/a | 0.1* | 0.1* | N/a |
| DEP Guidelines for Industrial Sites | N/a | N/a | N/a | N/a | 0.005 | 0.05 | 0.06 | 0.06 | 0.0001 | 0.0001 | N/a |
| Dutch Intervention Values | N/a | | 0.6 | | 0.03 | 1.04 | 0.15 | 0.066 | - | - | - |

***Where: All results expressed as mg/L are not analysed: N/a = Not applicable.***

** No guideline set except as a general limit of approximately 0.1 mg/L.*

Table 8-6. *Summary of other groundwater analyses from Dames & Moore (1998)*

| BORE | As | Cr | Cu | Fe | Pb | Zn | pH | EC (mS/cm) | FLUORIDE |
|---|---|---|---|---|---|---|---|---|---|
| MW1 | <0.01 | <0.01 | 0.01 | 0.04 | <0.005 | 0.02 | 7.8 | 0.64 | - |
| MW2A (deep) | <0.01 | <0.01 | <0.005 | 0.05 | <0.005 | 0.01 | 8 | 0.96 | - |
| MW2B (shallow) | <0.01 | <0.01 | <0.005 | 0.05 | <0.005 | <0.01 | 7.8 | 0.75 | - |
| MW3 | <0.01 | 0.01 | <0.005 | 0.03 | <0.005 | 0.02 | 8.3 | 13.1 | - |
| MW4A (deep) | 0.01 | <0.01 | <0.005 | 0.02 | <0.005 | <0.01 | 8.6 | 0.89 | - |
| MW4B (shallow) | <0.01 | <0.01 | <0.005 | 0.51 | <0.005 | 0.02 | 6.9 | 1.5 | - |
| MW5A (deep) | <0.01 | <0.01 | <0.005 | 1.48 | <0.005 | <0.01 | 7.2 | 1.7 | - |
| MW5B (shallow) | 1.0 | - | - | - | - | - | 5.6 | <0.01 | - |
| MW6 | 0.02 | <0.01 | <0.005 | - | <0.005 | 0.02 | 7.2 | 0.92 | - |
| MW7 | 0.11 | <0.01 | <0.005 | - | <0.005 | <0.01 | 7.4 | 0.61 | - |
| MW8 | <0.01 | <0.01 | 0.01 | - | <0.005 | <0.01 | 7.5 | 1.1 | - |
| MW9 | <0.01 | <0.01 | 0.02 | - | <0.005 | <0.01 | 7.2 | 1.1 | 1 |
| MW10 | <0.01 | <0.01 | 0.02 | - | <0.005 | <0.01 | 7.4 | 1 | - |
| MW12 | <0.01 | <0.01 | 0.01 | - | <0.005 | <0.01 | 7.5 | 0.75 | - |
| SA3 | <0.01 | <0.01 | <0.01 | - | <0.005 | <0.01 | 7.8 | 1.02 | - |
| EPA Bulletin 711 Protection of Freshwater Ecosystems | 0.05 | 0.01 | 0.01 | 1 | 0.01 | 0.05 | 6.5-9 | 1.5 | N/a |
| EPA Bulletin 711, Irrigation Water Guidelines | 0.1 | 1 | 0.2 | 1 | 0.2 | 2 | 4.5-9 | <2.3 | 1 |
| DEP Guidelines for Industrial Sites | N/a | N/a | N/a | N/a | 0.2 | N/a | N/a | N/a | N/a |
| Dutch Intervention Value | 0.055 | 0.026 | 0.035 | N/a | 0.054 | 0.29 | N/a | N/a | N/a |

***All results expressed in mg/L not analysed: N/a = Not applicable.***

In 1998 BP undertook site investigation and remedial work on Lot 15 relating to the identified PSH groundwater plume in the southeastern corner (BP, 1999). The results may be summarised as:

- PSH was recorded in bores MW5A, PICL 20, and PI10, 11, 12 and 19 adjacent to and within 30 m of the southern site boundary;
- Bores MW5A, PICL 11, 20, 21 and 30 contain high concentrations of TPH and BTEX compounds consistent with a dissolved phase hydrocarbon plume within groundwater. However, the results from bores MW5A and PICL 20 are questionable, since the analytical results are likely to be affected by sampling through the PSH layer; and
- Bores PICL 31 and 40 are located on the margins of the hydrocarbon plume.

The results are consistent with those of Dames & Moore, 1998. A plume of dissolved phase hydrocarbon contamination is present at concentrations exceeding relevant guidelines. The plume is migrating onto site from the southern boundary with the BP Refinery, and off-site onto BP land beyond the western boundary of Lot 15.

The hydrocarbon plume is being managed by BP to prevent further migration of contaminants onto Lot 15.

Two barrier systems were installed by BP in 1998, as described in BP 1999, to prevent further groundwater contaminant migration from the refinery:

- A cut-off trench to collect PSH, comprising a gravel pack and PSH recovery wells; and
- An air sparge curtain to prevent migration of dissolved phase hydrocarbon compounds in the groundwater column, comprising sparge points on a 4 m spacing, and a monitoring system.

Both systems extend for 215 m along the southern site boundary, across the inferred limit of the dissolved phase hydrocarbon plume (refer Figure 8-5). In the course of this work, approximately 6,100 $m^3$ of hydrocarbon contaminated soils were removed (refer Section 8.4.2), effectively removing the on-site source of the hydrocarbon contaminants to groundwater.

***Summary***

The estimated extent of on-site groundwater failing water quality guidelines that may be applicable, based on the results obtained in 1998 is shown on Figure 8-6 and Figure 8-7. The following comments are made:

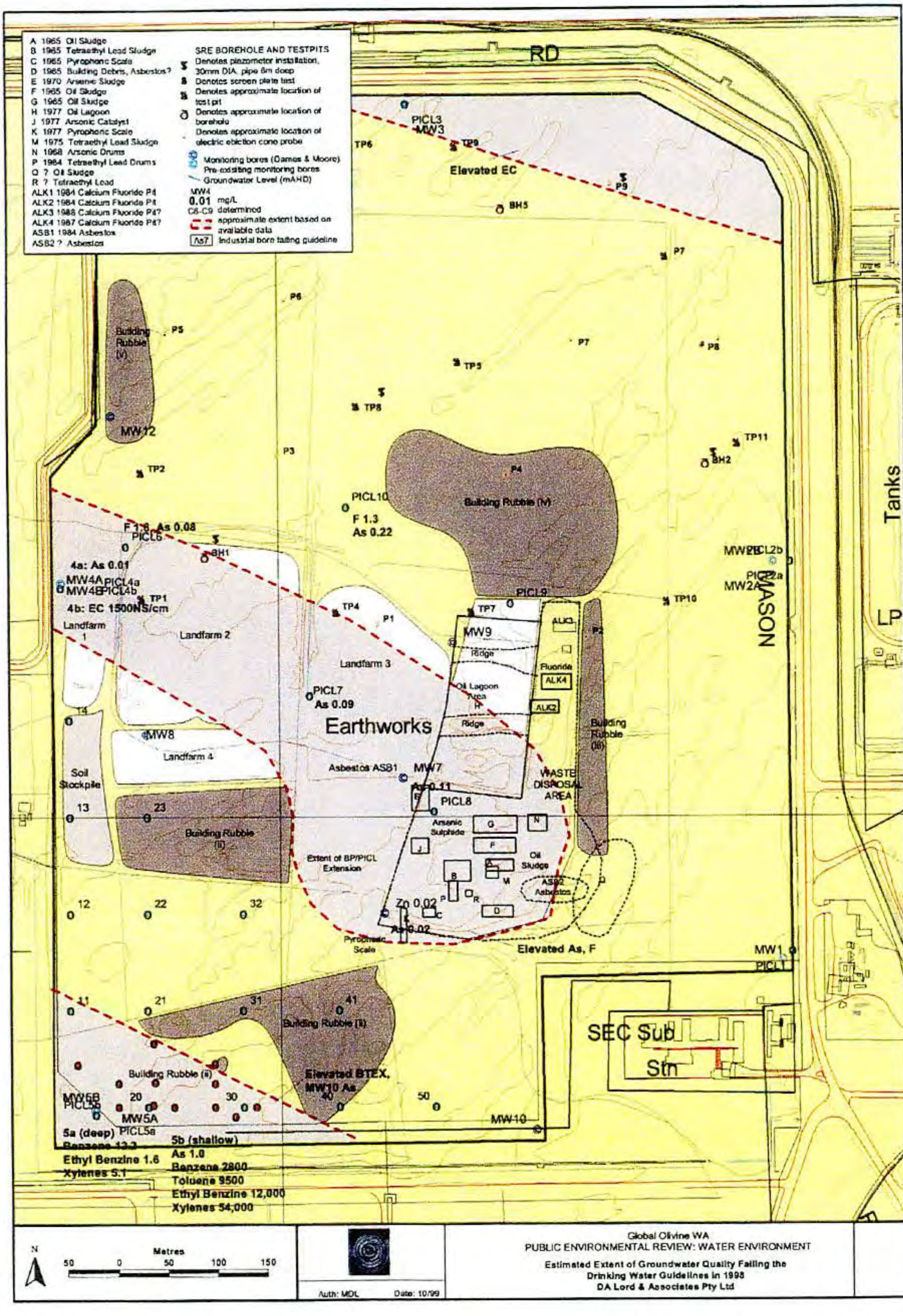
- The freshwater guideline is applicable to a receiving water body. Groundwater beneath the site is generally fresh;
- The DEP and WRC have commented that the use of shallow groundwater for drinking water purposes is not recommended anywhere within the Perth metropolitan area, and therefore there is no loss of this beneficial use;
- Observed concentrations of arsenic and fluoride in 1998 only marginally exceed or are equivalent to the irrigation water guidelines locally. Groundwater fit for irrigation purposes may be obtained at certain locations on site.

- Industrial guidelines for once-through fresh cooling water have been used to estimate the extent of groundwater exceeding this guideline. However, brackish water may be used for this purpose, subject to treatment for corrosion and scaling problems. However, the presence of the hydrocarbon contamination in the south-west also represents a potential hazard to contractors who may be exposed in the course of their work and in places a potential explosive hazard from volatile contaminants. Use of groundwater from this area is likely to be precluded.
- Since groundwater resources are fully allocated at present within the Cockburn Groundwater area, potentially none of these beneficial uses may be applicable. However, this ignores the future potential uses of the groundwater resource.
- No other users of groundwater have been identified downgradient of the site that may be affected by contaminant migration.
- Given the distance to the coast of approximately 700 m, no significant impact on the marine environment is anticipated from contaminant migration within groundwater.

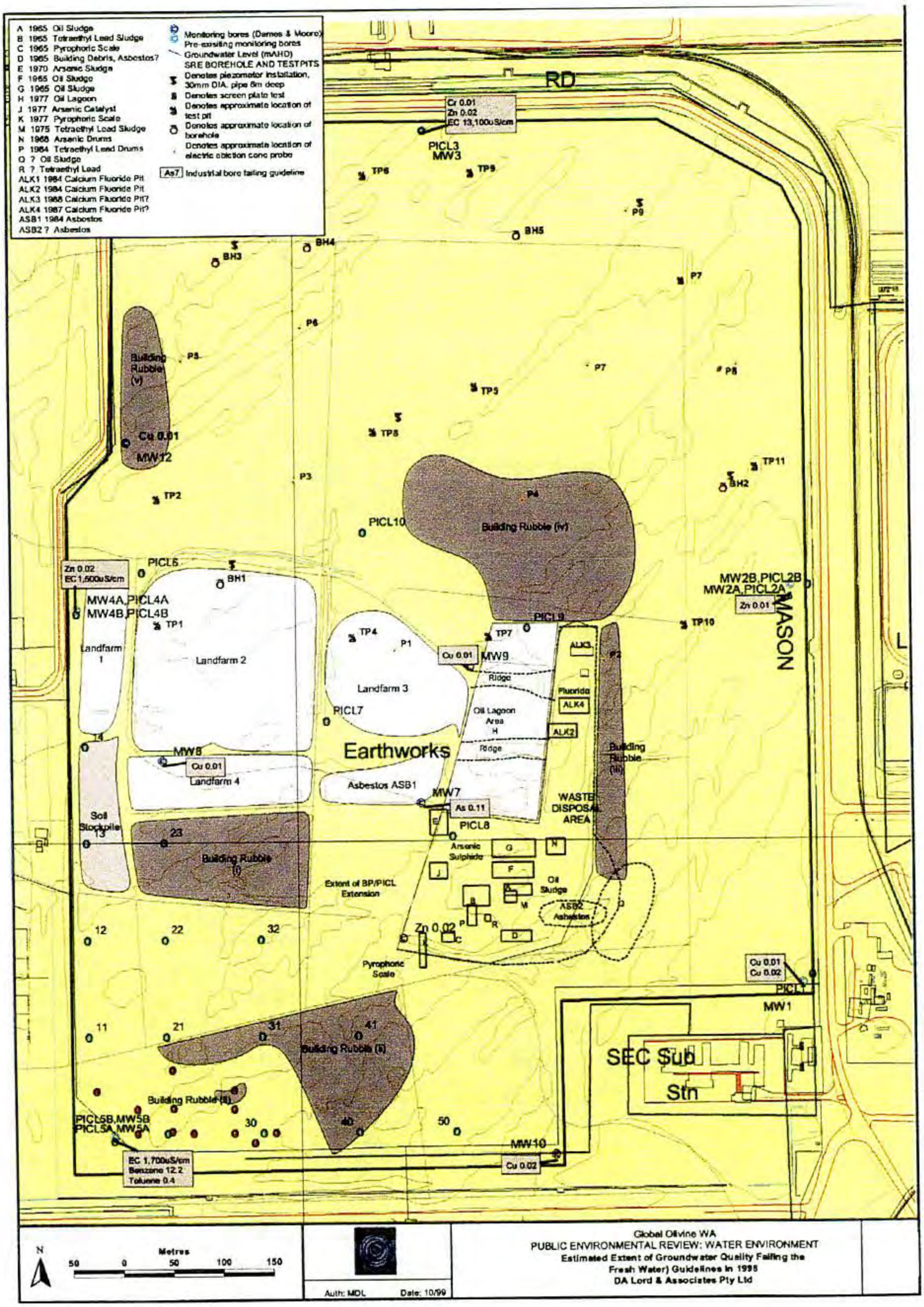
### *8.3.2 Surface water*

The site is located on relatively flat ground within 700 m of the coastline. The surface elevation ranges between 2.98 m Australian Height Datum (AHD) in excavated areas within the former waste disposal area and 4.6 m AHD near the western boundary. There are no surface drainage features present on site, reflecting the high infiltration capacity of the underlying sandy soils. Run-off from Mason Road directly infiltrates the ground on either side of the road.

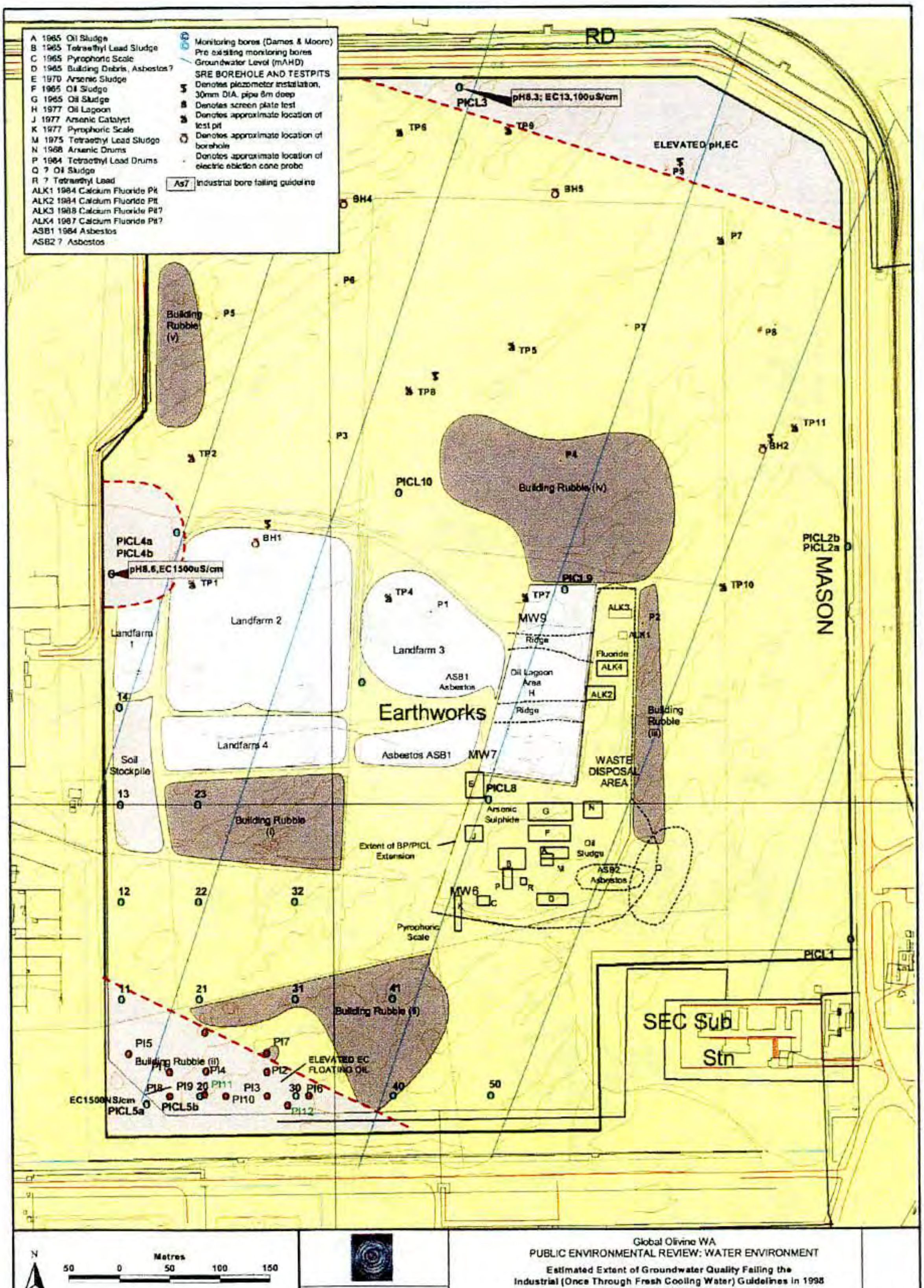
***Figure 8-5. Estimated Extent of Groundwater Failing Drinking Water Quality Guidelines in 1998***



## *Figure 8-6. Estimated Extent of Groundwater Quality Failing Fresh Water Guidelines 1998.*



## *Figure 8-7. Estimated Extent of Groundwater Quality Failing the Industrial Guidelines in 1998.*



## 8.4 LAND

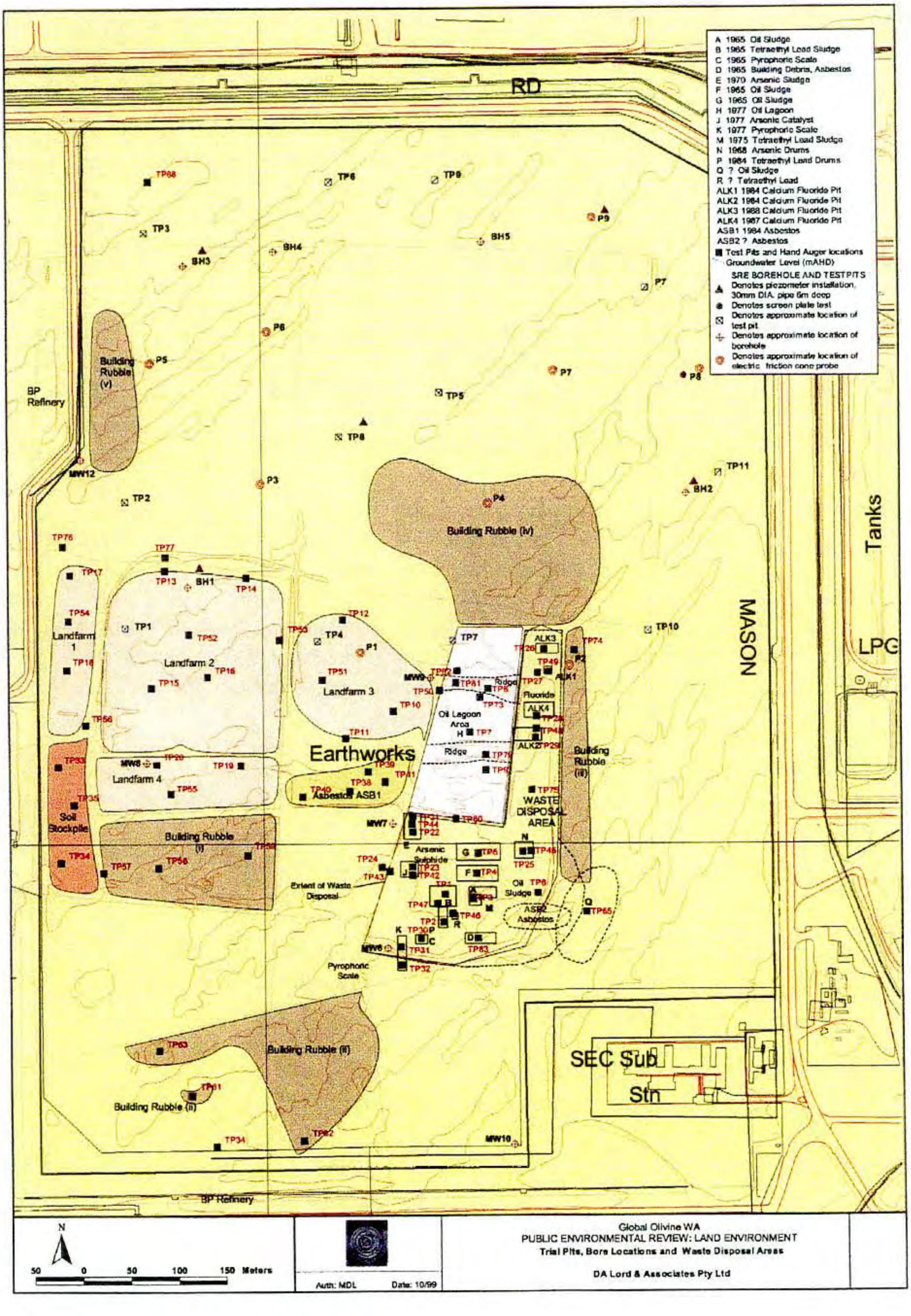
The geology of the site is summarised in Section 8.3.1, and is described in detail in DAL 2000.

### *8.4.1 Site history*

Lot 15 Mason Road was part of a major land grant to BP made in 1957. Prior to this the site is understood to have been greenfield. The site was used by the BP Refinery for the disposal of oil sludges, chemical wastes, asbestos and building rubble arising from its petroleum refining operations between approximately 1965 and 1984. Information on the types of wastes, periods of waste disposal and their approximate locations on site have been obtained from various consultant reports and interviews with BP staff. The site areas referred to below are shown on Figure 8-8. The location and types of wastes disposed of were as follows:

- Oily sludges deposited in three lined areas (Oil sludge ponds A, F and G) within the waste disposal area.
- Tetraethyl lead TEL (Pb(C2H5)4), an 'anti-knock' petroleum additive, was disposed in area B (1965), area L (1975) and as drummed sludge to area M (1976). Area L is now located on the Western Power site to the south of Lot 15.
- Acid soluble oil was stored in drums above a concrete pad in Area P during 1984. It is also understood that 'Heavy Trickle' by-product, which may have contained hydrofluoric acid may have been stored in a separate area adjacent to Area P.
- Pyrophoric materials (materials prone to spontaneous ignition in air), including 'iron sulphide' from the cleaning of gasoline storage tanks were stored in sealed containers and 'weathered' to a more stable form in areas C and K, and concrete slabs adjacent to Area.
- Arsenic trioxide sludges from the former production by BP of ammonia were deposited in three areas. The materials included washed saddles (areas E and J) and also drummed concentrated sludge (area N) which was buried beneath a 0.6 m thick soil cover.
- Calcium fluoride (CaF2), a process chemical used in the production of ethylbenzene, was deposited in four unlined pits (ALK 1–4) as a 'dryish' powder.
- Calcium molybdenum ($CaMoO_4$) and chrome molybdenum catalysts used in the refining process were deposited in two small pits on the southern margin of the waste disposal area.
- Asbestos materials from pipe lagging were buried within plastic bags in demarcated areas ASB1 and ASB2.
- Building rubble (comprising building debris, drums and refuse), which occurred in five separate areas (I-V).

*Figure 8-8. Trial Pits, Bore Locations and Waste Disposal Areas.*



The site was purchased by the former Petrochemical Industries Company Limited (PICL) in 1987, for the proposed development of an integrated petrochemical complex. PICL appointed consultants' Maunsell & Partners (now Halpern Glick Maunsell) to act on their behalf during negotiations regarding the extent of site contamination with BP for the purchase of the site. An initial audit report (Maunsell & Partners, 1987) identified a designated waste disposal zone that had received dangerous, toxic and hazardous waste, consistent with the materials identified above. The report recommended complete removal of materials within the disposal zone due to the 'relatively high degree of contamination' present. As part of the purchase agreement, BP was required to undertake remedial works stipulated in Maunsell & Partners, 1987. BP have indicated that the following materials were completely removed during 1987-1988:

- Oily sludges (areas A, F and G).
- TEL (areas B, L and M).
- Drummed oil (area P).
- Pyrophoric materials from areas C and K.
- Arsenic sludges (areas E, J and N).
- Calcium fluoride (areas ALK1-4).
- Calcium molybdenum and chrome molybdenum catalysts.
- Asbestos materials (areas ASB1 and ASB2).

The BP remedial work was audited following completion by Maunsell & Partners (1988), who prepared a certificate of site clean-up (Maunsell & Partners, 1989). No materials were removed from the Landfarm areas during this work.

In 1993 the Western Australian Land Authority (LandCorp) purchased the site, and remains the current (1999) site owner.

### 8.4.2 *Current conditions*

In 1994 LandCorp appointed consultants' Dames & Moore to undertake a desk study evaluation of the site history and contamination present (Dames & Moore, 1994). In 1998 a detailed site investigation was undertaken (Dames & Moore, 1998) to evaluate the (then) site conditions, which is described in detail in DAL, 2000. Site investigation locations are shown on Figure 8-8. Soil analytical results from this investigation are compared to currently applicable environmental guidelines for industrial sites to determine the level of contamination present. An estimate of the volume of waste material with contaminant concentrations exceeding all applicable guidelines was made by Dames & Moore (1998) which is summarised in Table 8-7.

The volume of contaminated soils with specific analytes at concentrations exceeding currently applicable guidelines is estimated in Table 8-7 at 34,014 $m^3$, based on a set of conservative assumptions described in DAL, 2000c and Dames & Moore, 1998. These may be summarised as:

- Building rubble area I: Elevated concentrations of copper and zinc (TP59) and chromium and copper (TP62) were obtained from surface dust samples only, estimated to be less than 500 g (Dames & Moore, 1998). No other samples analysed indicated contamination to be in this area.
- Landfarm areas 1, 2 and 3: Maximum TPH (and copper, Landfarm 1) concentrations exceed the former DEP Industrial Guideline—the entire

estimated volume of contaminated material present is assumed to require remediation.

- Oil Lagoon area H Berms: Maximum TPH and copper concentrations exceed the former DEP Industrial Guideline—the entire estimated volume of contaminated material present is assumed to require remediation.
- Pyrophoric Scale area C: Analysis of a sample of 'green material' from TP30 indicated elevated chromium, copper and zinc concentrations. The extent of the material was estimated at less than 10 g. No other samples analysed indicated contamination to be present in this area.
- Pyrophoric Scale area K: Analysis of samples from TP31 indicated elevated chromium, copper and zinc to be present- the entire estimated volume of contaminated material is assumed to require remediation.
- Isolated occurrences of elevated copper and zinc concentrations from dusts or pellets identified on the land surface may be consistent with the disposal of catalyst used in the refining process. No other occurrences of coloured dust or pelleted materials were reported from walk-over surveys conducted by Dames & Moore (1998), Alan Tingay (1994), and Maunsell & Partners (1989).

It is recognised, however, that additional contamination may be identified in the course of remedial works.

**Table 8-7. Summary of contaminated soil volumes**

| AREA | CONTAMINANT (MAXIMUM CONCENTRATION, mg/Kg) | ANZECC/NHMRC 'B' (mg/Kg) | DEP INDUSTRIAL GUIDELINE (Dutch 'C') | DUTCH INTERVENTION VALUE | DRAFT NEPM HIL ('F'- COMMERCIAL/INDUSTRIAL) | ESTIMATED VOLUME ($m^3$) |
|---|---|---|---|---|---|---|
| Building rubble area (I) | Cu (220,000)<br>Zn (22,000)<br>As (4) | 60<br>200<br>20 | 500<br>3000<br>50 | 190<br>720<br>55 | 5000<br>35000<br>500 | (<500 grams) |
| Building rubble area (ii) | As (11) | 20 | 50 | 55 | 500 | (<500 grams) |
| Landfarm area 1 | $C_{10}$–$C_{15}$ (2,200)<br>$C_{15}$–$C_{38}$ (25,500)<br>Cu (1,300) | -<br>-<br>60 | 1000<br>5000<br>500 | N/a<br>N/a<br>190 | -<br>28000<br>5000 | 6,240 |
| Landfarm area 2 | $C_{10}$–$C_{15}$ (2,400)<br>$C_{15}$–$C_{38}$ (16,300) | -<br>- | 1000<br>5000 | N/a<br>N/a | -<br>28000 | 20,720 |
| Landfarm area 3 | $C_{15}$–$C_{38}$ (18,400) | - | 5000 | N/a | 28000 | 4,000 |
| Oil Lagoon area H berms | $C_{10}$–$C_{15}$ (1,000)<br>$C_{15}$–$C_{38}$ (16,800)<br>Cu (720) | -<br>-<br>60 | 1000<br>5000<br>500 | N/a<br>N/a<br>190 | -<br>28000<br>5000 | 3,024 |
| Pyrophoric scale C | Cu (9,300) | 60 | 500 | 190 | 5000 | (<10 grams) |
| Pyrophoric scale (K) | Cu (1,900)<br>As (170) | 60<br>20 | 500<br>50 | 190<br>55 | 5000<br>500 | 30 |
| **TOTAL ($m^3$)** | | | | | | **34,014** |

*(after Dames & Moore, 1998)*

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Comparison of the contaminant concentrations to the NEPM Health Investigation Level (HIL) 'F' for Commercial or Industrial sites (NEPC, 1999) indicates that the volume of contaminated soils that requires remediation may be substantially less than the 34,014 m3 estimated by Dames and Moore (1998). However, this assumes that human health is the only significant receptor, with no associated impact on the groundwater ecology. This may be the case, since the majority of the remaining contaminated material is present within the landfarms, and was placed specifically to 'weather' to a more stable form. Given the non-detection of hydrocarbon compounds in groundwater from the most recent analyses (Table 8-5) downgradient of the landfarms, this indicates that the contaminated material is unlikely to have any remaining substantial potential to leach to groundwater. A revised estimate of the contaminated soil volume that may require remediation is summarised in Table 8-8.

***Table 8-8. Summary of contaminated soil volumes by comparison to NEPM HILs***

| AREA | CONTAMINANT (MAXIMUM CONCENTRATION, mg/Kg) | FORMER DEP INDUSTRIAL GUIDELINE (Dutch 'C') | NEPM HIL ('F'-COMMERCIAL/INDIUSTRIAL) | ESTIMATED VOLUME ($m^3$) |
|---|---|---|---|---|
| Building rubble area (I) | Cu (220,000)<br>Zn (22,000)<br>As (4) | 500<br>3000<br>50 | 5000<br>35000<br>500 | 0 |
| Building rubble area (ii) | As (11) | 50 | 500 | 0 |
| Landfarm area 1 | $C_{10}$–$C_{15}$ (2,200)<br>$C_{15}$–$C_{38}$ (25,500)<br>Cu (1,300) | 1000<br>5000<br>500 | -<br>28000<br>5000 | 6,240 |
| Landfarm area 2 | $C_{10}$–$C_{15}$ (2,400)<br>$C_{15}$–$C_{38}$ (16,300) | 1000<br>5000 | -<br>28000 | 20,720 |
| Landfarm area 3 | $C_{15}$–$C_{38}$ (18,400) | 5000 | 28000 | 0 |
| Oil Lagoon area H berms | $C_{10}$–$C_{15}$ (1,000)<br>$C_{15}$–$C_{38}$ (16,800)<br>Cu (720) | 1000<br>5000<br>500 | -<br>28000<br>5000 | 3,024 |
| Pyrophoric scale C | Cu (9,300) | 500 | 5000 | 0 |
| Pyrophoric scale (K) | Cu (1,900)<br>As (170) | 500<br>50 | 5000<br>500 | 0 |
| **TOTAL ($m^3$)** | | | | **29,984** |

*(NEPC, 1999)*

In May 1998 BP undertook, with the permission of LandCorp, site investigation and remedial work to determine the extent of soil and groundwater contamination from the historical leak of petroleum on the refinery site (BP, 1999). The investigation identified TPH and BTEX concentrations in soils exceeding the DEP Industrial Guidelines (based on the Dutch 'C' guidelines) for samples near the water table zone in bores PI2, PI9, PI11, and PI12. In addition, phase separated hydrocarbon (PSH) was identified in bores MW5a, PICL20, and PI10, 11, 12 and 19 along and within 30 m of the southern site boundary. In May 1999 BP removed approximately 6,100 $m^3$ of contaminated soil by excavation and relocated it to landfarms within the refinery. Details of the remedial work and validation of clean-up are provided in BP, 1999. The remaining source of hydrocarbon compounds to groundwater from on-site contaminated soils has therefore been removed. Barrier systems installed at the time to prevent further contaminant migration on the water table are described in Section 8.3.1, and detailed in BP, 1999.

## 8.5 TRAFFIC

The general area of the proposed plant forms the southern section of the Kwinana Industrial Area and is accessed only by Mason Road. The interconnection between the northern and southern cells of the Kwinana Industrial Area is only by way of private internal roads accessible only under emergency conditions. This arrangement is known as the Kwinana Integrated Emergency Strategy Plan and designates access and escape routes through the established industries. An outline is shown in Figure 8-9.

### *Existing Road Network*

The local road network providing immediate access to the site is Mason Road. Mason Road terminates as a public road at the northern boundary of the Site but continues westwards as private road providing access to BP oil refinery. Access to the plant from the private section of the road is not available.

Mason Road connects directly via a signalised junction to Rockingham Road just north of Mandurah Road and Patterson Road. East-west routes from Rockingham Road at Thomas Road and Anketell Road provide direct connections to the Kwinana Freeway. The Kwinana Freeway is the primary north/south arterial road for the Perth Metropolitan Region and extends from Joondalup in the north through to Rockingham in the south.

Rockingham Road and Patterson Road to the south form part of Bunbury Highway which has control of access and is a designated heavy haulage route. It is the major traffic carrier of the Kwinana Industrial Area and carries about 43,000 vehicles per day in the vicinity of Mason Road. Mason Road is a two lane two way local access road providing access to abutting industries and carries about 3,900 vehicles per day.

### *Existing Intersections*

Intersections along Rockingham Road and Patterson Road within the Kwinana Industrial Area are created as staggered T junctions with the major intersections at Thomas Road, Mason Road and Mandurah Road being controlled by traffic signals. The signals at Mason Road and Mandurah Road are in close proximity and are programmed to operate as one installation. The layout of Mason Road, Rockingham Road, Paterson Road, Mandurah Road junction is shown in Appendix L.

The development of this coordinated signalised junction has taken place only recently in response to industry concern regarding traffic congestion associated with industry shift change over times. The signalised junction has improved entry and exit movements to Mason Road but has reduced the level of service for through traffic on Rockingham Road and Patterson Road.

### *Existing Traffic Volumes*

Existing traffic volumes for the roads in the area of the Site are shown in Appendix L. The traffic characteristics on the major through facilities indicate that the traffic split is approximately 60/40 according to the direction of peak flow, there are approximately 12% heavy vehicles in the traffic stream and the peak hours occur between about 0630 to 0730 hours and 1615 to 1715 hours.

Traffic volumes over the last five years indicate that there has been no growth in the traffic using Mason Road, a general 3-4% increase in traffic using the Rockingham Road and Patterson Road and a 2% increase in traffic using Mandurah Road.

***Roadway Capacity***

The acceptable vehicle volume capacities of the roads in the immediate area have been established by the State Planning authorities (State Planning Commission 1991 **Road Reserves Review**).

Rockingham Road and Patterson Road are both four lane divided dual carriageways with control of access and expected to carry 45,000 vehicles per day. Current vehicle volumes are within that capacity.

Mandurah Road is wide two lane two way road with sections of median and channelization and is expected to carry up to 12,000 vehicles per day. Current vehicle volumes are within that capacity.

Mason Road is a wide two lane two way road with limited access places due to the large size of the abutting industrial establishments and expected to carry 9,000 vehicles per day. Current vehicle volumes are well within that capacity.

Recent analysis of the Mandurah Road, Patterson Road, Rockingham Road and Mason Road intersection using the Austroads SIDRA Program shows that the intersection currently operates at a level of service of F (Halpern Glick Maunsell November 1999 **Mandurah Road-Mason Road Intersection**). This is a low level of service with delays on some turn movements of up to 90 seconds. A preferred level of service is D.

The level of service is a performance standard and a qualitative assessment of the quantitative effects of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays and freedom to manoeuvre (Austroads 1998 **Guide to Traffic Engineering Practice – Roadway Capacity**).

Level of service F is in the zone of forced flow where queuing and delays occur. Intersections are at capacity where incidents will cause excessive delays. Level of service D is near the limit of stable flow where drivers are restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. Intersections are operating near capacity

***Crash Pattern***

Crash data obtained from Main Roads WA and the Town of Kwinana for the last three years show that 20 crashes have occurred on Mason Road with the majority taking place at the Mason Road and Rockingham Road junction. These are primarily lower severity rear end crashes which are typical of signalised junctions.

Main Roads WA records crash data for the road network and issues rankings based on the number of crashes and the severity. In the immediate area around the Site the

Ennis Avenue and Dixon Road junction is the highest ranked intersection followed by the Ennis Avenue and Patterson Road junction.

Higher ranking is to be expected on the Regional road route and the District cross road intersections due to the higher number of vehicle kilometres travelled and higher number of vehicles entering the intersection.

***Future Roads***

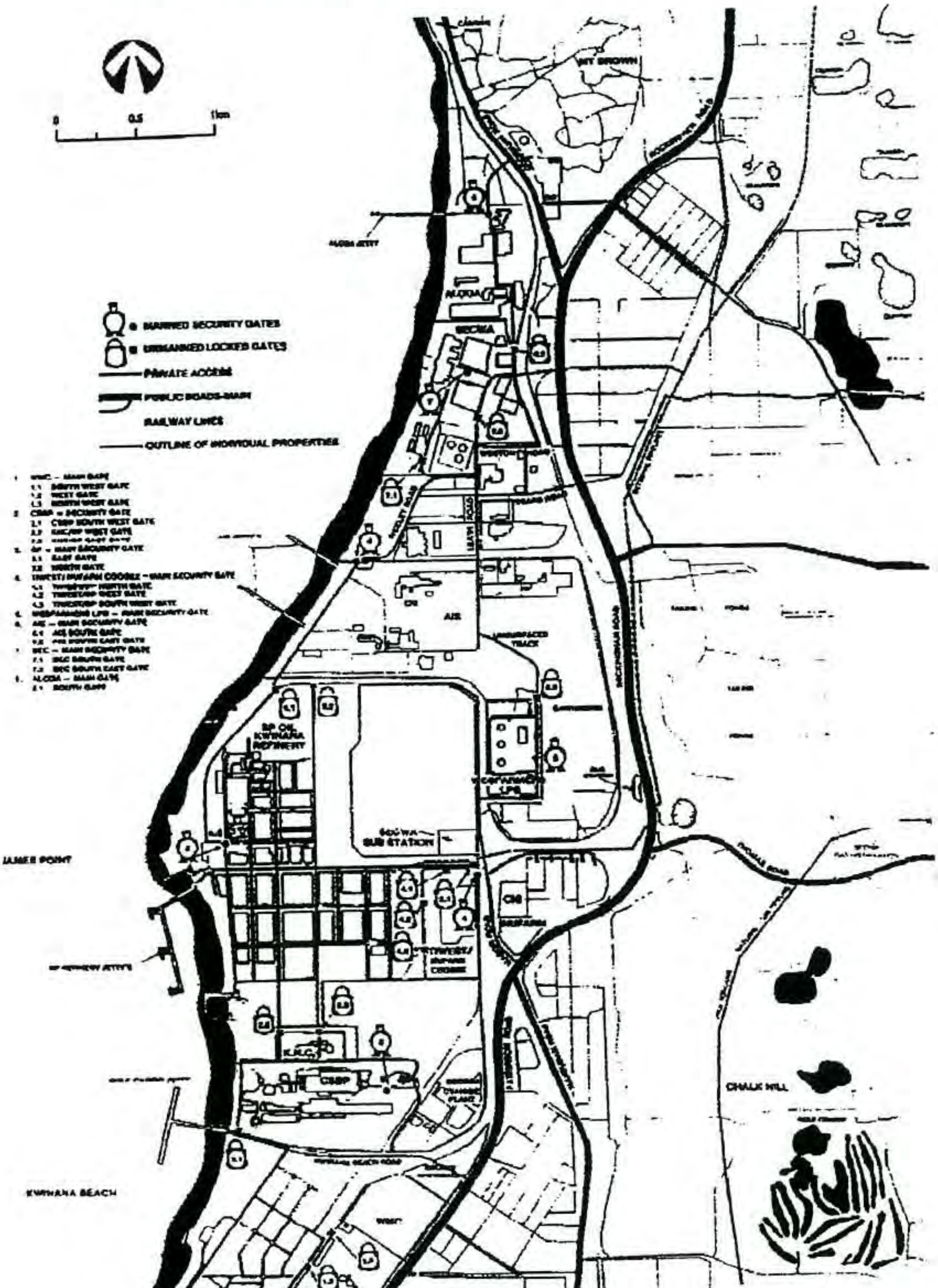
There are proposals to extend Anketell Road into the Kwinana Industrial Area and to create an internal link between Mason Road and Beard Street. Beard Street is the only access to the Northern section of the Kwinana Industrial Area.

If this network is created it will reduce traffic volumes on Mason Road and improve the level of service at the Mason Road and Rockingham Road intersection.

The majority of traffic from the north of the Site could be expected to use the Anketell Road access.

The development of this network, however, is not expected before the Plant is fully operational. It is therefore not considered further in the assessment of traffic impact.

## *Figure 8-9. Kwinana Industries Mutual Aid Emergency Access.*



# 9. POTENTIAL ENVIRONMENTAL IMPACTS

## 9.1 MARINE IMPACTS

The GOWA discharge characteristics will vary from summer to winter and will typically have the properties shown in Table 9-1, calculated assuming ambient Cockburn Sound mean summer water temperature is 24 °C and mean winter water temperature is 16 °C (DEP, 1996).

***Table 9-1. Typical discharge characteristics***

| PARAMETER | VALUE |
|---|---|
| Flow (summer) | 3.34 $m^3/s$ |
| Flow (winter) | 1.42 $m^3/s$ |
| Temperature | 32 °C (constant) |
| Salinity (summer) | 48 ppt |
| Salinity (winter) | 60 ppt |
| Anti-scalant (summer) | 3.4 ppm |
| Anti-scalant (winter) | 8 ppm |

The two proposed locations for the discharge are shown on Figure 3-13.

1. Initially at the shore line prior to construction of the final stage of the JPPL development; and
2. Eventually at the south-western edge of the final JPPL development in combination with the BP discharge.

There are two industrial cooling water outlets in the vicinity of the proposed GOWA discharge outlet: the BP cooling water outlet; and the Western Power cooling water outlet.

The BP cooling water outlet presently discharges warm water into the shoreline at a rate of 5.1 $m^3s^{-1}$ with an excess temperature of approximately 15 °C. This water is discharged with a density of approximately 1021.5 kg $m^{-3}$, approximately 4 kg $m^{-3}$ less dense than the receiving waters. Although this density difference is significant, the discharge is introduced to the receiving waters as a thin surface layer, which allows rapid dissipation by wind mixing, wave action in the surf zone and dispersion by wind driven currents and littoral currents. Following construction of the final harbour development at James Point it is currently proposed that the GOWA discharge will be combined with the BP discharge (dependant on further negotiations with BP). The combined discharge will have the characteristics shown in Table 9-2.

***Table 9-2. Characteristics of combined BP/GOWA discharge***

| CONDITION | BP | GOWA | COMBINED BP/GOWA |
|---|---|---|---|
| Summer flow ($m^3/s$) | 5.1 | 3.34 | 8.4 |
| Winter flow ($m^3/s$) | 5.1 | 1.42 | 6.5 |
| Summer temperature (°C) | 39 | 32 | 36.2 |
| Winter temperature (°C) | 31 | 32 | 31.2 |
| Summer salinity (ppt) | 36.5 | 48 | 41.1 |
| Winter salinity (ppt) | 34 | 60 | 39.7 |

The Western Power cooling water outlet discharges to the shoreline via two canals 66 m apart with a total flow of approximately 19 $m^3s^{-1}$ and an excess of temperature of approximately 6 $^oC$. This results in an effluent which is approximately 1.7 kg $m^{-3}$ less dense than the receiving waters.

### 9.1.1 *Numerical modelling study*

The potential influence of the discharge on the nearshore environment has been established through the use of the numerical modelling techniques described below. Today's advanced numerical models allow accurate simulations of complex fluid movements to be undertaken with confidence. The models are generally very good at representing the fluid dynamics of the system and the determining the effects on the dynamics caused by changing any component. The accurate representation of the dynamics provides information on the spatial and temporal scale and degree of any changes. This allows conclusions to be drawn about the effects of changes on the ecosystem. This is done by applying knowledge of the effects of changes in temperature and salinity on the ecosystem.

### 9.1.2 *Aims*

The model study had the following aims:

- to simulate the behaviour of the GOWA plume relative to discharges from Western Power and BP under meteorological conditions typical for Cockburn Sound;
- to simulate any interaction of GOWA's plume with the thermal discharges from Western Power and BP; and
- to simulate the likely behaviour of the combined BP/GOWA plume following completion of the ultimate James Point development.

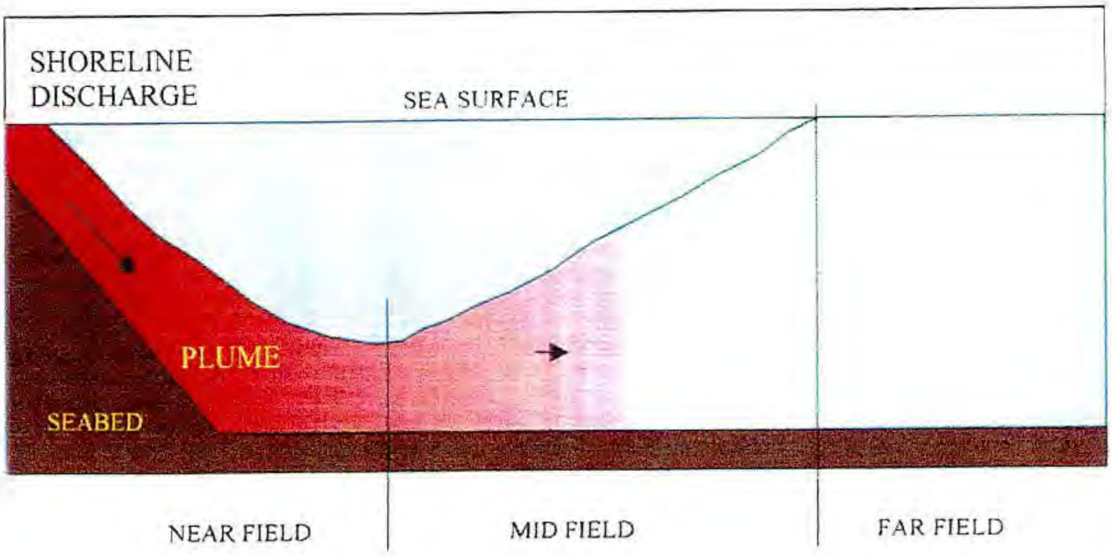
### 9.1.3 *Modelling strategy*

There are generally three regions of dilution which can be used to characterise a plume):

- the near field—within which the momentum of the plume is arrested and the plume becomes advected by the receiving waters;
- the mid field—within which the plume is mixed vertically; and
- the far field—within which the plume spreads laterally.

The near-field and mid-field dilution of the plume was investigated using analytical techniques and the far-field dispersion of the plume was modelled using a three dimensional hydrodynamic model.

*Figure 9-1. Fields of dilution for a negatively buoyant plume discharged at the shoreline*




The hydrodynamic modelling was conducted for the following meteorological scenarios:

1. Discharges only—no wind for 48 hours, ambient summer temperature and salinity;
2. Discharges under typical summer conditions for 48 hours;
3. Discharges under typical winter conditions for 48 hours; and
4. Discharges with constant easterly wind of 5 m/s for 48 hours, ambient summer conditions.

The conditions for modelling were selected to provide both worst case and typical scenarios. The typical summer and winter wind patterns were synthesised by Centre for Water Research from one year of wind records obtained from Swanbourne. Although a calm or an easterly wind of 5 m/s occurring continuously for two days is extremely unlikely, these conditions were modelled to provide a conservative estimate of the worst possible scenarios.

The ambient winter water temperature was taken to be 16 °C and the ambient summer water temperature was taken to be 24 °C (DEP, 1996). Two different model set-ups were used for each meteorological scenario:

1. Pre-JPPL development, with shoreline discharge of Western Power, BP and GOWA; and
2. Post-JPPL development, with shoreline discharge of Western Power and combination of BP and GOWA discharges which are run through JPPL wharf.

The model domain was chosen to incorporate the likely area of influence of the discharges while also minimising the model run time. The model contained 6 vertical layers and approximately 50,000 computational cells. The grid cell size was 50 m x 50 m in the horizontal, the domain was 160 cells in the north direction by 80 cells in the east direction. The vertical layers were set at 1 m, 2 m, 3 m, 5 m, 10 m and 20 m depths. The model boundary conditions applied were for "no slip" at all lateral (solid) boundaries irrespective of whether they were at the surface (land) or submerged. There was no imposed set-up in sea surface gradient and coriolis forces were included in all calculations

The modelling study conservatively assumed that there would be no cooling of the discharge between the plant and Cockburn Sound.

The worst case discharge scenario was found to be the summer flow, when the greater volume of discharge resulted in greater potential impact than winter discharge, though the winter flow is denser than the summer flow.

***Near-field modelling***

Estimates of the initial dilution expected from the GOWA discharge were made using scaling arguments and laboratory data presented in the literature (DAL, 2000). The resultant mean dilution was computed to be between 25 and 80 at the end of the first model cell (i.e. 50 m offshore of the discharge).

### *9.1.4 Far-field model description*

The Hamburg Shelf Ocean Model (HAMSOM) was selected for modelling the far field dispersion of the thermal discharges. HAMSOM is a three-dimensional, semi-implicit finite-difference model, based on the primitive equations of motion. The model was originally developed for application to the North Sea (Backhaus, 1983; Backhaus, 1985) and has recently been successfully applied to the Western Australian shelf region (Pattiaratchi *et al.*, 1996; Burling, 1994; Ranasinghe & Pattiaratchi, 1998 and Burling, 1998). A full description of the theory and numerical schemes can be found in both Backhaus (1985) and Stronach *et al.* (1993). The model has also recently been applied to investigate impacts on Cockburn Sound scale exchange processes resulting from a harbour development within Cockburn Sound (Kinhill, 1998).

HAMSOM was selected as it satisfied all of the following requirements:

- fully three-dimensional;
- extensive literature regarding development and application exists;
- includes tide, wind and inflow forcings; and
- capable of baroclinic (varying density) simulations.

### *9.1.5 Results*

Figure 9-2 to Figure 9-4 show selections of modelled surface temperature and salinity for the pre-JPPL and post-JPPL development scenarios (DAL, 2000). The temperature scale is shown over a range of 0.5 °C at 0.1 °C intervals, the salinity scale is shown over a range of 0.5 ppt at an interval of 0.1 ppt. It is important to note that although the figures appear dramatic, with the colour scale from red through to blue, the actual ranges of temperature values are very small.

The proposed point of discharge is immediately to the north of James Point, one of the broadest shallow areas of Cockburn Sound, with water depths not exceeding 5 m until approximately 400 – 500 m offshore. The model resolved the upper 5 m of the water column as four separate vertical layers. The modelling found that the GOWA and BP discharges were essentially well mixed vertically in this shallow region, with limited differences between results for surface and lower layers.

The results are shown in terms of surface layer temperatures and bottom layer salinities. Surface layer temperatures show the maximum influence of the positively buoyant Western Power and BP plumes, while bottom layer salinity plots ensure that the maximum extent of the GOWA plume is shown.

### *Pre-JPPL development*

The modelled surface temperatures after 36 hours of typical summer wind pattern are shown in Figure 9-2, the wind at this stage is easterly and the plumes are migrating south-west. The trace of the Western Power plumes to the north is a residual from the previous days south-west winds.

The modelled bottom salinity after 48 hours of typical summer wind pattern is shown in Figure 9-3. The higher salinity of the GOWA discharge has resulted in a small trace of elevated salinity heading north along the coastline with wind driven currents.

### *Post-JPPL development*

The modelled surface temperatures after 36 hours of typical summer wind pattern are shown in Figure 9-4, the wind at this stage is easterly and the two plumes are migrating south-west. There is some trace of the effects of earlier south-west winds in the residual Western Power plume north along the coast.

*Figure 9-2. Pre-JPPL development: temperature, summer wind pattern (morning)*

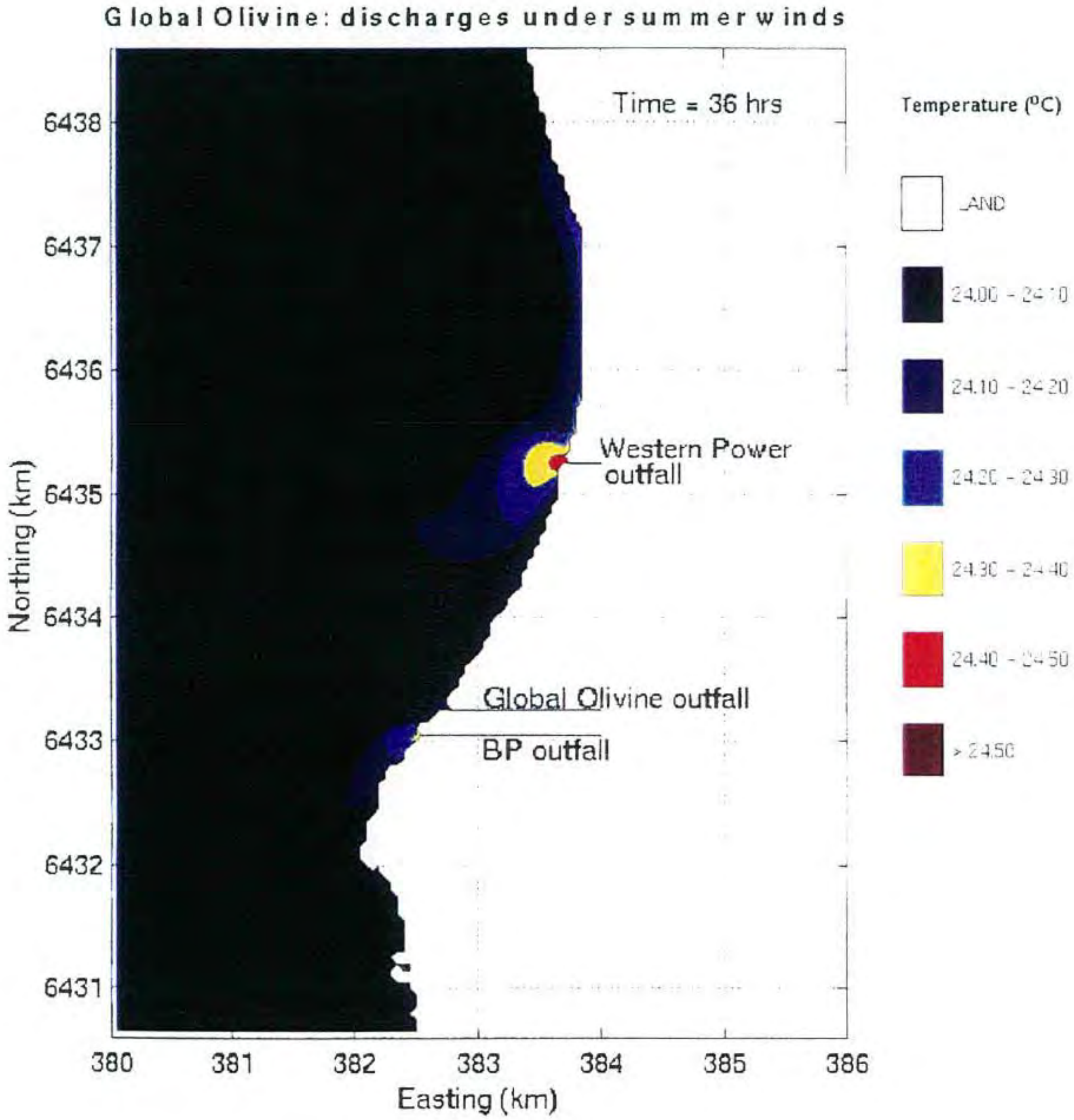


*Figure 9-3. Pre-JPPL development: bottom salinity, summer wind pattern (afternoon)*

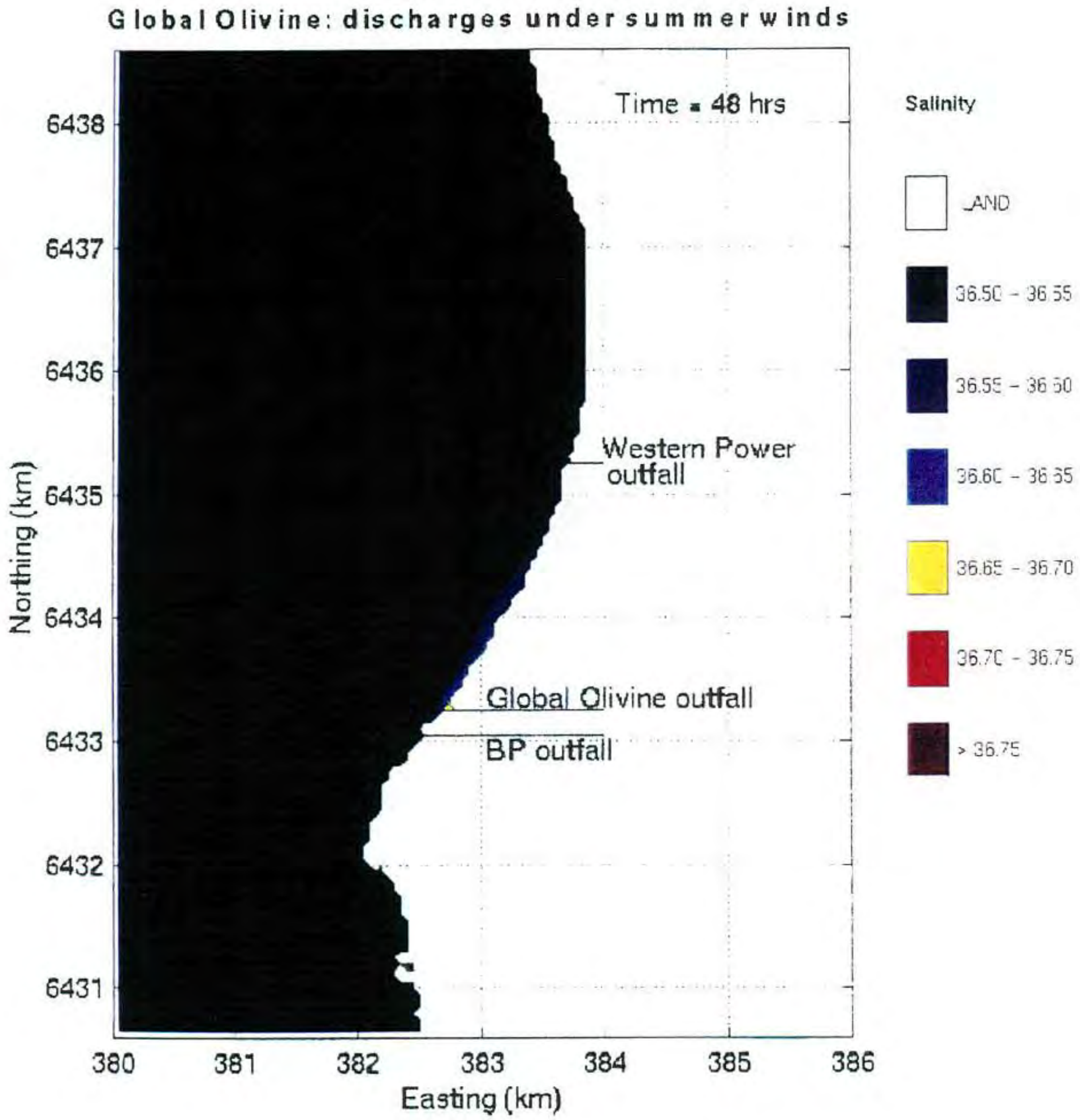
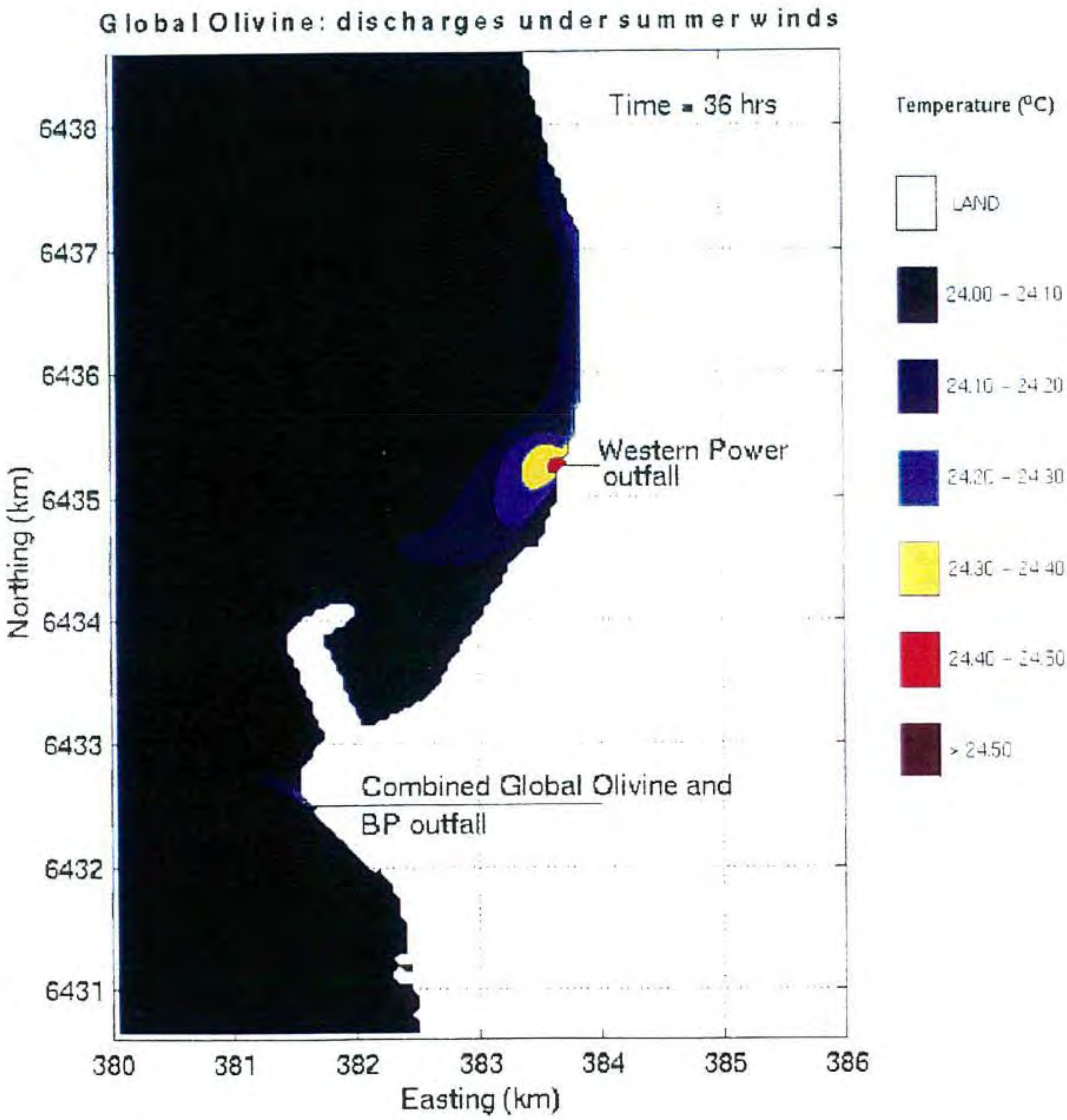


*Figure 9-4. Post-JPPL development: temperature, summer wind pattern (morning)*



### 9.1.6 *Conclusions*

The modelling results uniformly showed that the GOWA discharge will cause less than 0.5 °C difference between the median temperature of a parcel of water 50 m x 50 m wide immediately adjacent to the GOWA outfall and water further offshore (DAL, 1999a). Natural phenomena regularly cause temperature differences greater than this over similar spatial scales in Cockburn Sound (DEP, 1996).

It was also found that due to the shallow nature of the region in the vicinity of the discharge, the GOWA discharge would generally be fully mixed through the water column following initial dilution. Prior to commencement of construction of the discharge, GOWA will collect data on the extent of influence and dispersion of nearby plumes to allow a model validation exercise to be undertaken. The results of the model validation exercise will be presented to DEP for review prior to commencement of construction.

Modelling also demonstrated that outside of the first 50 x 50 m parcel of water adjacent to the outfall, the discharge will result in a salinity difference of less than 0.5 ppt, which is insignificant. Greater salinity differences occur naturally in Cockburn Sound (DEP, 1996).

The modelling study demonstrated the following key points:

1. The relatively low flow of the GOWA discharge means that GOWA discharge has relatively low influence compared to adjacent discharges; and
2. The impact of the BP and GOWA discharges may be further reduced following construction of the James Point harbour due to: the reduced salinity of the discharge following mixing with the BP discharge; the increased water depth at the point of discharge (10 m as opposed to shoreline discharge); and, the more exposed nature of the point of discharge which promotes increased mixing.

### 9.1.7 *Proposed limited quality zone*

The ANZECC criteria for median temperature and salinity change should be met within 50 m of the outfall location. However, the nature of the discharge is such that it will travel between 20 m and 80 m before it is mixed through the entire depth of the water column and the plume will be diluted between 25 to 80 fold at this point. This dilution is such that it would be very difficult to distinguish the GOWA plume from ambient conditions beyond this distance.

It is proposed that a Limited Quality Zone of 100 m radius is set around the point of discharge of the GOWA plume. All ANZECC (1999) salinity and temperature criteria will be met outside this zone, and in most conditions these should be met within this zone.

## 9.2 IMPACTS ON WATER QUALITY

The modelling suggests that the Olivine discharge will influence temperature and salinity only in the immediate vicinity of the discharge and in a very limited manner. Changes from ambient salinity and temperature will be restricted to less than 0.5 ppt and 0.5 °C respectively. It is concluded that the difference between the salinity and temperature of the discharge and that of the Sound will not result in detrimental impacts on the water quality of Cockburn Sound.

Once operational, GOWA propose to undertake a field survey to measure the dilution and dispersion of the plume to confirm these conclusions and compare the field results with the model data.

The presence of anti-scalant in the discharge at between 5 and 8 ppm does not appear likely to be harmful given the low toxicity (Appendix M) and low initial concentration. The concentration following initial dilution will be approximately 50 to 80 times less again. There is unlikely to be a discernible impact on the water quality of Cockburn Sound due to the use of anti-scalant in the proportions proposed by GOWA. GOWA will undertake eco-toxicological testing of the effects of the discharge on marine organisms to confirm the level of toxicity of the discharge.

## 9.3 IMPACTS ON SEDIMENT QUALITY

There is unlikely to be significant contamination of the sediments near the GOWA discharge. This statement is made on the following basis:

- sediment quality data collected in the vicinity of other outfalls around Cockburn Sound (Burt *et al.* 1995) shows contaminants are generally an order of magnitude below ANZECC (1999) trigger levels; and
- the GOWA discharge should not contain significant concentrations of contaminants.

The proponent proposes to undertake pre- and post- commissioning surveys of sediment quality in the vicinity of the discharge to confirm this assumption. The discharge will also be analysed for all constituents of possible concern.

## 9.4 IMPACTS ON BENTHIC HABITAT

The proposal will not result in any direct or indirect impacts on seagrasses or reef environments.

## 9.5 IMPACTS ON RECREATIONAL AMENITY

The proposal will not result in any impacts on the recreational amenity of Cockburn Sound waters as the region which is proposed for a limited quality zone is within an area of restricted boating and public access.

## 9.6 IMPACTS ON LITTORAL TRANSPORT

The proposal will not impact on the littoral transport in the region.

## 9.7 AIR IMPACTS

### *9.7.1 Dispersion Modelling*

Detailed dispersion modelling of emissions of sulphur dioxide, nitrogen dioxide, hydrogen chloride, fluorides, carbon monoxide, particulate material ($PM_{10}$), lead and mercury from the GOWA WTE&W plant stacks has been undertaken to determine their effect on air quality in the Kwinana airshed. Results of dispersion modelling of emissions of dioxins and heavy metals, undertaken as part of the multi-pathway health risk assessment are also discussed briefly here.

The principal air quality concern in the Kwinana area is with sulphur dioxide, which is the key pollutant on which the areas and Standards of the Kwinana EPP are based.

### 9.7.2 *Dispersion modelling approach*

1. *The WTE&W plant in isolation and operating at constant emission rates.*
This assessment provides a measure of the possible concentration contributions attributable directly to the WTE&W plant emissions, and also provides a convenient means of showing the spatial variation of contributions from the project emissions to concentrations of sulphur dioxide and other pollutants in air in the Kwinana area

2. *The WTE&W plant in isolation, with assessment of the implications of the frequency distribution of emission rates and meteorological conditions.*
This assessment provides an appreciation of the frequency with which particular plant in isolation contributions are likely to occur.

3. *The WTE&W plant operating at a constant emission rate, in conjunction with all other sulphur dioxide emissions to the Kwinana airshed.*
This modelling takes account of the fact emission sources at different locations and with differing characteristics, such as stack height and plume buoyancy, contribute to cumulative concentrations at any site to varying degrees under different meteorological conditions. For example, a source will not contribute to concentrations at a particular site when the wind is not in the direction of the site, or when the wind speed is too low to overcome the buoyancy of the plume and mix its emissions down to ground before reaching the site. A new source may not necessarily increase the maximum concentrations occurring at a particular site because it does not contribute to concentrations at that site under the conditions that result in other sources producing the maximum concentrations. This modelling determines the potential incremental cumulative effect of all emissions plus the proposed emissions

4. *As for 3. above, but with a probabilistic variability in emission rates, selected to reflect the worst likely frequency of high levels of emissions, for both the existing sources and the proposed new source.*
This modelling takes account of the variation in emission rates from different sources, which often means that, for example, two sources which might contribute under the same conditions to concentrations at any particular location, may not, in fact, do so to the maximum possible degree, because one or both of the sources is not emitting at its maximum rate at the time. It indicates the extent to which the potential for increased maximum and 99.9 %ile concentrations will be realised in practice.

Modelling of the cumulative effect of all sulphur dioxide emission sources in the Kwinana area usually focuses particularly on the areas where the highest concentrations tend to occur:

- The Eastern modelling area, which is a square with sides about 3 km, extending from about 1.7 km East of the WTE&W plant, and including the northern part of the Kwinana town. This is the area where the WTE&W plant emissions produce their greatest 1-hour average concentrations outside Area A. Even so, the incremental impact from the WTE&W plant emissions in this area is very minor.

- The Northern modelling area, which is a similar square located about 10 km NNE of the WTE&W plant, reflecting particularly the combined effects of emissions from the Cockburn Cement plant and other emissions closer to the WTE&W plant. Under the common SSE winds, a number of these emissions tend to be in line, producing higher concentrations in the northern area. The WTE&W plant makes only very small contributions to concentrations in this area.

For 24-hour average contributions to sulphur dioxide from the WTE&W plant, modelling of fixed emission rates for the plant in isolation showed that the plant in isolation contributions and, using a worst case assessment, the maximum likely cumulative concentrations were small enough not to be of concern. Accordingly, cumulative modelling of all emissions sources for 24-hour averages was not done.

For annual averages, the contributions from all sources are additive, so that cumulative annual average concentrations can be assessed on the basis of average annual average emissions, modelled in isolation for all sources. Plant in isolation modelling for the WTE&W plant showed that its sulphur dioxide emissions will make only a very small contribution to existing annual average concentrations at any of the monitoring sites, and that the contributions will be less than 0.5% of the Kwinana EPP Standard, so that cumulative annual average modelling of all sources was not considered necessary.

The DISPMOD model is not set up with $NO_x$ emissions rates for existing sources, so that cumulative modelling of the WTE&W plant emissions to predict nitrogen dioxide concentrations cannot be done, either for fixed or probabilistically varying emission rates, unless the required data is gathered and entered into the programme. A different approach which combined hour-by-hour modelling results with hour-by-hour monitoring data was used to estimate the cumulative effect of the WTE&W plant $NO_x$ emissions and the existing emissions.

For particulates emissions (taken, conservatively, to be entirely $PM_{10}$), fixed emission rate, plant in isolation modelling showed that the maximum possible contributions are so small as to make no significant contribution to existing levels or the NEPM Standard.

For other contaminants assessed in this report, neither emission rates for other industries in the Kwinana area, nor ambient air monitoring data are available. Consequently, it is not possible to estimate cumulative concentrations resulting from the WTE&W plant emissions, together with existing sources in the area. However, if, as is the case, modelling the WTE&W plant emissions in isolation shows that contributions of these contaminants are small percentages of guidelines or standards, it provides an assurance that either the cumulative concentrations will be acceptable, or that the WTE&W plant contributions will not make any significant contribution to whether the air quality does or does not meet acceptable guideline or standards.

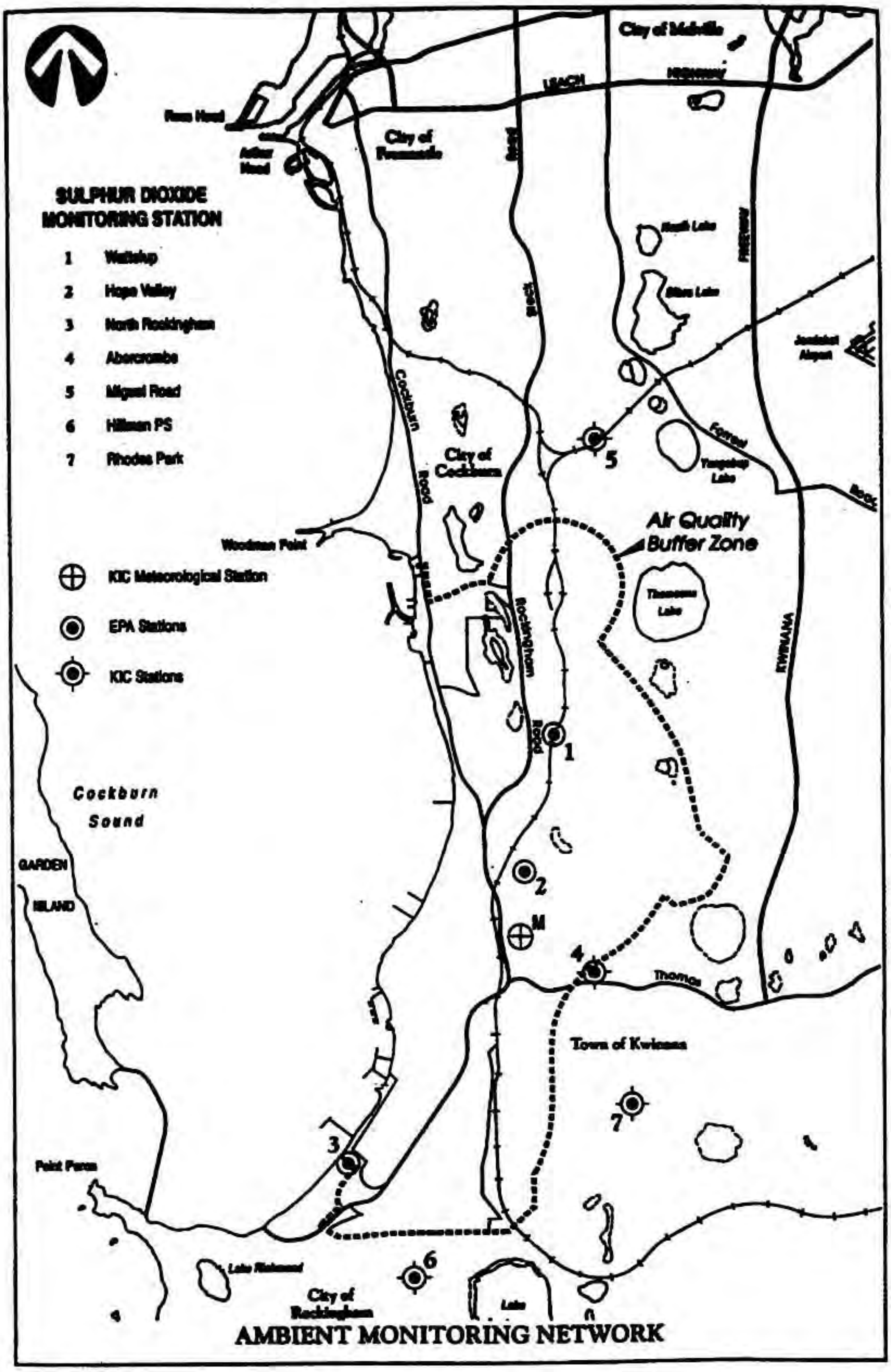
The concentrations of air pollutants which cause adverse effects over long periods of time are lower than the concentrations required to cause effects over short periods of exposure. Accordingly, air quality standards or guidelines are set for particular averaging periods which reflect typical exposure periods relevant to the effect which the standard is established to avoid. Common averaging periods are 1 hour, 24 hour and annual.

***Table 9-3. Source details for modelling.***

| | 1-hour averages | | 24-hour and annual averages | |
|---|---|---|---|---|
| | Stack 1 | Stack 2 | Stack 1 | Stack 2 |
| Temperature ($^{o}C$) | 135 | 135 | 135 | 135 |
| Diameter (m) | 4.1 | 4.1 | 4.1 | 4.1 |
| Height (m) | 70.0 | 70.0 | 70.0 | 70.0 |
| Exit Velocity (m/sec) | 19.5 | 19.5 | 14.4 | 14.4 |
| Flue gas emission rate ($m^3$/sec) | 258 | 258 | 190 | 190 |

Ambient air monitoring data is available for sulphur dioxide for a number of sites in the Kwinana area, as shown in Figure 9-5. The Wattleup, Hope Valley, Abercrombie Rd and North Rockingham sites are particularly relevant to this assessment. Nitrogen dioxide data are available for the Hope Valley and North Rockingham sites, and $PM_{10}$ is available for the Abercrombie Rd site.

*Figure 9-5. Ambient air monitoring sites in the Kwinana area*

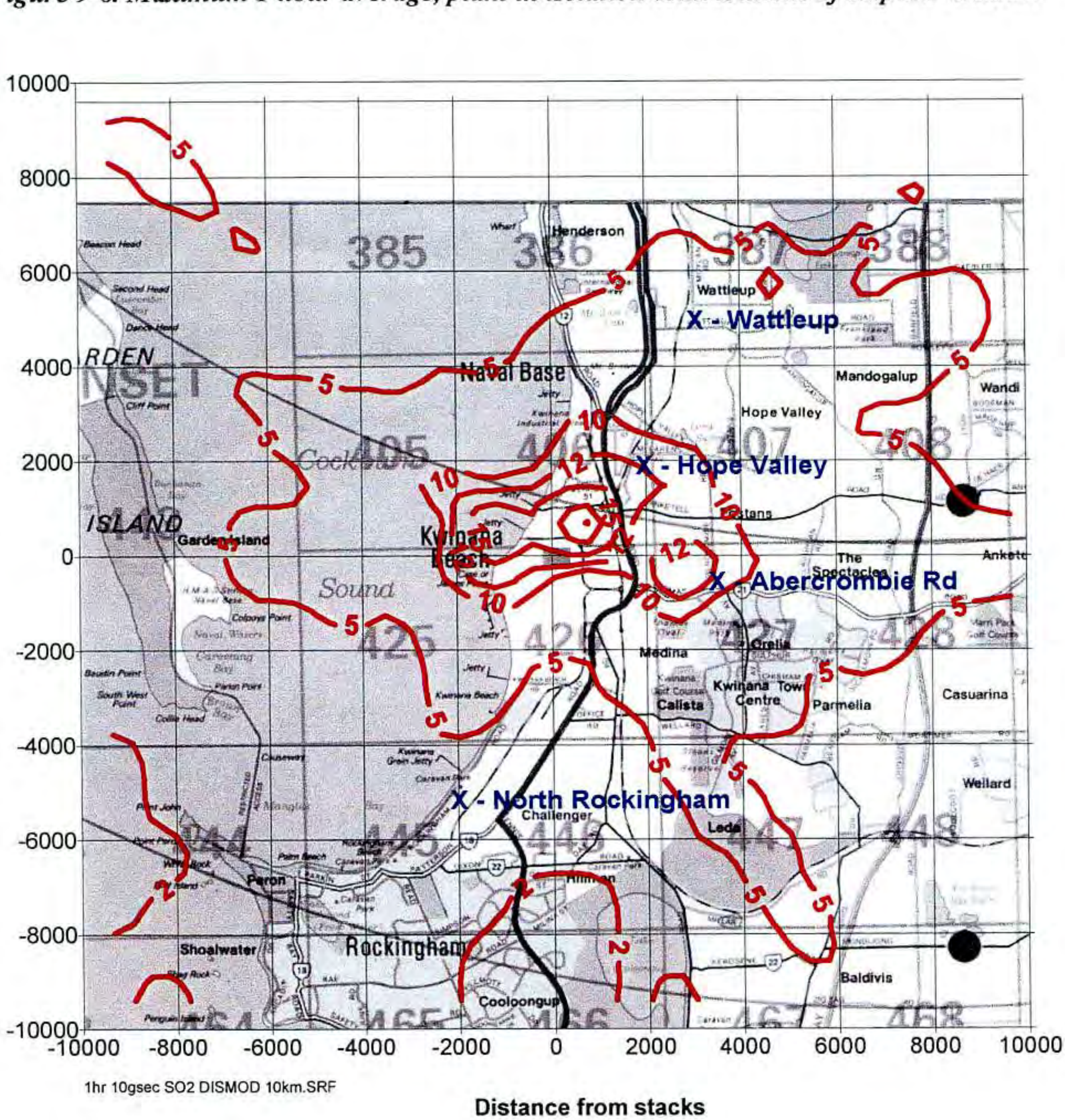


### 9.7.3 *Modelling of 1-hour average concentrations*

***Spatial variation in 1-hour average concentration increments from the WTE&W plant.***

Figure 9-6 shows the pattern of 1-hour average maximum, plant in isolation concentration contributions of sulphur dioxide for continuous emission at 10 g/sec, and for the plant operating at maximum design loading (flue gas emission rate 228 $m^3$/sec from each stack). This sulphur dioxide emission rate is about the 87 %ile emission rate corresponding to the proposed emission limits for the WTE&W plant. Although the emission rates may, at times, be up to about 3 times the rate for Figure 9-6, such emission rates will occur infrequently, and for short periods (less than 2% of the time), so that they are very unlikely to coincide with meteorological conditions giving the maximum concentrations, corresponding to those in Figure 9-6.

*Figure 9-6. Maximum 1-hour average, plant in isolation contributions of sulphur dioxide.*



The maximum concentration (25 $\mu g/m^3$) contribution is predicted to occur about 1 km NE of the plant, within Area A of the Kwinana Environmental Protection Policy. The highest maximum 1-hour average concentration (12 $\mu g/m^3$) outside Area A, in a residential area, is at Hope Valley, which is in Area B. The highest concentration in Area B (14 $\mu g/m^3$) is in the centre of the isolated, 12 $\mu g/m^3$ contour about 2500 m east of the origin. This location is about 800m west of the Abercrombie Rd monitoring station. The highest maximum 1-hour average concentration (12 $\mu g/m^3$) outside the air quality buffer zone comprising Areas A and B is at the location of the Abercrombie Rd monitoring site.

The 1-hour average maximum concentration contributions for other pollutants emitted from the WTE&W plant will also show similar spatial patterns to that in Figure 9-6. For sulphur dioxide and the other pollutants considered, if emissions from the WTE&W plant do not cause significant deterioration or unacceptable air quality at either the most affected residential area (Hope Valley) or at the point of highest concentration contributions outside the air quality buffer zone (Abercrombie Rd), there is a good assurance of protection of air quality from the effects of WTE&W plant emissions on 1-hour average concentrations in the Kwinana area in general.

### 9.7.4 *Plant in isolation sulphur dioxide contributions and frequency of occurrence.*

A frequency distribution for sulphur dioxide emissions from the WTE&W plant was developed based on the very conservative assumption that the plant will operate continuously at the maximum emissions allowed by the limits proposed for the plant. This frequency distribution, combined with the frequency of occurrence of meteorological conditions giving the annual maximum 1-hour average concentration contribution (0.01% of the time) and 99.9 %ile concentration (0.1% of the time), then indicates the probability of occurrence of concentrations exceeding these contributions in any year, or, as presented here, the return period.

Table 9-4 presents plant in isolation sulphur dioxide concentration contributions for a selection of emission rates for a number of sites, together with the estimated return periods for the predicted contributions.

For high emission rates, contributions as high as 88 $\mu g/m^3$ (13% of the Kwinana EPP Standard for Area A) are predicted, but contributions this high would be expected to occur for only about 1 hour in 300 years. Concentration contributions likely to be exceeded more frequently, for example for about 1 hour each year, are quite low, being in the range of about 5-10 $\mu g/m^3$, or about 1-2% of the relevant Kwinana EPP Standards.

This plant in isolation modelling indicates that WTE&W plant emissions will, at most make moderate contributions to sulphur dioxide concentrations compared with the relevant Standards, but these maximum contributions will occur so infrequently as to be of very little significance. Contributions occurring more frequently, although still only for about one hour a year at any site, are about 1-2% of the relevant Standards.

*Table 9-4. Plant in isolation sulphur dioxide contributions and their return periods.*

| | Emission rate | | Northern Model Area (1996 Data) | | Eastern Model Area (1995 Data) | | Area A maximum | Hope Valley | Abercrombie Rd | North Rockingham |
|---|---|---|---|---|---|---|---|---|---|---|
| | (g/sec) | %ile | Maximum | 99.9%ile | Maximum | 99.9%ile | Maximum | Maximum | Maximum | Maximum |
| Kwinana EPP Standard | | | 350 | | 500 | | 700 | 500 | 350 | 350 |
| | 35 | 99.7% | 1-hour average, plant in isolation, sulphur dioxide ( $\mu g/m^3$) | | | | | | | |
| | | | 17 | 12 | 55 | 40 | 88 | 42 | 42 | 14 |
| % of EPP Standard | | | 5% | 3% | 11% | 8% | 13% | 8% | 12% | 4% |
| Return period (years) | | | 333 | 38 | 333 | 38 | 333 | 333 | 333 | 333 |
| | 26 | 97% | 1-hour average, plant in isolation, sulphur dioxide ( $\mu g/m^3$) | | | | | | | |
| | | | 10 | 7 | 38 | 28 | 65 | 31 | 31 | 10 |
| % of EPP Standard | | | 3% | 2% | 8% | 6% | 9% | 4% | 9% | 3% |
| Return period (years) | | | 33 | 3.8 | 33 | 3.8 | 33 | 33 | 33 | 33 |
| | 10 | 87% | 1-hour average, plant in isolation, sulphur dioxide ( $\mu g/m^3$) | | | | | | | |
| | | | 4 | 3 | 14 | 14 | 25 | 12 | 12 | 4 |
| % of EPP Standard | | | 1.2% | 0.9% | 3% | 3% | 4% | 2% | 3% | 1.1% |
| Return period (years) | | | 8 | 0.9 | 8 | 0.9 | 8 | 8 | 8 | 8 |
| | 4.6 | 50% | 1-hour average, plant in isolation, sulphur dioxide ( $\mu g/m^3$) | | | | | | | |
| | | | 2.2 | 1.6 | 7 | 5 | 12 | 6 | 6 | 2 |
| % of EPP Standard | | | 1% | 0.5% | 1.4% | 1.1% | 1.6% | 1.1% | 1.6% | 0.5% |
| Return period (years) | | | 2 | 0.23 | 2 | 0.23 | 2 | 2 | 2 | 2 |

### 9.7.5 *Cumulative probabilistic modelling of 1-hour averages for sulphur dioxide*

Fixed emission rate cumulative modelling showed that there is potential for WTE&W plant emissions to increase maximum and 99.9 %ile concentrations that could occur from existing sources, in both the Northern and Eastern Model Areas, if high emissions from both the WTE&W plant and existing sources happen to coincide with the required meteorological conditions. The probabilistic modelling presented here examines the degree to which this potential is likely to be realised.

The results of cumulative sulphur dioxide concentrations from probabilistic modelling of all emission sources in the Kwinana area, and using the emission frequency distribution corresponding to the proposed emission limits for the WTE&W plant, are given in Table 9-5.

***Table 9-5. Modelled cumulative concentrations for sulphur dioxide emissions***

| | Northern Model Area (1996 Data) | | | Eastern Model Area (1995 Data) | | |
|---|---|---|---|---|---|---|
| | $SO_2$ μg/m$^3$ | | | $SO_2$ μg/m$^3$ | | |
| | Maximum | 99.9%ile | Hours>350 | Maximum | 99.9%ile | Hours>350 |
| Base Case - existing emissions only | 410 | 349 | 8.66 | 450 | 306 | 3.51 |
| Existing emissions plus WTE&W plant | | | | | | |
| Cumulative modelling for flue gas emission rate 258 m$^3$/sec and probabilistic SO2 emission rates | | | | | | |
| Cumulative concentrations | 411 | 350 | 8.78 | 450 | 313 | 3.54 |
| Increase compared with base | 1 | 1 | 0.12 | 0 | 7 | 0.03 |
| % increase | 0.2% | 0.2% | 0.03% | 0.0% | 2.3% | 0.9% |
| Cumulative modelling for flue gas emission rate 228 m$^3$/sec and probabilistic SO2 emission rates | | | | | | |
| Cumulative concentrations | 411 | 350 | 8.82 | 450 | 313 | 3.53 |
| Increase compared with base | 1 | 1 | 0.16 | 0 | 7 | 0.02 |
| % increase | 0.2% | 0.2% | 0.04% | 0.0% | 2.3% | 0.6% |

The incremental increases in the 1-hour maximum (0.2% or less) and 99.9 %ile (2.3% or less) concentrations, and in the number of hours of concentrations exceeding 350 μg/m$^3$ (0.16hr or less) are very small. Clearly, emissions at the proposed limits will, in practice, make a very small contribution to the 1-hour maximum and 99.9 %ile concentrations sulphur dioxide concentrations in the Kwinana airshed.

It may be noted that the base case predicted maximum 1-hour average concentrations (ie predictions for existing sources without the WTE&W plant emissions) are 411 μg/m$^3$ for the Northern model area and 450 μg/m$^3$ for the Eastern model area, and 99.9 percentile concentrations are 349 μg/m$^3$ and 306 μg/m$^3$ respectively. The Kwinana EPP 1-hour average Standard (the level desirable not to exceed ) applicable to much the area of both the Northern and Eastern model areas is 350 μg/m$^3$, and the Limit (not to be exceeded) is 700 μg/m$^3$. These figures indicate the situation which might arise if all industries in the Kwinana area discharged sulphur dioxide at their maximum permitted levels. However, most industries are discharging sulphur dioxide at rates considerably below those allowed in their licence conditions, the existing concentrations of sulphur dioxide in the Kwinana airshed, as shown by ambient air monitoring, are much lower than the modelling of all sources at their maximum emission rates would indicate. The section describing existing air quality indicates that, in most years over the past decade, the maximum 1 hour average concentrations have been below the Kwinana EPP Standards (the level desirable not to exceed), with occasional hours being intermediate between these Standards and the Limits (not to be exceeded). The 99.9 percentile concentrations have typically been about half or less of the relevant Kwinana EPP Standards. These ambient air monitoring results indicate satisfactory air quality in the Kwinana area, in clear compliance with the Kwinana EPP. The very small changes resulting from the GOWA WTE&W plant emissions will not change this situation to any appreciable degree.

Notwithstanding the very small changes resulting in air quality in the Kwinana airshed from the currently proposed sulphur dioxide emission limits, GOWA is committed to a review, after one year of operation, of the levels of emission practically achievable, with a view to reducing the emission limits applying to the project.

***Nitrogen dioxide***

One of the principal concerns about $NO_x$ emissions is the nitrogen dioxide ($NO_2$) concentrations resulting at ground level from the minor proportion of nitrogen dioxide usually in emissions (about 5-10%) and oxidation of nitric oxide after discharge to the air.

Contributions of $NO_x$ at any site indicate the maximum possible contributions to $NO_2$ concentrations, if 100% of the $NO_x$ is oxidised to $NO_2$. Table 9-6 gives modelled, plant in isolation $NO_x$ concentration contributions from the WTE&W plant emissions, for continuous operation at the proposed 24-hour average emission concentration limit, for Hope Valley and Abercrombie Rd for 1995 and 1996, and for North Rockingham for 1996.

***Table 9-6. Modelled $NO_x$ plant in isolation contributions from WTE&W plant emissions***

| Site* | HV | Ab | HV | Ab | NR | HV | Ab | HV | Ab | NR |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | | 1996 | | | 1995 | | 1996 | | |
| | Average flue gas emission rate | | | | | Maximum flue gas emission rate | | | | |
| Emission concentration (mg/m3 as NO2) | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| Flue gas emission rate (m3/sec per stack) | 190 | 190 | 190 | 190 | 190 | 228 | 228 | 228 | 228 | 228 |
| | $NO_x$ ($\mu g/m^3$ as $NO_2$) | | | | | | | | | |
| Maximum | 75 | 72 | 69 | 40 | 26 | 85 | 80 | 80 | 44 | 26 |
| 99.9%ile | 54 | 38 | 45 | 23 | 15 | 58 | 41 | 52 | 26 | 18 |
| 99%ile | 25 | 12 | 22 | 9 | 6 | 29 | 13 | 25 | 10 | 7 |
| 90%ile | 1.5 | 0.0 | 1.5 | 0.0 | 0.0 | 1.5 | 0.0 | 1.5 | 0.0 | 0.0 |
| Mean | 1.2 | 0.5 | 1.0 | 0.3 | 0.2 | 1.3 | 0.5 | 1.2 | 0.4 | 0.2 |

* Site codes HV Hope Valley
Ab Abercrombie Rd
NR North Rockingham

The largest potential $NO_2$ contributions, as indicated by $NO_x$ contributions, occur at the Hope Valley site. The maximum 1-hour average contributions at both Hope Valley and Abercrombie Rd are closely similar, for both average and maximum flue gas emission rates for 1995, but contributions at Abercrombie Rd markedly lower in 1996. The 99.9 %ile and lower percentile contributions at Abercrombie Rd are markedly lower than those for Hope Valley for both 1995 and 1996. The contributions at North Rockingham about 30% lower that those at Abercrombie Rd.

The effect of $NO_x$ emissions from the WTE&W plant on nitrogen dioxide levels, in combination with existing emissions was assessed using a combination of dispersion modelling with DISPMOD and ambient air monitoring data from the monitoring sites at Hope Valley and North Rockingham. The dispersion modelling was used to generate the predicted $NO_x$ concentrations resulting from the WTE&W plant emissions in isolation for each hour throughout the year, for the Hope Valley and North Rockingham monitoring site locations. The dispersion modelling results show zero concentrations for each of the sites for all hours when the wind direction does not carry the emissions to the site. All non-zero concentrations are the modelling estimates of the contribution from the WTE&W plant emissions to the cumulative concentrations at the monitoring sites for those hours.

Combining these estimates with conservative estimates of the percentages of $NO_x$ oxidised to nitrogen dioxide gave estimates of cumulative concentrations for the Hope Valley and North Rockingham sites that are effectively estimates of the cumulative concentrations which could potentially have occurred there if the WTE&W plant had been in operation over the period of the monitoring. Combination of these estimates with a conservative frequency distribution for $NO_x$ emissions based the proposed emission limits for the plant allowed estimation of the frequency of occurrence of the estimated cumulative maximum and 99.9 %ile concentrations of nitrogen dioxide.

Table 9-7 gives estimated cumulative nitrogen dioxide concentrations for the Hope Valley site, which may to have occurred if the WTE&W plant were operating at full capacity in 1996, together with the frequency of occurrence cumulative concentrations exceeding those estimated. The concentrations in the last row are the concentrations measured in 1996, resulting from existing sources.

This analysis shows that the maximum 1-hour average concentration of nitrogen dioxide which could have occurred at Hope Valley would have been 134 $\mu g/m^3$, 54% of the NEPM Standard. However, there is only a 1 in 200 chance that this maximum possible concentration would have actually occurred in 1996. Maximum 1-hour average concentrations of $NO_2$ exceeding 50% of the NEPM Standard are not likely to occur more frequently than about 1 year in 20. In 3 years out of 4, WTE&W plant emissions will not result in any increase in the 1-hour average maximum, and will not increase the 99.9 %ile concentrations of $NO_2$ by more than 6 $\mu g/m^3$ or 3% of the NEPM Standard.

These small changes predicted to result from the expected average $NO_x$ emissions from the WTE&W plant, and the very infrequent occurrence of any significant elevation in existing maximum $NO_x$ concentrations under a conservative emissions scenario, mean that the overall effect of WTE&W plant $NO_x$ emissions on $NO_2$ concentrations at Hope Valley is very small. The maximum 1-hour average $NO_2$ concentrations there will remain well within the NEPM Standard.

***Table 9-7. Cumulative concentrations of $NO_2$ at Hope Valley and their frequency of occurrence***

| $NO_x$ emission rate (g/sec) | % of time exceeding emission rate | Hope Valley $NO_2$ concentrations (μg/m3) | | % of NEPM standard | | Occurrence 1 year in: |
|---|---|---|---|---|---|---|
| | | Maximum | 99.9%ile | Maximum | 99.9%ile | |
| 123 | 0.5% | 134 | 79 | 54% | 32% | 200 |
| 108 | 1.8% | 130 | 78 | 53% | 32% | 57 |
| 103 | 2.8% | 131 | 77 | 53% | 31% | 36 |
| 92 | 4.6% | 118 | 72 | 48% | 29% | 22 |
| 90 | 7.1% | 120 | 73 | 49% | 30% | 14 |
| 77 | 14% | 106 | 72 | 43% | 29% | 7 |
| 64 | 20% | 98 | 70 | 40% | 28% | 5 |
| 51 | 28% | 92 | 66 | 38% | 27% | 4 |
| 51 | 36% | 92 | 66 | 38% | 27% | 3 |
| 38 | 55% | 92 | 66 | 38% | 27% | 2 |
| 26 | 75% | 92 | 63 | 38% | 25% | 1 |
| 15 | 100% | 92 | 60 | 38% | 24% | 1 |

The following considerations, based on evaluation of the $NO_x$ and nitrogen dioxide monitoring data, meteorology of the area, and modelling results, leads to a useful assessment of the likely cumulative nitrogen dioxide concentrations at Abercrombie Rd monitoring site during conditions when the WTE&W plant will contribute to nitrogen dioxide concentrations there. If the effects of WTE&W plant emissions on nitrogen dioxide concentrations at both Hope Valley and Abercrombie Rd are acceptable, a good assurance is provided of the acceptability of this aspect of air quality in any other residential area in the Kwinana area.

- Moderate elevations in $NO_2$ concentrations measured at Hope Valley under moderate SW quarter winds are likely to result from $NO_x$ emissions from the BP refinery at James Pt, alongside the WTE&W plant site. The refinery is the only significant NOx source in the immediate vicinity of the WTE&W plant.
- Similar or somewhat lower maximum concentration contributions than those at Hope Valley during moderate south-westerlies are likely to result at the Abercrombie Rd monitoring site from BP refinery emissions during similar westerly winds.
- The lower frequency of westerly compared with south westerly winds in the Kwinana area will result in a lower frequency of significant $NO_2$ concentration contributions from either the BP refinery or WTE&W plant at Abercrombie Rd than at Hope Valley.
- Likely local area sources, such as vehicle emissions are not likely to contribute significant $NO_x$ or $NO_2$ concentrations under the conditions when either the BP refinery or the WTE&W plant are likely to make their largest contributions to $NO_2$ concentrations at either the Hope Valley or Abercrombie Rd sites.
- Maximum contributions to $NO_2$ concentrations at Abercrombie Rd from WTE&W plant emissions are predicted to be either similar to or lower than those predicted for the Hope Valley site, and significant concentration contributions will occur there at lower frequencies than at Hope Valley.

- The maximum and other percentile 1-hour average cumulative $NO_2$ concentrations at Abercrombie Rd from both the WTE&W plant and the BP refinery emissions can confidently be estimated to be not larger than those estimated for Hope Valley.
- In view of the very small effect of WTE&W plant $NO_x$ emissions on 1-hour average $NO_2$ concentrations at Hope Valley, very small effects on these concentrations at Abercrombie Rd is clearly assured.

Although the air quality resulting from the currently proposed $NO_x$ emission limits is clearly satisfactory, GOWA is committed to a review, after one year of operation, of the levels of emission practically achievable, with a view to reducing the emission limits applying to the project.

***Other pollutants.***

Combination of a conservative frequency distribution of emission rates based on the proposed emission limits for hydrogen chloride with plant in isolation modelling of contributions from the WTE&W plant showed that 1-hour average concentration contributions exceeding 12 $\mu g/m^3$ at either Hope Valley or Abercrombie Rd are not likely to occur more frequently than once in 100 years. This concentration contribution is 0.6% of the California Reference Exposure Level (REL), and 11% of the Victoria Design Ground Level Concentration (DGLC). Concentration contributions likely to be exceeded for about one hour per year at these sites are about 2 $\mu g/m^3$, or 0.1% of the REL and 2% of the DGLC.

As discussed in Section 9.7.2, where plant in isolation contributions are small percentages of guidelines or standards, there is a good assurance that that either the cumulative concentrations will be acceptable, or that the WTE&W plant contributions will not make any significant contribution to whether the air quality does or does not meet acceptable guideline or standards. Accordingly there will be no adverse effects that could be reasonably argued to result from discharges of hydrogen chloride from the WTE&W plant.

Assessment of the effects of WTE&W plant emissions on concentrations of carbon monoxide and hydrogen fluoride used only plant in isolation estimates for the extreme maximum possible emission rates, since even they show that the effects of emission of these pollutants will be negligible. The return periods for these estimated contributions will be well in excess of 100 years, since the emission rates are larger than even the 99.9 %ile emission rates.

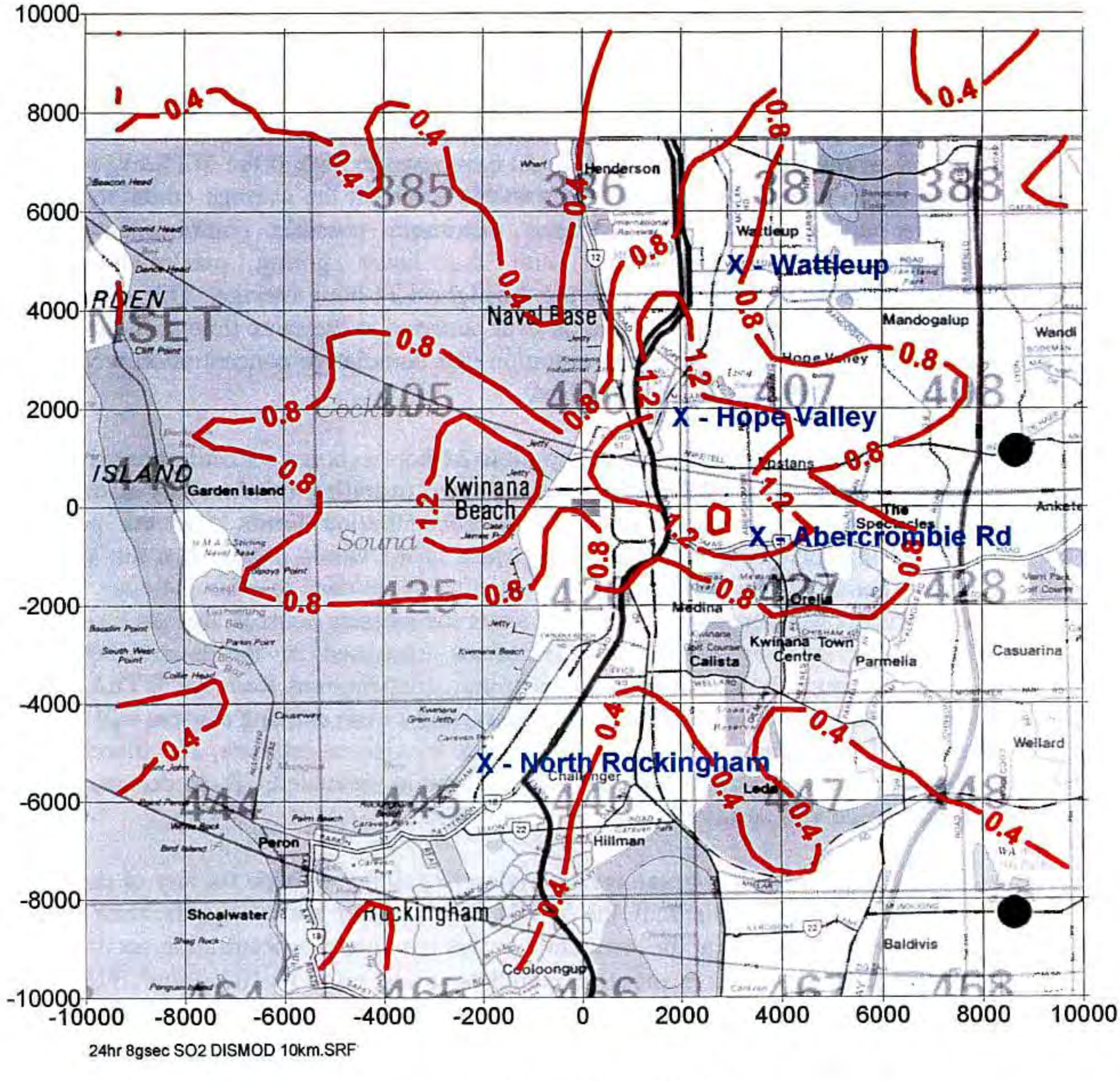
Using the 4-hour limit emission rate for carbon monoxide to model the maximum 1-hour average, will over-estimate the ambient air concentration contribution for comparison with the 8-hour NEPM Standard. This predicted maximum 1-hour average ambient air concentration contribution of 0.04 $mg/m^3$ near the Abercrombie Rd site is 0.4% of the NEPM Standard, clearly indicating a negligible effect.

The hydrogen fluoride maximum 1-hour average contribution near the Abercrombie Rd site is 1.9 $\mu g/m^3$, 0.8% of the California REL of 240 $\mu g/m^3$. This extreme maximum concentration contribution is clearly negligible compared with the guideline level.

### 9.7.6 24-Hour Average Concentrations

Figure 9-7 shows the spatial variation of maximum 24-hour average plant in isolation concentration contributions of sulphur dioxide, to illustrate the concentration contribution patterns for sulphur dioxide and other pollutants, all of which will show similar spatial variation. The maximum sulphur dioxide concentration contributions from the WTE&W plant for the various ambient monitoring site locations were read from this Figure. The maximum 24-hour average contributions are predicted to occur about 2.5 km east of the plant, about 800m west of the Abercrombie Rd monitoring site.

***Figure 9-7. Maximum 24-hour average plant in isolation concentration contributions of sulphur dioxide ($\mu g/m^3$).***




**Distance from stacks**

### 9.7.7 *Sulphur dioxide*

The predicted maximum 24-hour average sulphur dioxide plant in isolation concentration contribution, for the average sulphur dioxide emission rate, at the ambient air monitoring site giving the highest concentration (Abercombie Rd) is 1.3 μg/m$^3$, 4% of the average of annual maximum 24-hour average concentrations over the monitoring period (1993-98). This maximum contribution is 1% of the Kwinana EPP Standard outside the Air Quality Buffer zone. The maximum 24-hour average sulphur dioxide concentration measured for this site over the 1993-98 period is 37% of the EPP Standard, and would have risen to 38% if the WTE&W plant had been contributing to the maximum possible extent at the average emission rate. A further calculation of the extreme maximum possible contribution matched maximum possible emissions with the hours giving maximum possible concentrations, during the day giving the highest 24-hour average. This showed that, if this exceedingly unlikely situation ever occurred at the same time as the maximum monitored 24-hour average concentration, the cumulative concentration would have increased to 39% of the EPP Standard.

These estimates are the maximum possible 24-hour average concentrations that could have occurred if the WTE&W plant had been operating continuously at maximum capacity and at its proposed emission concentration limits over the period of monitoring for the various monitoring sites. They would require that the WTE&W plant emission contributed to its maximum extent to the 24-hour average concentrations over the same periods when the existing sources also gave rise to the maximum 24-hour average concentrations measured in the monitoring. Any departure from the coincidence of maximum contributions from the WTE&W plant with those giving the maximum 24-hour averages from existing sources will decrease the WTE&W plant contribution from these maximum estimate, and therefore will decrease the cumulative maximum concentration estimated. Such departures from coincidence will certainly be the usual situation.

The highest 24-hour average concentration of sulphur dioxide for any of the sites is 106 mg/m$^3$ for Wattleup. If the WTE&W plant had made its maximum plant in isolation contribution at the same time as this maximum concentration occurred from exiting sources, the concentration would have increased to 107 μg/m$^3$, 71% of the Kwinana EPP Standard and less than 50% of the NEPM Standard.

The maximum plant in isolation contribution to maximum 24-hour average concentrations at the Hope Valley and North Rockingham monitoring sites are smaller than those at Abercrombie Rd. The maximum 24-hour averages from monitoring at these sites are smaller than for Wattelup. The monitoring sites are located where they give a good indication of the maximum likely exposures experienced in the residential areas in the Kwinana area. Accordingly, the very small plant in isolation contributions predicted from WTE&W plant emissions, combined with monitoring data showing maximum 24-hour average concentrations well below the relevant Kwinana EPP Standards, give a very good assurance of the acceptability of air quality with respect to 24-hour average conditions. The WTE&W plant will clearly not affect the present situation with respect to compliance with 24-hour average sulphur dioxide Standards.

### 9.7.8 *Particulate material*

The largest 24-hour average ambient air concentration contribution of particulate material ($PM_{10}$) from WTE&W plant emissions occurs about 800m west of the Abercombie Rd monitoring site and is about 1% of the NEPM. Although there is a Kwinana EPP Standard for Total Suspended Particulates, the fabric filter particulate emission control technology means that most of the particulate material emitted from the WTE&W plant will be very fine, so that comparison with the NEPM $PM_{10}$ Standard is both more appropriate, and a more stringent assessment. The contribution from the WTE&W plant is clearly negligible in terms of either existing ambient $PM_{10}$ concentrations or any possible health effects.

The 24-hour average $PM_{10}$ concentration at the Abercombie Rd monitoring site exceeded the NEPM Standard (50 $\mu g/m^3$) by a small margin on several occasions during the two years for which monitoring data are available for the site (1997 and 98), with a maximum of 67 $\mu g/m^3$. There were 2 days of exceedance in 1997 and 4 days of exceedance in 1998. However, even the maximum effect of the emissions from the WTE&W plant are so small as to have a negligible effect on this existing situation. The probable average emission rate of particulates from the WTE&W plant would result in a maximum contribution anywhere of only 0.2 $\mu g/m^3$.

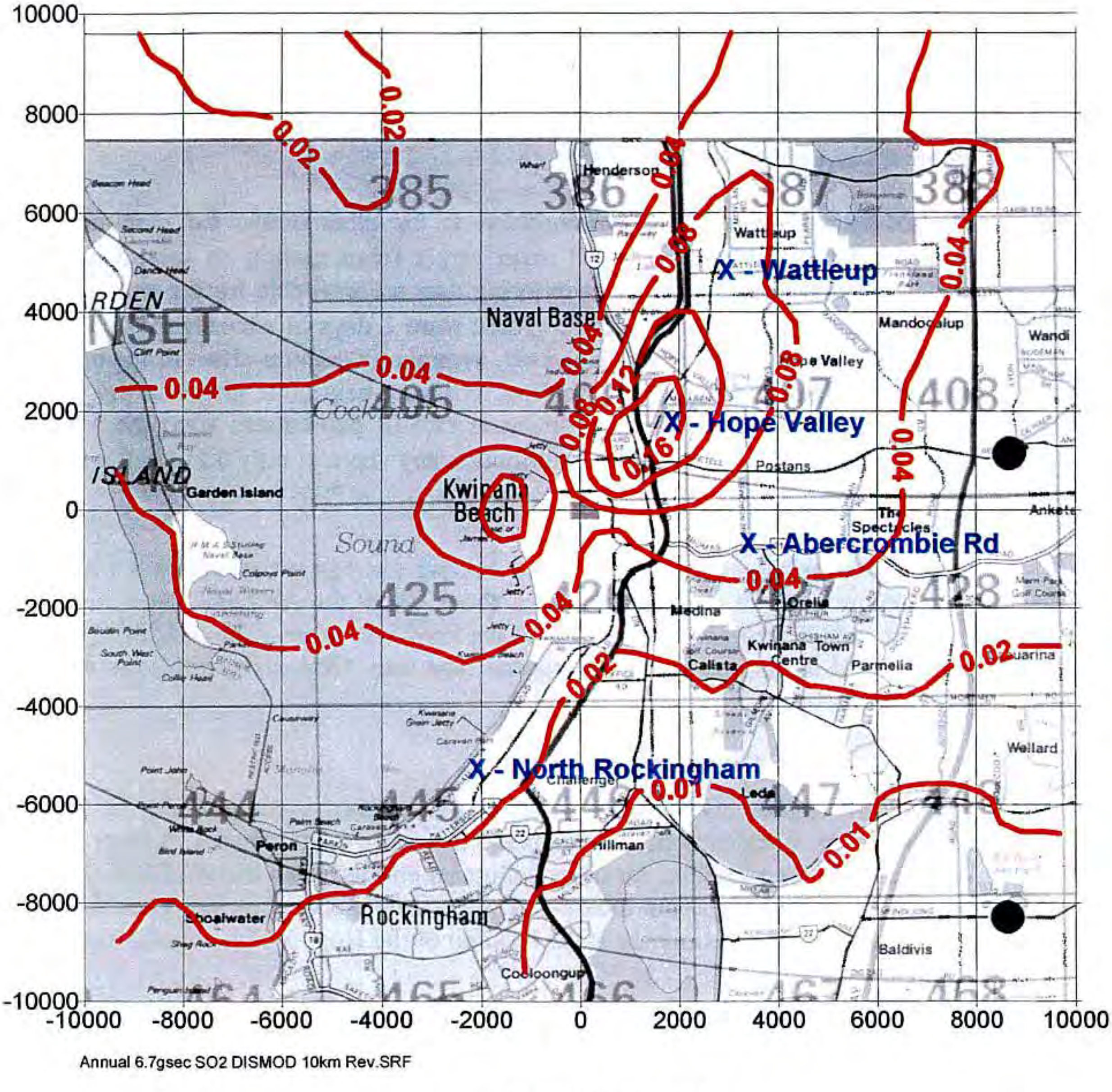
### 9.7.9 *Fluoride*

Continuous emissions of fluoride at the 24-hour average emissions limit would give a maximum ambient air contribution of about 4% of the ANZECC Goal for special land use, where fluoride-sensitive plants are known to grow. The ANZECC Goal for general land use is double that for special land use. Obviously no effects will arise from the discharge.

### 9.7.10 *Annual Average Concentrations*

Figure 9-8 shows the spatial variation of annual average plant in isolation concentration contributions for sulphur dioxide. The spatial pattern for the concentration contributions for other pollutants emitted from the WTE&W plant will be similar to that for sulphur dioxide. The maximum contributions occur about 2km NE of the plant, approximately at the location of the Hope Valley monitoring site.

*Figure 9-8. Maximum annual average plant in isolation concentration contributions of sulphur dioxide ($\mu g/m^3$).*




**Distance from stacks**

### 9.7.11 *Sulphur dioxide*

The maximum estimated annual average concentration contribution for sulphur dioxide is 4% of the average of the annual average concentrations for the Hope Valley monitoring site, and 0.4% of the annual average Kwinana EPP and NEPM Standards for sulphur dioxide. The maximum annual average concentration for any of the sites is about 20% of the NEPM Standard, and emissions from the WTE&W plant will not change this situation appreciably.

### 9.7.12 *Nitrogen dioxide*

The largest of the annual average nitrogen dioxide contributions predicted is for Hope Valley. This plant in isolation contribution from continuous emission at the 24-hour average emission limit over the full year, and 75% of $NO_x$ present as $NO_2$, is 1.5% of the annual average NEPM Standard. The largest annual average concentration found in ambient air monitoring for this site was 14 $\mu g/m^3$, about 25% of the NEPM Standard. Addition of the maximum estimated contribution of 0.9 $\mu g/m^3$ from the WTE&W plant emissions will not appreciably affect this situation. The increases in existing annual average nitrogen dioxide concentrations are small and there is no prospect of the total annual average concentrations reaching more than a modest percentage (about 27%) of the annual average NEPM Standard as a result of the WTE&W plant emissions.

The contributions from WTE&W plant emission to annual average concentrations at the locations of the other monitoring sites are smaller than that for Hope Valley. The monitoring data for North Rockingham shows a maximum annual average $NO_2$ concentration of about 20% of the NEPM Standard, to which the maximum WTE&W plant contribution would add only 0.2%. Although $NO_2$ monitoring data are not available for Abercrombie Rd and Wattleup, the very small contributions from the WTE&W plant (less than 0.7% of the NEPM Standard) ensure that existing annual average $NO_2$ concentrations, and their compliance with the NEPM Standards will not be changed to any appreciable degree by the WTE&W plant emissions.

### 9.7.13 *Other pollutants*

Continuous emissions at the proposed emission limit for lead would result in an annual average ambient concentration contribution at the most affected site (Hope Valley) of about 0.001 $\mu g/m^3$, 0.2% of the NEPM annual average Standard.

Continuous emission at the 24-hour average emission limit for hydrogen chloride would result an annual average ambient concentration contribution of 0.06 $\mu g/m^3$ at the most affected site. This is about 1% of the California Reference Exposure Level (REL).

Continuous discharge of hydrogen fluoride at the 24-hour average emission limit will result in an annual average ambient air contribution at the maximum site of 0.006 $\mu g/m^3$, about 0.02% of the California REL.

The predicted annual average fluoride concentration contribution at the maximum site is 2.5% of the 90-day average ANZECC Goal for special land use (fluoride-sensitive plants) and 1.5% of the Goal for general land use. Adjustment of the averaging period using the usual power law increases the percentages of the Goals to 3.3% and 1.6% respectively. No possible effects on plants will result.

Continuous discharge of mercury at the proposed emission limit would result in a maximum annual average ambient air concentration contribution anywhere of 0.0003 $\mu g/m^3$ 0.03% of the WHO 1996 ambient air guideline. Clearly no effects will result.

The dispersion modelling for annual average concentrations of dioxins and heavy metals was undertaken as part of the multi-pathway exposure assessment reported in the health risk assessment. These indicate very small annual average concentration contributions compared with likely existing ambient air concentrations. For example, for continuous extreme maximum emissions, the predicted annual average dioxin contribution at the maximum site (Hope Valley) is 0.6 fg I-TEQ/$m^3$, compared with concentrations measured at remote locations and a rural site in the range 1-4 fg I-TEQ/m3, and 28-100 fg I-TEQ/m3 at town and urban sites in New Zealand. For continuous probable average emissions, the predicted annual average concentration contribution at the Hope Valley site is 0.24 fg I-TEQ/$m^3$. The implications of the concentration contributions for dioxins and heavy metals are evaluated in the health risk assessment. They present no reasonable possibility of risks to health or the environment.

### *9.7.14 Effects of emissions on photochemical smog formation*

Emissions from the proposed WTE&W project could affect formation of photochemical smog, which occurs under some meteorological conditions in the Perth region (Perth Photochemical Smog Study, 1996). Formation of photochemical smog requires three principal components:

- Oxides of nitrogen ($NO_x$)
- Reactive organic compounds (ROC)
- Sunlight, warm temperatures and time for reactions to occur.

All three of these requirements must be met simultaneously, over a period of a few hours for significant smog formation. If, for example, high atmospheric turbulence disperses emissions of $NO_x$ and ROC to low concentrations, significant smog formation will not occur.

In Perth, the most common meteorological conditions that provide required conditions occur when there are gentle offshore morning breezes, which collect emissions as the breezes pass over Perth and Kwinana. Because of persistence of stable atmospheric conditions from the previous night and the usual stable atmospheric conditions over the sea, the airmass containing the pollutants is not dispersed to any significant degree, so that photochemical reactions can proceed at high rates. When sea breezes develop in the late morning or early afternoon, the developing smog airmass (if the offshore breezes have not moved it too far offshore) is moved back on shore where it may receive another injection of emissions.

The Perth Photochemical Smog Study (1996) has shown that emissions from motor vehicles are the predominant source of ROC, and contribute about half of the total $NO_x$ emissions in the Perth region. Industrial emissions, which are predominantly located in the Kwinana area, contribute $NO_x$ emissions similar to those from motor vehicles, but only a small proportion of ROC.

It may also be important that much of the $NO_x$ emission from the Kwinana area is from tall stacks, in buoyant plumes. This will tend to have the effect of delaying mixing of these emissions with high ratios of $NO_x$/ROC with emissions containing higher proportions of ROC, which tend to be emitted close to ground level (for example from cars or industrial fugitive emissions). The $NO_x$ emissions in these elevated plumes may then be less effective in producing elevated ozone concentrations than $NO_x$ emissions near ground level, and more likely to produce the ozone reductions via ozone titration, characteristic of "fresh" emissions, for considerable distances downwind in their plumes.

Modelling of photochemical smog formation, undertaken as part of the Perth Photochemical Smog Study, indicates that ozone formation, at most locations and under most situations giving high ozone concentrations, is light limited, and that decreases in ROC emissions are required to decrease ozone levels. Small decreases in $NO_x$ emissions are more likely to result in increased ozone concentrations. The modelling indicates that $NO_x$ emissions from the Kwinana emission plumes generally result in decreased ozone concentrations as a result of ozone titration. However, further research is desirable, *inter alia,* to confirm the generality of this effect, particularly for the low ROC/$NO_x$ ratios typical of the Perth region, and to better handle industrial stack emissions in the modelling.

The DEP also remains uncertain about the effects of increased $NO_x$ emissions during other seasons and conditions (Rayner, pers.comm.)

Emissions from the WTE&W project will contribute to the total of $NO_x$ emissions from the industrial area, but will contribute essentially no ROC, because of the excellent combustion conditions, which result in extremely low concentrations of organic compounds in the emissions. The WTE&W project emissions will be discharged through relatively high stacks (70m) and are highly buoyant, so that they can be expected to reinforce the patterns indicated for the existing Kwinana emissions, and result in ozone concentration decreases in areas affected by their plume.

An indication of the relative contribution of $NO_x$ emissions from the WTE&W project can be obtained by comparison of its estimated emissions with emissions estimates made in conjunction with the Perth Photochemical Smog Study. $NO_x$ emissions for the various source types from the 1992/93 Perth emission inventory are set out in Table 9-8. About 85% of the industrial point sources of $NO_x$ emissions are from the Kwinana area.

***Table 9-8. $NO_x$ emissions from the Perth emissions inventory***

| Perth emissions 92/93 | Vehicular | Industrial | Area | Total |
|---|---|---|---|---|
| Total NOx as NO2 tonnes/year | 23100 | 20300 | 2300 | 45700 |
| Total NOx as NO2 tonnes/day | 63 | 56 | 6 | 125 |

Table 9-9 sets out estimated daily $NO_x$ emissions from the WTE&W project, and calculates the percentage increases which these emission would cause in the total emissions from the total Perth and industrial point source emissions. The percentage increases are small compared with the total Perth emissions, and minor compared with the industrial emissions. As indicated above, emissions of reactive organic compounds (ROC) from the WTE&W project will be very low, because of the excellent combustion achieved.

***Table 9-9. Percentage increases in $NO_x$ emissions from the proposed WTE&W project***

| Emissions estimate | NOx concentrations mg/m3 as NO2 at 11% O2, dry, 0oC. | Emission rates (g/sec as NO2) | Daily emission rates (tonnes as NO2) | Percentages of 92/93 Perth emissions | |
|---|---|---|---|---|---|
| | | | | Total emissions | Industrial emissions |
| Proposed 24 hr limit | 200 | 51 | 4.4 | 3.5% | 8.0% |
| Probable average | 100 | 26 | 2.2 | 1.8% | 4.0% |

The most relevant comparison may with the industrial emissions, since the emissions from the WTE&W plant will tend to move and mix with the emissions from other sources in the area.

In view of the complexity and the interrelationship of a wide range of factors in photochemical smog formation, which leaves some uncertainty about the effects of increased emissions of $NO_x$, GOWA will seek to minimise $NO_x$ emissions from the proposed WTE&W project. The Emissions Estimates report sets out the measures whereby $NO_x$ emissions will be minimised, and provides the basis for the expectation that the Olivine Ultra-High Temperature Combustors will be unusually low emitters of $NO_x$ compared with other MSW combustors. GOWA proposes that the European $NO_x$ emission limits apply to project emissions as an interim measure, and that after 1 year of operation, the $NO_x$ emission limits be reviewed in light of the levels of $NO_x$ emissions achieved in practise, with a view to decreasing the emission limits. This may result in significant decreases from the emissions estimates set out in Table 9-9, and will ensure that $NO_x$ emissions are minimised to the maximum extent practical.

## 9.8 AIR EMISSION HEALTH EFFECTS

### *9.8.1 Introduction*

Hazardous waste incinerators, medical waste and municipal solid waste (MSW) incinerators have a bad reputation as major sources of dioxins, and to a lesser extent other contaminants such as mercury, in the environment. This reputation was well deserved by old incinerators, which often had poor combustion conditions and inadequate air pollution control systems, resulting in extremely high concentrations in emissions.

Modern combustors achieve far better combustion conditions, resulting in essentially complete destruction of any dioxins in the material being burned. The combination of improved combustion conditions and air pollution control processes such as spray/dry lime scrubbing followed by fabric filters, often with injection of activated carbon, allows modern combustors to comply with dioxin emission limits which are now typically less than 0.1 ng/m$^3$, compared with typical emission concentrations of about 50 ng/m$^3$ for incinerators built in the 1970s. This corresponds to about a 500-fold reduction in dioxin emissions. There can be little wonder that old incinerators caused severe pollution of their surrounding environments. The improved air pollution control systems have also greatly decreased emissions of all other contaminants, and modern, well-designed and well operated combustors have low levels of emissions compared with many familiar emission sources, such as coal boilers and domestic fires.

Although the performance of MSW combustors has improved dramatically, the perceptions of them in some quarters has not, in spite of extensive investigation and assessment showing that they are now very good environmental neighbours. This "good neighbour" performance is illustrated by the usual siting for new combustors in Europe in towns and cities, to take advantage of the energy they provide for district heating.

In view of the variable perceptions of MSW combustors, GOWA decided to commission a comprehensive multi-pathway health risk assessment for the emissions from the proposed WTE&W facility at Kwinana, to thoroughly investigate and reliably establish limits on the levels of exposure for people in the area possibly affected by project emissions and to assess the possible health implications of these exposures. As routinely found in other multi-pathway health risk assessments of effects from modern MSW combustors, the multi-pathway exposure and health risk assessment has shown extremely low levels of exposure resulting from project emissions, and therefore no change in health risks.

Because dioxin emissions from MSW combustors have been a concern in the past, and are still perceived by some to be a problem, a paper "*Background information about dioxin sources and their presence in the environment and foods.*" (ESR, 2000D) has been prepared to provide more general information about dioxins, and a context against which the emissions and exposure increments from the WTE&W project can be considered.

This section focuses particularly on the contributions which emissions of dioxins, arsenic, beryllium, cadmium, chromium, lead, mercury and nickel from the WTE&W plant will make to exposures and dietary intakes for people in the Kwinana area, and the health implications of those contributions.

Adverse effects from exposures to gaseous contaminants, such as sulphur dioxide, nitrogen dioxide, other acid gases, and carbon monoxide, and to particulate material ($PM_{10}$) are considered in the dispersion modelling section and are not part of this multi-pathway health risk assessment. Their health effects result almost exclusively through inhalation exposures, so that multi-pathway exposure assessment is not required. Exposures at levels high enough to cause adverse effects over any timescale are extremely unlikely to arise from emissions from the WTE&W plant, in conjunction with the other Kwinana area emissions, as discussed in the dispersion modelling section.

The following information is based on a comprehensive report "*Multi-Pathway Health Risk Assessment for Emissions to Air for the GOWA Waste to Energy and Water Project.*" (ESR, 2000C).

### 9.8.2 *Overview of the health risk assessment calculations.*

This section provides only a brief outline of the procedures followed in carrying out the multi-pathway health risk assessment for the WTE&W plant. Fuller details are provided in the full report (ESR, 2000C).

Multi-pathway health risk assessments estimate the concentrations and accumulation of contaminants in all significant environmental media including air, rain, soil, pasture, fruit and vegetables, meat and milk. Based on a range of scenarios, such as whether people grow their own fruit and vegetables or obtain their drinking water from a roof supply at a location potentially affected by emissions, people's intakes of contaminants are estimated. These intake estimates then allow comparisons to be made with a range of health-related criteria, such as the WHO Tolerable Daily Intake or Target Tolerable Daily Intake for dioxins, to consider possible health implications arising from the emissions. The estimated intakes are also compared with typical, normal dietary intakes for the general population not exposed to any identified contaminant source, to identify whether estimated contaminant intake increments from the proposed project will make any significant contribution to those normal intakes.

All of the contaminants of possible concern are present naturally in the environment, although some at concentrations significantly above those which would be expected in a pristine environment.

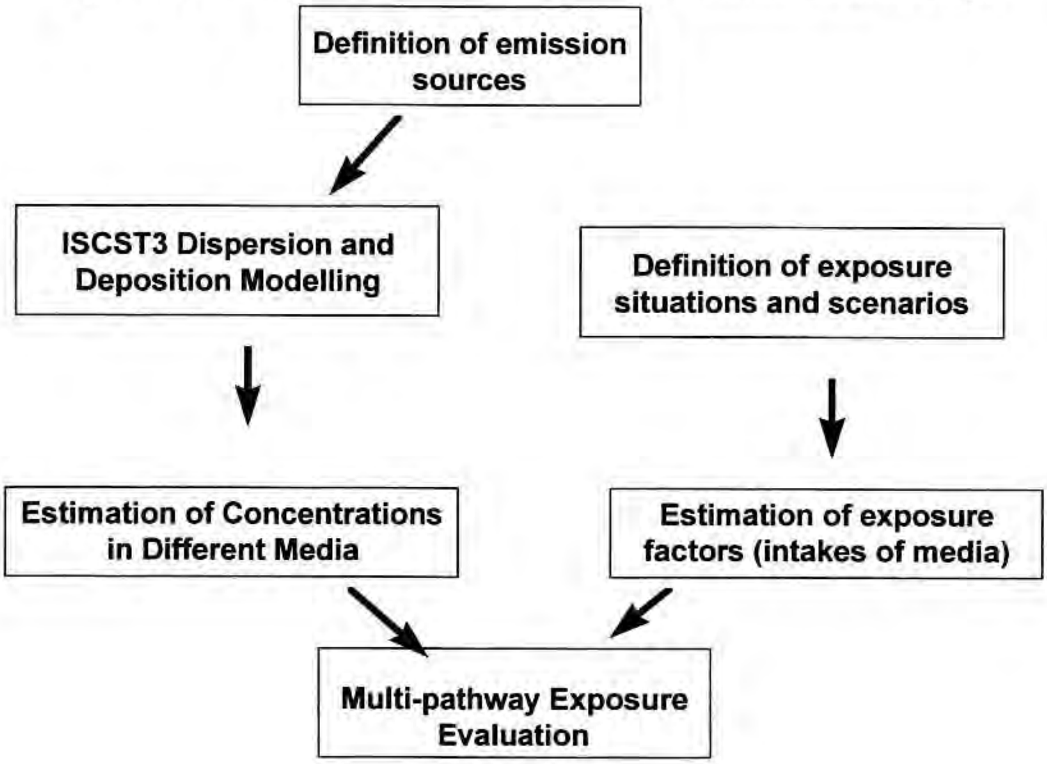
The multi-pathway assessment generally follows the 1998 United States Environmental Protection Agency (US EPA) peer review draft "Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities" (referred to as the HHRAP) (US EPA 1998). This approach was selected because the protocol is the result of several years of development, building on previous protocols which have been used extensively for multi-pathway health risk assessments.

The multi-pathway assessment involves, initially, air dispersion/deposition modelling calculations using the US EPA ISCST3 dispersion model to estimate air concentrations and wet and dry deposition rates resulting from emissions. The multi-pathway risk assessment calculations themselves use the US EPA equations set up in a spreadsheet which calculates, for any given air concentration and wet and dry deposition rate (from the dispersion/deposition modelling), the concentrations in all media of interest, including air, rain, soil, plants, milk and meat. They use a number of parameters, provided in the US EPA protocol, specific to each contaminant, which describe the behaviour and transfer of the contaminant from air, directly or indirectly, into each of the various media. However, the modelling of transfer of dioxins from air, through grass, into grazing cows and milk used an alternative German model, which has been validated by both the model developer, and by ESR and Olivine using direct measurements of concentrations of dioxins in air and the resulting concentrations of dioxins in milk. The excellent results from the latter validation are given in the fuller report (ESR, 2000C). The US EPA calculation for dioxin concentrations resulting from both wet and dry deposition is retained, in addition to the German model estimates, and consequently, the concentrations estimated here in milk and beef are higher than those obtained from the US EPA protocol alone or would be predicted from the validated model alone. Accordingly they are very conservative.

Once the concentrations in the various media have been calculated, information about people's typical intakes (exposures) for each of the media (or food types) is used to calculate the exposures or intakes for each of the contaminants. Overall intake rates are calculated by the summation of estimated intakes associated with each potential exposure pathway.

An overview of the approach taken to estimate exposures is presented in Figure 9-9.

***Figure 9-9. Overview of the multi-pathway assessment methodology***




The overall assessment integrates the commonly recognised stages of health risk assessment (hazard identification, exposure assessment, dose-response assessment and risk characterisation), into the multi-pathway calculations. This is discussed more fully in the comprehensive report (ESR, 2000C). The risk characterisation stage for this health risk assessment involves a range of considerations, as follows:

1. Comparison of exposures resulting from project emissions with those encountered by the general population not exposed to the emissions. Comparisons presented here are with typical dietary intakes of the contaminants.
2. Comparison of increases in dietary intakes of contaminants estimated to result from the emissions with acceptable daily intakes established by authorities such as the World Health Organisation, below which continuing lifetime intakes are not considered to result in any adverse health effects.
3. For carcinogens, calculation of the additional cancer risks resulting from the exposures. These can then be compared with levels of additional cancer risk considered acceptable by various authorities.
4. For non-cancer health effects, calculation of hazard quotients, which are a measure of how close exposures are to levels of exposure considered safe for lifetime exposure.

5. Comparison of the concentration increments of contaminants in particular media, such as water or milk, with health-based standards for those media, such as drinking water standards or European standards for levels of dioxins acceptable in milk to be marketed.

These risk characterisation considerations are more extensive than the US EPA considerations, which are restricted to items 3 and 4 above.

### *9.8.3 Timescales of exposure and health effects.*

For all of the contaminants considered here, the exposures of significance are those occurring over very long periods, typically represented by annual averages. This arises from:

- Most of the exposure occurring via soil, food or water, which accumulate contaminants over long periods, so that the intake of contaminants via these routes is averaged, typically over months or years.
- The levels of exposure being far below those resulting in any short-term effects, so that only long-term exposures are relevant. This is reflected in the types of standards applicable to the various exposures, which are expressed in long term averages.

Adverse effects from short-term exposures are possible for high levels of gaseous contaminants, such as sulphur dioxide, nitrogen dioxide, other acid gases, carbon monoxide and particulate material ($PM_{10}$). Exposures at levels high enough to cause adverse effects over any timescale are extremely unlikely to arise from emissions from the WTE&W plant, in conjunction with the other Kwinana area emissions, as discussed in the dispersion modelling section.

### *9.8.4 Exposure routes and scenarios*

Two exposure scenarios have been considered for people resident at the exposure sites selected.

1. A *general population exposure scenario* indicates the maximum exposures to which most people living at those locations, and buying most of their food from the usual commercial outlets, would be subject. People would only have higher exposures than these if there are particular features of their living arrangements (such as drinking water from the roof) or sources of food (such as obtaining their chicken and eggs from free range poultry from a location significantly exposed to project emissions).
2. The *extreme exposure scenario* indicates the maximum possible exposure which people could achieve for a typical food consumption pattern, if they took all possible measures to maximise their exposure at the exposure location, including producing all of their foods, of all types, at the location. This exposure scenario would require an extraordinary lifestyle and dedication to maximising exposure, and accordingly is quite unrealistic. It is included here because if the extreme maximum possible exposure does not present any significant increase in health risks (as is the case for the GOWA WTE&W project), there is clearly no possible effect on health for more realistic scenarios, even if they include significant components of the extreme exposure scenario. This scenario sets the upper limit of exposure beyond which any increase is entirely unrealistic.

### 9.8.5 *Exposure factors*

Exposure of factors include rates of breathing, and ingestion of soil, food and drinking water used as the basis for the exposure estimates. Generally, the exposure factors recommended by the US EPA protocol were used, but the food intakes have been cross-checked against New Zealand intakes of particular food types, which indicates that the American figures are reasonably representative of typical Western diets.

The health risk assessment has focused primarily on assessment of adult exposures, except for exposures via soil ingestion, for which ANZECC (1992) rates for ingestion by children were used, as well as those for adults.

Exposures on a body weight basis for children are likely to be higher than those for adults. However, increased exposures and intakes compared with those occurring in the absence of inputs from WTE&W plant (or other emissions) can only occur via increased concentrations of contaminants in some or all of the exposure media (air, soil, the various food types and water). The multi-pathway exposure analysis shows that WTE&W plant emissions will result in only negligible changes in the concentrations in each of these media, for all the contaminants assessed. Because no appreciable concentration increases occur in any of the exposure media, it follows that there can be no appreciable increase in exposures for either adults or children. Children will have higher exposures and intakes for contaminants at existing concentrations in the exposure media, but if, as is the case, WTE&W plant emissions cause only negligible increases in concentrations in the media, it follows inevitably that the increases in exposures for children are also negligible.

### 9.8.6 *Selection of contaminants for assessment*

The exposure and health risk assessment focuses mostly on dioxins and wide range of heavy metals, although PCBs and PAHs are assessed and shown to be very small contributors to exposures or risks. Sulphur dioxide, nitrogen dioxide, carbon monoxide, particulate material ($PM_{10}$), hydrogen chloride and fluorides are considered in the dispersion modelling section. Because of the excellent combustion conditions in Olivine Ultra-High Temperature Combustors, volatile organic compound emissions, such as benzene, chlorobenzene and chlorophenols are negligible. This is confirmed by both emissions testing and dispersion modelling, as described in the full report (ESR 2000C).

### 9.8.7 *Estimates of emission rates used for assessment*

Estimates of the levels of emissions to air for a wide range of contaminants from the WTE&W plant are described in the emissions estimates section. For the health risk assessment, two levels of emissions are considered for each contaminant: an extreme maximum emissions estimate, and a probable average emissions estimate.

The ***extreme maximum*** emissions estimates are set at either the proposed emission limit for the WTE&W plant (dioxins, mercury, lead, cadmium) or corresponding to the maximum reliable emission concentration found for information gathered for a number of MSW combustors (arsenic, beryllium, chromium, copper, nickel, and selenium).

It is not realistically possible to maintain the emissions concentrations continuously at emissions limits, as the extreme emissions estimates imply, because this would inevitably result in exceedances of the legal limits applying to the plant. These extreme estimates are included in the risk assessment to indicate that, even in the case of impossibly high emissions, the risks presented by the project emissions are negligible.

The ***probable average*** emission rates are set to correspond to about the average of the emissions concentrations found for the MSW combustors referred to above, with allowance in some cases for additional air pollution control technology which will be installed at Kwinana, but was not installed at the combustors for which emissions data was available.

These probable average emissions estimates are the most reliable indication of the likely long-term levels of emissions from the project. Olivine is committed to achieving the lowest practical emissions from the WTE&W plant, both as a matter of ensuring no effects on the surrounding community and ecosystems, and for commercial reasons.

### *9.8.8 Selection of sites for multi-pathway exposure calculations*

Three approaches to selection of exposure sites are used in this assessment:

- locations of potentially exposed people as indicated by residences and townships or cities
- locations of maximum exposure, on the basis that at some time in the future people may wish to use sites currently unoccupied or not used for particular purposes, such as producing farming.
- locations where potentially important food production occurs.

Generally, sites within the Kwinana Environmental Protection Policy Area A are not included because of its special status with regard to air pollution. However, there is one residence at Kwinana Beach within Area A, and an exposure site at this location has been assessed.

Figure 9-10 and Figure 9-11 show sites selected for assessment of exposures.

Figure 9-10 shows a contour plot for wet deposition within 10km of the Perth WTE&W Project site. The plot shows how wet deposition rates decrease rapidly with increasing distance from the plant. The deposition rates have no particular relevance (further calculations are necessary to convert these into intakes of particular contaminants) and are shown simply to indicate the relative changes of wet deposition with distance from the Project.

***Figure 9-10. Wet deposition rates and exposure assessment sites within 10km.***

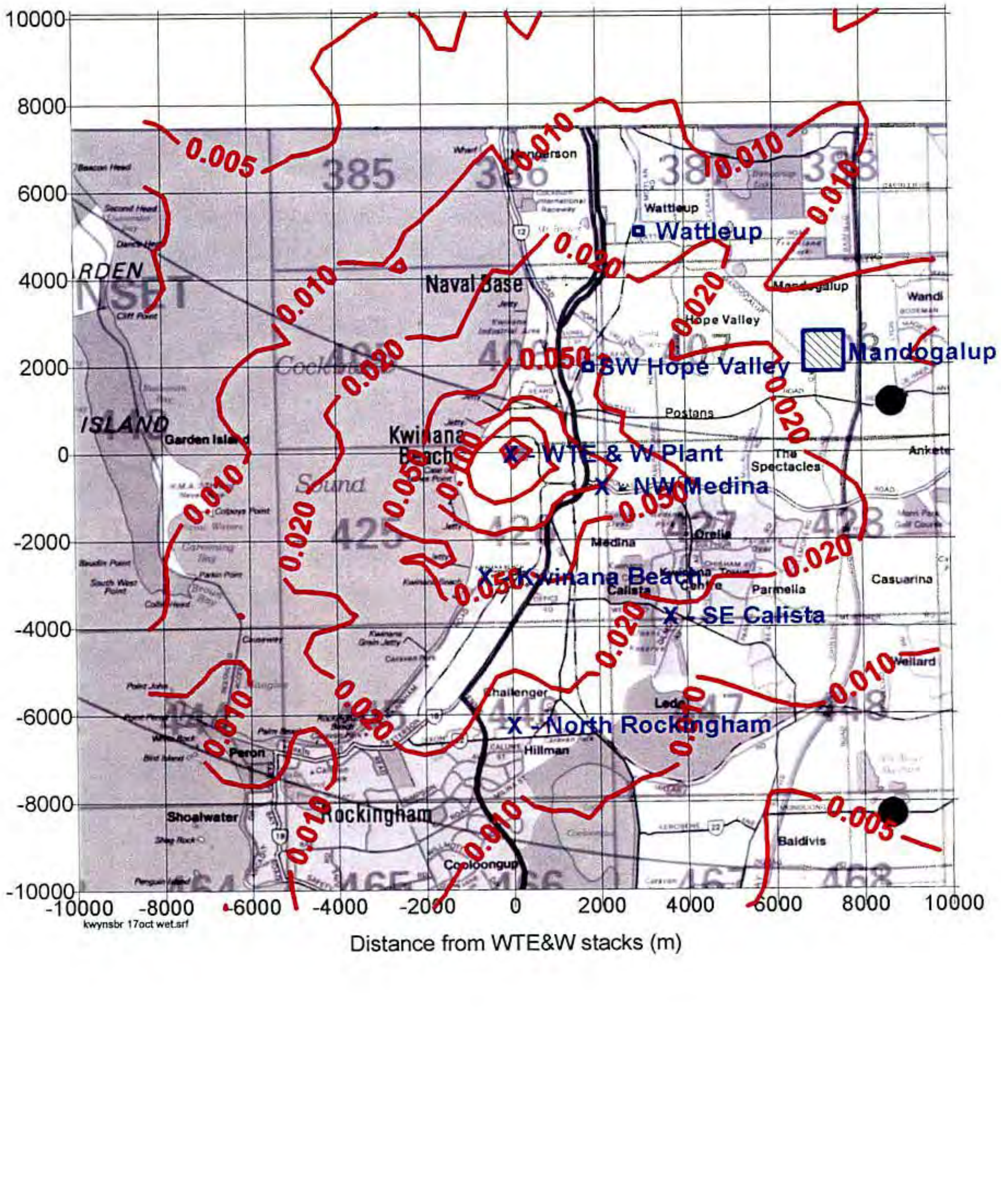
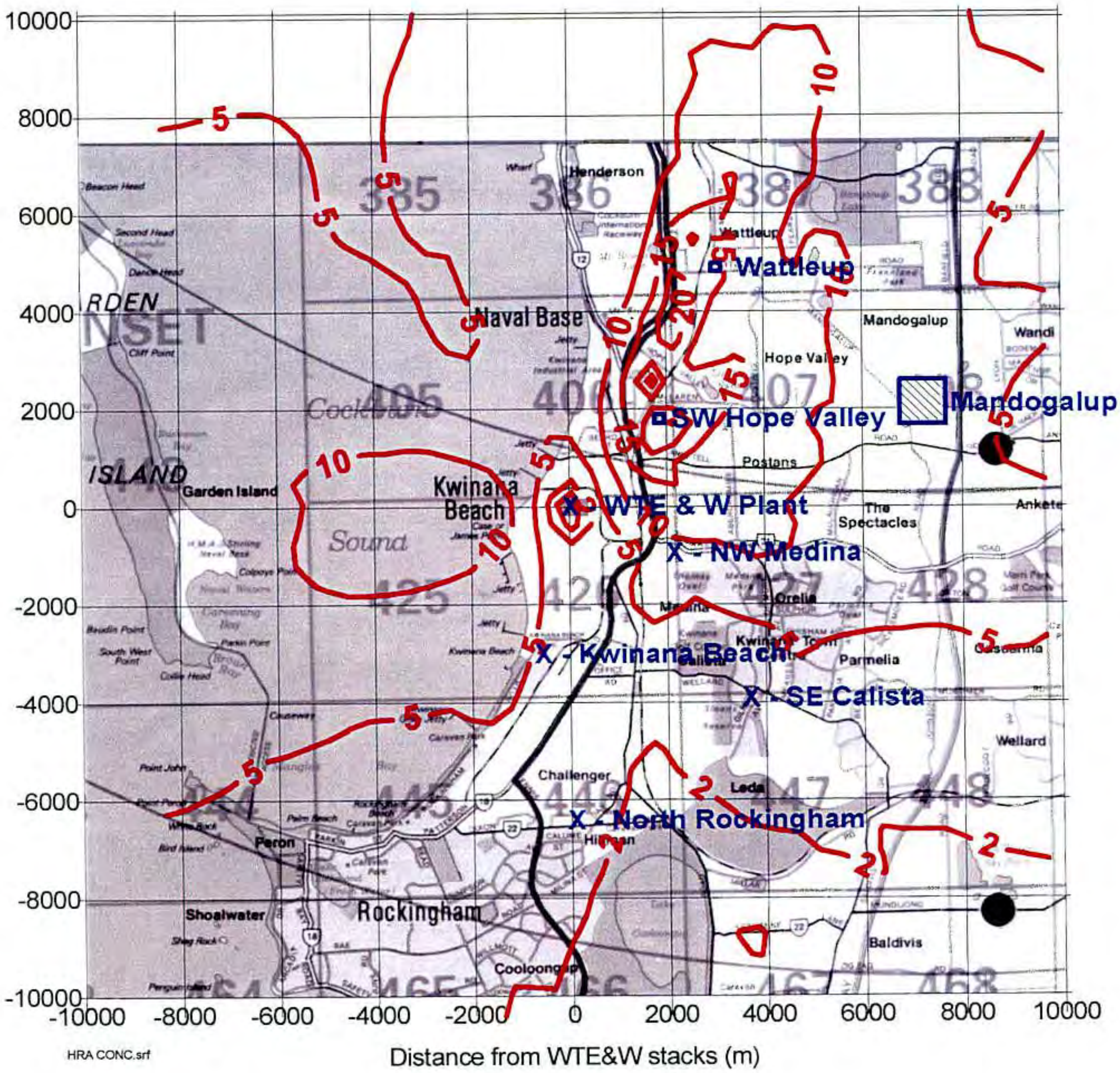


Figure 9-11 shows the pattern of annual average concentrations for contaminants in air within 10 km of the WTE&W Project, together with the selected exposure assessment sites, also shown in Figure 9-11. Because of the prevailing south-westerly winds, the highest annual average concentrations occur in a generally north-easterly direction from the plant, and the exposure assessment sites "SW Hope Valley" and "Wattleup" were selected partly to take account of this. The areas south of Kwinana are subject to markedly lower annual average concentrations of contaminant than elsewhere.

The annual average concentrations in Figure 9-11 are relative values only and further calculations are necessary to convert these into concentrations and intakes of particular contaminants. They are shown simply to indicate the pattern of concentrations with distance and direction from the Project, as used for selection of sites for health risk assessment calculations.

*Figure 9-11. Annual average concentrations and exposure assessment sites within 10km*



Dioxins are the contaminants most likely to give exposure levels of possible concern, and the dominant pathway for exposure to these compounds is via consumption of dairy foods and meat. Accordingly, the location of any dairy farms, or cattle or sheep farms potentially affected by emissions requires assessment. The only farm in the area potentially affected to any significant degree by emissions from the WTE&W plant is a dairy farm located at Mandogalup, represented by the site of that name.

Clearly, the extreme exposure scenario is unrealistic at some of these sites, because of their location in residential areas. However, as is evident from inspection of Figure 9-10 and Figure 9-11 these sites give a good indication of the maximum exposures likely to occur anywhere within the vicinity of the project where people might choose to pursue the lifestyle required for the extreme exposure scenario. The levels of exposure are determined by the rates of wet deposition shown in Figure 9-10, the annual average concentrations shown on Figure 9-11 and the rates of dry deposition, which are proportional to annual average concentrations. If none of the sites selected shows increases in levels of exposure sufficient to be of concern for the extreme exposure scenario, there is no basis for concern about increases in exposure anywhere.

### 9.8.9 Summary of findings from the health risk assessment

Only a summary of the results from the multi-pathway health risk assessment is presented here. Assessment of overall exposures via all pathways is presented for both general population exposure scenarios, and for extreme exposure scenarios representing the maximum exposures beyond which increases are entirely unrealistic. Information on the very low levels of contamination of drinking water collected from roofs is also presented, since even this low level of contamination is the major exposure pathway for many of the contaminants.

Information about the very low levels of exposures via other individual pathways, such as inhalation, soil ingestion, and free-range chicken and eggs, is presented in the full report (ESR, 2000C).

In overview, emissions from the WTE&W plant will cause negligible changes from existing levels of exposure or dietary intakes, for any of the contaminants considered, for any realistic exposure scenario. Because primarily the levels of exposure or intake determine health effects, this means that there will be negligible changes in health risks from those already experienced by people in the Kwinana area now.

### 9.8.10 General population exposures and health risks

All of the contaminants in emissions from the WTE&W plant which require multi-pathway health risk assessment occur in air, soils, water, vegetation, animals and foods, both naturally, and as a result of common emission sources, such as coal and wood combustion, and motor vehicle emissions. This results in existing exposures through all of the exposure routes through which people may be exposed to the same contaminants from the WTE&W plant emissions. For all of the contaminants, the multi-pathway exposure assessment indicates that these existing exposures are far greater than the maximum increases in exposure which can be predicted to result from emissions from the WTE&W plant, for any reasonably likely exposure scenario. Even for extremely unlikely maximum exposure scenarios, the maximum predicted exposures are, at most, a modest proportion of those already experienced by the general population.

For essentially all people in modern communities with reasonable levels of pollution control, and occupational health standards to control exposure in the workplace, the overwhelmingly predominant exposure to the contaminants considered here is via the food they eat and, sometimes, the water they drink. This means that information about typical dietary intakes gives a good measure of the likely total exposures. It also means that, unless foods consumed are grown predominantly in the area possibly contaminated by, for example, industrial or other emissions, the potential for exposure to contaminants in those emissions is limited. For the great majority of people, and particularly those living close to industrial areas, most of their food is purchased from commercial outlets that obtain their food from very widely distributed production, essentially all of which will be unaffected by local emissions. Therefore, even if there were quite high levels of pollution in a particular locality, this would not translate into significant increases in intakes for most people.

Multi-pathway health risk estimates are directly affected by several factors including:

- the location of the exposure site selected
- the proportion of time spend at sites affected by emissions
- the proportions of which types of food consumed are produced at the site
- the estimate of emissions used

Since the effect each of these factors can be to vary the exposures and risk by factors between about 2 and 10, overall risks estimated can easily vary by factors of about 100. Accordingly it is essential to put the risk estimates in the context of the likelihood of their occurrence. For example, the combination of the maximum exposure site with the maximum consumption of foods from the site, for the maximum emissions estimate is very unlikely to occur.

Figure 9-12 to Figure 9-15 present the contributions from WTE&W plant emissions to total exposures for dioxins, lead and cadmium for a general population exposure scenario that includes:

- exposure to air and soil ingestion at the location 100% of the time
- 100% of fruit and vegetables consumed grown at the location
- consumption of dairy foods and meat, to the maximum extent that production from farms potentially affected by project emissions are estimated to increase contaminant levels in these foods sold through normal commercial outlets
- drinking water from either a reticulated supply or groundwater (neither of which would be affected by emissions).

Dioxins, lead and cadmium contributions were selected for presentation as charts because these are the contaminants for which WTE&W plant emissions make the largest contributions relative to typical dietary intakes and acceptable daily intakes. More detailed information, including other contaminants and contributions for probable average emissions is included in Table 9-10.

This exposure scenario over-estimates exposures for most people because very few people will spend 100% of their time at home or produce all of their own fruit and vegetables at their place of residence. People would only have higher exposures than these if there are particular features of their living arrangements (such as drinking water from the roof) or sources of food (such as obtaining their chicken and eggs from free range poultry from a location significantly exposed to project emissions). If all fruit and vegetables are purchased from normal commercial outlets, the increases in exposures would be about half those shown. Estimated increases in exposures as a result of emissions from the WTE&W plant are given for the three locations giving the largest exposure increases for people living in any existing residences anywhere in the Kwinana area (or beyond).

Figure 9-12 to Figure 9-15 show the contributions for the "Extreme maximum emissions", which are unrealistically high, but are included to indicate that, even in the case of impossibly high emissions, the risks presented by the project emissions are negligible. It is not realistically possible to maintain the emissions concentrations continuously at maximum emissions limits, as the extreme emissions estimates imply, because this would inevitably result in exceedances of the legal limits applying to the plant. In reality, the WTE&W plant is likely to operate at under half of its emissions limits and accordingly, the maximum emissions exposure estimates are very conservative, and will not occur. The figures for "Probable average emissions" indicate the most likely total increases in exposures for these maximum residential sites.

In addition to the estimated dioxin contributions from extreme maximum emissions from the WTE&W plant, Figure 9-12 also shows the World Health Organisation Tolerable Daily Intake (WHO TDI) and Target Tolerable Daily Intake (WHO Target TDI), both determined in 1998. The typical dietary intake for Europe and USA estimated from studies published since 1994 (see ESR, 2000D), and for New Zealand (Ministry for the Environment, 1998) are also shown. In spite of using extreme maximum emissions estimates, the contributions to exposure from the WTE&W plant are too small to be distinguished from the baseline of the chart. This is also the situation if the WHO TDI is omitted from the chart, and the scale is re-set to a maximum of 1, the WHO Target TDI. If the chart is magnified still further, shown in Figure 9-13, setting the scale maximum to the typical New Zealand dietary intake estimate, the contributions from the WTE&W plant emissions show as a thickening of the baseline. Obviously, the contributions from the project are extremely small.

***Figure 9-12. Contributions to dioxin exposures for general population***

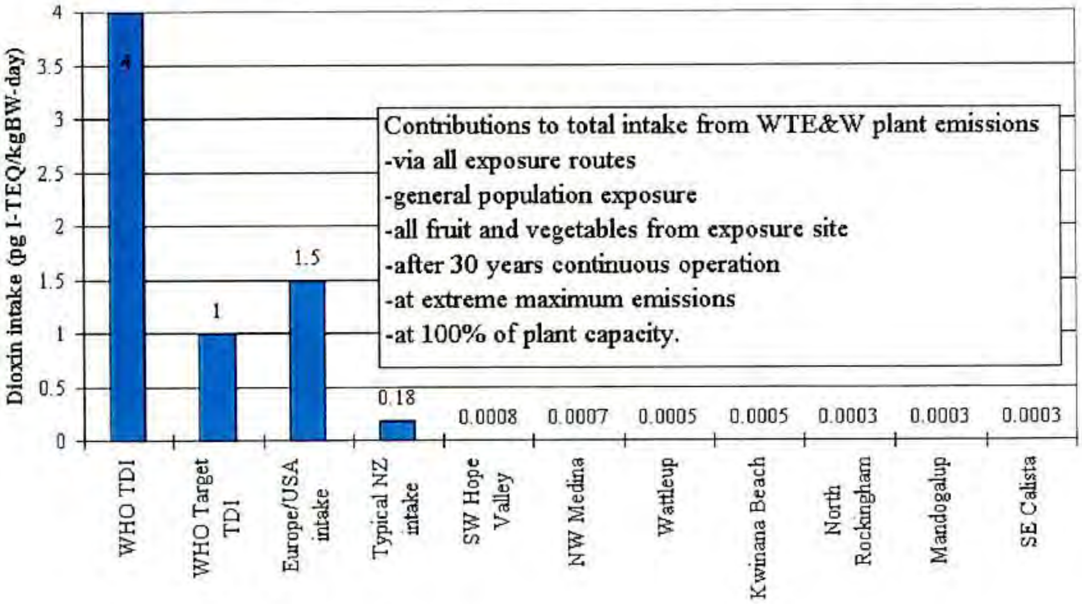



***Figure 9-13. Contributions to dioxin exposures for general population – expanded scale***

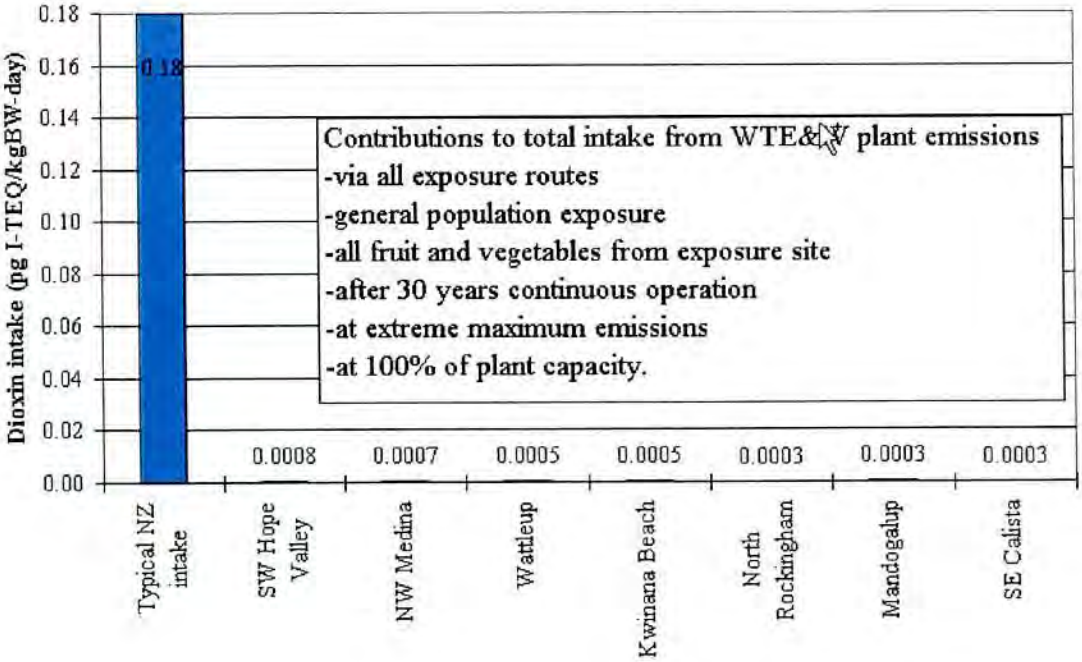


*Figure 9-14. Contributions to lead exposures for general population*

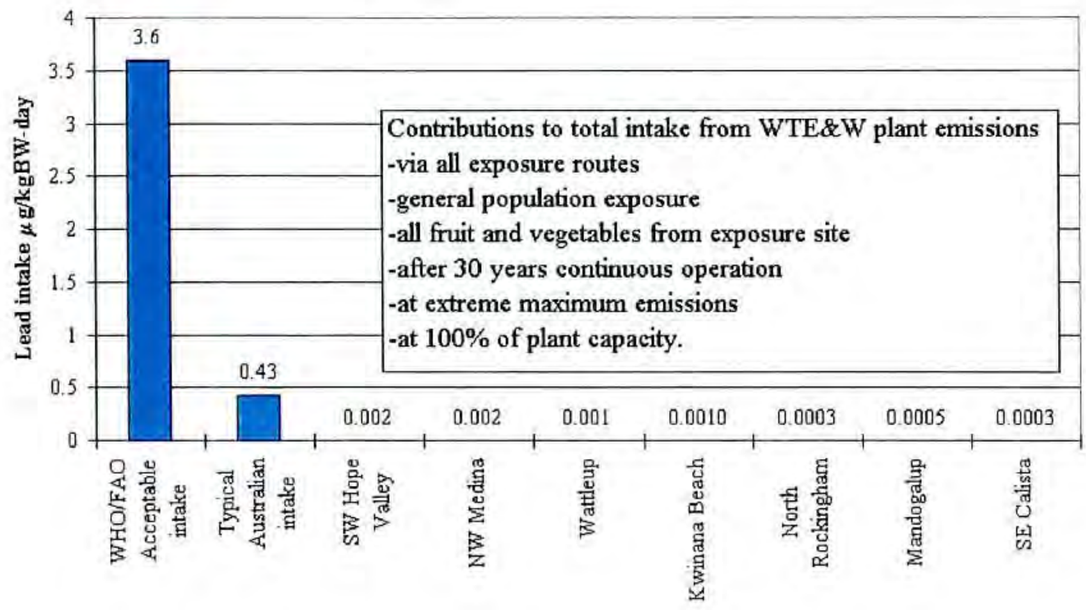



*Figure 9-15. Contributions to cadmium exposures for general population*

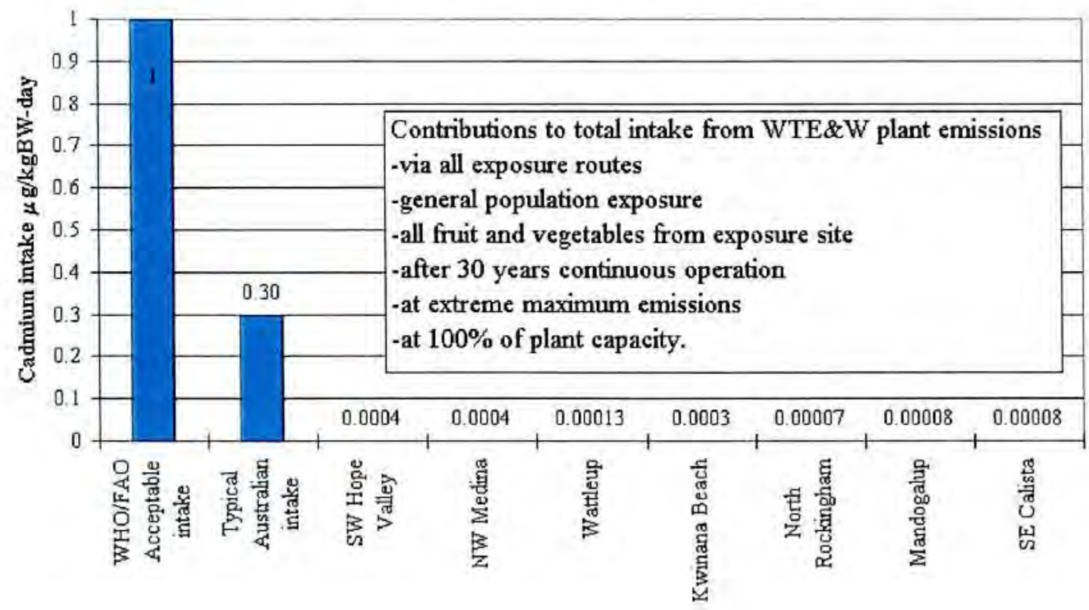


**Table 9-10. Summary of maximum increases in exposures for general population to contaminants from WTE&W emissions**

| | Arsenic | Beryllium | Cadmium | Chromium III | Chromium VI | Lead | Mercury | Nickel | Dioxins | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| **SW Hope Valley** | **Extreme maximum emissions** | | | | | | | | | |
| % of typical dietary intake | 0.3% | - | 0.12% | - | - | 0.6% | 0.16% | - | 0.5% | |
| % of acceptable daily intakes | 0.0019% | 0.00016% | 0.04% | 0.00001% | 0.0014% | 0.07% | 0.05% | 0.012% | 0.08% | |
| **Incremental cancer risk** | **3E-08** | **1E-09** | **8E-08** | **-** | **1E-07** | **-** | **-** | **1E-07** | **5E-08** | **4E-07** |
| **Hazard quotient** | **0.00014** | **0.0000016** | **0.00036** | **0.0000001** | **0.000014** | **0.0007** | **0.0008** | **0.00012** | **0.0008** | **0.003** |
| **SW Hope Valley** | **Probable average emissions** | | | | | | | | | |
| % of typical dietary intake | 0.03% | - | 0.010% | - | - | 0.05% | 0.08% | - | 0.18% | |
| % of acceptable daily intakes | 0.00018% | 0.00008% | 0.003% | 0.00000% | 0.0005% | 0.006% | 0.023% | 0.003% | 0.03% | |
| **Incremental cancer risk** | **2E-09** | **6E-10** | **6E-09** | **-** | **3E-08** | **-** | **-** | **3E-08** | **2E-08** | **9E-08** |
| **Hazard quotient** | **0.000013** | **0.0000008** | **0.000030** | **0.0000000** | **0.0000048** | **0.000060** | **0.00039** | **0.000028** | **0.0003** | **0.0008** |
| **NW Medina** | **Extreme maximum emissions** | | | | | | | | | |
| % of typical dietary intake | 0.3% | - | 0.13% | - | - | 0.4% | 0.09% | - | 0.4% | |
| % of acceptable daily intakes | 0.0018% | 0.00008% | 0.04% | 0.00001% | 0.0009% | 0.04% | 0.03% | 0.007% | 0.07% | |
| **Incremental cancer risk** | **3E-08** | **3E-10** | **2E-08** | **-** | **3E-08** | **-** | **-** | **4E-08** | **4E-08** | **2E-07** |
| **Hazard quotient** | **0.00013** | **0.0000008** | **0.00040** | **0.0000001** | **0.000009** | **0.00044** | **0.00043** | **0.00007** | **0.0007** | **0.0022** |
| **NW Medina** | **Probable average emissions** | | | | | | | | | |
| % of typical dietary intake | 0.025% | - | 0.011% | - | - | 0.03% | 0.04% | - | 0.15% | |
| % of acceptable daily intakes | 0.00017% | 0.00004% | 0.003% | 0.00000% | 0.0003% | 0.004% | 0.013% | 0.0015% | 0.03% | |
| **Incremental cancer risk** | **2E-09** | **2E-10** | **2E-09** | **-** | **1E-08** | **-** | **-** | **8E-09** | **2E-08** | **4E-08** |
| **Hazard quotient** | **0.000012** | **0.0000004** | **0.000033** | **0.0000000** | **0.000003** | **0.000039** | **0.00021** | **0.000015** | **0.00026** | **0.0006** |
| **Wattleup** | **Extreme maximum emissions** | | | | | | | | | |
| % of typical dietary intake | 0.12% | - | 0.042% | - | - | 0.3% | 0.10% | - | 0.3% | |
| % of acceptable daily intakes | 0.0008% | 0.00009% | 0.013% | 0.00001% | 0.0008% | 0.034% | 0.029% | 0.007% | 0.05% | |
| **Incremental cancer risk** | **1E-08** | **8E-10** | **5E-08** | **-** | **7E-08** | **-** | **-** | **8E-08** | **3E-08** | **3E-07** |
| **Hazard quotient** | **0.00006** | **0.0000009** | **0.00013** | **0.0000001** | **0.000008** | **0.00034** | **0.0005** | **0.00007** | **0.0005** | **0.0016** |
| **Wattleup** | **Probable average emissions** | | | | | | | | | |
| % of typical dietary intake | 0.012% | - | 0.0035% | - | - | 0.026% | 0.05% | - | 0.10% | |
| % of acceptable daily intakes | 0.00008% | 0.00004% | 0.0011% | 0.00000% | 0.00026% | 0.0031% | 0.014% | 0.0015% | 0.019% | |
| **Incremental cancer risk** | **1E-09** | **4E-10** | **5E-09** | **-** | **2E-08** | **-** | **-** | **2E-08** | **1E-08** | **6E-08** |
| **Hazard quotient** | **0.000005** | **0.0000004** | **0.000011** | **0.0000000** | **0.0000026** | **0.000031** | **0.00024** | **0.000015** | **0.00019** | **0.0005** |

Energy, Water & Materials from Waste & Biomass Resources

### 9.8.11 *Comparison with typical dietary intakes*

For the extreme maximum emissions estimates, the largest percentage increases resulting from WTE&W plant emissions, compared with typical dietary intakes for people not exposed to such emissions, are for lead and dioxins. These increases are 0.5-0.6%. The largest of the more realistic increases resulting from probable average emissions is for dioxins (0.18%).

The "% of typical dietary intake" figures for dioxins are the percentage increases resulting from WTE&W plant emissions compared with the recently determined dietary intakes of dioxins for New Zealand. The New Zealand intakes are the lowest determined anywhere in the world to date, and are about 6-9 times lower than typical general population intakes for Northern Hemisphere countries. Accordingly, a maximum increase of 0.5% of the New Zealand typical dietary intake at the extreme maximum emission rate is extremely small by world standards.

Northern hemisphere intakes are much higher than New Zealand intakes essentially because of the population density in Europe and North America. Multiple urban and industrial sources spread over large areas result in concentrations of dioxins in air in rural areas much higher than those in similar areas in New Zealand. These are the areas where milk and meat, the predominant dietary sources of dioxins, are produced. Perth's relatively small size compared with Northern hemisphere cities and its isolation means that dietary intakes there are likely to be closer to the New Zealand intakes than those for the Northern hemisphere.

The estimated increases in intakes resulting from emissions from the WTE&W plant occur through the same routes and in the same foods as the intakes for the same contaminants in typical dietary intakes for people not exposed in any way to such emissions. They are so small as to be entirely negligible in terms of any possible health effects.

### 9.8.12 *Comparison with acceptable dietary intakes*

The increases in intake resulting from WTE&W plant emissions are even smaller compared with acceptable daily intakes established by the World Health Organisation and US EPA. These acceptable daily intakes are set at levels that it would be safe to consume for a lifetime without significant risks to health.

For dioxins, the WHO has established both a Tolerable Daily Intake of 4 pg I-TEQ/kgBW-day and a Target Tolerable Daily Intake of 1 pg I-TEQ/kgBW-day. The WHO advises that the 4 pg I-TEQ/kgBW-day intake level "should be considered a maximal tolerable intake on a provisional basis and that the ultimate goal is to reduce human intake levels below 1 pg TEQ/kgBW-day". The "target" component of the Target Tolerable Daily Intake is readily evident from the estimates of typical European and North American intakes, which exceed the target, and for some segments of the population also exceed the Tolerable Daily Intake.

Dioxins, lead, cadmium and mercury show the largest increases, but even for the extreme maximum emissions, these are only 0.04-0.08% of the acceptable dietary intakes. If, as a result of the emissions from the project, the total contaminant intakes from both the typical dietary intakes and the increments from the emissions were to approach the levels of the acceptable dietary intakes, the emissions would have to be continuously between about 1000 (dioxins) and 50,000 times (arsenic) higher than the extreme maximum emissions. There is no realistic possibility of the emissions resulting in increases in dietary intakes to levels approaching the acceptable daily intakes.

### *9.8.13 Cancer risk estimates*

American and Dutch regulatory and health agencies regard a lifetime additional cancer risk of one in a million people exposed (1E-06 in the notation in Table 9-10) as a negligible level of risk for exposure to an individual contaminant. A level of risk 10 times this (1E-05) is quite often used to determine acceptable levels of carcinogenic contaminants, as, for example, has been done in New Zealand for determination of acceptable concentrations of most carcinogens in drinking water. The US EPA, in their guidance on health risk assessment for combustion facilities (1998) has determined that the total individual risk associated with exposures to potential carcinogens released from a single facility should not exceed 10 in a million (1 in 100,000 or 1.0 x 10-5 or 1E-05).

These are extremely small levels of risk. The "one in a million" level is one additional cancer death occurring among one million people, all of whom are exposed continuously over their lifetime, to the contaminant(s) at the specified level(s). That is, one additional death in 70 years resulting from the exposures of one million people. As a comparison, about 20% of the general population in Australia die from cancer, and if this health risk is expressed in the same way, the lifetime risk of cancer death from all causes is about 200,000 per million. Obviously the vast majority of these cancer deaths is not attributable to exposures to environmental contaminants.

To put the extremely small maximum estimates of increases in cancer risks arising from WTE&W plant emissions in context, it is useful to consider the cancer risks estimated to arise from exposure to typical urban and suburban air in exposure situations which almost everyone experiences every day. Table 9-11 sets out the additional cancer risk estimates for all sites assessed in the Kwinana area, together with the lifetime cancer risk estimates for general population exposures to typical concentrations of ten common pollutants usually present in ambient air, in motor vehicles and indoors in typical urban and suburban environments (Stevenson and Mills, 1999). These levels of cancer risk for the "top 10" are what essentially everyone is exposed to all of the time, unless they live in a remote area.

***Table 9-11. Additional cancer risks from WTE&W plant emissions and typical exposures to carcinogenic air pollutants***

<table>
<tr><td colspan="3">Additional lifetime cancer risks per million experienced by essentially everyone from typical urban and suburban exposures to common air pollutants</td></tr>
<tr><td>Diesel exhaust particulates</td><td colspan="2">509</td></tr>
<tr><td>Formaldehyde</td><td colspan="2">351</td></tr>
<tr><td>1,4-Dichlorobenzene</td><td colspan="2">170</td></tr>
<tr><td>Polycyclic Organic Matter (POM)<br>Benzo[a]pyrene (surrogate)</td><td colspan="2">81</td></tr>
<tr><td>Benzene</td><td colspan="2">34</td></tr>
<tr><td>Methylene chloride</td><td colspan="2">19</td></tr>
<tr><td>Carbon tetrachloride</td><td colspan="2">19</td></tr>
<tr><td>Acetaldehyde</td><td colspan="2">14</td></tr>
<tr><td>Tetrachloroethylene</td><td colspan="2">9</td></tr>
<tr><td>Asbestos</td><td colspan="2">7</td></tr>
<tr><td>"Top ten" total</td><td colspan="2">1212</td></tr>
<tr><td colspan="3">Additional lifetime cancer risks per million from WTE&W plant emissions for general population exposure scenarios at different exposure locations</td></tr>
<tr><td rowspan="2">Exposure sites</td><td colspan="2">Continuous emission rate estimates</td></tr>
<tr><td>Extreme maximum</td><td>Probable average</td></tr>
<tr><td>Kwinana Beach</td><td>0.1</td><td>0.03</td></tr>
<tr><td>SE Hope Valley</td><td>0.4</td><td>0.09</td></tr>
<tr><td>NW Medina</td><td>0.2</td><td>0.04</td></tr>
<tr><td>North Rockingham</td><td>0.04</td><td>0.01</td></tr>
<tr><td>Wattleup</td><td>0.3</td><td>0.06</td></tr>
<tr><td>Mandogalup</td><td>0.09</td><td>0.02</td></tr>
<tr><td>SE Calista</td><td>0.05</td><td>0.01</td></tr>
</table>

### *9.8.14 Hazard quotients*

Hazard quotients are a measure of non-cancer chronic health risks. They are calculated by dividing the intake of a contaminant via all exposure routes by a chronic exposure intake or "Reference Dose (RfD)" which has been determined to be safe for lifetime ingestion without any adverse health effects. For an individual contaminant, a hazard quotient of 1.0 would mean that the long-term average intake estimated through exposure modelling was at the level determined by, for example, the US EPA to be safe for lifetime exposure. For hazard quotient values below 1.0, the long term average intake clearly does not present any health risk.

The US EPA, in their guidance on health risk assessment for combustion facilities (1998) has determined that the total of hazard quotients for all contaminants should not exceed 0.25. This makes allowance both for possible exposures to the contaminants already in the diet and environment, and for the possibility of combined effects when more than one contaminant is present at concentrations close to the RfD.

The largest total of hazard quotients in Table 9-10 is 0.003 so that, on the basis of the US EPA guidance, the maximum exposure level, for the extreme maximum emissions estimate is 80 times smaller than the increase in exposure that would be considered safe. For the most probable emissions estimate, the maximum increase in exposures would be 300 times smaller than the US EPA safe level.

### *9.8.15 Drinking water from roof catchments*

Because consumption of drinking water collected from roofs is not included in the general population exposure scenario, the assessment of contaminant concentrations in rain water is presented here. The concentrations of contaminants in rainwater collected from roofs will not exceed drinking water standards anywhere, for either the extreme maximum or probable average emission rates.

Table 9-12 gives the concentrations in rain for the residential sites assessed in the Kwinana area. The highest percentage of the standard for any contaminant, at the maximum site, for the extreme maximum emission rate, is 5% for lead at the SW Hope Valley site. Even on the site of the WTE&W plant itself, where the highest concentrations in rainwater occur, the concentrations in the rain will not exceed 20% (for lead) of the drinking water standard for any contaminant, for the extreme maximum emissions, and will not exceed 2% of the standard for probable average emissions.

***Table 9-12. Contaminant concentrations in rainwater collected from roofs.***

| | Arsenic | Cadmium | Chromium | Lead | Mercury | Nickel | Dioxins pg I-TEQ/l |
|---|---|---|---|---|---|---|---|
| **Drinking water standards (µg/l)** | **10** | **3** | **50** | **10** | **2** | **20** | **30** |
| **Concentrations in rainwater for extreme maximum emissions (µg/l except dioxins (pg I-TEQ/l))** | | | | | | | |
| **Kwinana Beach** | 0.008 | 0.022 | 0.03 | 0.3 | 0.012 | 0.22 | 0.13 |
| **SE Hope Valley** | 0.010 | 0.03 | 0.05 | 0.5 | 0.014 | 0.6 | 0.17 |
| **NW Medina** | 0.012 | 0.03 | 0.04 | 0.4 | 0.018 | 0.4 | 0.20 |
| **Wattleup** | 0.003 | 0.009 | 0.025 | 0.25 | 0.004 | 0.3 | 0.05 |
| **North Rockingham** | 0.0019 | 0.005 | 0.006 | 0.06 | 0.003 | 0.05 | 0.03 |
| **SE Calista** | 0.0023 | 0.006 | 0.008 | 0.08 | 0.004 | 0.07 | 0.04 |
| **Mandogalup** | 0.0023 | 0.006 | 0.010 | 0.10 | 0.003 | 0.10 | 0.04 |
| **Concentrations in rainwater for probable average emissions (µg/l except dioxins (pg I-TEQ/l))** | | | | | | | |
| **Kwinana Beach** | 0.0007 | 0.0018 | 0.009 | 0.024 | 0.006 | 0.05 | 0.05 |
| **SE Hope Valley** | 0.0009 | 0.0023 | 0.018 | 0.05 | 0.007 | 0.13 | 0.06 |
| **NW Medina** | 0.0011 | 0.003 | 0.014 | 0.04 | 0.009 | 0.08 | 0.08 |
| **Wattleup** | 0.0003 | 0.0007 | 0.008 | 0.022 | 0.0021 | 0.07 | 0.020 |
| **North Rockingham** | 0.00018 | 0.0004 | 0.0020 | 0.005 | 0.0017 | 0.011 | 0.012 |
| **SE Calista** | 0.00021 | 0.0005 | 0.003 | 0.007 | 0.0018 | 0.016 | 0.014 |
| **Mandogalup** | 0.00021 | 0.0005 | 0.003 | 0.009 | 0.0017 | 0.022 | 0.015 |

### *9.8.16 Extreme exposure scenarios*

The extreme exposure scenario indicates the maximum possible exposure which people could achieve for a typical food consumption pattern, if they took all possible measures to maximise their exposure at the exposure location. This exposure scenario would require an extraordinary lifestyle and dedication to maximising exposure, which would have to be continued for the 30 year period on which these assessments are based, and accordingly is quite unrealistic. The scenario is included here because, if the extreme maximum possible exposure does not present any significant increase in health risks (as is the case for the GOWA WTE&W project), there is clearly no possible effect on health for more realistic scenarios, even if they include significant components of the extreme exposure scenario. This scenario sets the upper limit of exposure beyond which any increase is entirely unrealistic.

The exposure routes included in the extreme maximum exposure scenario are:

- exposure to air and soil ingestion at the location 100% of the time
- 100% of drinking water from roof supply at the location
- 100% of fruit and vegetables consumed grown at the location
- 100% of milk and meat consumed from animals grazed only at the location
- 100% of eggs and chicken consumed from free-range poultry raised at the location

Table 9-13 gives a summary of results from the multi-pathway health risk assessment for this extreme exposure scenario for the 3 residential sites giving the highest exposures. Because these sites indicate close to the maximum exposures for any sites outside Area A of the Kwinana Environmental Protection Policy, they give a good indication of the maximum exposures which could be encountered for the extreme exposure scenario for any site in the Kwinana area or beyond.

*Table 9-13. Summary of maximum increases in exposures to contaminants from WTE&W emissions for extreme exposure scenarios*

| | Arsenic | Beryllium | Cadmium | Chromium III | Chromium VI | Lead | Mercury | Nickel | Dioxins | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| **SW Hope Valley** | **Extreme maximum emissions** | | | | | | | | | |
| % of typical dietary intake | 2.2% | - | 0.3% | - | - | 4% | 0.8% | - | 28% | |
| % of acceptable daily intakes | 0.014% | 0.0012% | 0.10% | 0.00025% | 0.025% | 0.5% | 0.2% | 0.2% | 5% | |
| Incremental cancer risk | **2E-07** | **1E-09** | **8E-08** | **-** | **1E-07** | **-** | **-** | **1E-07** | **3E-06** | **4E-06** |
| Hazard quotient | **0.0010** | **0.000012** | **0.0010** | **0.0000025** | **0.00025** | **0.04** | **0.004** | **0.002** | **0.05** | **0.10** |
| **SW Hope Valley** | **Probable average emissions** | | | | | | | | | |
| % of typical dietary intake | 0.20% | - | 0.03% | - | - | 0.3% | 0.4% | - | 11% | |
| % of acceptable daily intakes | 0.0013% | 0.0006% | 0.008% | 0.0001% | 0.008% | 0.04% | 0.11% | 0.04% | 1.9% | |
| Incremental cancer risk | **2E-08** | **6E-10** | **6E-09** | **-** | **3E-08** | **-** | **-** | **3E-08** | **1E-06** | **1E-06** |
| Hazard quotient | **0.00009** | **0.000006** | **0.00008** | **0.000001** | **0.00008** | **0.003** | **0.0019** | **0.0004** | **0.019** | **0.025** |
| **NW Medina** | **Extreme maximum emissions** | | | | | | | | | |
| % of typical dietary intake | 2.44% | - | 0.4% | - | - | 3% | 0.9% | - | 25% | |
| % of acceptable daily intakes | 0.016% | 0.0007% | 0.12% | 0.00017% | 0.017% | 0.3% | 0.2% | 0.1% | 5% | |
| Incremental cancer risk | **2E-07** | **3E-10** | **2E-08** | **-** | **3E-08** | **-** | **-** | **4E-08** | **3E-06** | **3E-06** |
| Hazard quotient | **0.0012** | **0.000007** | **0.0012** | **0.0000017** | **0.00017** | **0.03** | **0.004** | **0.001** | **0.05** | **0.08** |
| **NW Medina** | **Probable average emissions** | | | | | | | | | |
| % of typical dietary intake | 0.225% | - | 0.03% | - | - | 0.2% | 0.4% | - | 10% | |
| % of acceptable daily intakes | 0.0015% | 0.0004% | 0.01% | 0.00006% | 0.006% | 0.03% | 0.12% | 0.02% | 1.8% | |
| Incremental cancer risk | **2E-08** | **2E-10** | **2E-09** | **-** | **1E-08** | **-** | **-** | **8E-09** | **1E-06** | **1E-06** |
| Hazard quotient | **0.00011** | **0.000004** | **0.0001** | **0.0000006** | **0.00006** | **0.002** | **0.002** | **0.0002** | **0.018** | **0.02** |
| **Wattleup** | **Extreme maximum emissions** | | | | | | | | | |
| % of typical dietary intake | 0.72% | - | 0.11% | - | - | 1.8% | 0.3% | - | 12% | |
| % of acceptable daily intakes | 0.005% | 0.0006% | 0.03% | 0.00012% | 0.012% | 0.2% | 0.09% | 0.09% | 2% | |
| Incremental cancer risk | **7E-08** | **8E-10** | **5E-08** | **-** | **7E-08** | **-** | **-** | **8E-08** | **1E-06** | **2E-06** |
| Hazard quotient | **0.0003** | **0.000006** | **0.0003** | **0.0000012** | **0.00012** | **0.018** | **0.0014** | **0.0009** | **0.02** | **0.04** |
| **Wattleup** | **Probable average emissions** | | | | | | | | | |
| % of typical dietary intake | 0.066% | - | 0.009% | - | - | 0.16% | 0.15% | - | 5% | |
| % of acceptable daily intakes | 0.0004% | 0.0003% | 0.003% | 0.00004% | 0.004% | 0.019% | 0.04% | 0.02% | 0.8% | |
| Incremental cancer risk | **6E-09** | **4E-10** | **5E-09** | **-** | **2E-08** | **-** | **-** | **2E-08** | **5E-07** | **6E-07** |
| Hazard quotient | **0.00003** | **0.000003** | **0.00003** | **0.0000004** | **0.00004** | **0.0016** | **0.0007** | **0.0002** | **0.008** | **0.011** |

### 9.8.17 *Comparison with typical dietary intakes*

Because of the importance of intakes from dairy foods and meat in overall dioxin intakes, the largest increase in exposures compared with typical dietary intakes for the extreme exposure scenario occur for dioxins. This exposure route was included in the general population exposure scenario (Section 9.8.10) only to the extent that meat and dairy foods from the farm at Mandogalup contributed to the general meat and dairy food supply for the Kwinana area.

After 30 years of continuous operation of the plant at the extreme maximum emission rates, the resulting increase in dioxin intake would be 28% of the current New Zealand dietary intake of dioxins. The increased intake is distributed roughly equally between dairy foods, meat, and chicken and eggs. This increase is well inside the variability in dioxin intake for people whose food sources are not subject to identifiable local dioxin emissions, simply as a result of dietary choice and existing variations in the dioxin content of foods from different localities. These variations can be expected to exceed 100% of the typical intake, just on the basis of variability of the quantities of dairy foods and meat different people eat. For the probable average emissions, the increase in dioxin intake would be 11% of the typical New Zealand dietary intake.

Given the variability in existing dietary intakes between people, the increases resulting from either the extreme maximum or probable average emissions are not significant, particularly when it is considered how unlikely it is for anyone to meet all of the requirements to achieve the exposures of the extreme exposure scenario.

Comparison with typical dietary intakes in North America and Europe also indicates that the increases in intake, even for the extreme exposure scenario, are not significant. For the extreme maximum emissions, the increase at the SW Hope Valley site, resulting from the WTE&W plant emissions, is about 5% of typical North American and European dietary intakes. That for probable average emissions is about 2%.

The increases for any of the other contaminants are substantially smaller than for dioxin, with the maximum increase being 4% of the typical dietary intake for lead, for the maximum emissions estimates, and 0.5% for the probable average emissions. These are clearly not significant changes from existing typical dietary intakes.

### 9.8.18 *Comparison with acceptable dietary intakes*

For the extreme maximum emissions, the increase in dioxin intakes for the SW Hope Valley site is 5% of the WHO Target Tolerable Daily Intake, and for the probable average emissions, it is 2%.

Unless a person's existing dioxin intake were already very close to the WHO Target Tolerable Daily Intake, there is no prospect of the emissions from the WTE increasing intakes above this target level. In such a case, the uncertainties in estimating dioxin intakes would make it impossible to know whether the existing intake was above or below the WHO target.

Also, although the WHO Target Tolerable Daily Intake has been chosen for comparisons here, this is only a target level, below which it is desirable to reduce dioxin intakes. The WHO Tolerable Daily Intake, as opposed to the Target Tolerable Daily Intake is 4 pg I-TEQ/kg BW-day. The increase in dioxin intake for the extreme exposure scenario and extreme emissions is only 1.2% of this Tolerable Daily Intake, so that even the extreme maximum contributions to dioxin exposures resulting from WTE emissions do not present any realistic increases in health risks.

### *9.8.19 Cancer risk estimates*

For the extreme maximum emissions, the additional lifetime cancer risks are in the range 2-4 per million, less than half the target of 10 per million set by the US EPA for combustor facilities. This US EPA target does not require assessment in terms of the extreme exposure scenario considered here, but in terms of realistic exposure scenarios for the particular facility, so that even the most extreme estimate of project emissions easily meets the US EPA requirement. For probable average emissions, the additional lifetime cancer risks are in the range 0.6-1 per million.

### *9.8.20 Hazard quotients*

The maximum hazard quotient total from Table 9-13 is 0.1, for extreme maximum emissions. This easily complies with the US EPA target of 0.25, which would apply to realistic exposure scenarios for the particular facility, rather than the extreme exposure scenario considered here.

The hazard quotients are calculated here on a very conservative basis, compared with calculation according to the US EPA procedure, because dioxins are included, calculated as the estimated intake divided by the WHO Target Tolerable Daily Intake. This dioxin hazard quotient contributes 50% of the hazard quotient total for the extreme maximum emissions, and 75% of the total for probable average emissions. The US EPA does not provide a Reference Dose for dioxins, so that they are assessed only in terms of cancer risk in the US EPA protocol. Strictly, the hazard quotient totals for comparison with the US EPA target might reasonably be reduced by a factor of 2 or 4, for the different emissions estimates.

### *9.8.21 Comparison with German dioxin standards for milk.*

Comparison of the dioxins concentration in milk fat which would result from the emissions from the WTE&W plant at extreme maximum emissions, with German standards for dioxins in milk fat in milk for sale, also provides a useful perspective on the significance of the effect of dioxin emissions from the plant. The German milk fat dioxin standards are:

| | |
|---|---|
| Target value | 0.9 pg I-TEQ/g |
| Investigate and reduce guideline | 3.0 pg I-TEQ/g |
| Market prohibition limit | 5.0 pg I-TEQ/g |

The estimated increase in dioxin concentration in milk fat produced from the SW Hope Valley site, as a result of the extreme maximum estimated emissions from the WTE&W plant is 0.06 pg I-TEQ/g, 7% of the German target value, and 1.2% of the Market prohibition limit. Germany is currently working towards having 50% of its milk supply with dioxin concentrations in milk fat not exceeding the target value, so that much of their milk contains more than 100% of the target value of dioxins in its milk fat. If there were no dioxin sources other than the WTE&W plant contributing to dioxin levels at the SW Hope Valley site, milk produced here would be of exceptionally good quality in the German market.

### 9.8.22 *Consideration of cumulative Kwinana industrial emissions.*

Table 9-14 sets out the estimated annual emissions of heavy metals from the WTE&W plant, together with the annual emissions for industries in the Kwinana area, reported in the National Pollutant Inventory (NPI) database.

***Table 9-14. Annual emissions from the WTE&W plant and existing Kwinana industries***

| | WTE&W Plant Emissions | | NPI emissions |
|---|---|---|---|
| | Extreme maximum | Probable average | Kwinana |
| | kg/yr | | |
| Arsenic | 40 | 3.6 | 113 |
| Beryllium | 1 | 0.6 | 0.001 |
| Cadmium | 111 | 8 | 35 |
| Chromium Total | 111 | 36 | - |
| Chromium VI | 22 | 7 | 21 |
| Lead | 1109 | 98 | 151 |
| Mercury | 396 | 198 | 180 |
| Nickel | 792 | 179 | 610 |

As a rough guide, the contribution to exposures and intakes from these existing industrial sources will be proportional to the annual emissions, compared with the estimated emissions from the WTE&W plant. The factors by which the cumulative emissions, including those from the WTE&W plant, are higher than those for the extreme maximum WTE&W plant emissions estimates range from 1.0 (no increase) to about 4. As indicated in Section 9.8.12, the extreme maximum emissions estimates for the WTE&W plant would have to increase by factors in the range 1000 – 50,000 if total contaminant intakes from both typical dietary intakes and the increments from emissions were to approach the levels of acceptable dietary intakes. The largest increase between cumulative Kwinana industrial emissions and the extreme maximum WTE&W plant emissions estimate alone is for arsenic (a factor of 4), with the increases for all of the other heavy metals being smaller than a factor of 2.

Clearly, the overall conclusion from the multi-pathway exposure assessment, that WTE&W plant emissions will produce negligible changes in the levels of exposure and intakes for people in the area, also applies to the cumulative heavy metal emissions from both the existing industries in Kwinana and the WTE&W plant, considered together.

The NPI database does not include information about dioxin emissions to the Perth airshed. Based on information from emission inventories, there will be dioxin emissions from the Kwinana power station, the cement plant, other industries burning coal, and possibly from other industrial sources. These emissions may be of similar magnitude to those from the WTE&W plant.

The recently published dioxin emission inventory for New Zealand (Buckland *et al.*, 2000) shows that the largest sources of dioxin emissions in New Zealand are landfill fires, domestic wood burning, domestic waste burning, industrial coal burning, uncontrolled fires, and waste incineration (old medical and quarantine waste incinerators). The relative contributions from the different types of sources are likely to be similar in the Perth area, although there may be a higher reliance on coal as a fuel, which could make domestic coal burning an important contributor.

As discussed in the report "*Background information about dioxin sources and their presence in the environment and foods.*" (ESR, 2000D) transfer of dioxin from buoyant plumes of industrial emissions from tall stacks into local ecosystems is relatively inefficient compared with that from small emission sources released closer to ground level in only weakly buoyant plumes. This factor, combined with the larger dioxin emissions from common, everyday human activities than is likely from the industrial emissions in the area, means that dioxin levels and ecosystem inputs in residential areas will be determined predominantly by the level of dioxin-producing activities of people living in those areas.

This can be clearly illustrated using the estimated annual average dioxin concentration contributions from the WTE&W plant emissions with dioxin concentrations measured in ambient air in several towns and cities in New Zealand. This information is set out in Table 9-15. The towns and locations in the cities were chosen to be typical, rather than indicate the influence of industrial activity.

***Table 9-15. Dioxin concentrations in ambient air from WTE&W plant emissions and measured at New Zealand sites.***

| | Site annual averages fg I-TEQ/m$^3$ |
|---|---|
| Contributions from WTE&W plant emissions at most affected site | |
| For extreme maximum emissions estimate | 0.6 |
| For probable average emissions estimate | 0.2 |
| Contributions from WTE&W plant emissions at Mandogalup | |
| For extreme maximum emissions estimate | 0.15 |
| For probable average emissions estimate | 0.06 |
| Annual average concentrations in ambient air in New Zealand | |
| Remote sites | 1.4 - 3.4 |
| Rural site | 3.8 |
| Town & urban sites | 28 - 100 |

The measured concentrations of dioxins are 50 – 500 times higher than the contributions estimated to result from the WTE&W plant emissions. Accordingly, even if the cumulative dioxin contributions from all industrial sources in the Kwinana were several times larger than those estimated for the WTE&W plant, the contribution to dioxin concentrations in ambient air in residential and urban areas is likely to be small.

In fact, rather than increasing dioxin emissions in the Kwinana area, the WTE&W plant can almost be guaranteed to decrease them. Combustion of MSW in the Ultra High Temperature Combustors will avoid the risks of very large dioxin emissions that result from landfill fires. Also, to the extent that the WTE&W project educates people about the very high level of dioxin emissions from domestic rubbish burning, this practice is likely to decrease, with consequent significant reduction in dioxin emissions.

## 9.9 AIR EMISSION ECOLOGICAL EFFECTS

Adverse effects on ecosystems may occur through the following mechanisms:

- direct toxicity to plants or animals through gases such as sulphur dioxide, hydrogen fluoride, ozone and nitrogen dioxide.
- acidification of terrestrial and/or aquatic ecosystems.
- eutrophication of terrestrial or aquatic ecosystems.
- toxic or carcinogenic effects of hazardous air pollutants.

Potential ecosystem effects, with a few exceptions (for example, possible short-term effects from high ozone concentrations over a period of a few days) result from long-term exposures or contaminants inputs. These effects are best considered in terms of annual average concentrations of contaminants.

For all of these potential ecosystem effects, any effect attributable to the WTE&W plant will not be greater than the contribution from its emissions either to ambient air concentrations at sites under consideration, or to total emissions from the area, for the relevant contaminants. Similarly, if concentration increments resulting from the WTE emissions are a very small percentages of existing levels in relevant environmental media, no effect will result.

### *9.9.1 Sulphur dioxide and $NO_x$*

Acidification of terrestrial and/or aquatic ecosystems results predominantly from emissions of sulphur dioxide and $NO_x$.

Eutrophication of pristine, low-nutrient terrestrial systems can result from $NO_x$ emissions, but such an effect is extremely unlikely in an industrial/urban/rural environment such as the Kwinana area. $NO_x$ does not contribute to eutrophication of waters, because of slow transfer processes. For example, neither nitric oxide nor nitrogen dioxide are scavenged by rain to any significant extent, because of slow reaction kinetics (Seinfeld, 1986).

The dispersion modelling section and report indicate that emissions from the WTE&W plant, when operating continuously at its proposed emissions limits are, at most, minor percentages of existing concentrations of sulphur dioxide and $NO_x$ at the monitoring sites where they have the greatest proportional effect (Hope Valley). For example, the maximum contribution from the WTE&W plant to annual average sulphur dioxide concentrations is at the Hope Valley site, where, for continuous operation at levels consistent with the proposed emission limits, the predicted concentration increments is 6% of the existing long-term, annual average concentrations. Similarly, for $NO_x$ the maximum contribution, assuming continuous plant operation at the proposed 24-hour emission limit, is 11% of the existing long-term annual average concentration at the maximum, Hope Valley, site. The probable average emissions are not greater than 50% of the emission limits, so that the corresponding contributions at the Hope Valley site are 5% of the existing concentrations.

The UNECE and WHO (Umweltbundesamt, 1996) critical levels for toxic effects of sulphur dioxide are 20 $\mu g/m^3$ for forests and natural vegetation and 30 $\mu g/m^3$ for agricultural crops, both as annual averages. The existing annual averages for the two sites giving the highest concentrations in the Kwinana monitoring network are in the range 3 - 6 $\mu g/m^3$ for Hope Valley, and 3 - 11 $\mu g/m^3$ for Wattleup. Accordingly the existing levels are well below the UNECE/WHO critical levels, and the small increments from the WTE&W plant emissions will not affect this situation.

The UNECE and WHO (Umweltbundesamt, 1996) critical level for toxic effects of $NO_x$ on plants is 30 $\mu g/m^3$ as an annual average. The existing annual averages at Hope Valley are in the range 12 - 16 $\mu g/m^3$ and those at North Rockingham are in the range 21 - 25 $\mu g/m^3$. Although the maximum annual average concentration at North Rockingham approaches the critical level, the level only applies when concentrations of sulphur dioxide and/or ozone are also close to their respective critical levels. The annual average sulphur dioxide concentrations at the North Rockingham site are about 3 $\mu g/m^3$, and indications from the Perth Photochemical Smog Study are that ozone may infrequently approach short term levels which might result in visible damage to plants. Overall it appears unlikely that ecotoxic effects on plants would result from existing concentrations. Emissions from the WTE&W plant will have essentially no effect at this site, contributing about 1% to the existing annual average concentrations. Maximum $NO_x$ emissions from the WTE&W plant would increase the annual average concentrations at Hope Valley by about 1.5 $\mu g/m^3$, to a maximum annual average concentration of 17.5 $\mu g/m^3$, well below the critical level.

Accordingly, no ecosystem effects are likely to result from the small contributions from the WTE&W plant emissions of sulphur dioxide and $NO_x$.

### *9.9.2 Fluoride and hydrogen fluoride*

The dispersion modelling report specifically compares predicted hydrogen fluoride and fluoride concentrations resulting from the WTE&W plant emissions with guidelines for protection of sensitive plants, and demonstrates that no such effects will occur.

### *9.9.3 Ozone*

Ozone is not emitted as such, but it is formed via photochemical reactions occurring in the air after discharge. $NO_x$ is the only contaminant emitted from the WTE&W plant with the potential to affect ozone formation. The most likely effect of the WTE&W plant emissions of $NO_x$ is a decrease in ozone concentrations in the emission plume downwind from the plant. Accordingly, the emissions are more likely to be beneficial than to result in adverse effects to plants. However, oxides of nitrogen also have the potential to increase ozone concentrations if more time is available during hours of strong sunlight for photochemical reactions to occur, and/or if emissions of reactive organic compounds from other sources were to increase. Although modelling undertaken as part of the Perth Photochemical Smog Study indicates that increased $NO_x$ emissions are more likely to decrease ozone formation than to increase it, there is some uncertainty about this.

An overview of the likelihood of existing ozone concentrations in the Perth region producing adverse effects on plants may be helpful. This can best be considered in terms of the UNECE and WHO (Umweltbundesamt, 1996) critical levels for ozone, which are expressed as a cumulative exposure over a concentration threshold. This exposure index is referred to as the AOT40 (Accumulative exposure Over a Threshold of 40ppb). The AOT40 is calculated as the sum of the differences between hourly ambient ozone concentration and 40ppb when ozone concentrations exceed 40ppb.

To avoid decreases in the yield in crops or semi-natural vegetation, the WHO/UNECE recommend that the AOT40 should not exceed 3,000 ppb.h over a three month growing season. This would mean, for example, that there should not be more than 30 days on which there are 4 hours per day with ozone concentrations of 65 ppb or more, or 30 days with one hour per day in which the ozone concentration exceeds 80 ppb. However, the WHO/UNECE critical levels for ozone only apply when nutrients and soil moisture are not limiting. If water availability is restricted, for example, leaf stomata close, decreasing the access of ozone to leaf tissues where they can cause damage.

Ozone can also cause visible injuries to plants, which can occur over shorter exposure periods. The WHO/UNECE 5-day critical level is 200 ppb.h for low water vapour pressure deficit (vpd) conditions (mean daytime vpd below 1.5 kPa), and 500 ppb.h for drier conditions (mean daytime vpd above 1.5 kPa). If, as an example, there were an ozone event in which the concentration was at or above 90 ppb over a 4 hour period, the lower of the critical levels would be reached.

Consideration of information about ozone concentrations in the Perth region from the Perth Photochemical Smog Study report suggests that the frequency of occurrence of elevated ozone concentrations is unlikely to result in AOT40 values which might cause yeild reductions. It appears possible that high enough ozone concentrations might, very infrequently, occur over periods long enough to cause visible injury to sensitive plants. Detailed analysis of the original data would be required to confirm these possibilities of either yield reduction or visible damage. However, this assessment would also need to take into account likely soil and atmospheric moisture conditions in the Perth region, which are likely to decrease the sensitivity to ozone of plants not grown under irrigation, over the summer period when elevated ozone concentrations occur.

### *9.9.4 Toxic or carcinogenic effects of hazardous air pollutants.*

The term "hazardous air pollutants" refers here to toxic elements and heavy metals, and volatile and semi-volatile toxic organic compounds. Some of these contaminants are persistent and bio-accumulate in ecosystems.

Apart from organochlorine hazardous air pollutants (e.g. dioxins, PCBs and DDE) and some toxic elements (such as heavy metals), most hazardous air pollutants exist in the atmosphere as gases. They either do not deposit to soils and vegetation to any significant degree and/or usually break down in natural biological systems such as soils.

Among the organochlorine hazardous air pollutants, only dioxins are emitted from the WTE&W plant at concentrations which might possibly contribute to ecosystem effects. Other organochlorine compounds are effectively destroyed under the excellent combustion conditions in modern combustors, and are not produced in post-combustion reactions, as occurs via de-novo synthesis for dioxins.

Emissions of volatile hazardous pollutants from the WTE&W plant, such as benzene, are extremely small, and completely negligible compared with such emissions from, for example, motor vehicles.

For many of the hazardous air pollutants, carcinogenicity is the major concern from the human exposure perspective, but this is not a concern for ecosystem effects. The levels of cancer risk considered acceptable by regulatory agencies aim to restrict additional cancer incidence to extremely low proportions of the population as a result of possible lifetime exposures. The concern is essentially for the health and well-being of the individual human. On the other hand, for ecosystem protection, the concern is for the population as a whole and the levels of additional cancer risk arising from exposure to hazardous air pollutants is negligible compared with other factors affecting natural populations. As shown in the health risk assessment report, carcinogenicity risks resulting from WTE&W plant emissions, even for maximally exposed people, are extremely small, so that there is no prospect of such effects in ecosystems.

### *9.9.5 Possible effects of toxic elements and heavy metals in terrestrial ecosystems*

The multi-pathway exposure and health risk assessment undertaken for the WTE&W project demonstrated that that the increases in concentrations for all contaminants assessed, including heavy metals, are predicted to be very small percentages of likely existing concentrations in all of the various environmental media, including food. This is strong evidence that the normal, existing concentrations will not be changed to any significant extent, and accordingly there will be no effect on ecosystems in the vicinity of the WTE&W plant.

To further illustrate this point, the deposition modelling undertaken for the health risk assessment was used to estimate the periods of time over which the discharges from the WTE&W plant would have to occur for concentrations of the various contaminants either to double typical concentrations in uncontaminated soils, or to reach levels of possible environmental concern. These estimates are set out in Table 9-17.

***Table 9-16. Periods of operation required to reach specified soil concentrations of contaminants***

**Probable average emission rates**

| | Background soil level | Years to double background level in top 10 cm of soil | | Years to reach ANZECC Environmental Investigation level | | | Years to reach ANZECC Health Investigation level | | |
|---|---|---|---|---|---|---|---|---|---|
| | mg/kg | Centre of project site (250x250m) | Maximum at 2500m from stacks | level mg/kg | Centre of project site (250x250m) | Maximum at 2500m from stacks | level mg/kg | Centre of project site (250x250m) | Maximum at 2500m from stacks |
| Arsenic | 10 | 500000 | 3000000 | 20 | 1000000 | 6000000 | 100 | 5000000 | 30000000 |
| Cadmium | 0.2 | 4000 | 22000 | 3 | 60000 | 330000 | 20 | 400000 | 2200000 |
| Chromium | 10 | 30000 | 150000 | 50 | 150000 | 750000 | - | | |
| Copper | 10 | 10000 | 60000 | 60 | 60000 | 360000 | - | | |
| Lead | 20 | 10000 | 60000 | 300 | 150000 | 900000 | 300 | 150000 | 900000 |
| Mercury | 0.05 | 240 | 800 | 1 | 4800 | 16000 | - | | |
| Nickel | 10 | 4000 | 22000 | 60 | 24000 | 132000 | - | | |
| Zinc | 30 | 10000 | 120000 | 200 | 66667 | 800000 | - | | |

**Continuous operation at extreme maximum emissions**

| | Background soil level | Years to double background level in top 10 cm of soil | | Years to reach ANZECC Environmental Investigation level | | | Years to reach ANZECC Health Investigation level | | |
|---|---|---|---|---|---|---|---|---|---|
| | mg/kg | Centre of project site (250x250m) | Maximum at 2500m from stacks | level mg/kg | Centre of project site (250x250m) | Maximum at 2500m from stacks | level mg/kg | Centre of project site (250x250m) | Maximum at 2500m from stacks |
| Arsenic | 10 | 50000 | 250000 | 20 | 100000 | 500000 | 100 | 500000 | 2500000 |
| Cadmium | 0.2 | 350 | 1800 | 3 | 5250 | 27000 | 20 | 35000 | 180000 |
| Chromium | 10 | 10000 | 50000 | 50 | 50000 | 250000 | - | | |
| Copper | 10 | 2000 | 10000 | 60 | 12000 | 60000 | - | | |
| Lead | 20 | 1000 | 5000 | 300 | 15000 | 75000 | 300 | 15000 | 75000 |
| Mercury | 0.05 | 120 | 400 | 1 | 2400 | 8000 | - | | |
| Nickel | 10 | 1000 | 5000 | 60 | 6000 | 30000 | - | | |
| Zinc | 30 | 2500 | 25000 | 200 | 16667 | 166667 | - | | |

Estimates are shown both for extreme maximum WTE&W plant emissions rates, and for the probable average emission rates. It is essentially impossible for the extreme maximum emission rates to be maintained over an extended period. This would require, for example, continuous operation at the proposed emission limits (guaranteeing exceedance of these limits at least at times). The probable average emission rates are clearly the best estimates of likely emissions, in practice.

Table 9-16 shows that extremely long periods of operation would be necessary to double the concentrations of contaminants from concentrations typical of uncontaminated soils, even for the small area within 250 m of the stacks, which is where the maximum deposition rates occur. At the probable average emission rates, the shortest period required to double the concentrations typical of uncontaminated soil (if this exists at the centre of the site, which is unlikely) is for mercury, which would require 240 years of operation. Even at extreme maximum emission rates, sustained continuously, 120 years of operation would be required. Doubling the typical concentrations of uncontaminated soils would still not constitute any realistic adverse effect on the ecosystem, since these typical levels, even when doubled, would still be within the range of concentrations normally found in uncontaminated soils.

In fact, the estimates of mercury deposition are almost certainly extreme over-estimates, even for the probable average emission rates. This is discussed more fully below under "Mercury deposition considerations". If these considerations are taken into account, millennia of operation are likely to be required to double typical soil concentrations.

Table 9-16 also presents estimates of the periods of operation required to reach the ANZECC Environmental Investigation and Health Investigation levels. With the shortest of these periods exceeding two millennia, it is clear that no ecosystem effects will occur as a result of accumulation of contaminants in soils from emissions from the WTE&W plant. This is a good indication, particularly when combined with the following information indicating the absence of any effects in Cockburn Sound from deposition from the WTE&W plant emissions, that no adverse effects will occur in any part of the ecosystem.

### *9.9.6 Dioxins and terrestrial ecosystem effects*

The absence of possible effects resulting from emissions of dioxins from the WTE can best be demonstrated by consideration of the dioxin concentration increments predicted in milk fat at the site of maximum exposure outside Zone A (Hope Valley), if milk were to be produced there. Grazing agriculture is the most efficient known transfer mechanism for dioxins from air into animals and into the human food chain. This can also be expected to be the most efficient transfer process for ecosystem wildlife possibly affected by dioxins. Grasses are efficient at accumulating dioxins from air by absorption into their waxy cuticle. Each gram dry matter of grass scavenges the dioxin from approximately 9 $m^3$ of air and because of the large quantity of grass eaten by cows, the dioxin from a very large volume of air is accumulated by the cow, and either excreted in milk, or accumulated in fatty tissues.

As presented in the extreme exposure scenarios section of the health risk assessment, it is estimated that, as a result of the extreme maximum estimated emissions, for 30 years, milk fat produced at the Hope Valley site would contain about 0.06 pg I-TEQ/g, 7% of the German target value (0.9 pg I-TEQ/g), and 1.2% of the market prohibition limit (5 pg I-TEQ/g). At the probable average dioxin emissions rate, the milk fat concentration from this site would be about 0.025 pg I-TEQ/g, 3% of the German target value, and 0.5% of the market prohibition limit.

Germany is currently working towards having 50% of its milk supply having dioxin concentrations in milk fat not exceeding the target value, so that much of their milk will contain more than 100% of the target value of dioxins in its milk fat. If there were no dioxin sources other than the WTE&W plant contributing to dioxin levels at the Hope Valley site, milk produced there would be of exceptionally good quality in the German market.

Although no data are currently available, the existing annual average dioxin concentrations in air at the Hope Valley site will almost certainly be at least 10 times higher than the 0.6 fg I-TEQ/$m^3$ estimated to result from continuous WTE&W plant emissions at the extreme maximum emission rate, and are likely to be 50-100 times higher than the 0.25 fg I-TEQ/$m^3$ estimated for probable average emissions. Dioxin inputs to grass are determined predominantly by concentrations in air, rather than by wet deposition, and consequently, the present dioxin concentrations in grass at this site are likely to be at least 10 times the increments from the WTE&W plant extreme maximum emissions, and about 50 times the increments predicted for the WTE&W plant probable average emissions. Accordingly, at this highest exposure site, emissions of dioxins from the WTE&W plant would, at most, make a minor contribution to existing dioxin inputs to the ecosystem.

At sites further away, the relative contributions from the WTE&W plant compared with the existing concentrations and inputs will be progressively smaller, so that there is a very good assurance that no effects will result in the ecosystem in the vicinity of the plant or elsewhere.

Because of the excellent combustion conditions no other persistent toxic organic chemicals are emitted at concentrations high enough to have any possible effects in ecosystems.

### 9.9.7 *Possible effects of heavy metals and dioxins in Cockburn Sound.*

The possible effects of deposition of metals and dioxins from the WTE&W plant emissions into Cockburn Sound by both wet and dry deposition mechanisms has been assessed, using the deposition modelling carried out for the health risk assessment. This allowed estimation of the total quantities of the various metals and dioxins deposited annually into the Sound. The concentrations of the various contaminants which would result from their dissolution into the annual tidal exchange volume of the Sound was also estimated. Table 9-17 sets out these estimates, and compares :

- Estimates of loadings from the WTE&W plant emissions with estimates of loadings for the same metals from waste water and other discharges into the Sound (Muriale and Cary, 1998);
- Estimates of concentration increases in the annual tidal exchange volume with ANZECC guidelines for protection of aquatic ecosystems and consumption of aquatic organisms.

As discussed above, the estimates were made for both the probable average emission rates and the extreme maximum emission rates. The probable average emission rates are much the best indication of what is likely to happen in practice.

***Table 9-17. Estimated loadings and concentrations of contaminants in Cockburn Sound.***

| | | Probable average WTE&W emissions | | | | Extreme maximum WTE&W emissions | | | | ANZECC guideline |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1997 load kg/year | WTE&W load kg/year | % of 1997 load | Concentration in annual tidal exchange μg/l | % of ANZECC guideline | WTE&W load kg/year | % of 1997 load | Concentration in annual tidal exchange μg/l | % of ANZECC guideline | μg/l |
| Arsenic | 29 | 0.03 | 0.12% | 0.0000006 | 0.003% | 0.4 | 1.3% | 0.00001 | 0.03% | 0.02 |
| Cadmium | 20 | 0.08 | 0.4% | 0.0000015 | 0.001% | 1.0 | 5% | 0.00002 | 0.009% | 0.2 |
| Chromium | 108 | 0.5 | 0.4% | 0.000008 | 0.0001% | 1.4 | 1.3% | 0.00002 | 0.0002% | 10 |
| Copper | 827 | 0.6 | 0.07% | 0.000010 | 0.0005% | 3.3 | 0.4% | 0.00006 | 0.003% | 2 |
| Lead | 649 | 0.9 | 0.14% | 0.000015 | 0.015% | 10.1 | 1.6% | 0.00017 | 0.17% | 0.1 |
| Mercury | 15 | 0.2 | 1.4% | 0.000004 | 0.004% | 0.4 | 2.9% | 0.00001 | 0.007% | 0.1 |
| Zinc | 5279 | 2.3 | 0.04% | 0.000039 | 0.001% | 11.0 | 0.2% | 0.00019 | 0.004% | 5 |
| | | mg/yr | | pg/l | | mg/yr | | pg/l | | pg/l |
| Dioxins | ND | 2.8 | - | 0.00005 | 0.5% | 7.3 | - | 0.00013 | 1.3% | 0.01 |

For the probable average emission rates, none of the loadings to the Sound exceed 0.5% of the estimated 1997 loading in water discharges to the Sound, except for mercury at 1.4%. The mercury loading estimate is based on an extremely conservative assumption about the form of mercury in emissions from the WTE&W plant, and in practise, the mercury deposition rates are expected to be an order of magnitude or more lower than the estimates in Table 9-17. This is discussed further below under "Mercury deposition considerations". Among the metals, the highest percentage of the ANZECC guideline is for the lead, at 0.015%, a negligible contribution. For the extreme maximum emissions estimates, cadmium would contribute an additional loading of 5% of the estimates for 1997 from other sources, and mercury would contribute an additional 2.9%. Other metals would contribute less than 2%. The maximum percentage of the ANZECC guidelines would be for lead, at 0.17%, which is also negligible.

Table 9-17 also estimates dioxin inputs, and compares the resulting concentrations with the ANZECC guideline for protection of human consumption of aquatic foods. For the extreme maximum WTE&W plant emission rates, the concentration increment in the annual tidal exchange volume would be 1.3% of the ANZECC guideline. For the probable average emission rates, this would be 0.5%. Both of these concentration increments comply with the ANZECC guideline by large margins.

Overall, this assessment provides a very good assurance that deposition from emissions from the WTE will have no effects on Cockburn Sound.

### *9.9.8 Mercury deposition considerations*

Deposition of mercury can be considered to be completely negligible because of the degree of pollution control applied at the WTE&W plant. The following three paragraphs give the reasons for this. However, a highly conservative estimate is used in Table 9-16 and Table 9-17, to demonstrate that even under such extreme worst-case assumptions, there will be no adverse effects.

The form of the mercury in emissions is critically important for assessment of deposition rates. Elemental mercury exists almost exclusively in the vapour state, and is not deposited by either wet or dry processes. Mercuric chloride, after emission will exist partly as vapour phase and partly as particulate bound material. Mercuric chloride vapour is readily soluble in water, and is considered to be scavenged by rain with the same high efficiency as nitric acid. The particulate fraction of mercuric chloride will be subject to both wet and dry deposition through the normal particulate deposition mechanisms.

The US EPA "Mercury Study Report to Congress" (US EPA 1997) gives information about speciation of mercury emissions from coal electric utility boilers and municipal waste combustors. For municipal waste combustors, the speciation changes, depending on the level of mercury emission control, with the percentages of elemental mercury being higher as the degree of emission control increases. 100% of the mercury is considered to be elemental above an 85% reduction of mercury emissions. This results from mercury removal processes including wet/dry lime scrubbing, and particularly activated carbon injection being much more effective for mercuric chloride and particulate-bound mercury than for elemental mercury.

The GOWA combustors will employ activated carbon injection to achieve at least 85% reduction of mercury emissions, so that all of the mercury emitted can be taken to be present in the gaseous elemental state. Under these conditions, there will be no deposition, and therefore no impact (apart from possible inhalation exposures) from mercury emitted from the MSW units.

In spite of this strong evidence that no mercury deposition will occur, the estimates of deposition on which Table 9-17 are based, assume mercury speciation in the emissions to air intermediate between those typical of a coal fired power station (60% present as mercuric chloride) and the expected 100% elemental mercury. The percentage of total mercury present as mercuric chloride is taken to be 20%.

## 9.10 ODOUR

There are two principal odour sources at the proposed plant. They are the compost plant and the main MSW hall itself. The only other source of odour is the dangerous goods store that houses contaminated soils and organic residues that can have some odour potential. Although this is considered to have a low odour impact potential, the ventilation of this building to is necessary to minimise dust levels and to prevent potential explosive atmospheres from developing. A high ventilation rate for this building has been chosen and the potential for odour release is thus minimal.

All of these sources are fully enclosed and ventilate to the combustors where odorous emissions are destroyed by high temperature combustion.

High temperature combustion is a common form of odour destruction and the usual specifications (for example fume incinerators on paint baking operations) require a temperature of at least 750 °C with a residence time of 0.5 to 0.75 seconds[4].

The MSW UHTC's operate at 1100 to 1150 °C with a residence time in excess of 6 to 8 seconds which will completely destroy all odours.

The general requirements for odours are to ensure that odour emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem: and to use all reasonable and practicable measures to minimise the discharge of odours. These general requirements apply to the handling of the MSW material and green waste for composting, as well as the handling and storage of contaminated soils material.

The principal method of odour control in this proposal is full enclosure within buildings and ventilation of those buildings to ensure that odours are not discharged.

Recommended buffer distances for composting of green waste are provided in the DEP "Guidelines for the Storage, Processing and Recycling of Organic Wastes". For fully enclosed composting operations with sophisticated odour control, no buffer distances are required. Similarly with the handling of MSW, the fully enclosed nature of the operation means that buffer distances to sensitive neighbours are not required. However it is of note that the nearest sensitive neighbours (residential sites) are some 2 km distance from the proposed plant.

It is noted in the DEP guidelines that the buffer distances are not designed as a primary method of odour control, but serve as a safeguard against occasional odours that may occur as a result of unusual weather conditions or equipment and process failure. In this proposal shut down of a UHTC is anticipated as a potential failure of

[4] See for example- Air Pollution Engineering Handbook, Ed A.J. Buonicore and W.T Davis. Air and Waste Management Association 1992. ISBN 0-442-00843-0 Ch 2 Fig 1.

the odour control system. The ventilation system for this plant is designed so that effective ventilation and odour control is maintained during these shutdowns.

Given the fact that all odours are expected to be contained within the buildings and subsequently combusted, odour modelling is not considered necessary.

### *9.10.1 Design Considerations*

The rate of ventilation required for the effective containment of airborne contaminants, including odour, released within a building depends mainly on the airtightness of the structure. Leakage occurs via gaps around doors, windows and imperfections in cladding and roofs.

Ideally, the best form of containment is to capture the contaminant at source. In a similar fashion to the odours at municipal transfer stations it is not feasible to capture and treat these odours at source. The best option therefore is to ensure that the odours are well confined in the building itself. This is achieved by ensuring that the mechanical ventilation rate is sufficient to prevent or minimise the escape of these odours.

It is common practice in some industrial processes to specify a minimum number of air changes to achieve this. For example, the meat and fish rendering industry is often required to ensure that the processing and raw materials handling areas are ventilated at a minimum rate 10 air changes per hour. In many instances this is increased to up to 20 air changes per hour.

The actual reasoning behind this philosophy is not so much based on any detailed design analysis, but rather on the experience gained at specific industrial sites. In fact, the "minimum air changes" requirement is loosely based on the amount of heat that must be removed from within the building, so that doors and windows are not left open for worker comfort. Depending on the location, and the physical layout of the plant, 10 air changes per hour may be adequate. However in hotter climates and, again depending on the physical layout of the plant, in excess of 20 air changes per hour may be required. This approach is mostly empirical.

In this application, there are no significant heat sources in the waste handling hall due to the thermal insulation of the UHTC cover. An empirical approach based on a minimum number of air changes per hour for the rendering industry is therefore not required for odour containment. An alternative approach is therefore used to determine the minimum ventilation requirements based on the infiltration rate.

The determination of the ventilation requirements is based on the recommended rates described by Warren Spring Laboratory[5].

[5] Odour Control – A Concise Guide. Edited by F.H.H. Valentin and A.A. North. Prepared on behalf of the Dept of the Environment 1980. ISBN 0 85624 2144 Warren Spring Laboratory Stevenage Hertfordshire

The required rate of extract ventilation is determined as follows;

$$V = C \times \Sigma A$$

Where $V$ = Ventilation Rate in $m^3 s^{-1}$
$C$ = Ventilation Coefficient
$A$ = Total Infiltration Area $m^2$

Warren Spring recommend that the value A is determined as the maximum of the areas that are exposed to the windward side of the building, and uses a factoring procedure to take account of adjacent walls that are not directly exposed to the wind. However to ensure that the ventilation rate is not under-rated, the total infiltration area of the whole building has been used for this application. All walls and doors that are exposed to the outside are therefore used to determine the total area A irrespective of their individual aspect to the wind. This procedure thus provides for a ventilation rate that is in excess of the requirements of Warren Spring.

The ventilation coefficient C is dependent on the wind speed expected at the 2% level. At Kwinana[6], this wind is 7.9 m $s^{-1}$. In other words, winds exceeding 7.9 m $s^{-1}$ occur for only 2% of the time. The wind speed at the 1% level is 8.1 m $s^{-1}$. An average value of 8 m $s^{-1}$ is therefore chosen for this location. This is the design wind speed. The following data is taken from the Warren Spring Laboratory (WSL) recommendations.

***Table 9-18. Warren Spring Recommended Ventilation Coefficients***

| Building Location | Design Wind Speed m s-1 | Coefficient for a 10m High Building | Coefficient for a 20m High Building |
|---|---|---|---|
| Exposed Site | 10.0 | 7.2 | 7.9 |
| | 12.5 | 9.1 | 9.9 |
| | 15.0 | 10.8 | 11.9 |
| Sheltered Site | 10.0 | 4.1 | 5.2 |
| | 12.5 | 5.0 | 6.5 |
| | 15.0 | 6.1 | 7.8 |

The main MSW hall has an average height of 15 meters. Taking a worst case scenario, by assuming that the site is exposed, and the design wind speed of 8 m $s^{-1}$, the ventilation coefficient is (by interpolation) 6.04. The ventilation coefficient is only weakly dependent on the building height as shown in Table 9-18 above and in the graph in Appendix O. A simple linear interpolation is therefore considered adequate to estimate the value for a 15 m high building.

For buildings that are less than 10 m high, the 10 m high coefficient was used.

The infiltration is initially determined from the standard leakage area coefficients for doors walls and roof interfaces (WSL). These are listed in Table 9-19 below. Of note is that the coefficients for the walls are set to zero. This is due to the tilt-slab construction methods that are used that has virtually no leakage.

[6] DEP meteorological data set for the Eastern Industrial Area. This is the same data set used for modelling purposes in this report.

*Table 9-19. Interface Coefficients*

| Item | Coefficient<br>$m^2$ per lineal meter of interface |
|---|---|
| Doors | 0.002 |
| Walls | 0.000 |
| Roofs | 0.001 |

Tilt-slab construction includes proprietary sealant between the slabs so that there is no infiltration between them. Therefore no additional infiltration allowance is made for the wall construction, and the coefficient is set to zero.

Details of the ventilation rates required for individual buildings are provided in Appendix O, and are summarised in Table 9-20. In determining the ventilation rates, the procedure adopted by WSL is to assess the infiltration for individual walls that are exposed to the wind and then choose the largest of these to set the ventilation requirements. In this application, the infiltration from all the building walls has been used irrespective of the orientation to the wind (i.e. the sum of all contributions). This means that the overall ventilation rate will be in excess of those recommended by WSL that only considers the contributions from those openings that are exposed to the wind.

The procedure used to assess the ventilation requirements was to firstly use the infiltration method. If the infiltration method indicated a low rate of ventilation, a minimum of 2 air changes per hour (ACH) was set.

### *9.10.2 Compost Plant*

The proposed composting operation includes a forced aeration system that passes air through the green waste compost piles. No putrescible material will be composted. This air is drawn from within the building.

Air that has passed through the compost contains a mixture of gases, some of which are odorous, and some are not. These gases include water vapour, ammonia, carbon dioxide, and trace quantities of other gases such as hydrogen sulphide, higher order sulphides, and organic acids and aldehydes. These are vented directly into the composting building from where they are extracted to the main MSW hall and burned in the combustors. The total air required for the compost aeration system is estimated to be 180,000 $m^3$ $hr^{-1}$, but it must be remembered that this air is recycled within the compost building itself. Fresh air make up is supplied via an external vent opening.

The compost plant infiltration rate indicated a maximum ACH of 2.6. However, in line with usual indoor composting plant practice, a value of 10 to 12 ACH was set. This is achieved with an additional 3 $m^2$ total area of inlet air vent.

### *9.10.3 Critical Time For Odour – Compost Plant*

Green waste is a mixture of soft grassy material and relatively coarse prunings type material. Experience at other composting operations has shown that it is the softer green material that has the highest odour generation potential. Oxygen levels within this soft material declines over the first 24 hours, and odour generation begins at the same time. Once this material is over 48 hours old, anaerobic conditions are prevalent. However, odours are not released until the pile of material is broken open. The critical time for processing of soft green waste is generally accepted as being within the first 24 hours after reception. If the material is well mixed with the coarse fraction, then this time is greatly extended.

### 9.10.4 *MSW Hall*

For the main MSW hall the required airflow is 74,708 $m^3\ hr^{-1}$ or 0.46 ACH based only on the infiltration rate. Additional air make up for the combustor primary and secondary air supplies is provided by a total inlet vent area of 29 $m^2$. The overall total fresh air flow through the MSW hall is calculated to be 705,980 $m^3\ hr^{-1}$ or 4.3 ACH. Additional make up air is provided to the MSW hall from the extraction ventilation from the compost plant, the vitrifier building and the dangerous goods store.

The total air flow rate through the MSW hall is approximately 870,000 $m^3\ hr^{-1}$, matching the total air requirements for 12 MSW combustors operating at a nominal 9% oxygen level in the flue gases (870,000 $m^3\ hr^{-1}$ @ 8.9% $O_2$, calculated at 25 °C).

### 9.10.5 *Critical Time For Odour - MSW*

The nature of MSW is such that the actual age of the material varies from relatively fresh and odour free to old and extremely odorous. This is the situation at the outset of collection of the material. Experience at existing MSW transfer stations and other handling facilities indicates that the material is odorous from the outset, and there is no obvious change in the odour properties with time within a time frame of about 24 hours. In anycase, the building is fully enclosed and ventilated to UHTC's.

### 9.10.6 *Dangerous Goods Store*

The overall air exchange rate for the dangerous goods store is 5.2 ACH. However because each of the bays is ventilated directly into the main building, an exchange rate of 20 ACH is maintained in each of the individual bays. This ensures that any potential odours are contained within the building, as well as eliminating any potentially explosive atmospheres in the bays themselves.

### 9.10.7 *Vitrifier Building*

The vitrifier building will not contain odorous material. The ventilation rate is thus determined on the basis of infiltration only.

#### *Ventilation Detail*

The design flow rates and ventilation details are provided in Table 9-20.

***Table 9-20. Design Ventilation Air Flow Rates***

| | Room Volume $M^3$ | Additional Vent Opening $m^2$ | Air Flow $m^3s^{-1}$ | Air Flow $m^3\ hr^{-1}$ | Fresh Air Changes per Hour - ACH |
|---|---|---|---|---|---|
| MSW Hall | 162810 | 29 | 196 | 705980 | 4.3 |
| Compost Building | 7215 | 3 | 23.5 | 84725 | 12 |
| Dangerous Goods Store | 3240 | 0 | 4.7 | 16927 | 5.2 |
| Vitrifier Building | 31500 | 1.6 | 17.4 | 62605 | 2.0 |
| **Total** | **204765** | **33.5** | **242** | **870237** | |

### 9.10.8 *Intermittent Discharges to Air*

Intermittent discharges may occur when the doors are open for vehicular access, and when a UHTC is shut down for maintenance scheduled or unscheduled.

### 9.10.9 *Discharges via Open Doors*

The main access doors are 4.2 m by 3.6 m with a total cross sectional area of 15 $m^2$. Only one door is open at any one time. The nominal air velocity through the main inlet vents is 6-m $s^{-1}$ with the doors shut. This decreases to 4 m $s^{-1}$ when one door is opened. This will be adequate to contain odours for most of the time.

In addition, odour nuisance at off site locations is invariably associated with low wind speeds less than 1 m $s^{-1}$. An inflow air velocity of 4 m $s^{-1}$ is entirely adequate to eliminate odour escape when the doors are open.

Finally, it is not normal practice to capture and treat odours from conventional MSW transfer stations. Experience at these facilities is that odours are generally only significant within about 100 to 150 meters. In this proposal the entire facility is enclosed and ventilated. Even when the main doors are open the infiltration velocity is sufficient to contain all odours.

### 9.10.10 *WTE Plant Shut Down*

At times, one UHTC may be shut down for scheduled or unscheduled maintenance or repair. Whilst such an occasion is expected to be rare, it is possible that this will occur. The main consideration under any UHTC shut down is the temperature in the combustor room. A roof mounted vent is built into each UHTC covered building bay, and is opened only during shut down. Air from the UHTC room is vented directly to atmosphere via these vents.

Odour control for the MSW Hall is achieved by continuously ventilating the hall with fresh air at a rate of 4.36 air changes per hour. This rate is fixed by the combustion air requirements for the incinerators, and is effectively the balance of the combustion make up air, once the ventilation air for the other ancillary plant (vitrifier, compost, and dangerous goods store buildings) has been satisfied.

Ventilation air from the ancillary plant is ducted into the MSW hall, and fresh air make up is provided to give a total air flow rate that matches the combustion air requirements for the furnaces. The total number of air changes per hour for the MSW hall is in fact 5.4 ACH when the contributions from the ancillary plant ventilation air are included.

During startup, shutdown and other instances when one of the furnaces is out of operation, there is a reduction in the total extraction rate from the MSW hall. This occurs when the furnace fans for the unit that is out of operation are turned off. This should only occur once complete burn-out of the residual material in the furnace has been achieved. The actual reduction in the MSW hall ventilation rate is in fact quite small, amounting to only about 1/12$^{th}$ of the total flow. In effect, there will be very little change in the overall ventilation of the MSW hall during shutdowns.

Under normal operation, pre-heating of the combustion air is achieved by passing the air over the outer skin of the furnace. When shut down occurs, this heat is wasted to atmosphere via a vent in each of the furnace cells. Ventilation air for this is drawn directly from outside, and does not come into contact with the odorous MSW.

If necessary, it is possible during these events to increase the air flow of the remaining combustors raising the nominal oxygen level from 9% to 10%, thereby restoring the overall air flow rate to nominal 870,000. However since the nominal air flow provided by infiltration requirements is generally in excess of 706,000 $m^3 hr^{-1}$, the loss of one UHTC will only reduce the overall MSW extraction rate by 8%, the potential for odour releases is considered to be minimal.

Due to the small frequency and duration of such a shut down, and that the reduction in overall MSW hall ventilation will be reduced by only $1/12^{th}$, little change in overall odour containment is expected.

### *9.10.11 Vitrifier – Shutdowns*

The vitrifier will not contain any odorous material. However, it is proposed that the vitrifier process gases will be flared in the event of emergency shutdowns. Plant room ventilation will continue unchanged during this time.

### *9.10.12 Predicted Off-Site Odour Levels*

A requirement of the DEP is that off site odour levels should be assessed. In this application, all potential odour sources are fully enclosed and ventilated to the main MSW Hall. From there this air is used as both primary and secondary combustion air for the UHTC operation. All odours are thus combusted at 1100 to 1150 °C with a residence time in excess of 6 to seconds. The only residual odour discharge under normal operation will be that from the combustion gases themselves. Odour emission tests[7] on other combustion sources such as fume combustors and boilers that are used to combust odours, show that the odour concentration is typically between 200 and 400 odour units per cubic meter (OU $m^{-3}$) corrected to 20 °C. This equates to an odour emission rate of about 132,000 OU $s^{-1}$ for each stack.

Dispersion modelling using a stack odour concentration of 400 OU $m^{-3}$ follows the same pattern as the 10 minute $SO_2$ results presented elsewhere in this report. The maximum 10 minute average odour levels are predicted to be between 0.2 and 0.4 OU $m^{-3}$ at locations between 1 and 3 km from the plant. These predicted levels are below the DEP requirements of 0.5 OU $m^{-3}$ for a stack free from building downwash effects. Thus no further analysis to determine the predicted levels at the 99.5 or 99.9 %ile levels is considered necessary.. However in the interests of good odour management practices, the applicant will undertake an odour measurement program once the plant has been commissioned. This will provide data on the odour emission rates from the following sources.

- The main MSW stacks
- The air within the MSW hall
- The air within the composting building
- The air within the dangerous goods store.

Results will be provided to the DEP.

7 Watercare Services Odour Testing Laboratory, Auckland New Zealand, Pers Comm.

## 9.11 DUST

### *9.11.1 Dust Control During Construction*

Heavy construction is a source of dust emissions that may have a temporary impact on local air quality. Building and road construction are the prevalent construction categories with the highest emissions potential.

Emissions during the construction of a building or road are associated with land clearing, ground excavation, cut and fill operations, and the construction of the facility itself. Dust emissions vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing weather. A large portion of the emissions result from equipment traffic over temporary roads at the construction site.

The quantity of dust emission from construction operations is proportional to the area of land being worked, the level of construction activity on any day, the level of moisture in the soil and the silt content. While it is possible to use literature derived emission factors to estimate the quantity of dust emitted on a particular day or over a given time period, the uncertainty in these factors combined with the difficulty in predicting the other factors makes the use of such predictions somewhat limited.

In general terms, dust sources can be split into three categories, namely;

- Cut and fill operations, including excavation
- Vehicular movement
- Wind erosion

***Control Methods***

Watering is most often selected as a control method. The effectiveness of watering for control depends greatly on the frequency of application. An effective watering program (that is, twice daily watering with complete coverage) is estimated to reduce overall dust emissions by up to 50%. Watering will take place as and when required when visible dust emissions are considered to be significant. While this appears to be somewhat arbitrary, there are no other satisfactory methods available to trigger a watering program. Watering at a rate of 05 litres per square meter has been found to be a satisfactory rate to minimise dust emissions.

The next most effective method to minimise dust emissions is speed restrictions for all vehicular traffic. Table 9-21 shows the effect of speed on the emission of dust from vehicles (Orlemann *et al.*, 1983).

***Table 9-21. Dust Emission and Vehicle Speed***

| Speed Km $hr^{-1}$ | Dust Emission Reduction % |
|---|---|
| 65 | 0 |
| 50 | 25 |
| 30 | 65 |
| 25 | 80 |

It is proposed that a speed limit of 25 km $hr^{-1}$ will be enforced for all vehicles on the construction site.

Vehicles moving off site also have the potential to track silt and mud onto nearby roads. This will be eliminated by the provision of a wheel wash for all trucks leaving the site.

These measures will minimise most fugitive dusts from vehicular movements during the construction phase.

***Wind Erosion***

Fugitive dust from wind erosion occurs only during times of high winds, and it is generally accepted that it only becomes significant when the wind speed exceeds 5 m per second at the surface, or about 10 m per second at 10 m above the surface. An examination of the frequency of winds in the Kwinana area shows that the all wind speeds are less than 10 m per second at 10 m with a maximum of about 8.5. This means that fugitive dusts from wind erosion are unlikely to cause nuisance and no special dust control measures are proposed for general fugitive dusts during the construction phase, other than watering as and when required.

### *9.11.2 Dust Control During Operation*

***Lime and Limestone Handling***

Both burnt lime and limestone are delivered to the site in bulk in covered trucks. Bulk material is unloaded into the hoppers and air-conveyed into the silos. Fugitive emissions from the discharge into the hoppers have not been found to cause fugitive dust nuisance at other plants, and no special dust suppression measures are proposed.

Air displaced from the top of the silos, at a rate of about 20 $m^3$ per hour, is filtered through a fabric filter before discharge to atmosphere. The design of the fabric filter is in line with normal industry practice with an air to cloth ratio of 50 m $hr^{-1}$ (2.5 ft per min), using standard cotton or polyester fabric as the filter medium. The choice of filter medium is not critical

Although filter cleaning on bulk silo vents is not normally considered necessary, provision has been made to include a manual shaker mechanism if it is found to be required.

***Ash and Aggregate Handling***

The ash storage building is fully enclosed and ventilated to the main MSW hall. The overall ventilation rate achieves 5.2 air changes per hour. This is sufficient to ensure that all dust is fully contained within the building. Transfer of the ash to the rail cars for transport to the vitrifier building is also carried out within the building, and there will be no discharge of ash to the outside. In addition, the transfer point is fitted with an extraction hood and fabric filter to reduce dust in the general vicinity of the transfer point. The fabric filter will be designed according to standard practice and loading rate. The discharge from the fabric filter is returned to the ash conveying tunnel, and again there is no discharge to the outside air.

*Concrete Plant*

This is a proprietary packaged unit manufactured by CON-E-CO Ltd. Details of the plant are provided in Appendix P. Cement dust is the only potential discharge to air. In line with good engineering practice, the cement silos are equipped with integral bag filters to eliminate dust discharges during charging.

During concrete manufacture, cement and aggregate is metered onto a conveyor and into a waiting truck. Water is added to the truck bowl to complete the concrete preparation.

Cement dust that is raised during transfer from the silo to the conveyor is collected with a transfer point extraction hood that is ventilated to a bag filter, thus eliminating fugitive dusts. The dust controls on this unit are considered to be the best available technology for plant of its type. Experience with similar plants of its kind demonstrates that no dust nuisance will occur.

## 9.12 SMOKE EMISSIONS AND OPACITY

Baghouses, as will be fitted to the Kwinana combustor units, ensure very low levels of smoke and opacity in emissions. Monitoring data from the Olivine combustor in Bellingham, USA, shows daily average opacities in the range 0.3%-6.2%, with a maximum reading of 9.9%. This easily complies with the National Guidelines for Control of Emissions on Air Pollutants from New Stationery Sources (1985) requirement of opacity less than 20%. The requirement for dark smoke not to exceed the standard of Ringelmann 1 is equivalent to opacity not exceeding 52%, so that the emissions from the WTE&W plant will be far below this requirement when measured using the AS 3543 method.

## 9.13 GREENHOUSE EMISSIONS

### *9.13.1 Comparison of the GOWA Waste-to-Energy and Water Project with other Electricity Generation and Waste Management Approaches.*

The GO Western Australia Waste-to-Energy and Water project includes a number of components with implications for greenhouse balances. Accordingly, a simple comparison cannot give a full and realistic picture of the benefits offered by the project. The important components include:

- Avoidance of methane emissions from landfills
- Generation of electricity, predominantly from the biomass sources
- Avoiding wastage of biomass fuel through landfilling of MSW.
- Enhanced recovery of steel and non-ferrous metals
- Production of fresh water by multiple-effect desalination
- Manufacture of glass-based products
- Hazardous waste destruction
- Composting of green wastes

The proposed Waste-to-Energy and Water project incorporates substantial elements of improved recycling, including enhanced steel recovery by magnetic separation from the bottom ash, and non-ferrous metals by eddy-current separation. Most recycling programmes integrate well with waste-to-energy projects, and the Kwinana project will encourage this. Improved recycling of plastics decreases the fossil carbon dioxide emissions from the plant, and is therefore desirable. However, there are economic and practical limitations on the quantities and types of plastics which can be recycled. Information presented here indicates that recycling of paper may not provide greenhouse emissions benefit overall, whereas combustion of paper in waste-to-energy plants does provide clear benefit.

The Kwinana project will include a composting plant to provide for green wastes.

This report concentrates mainly on the greenhouse gas emission implications of diverting wastes from landfills, providing alternative, predominantly biomass-fuelled electricity generation, and enhanced recovery of steel not already recovered by separation at source and transfer stations. A full report is available (ESR, 2000E).

### 9.13.2 *"Business as usual", "No regrets", and "Beyond no regrets" measures.*

#### *"Business as usual"*

"Business as usual" in relation to municipal solid waste management appears to be best defined as progressive movement towards waste reduction, re-use, and recycling, with continuation of disposal of waste in landfills, although in decreasing per capita quantities. This is in accordance with the waste management hierarchy as it applies in areas which do not use waste-to-energy as an integrated strategy of waste management, energy recovery and recycling.

States are committed to reducing the quantities of waste going to landfill by 50% compared with 1990 on a per-capita basis, by the year 2000. A 1998 report (DEP, 1998) indicated that Western Australia would not achieve this target. However, data collected over the 1995-97 period indicates an overall reduction in per capita disposal to landfills of 10.4%, consistent with a rate of reduction which would, if sustained, halve the quantities of waste going to landfill over 10 years, as required by the original commitment.

The reduction in quantities of wastes going to landfill will also be accompanied by movement towards increased recovery of methane generated by landfilled wastes for generation of electricity, other use as a fuel or for flaring. The overall Australian average recovery of methane generated at landfills was 10% in 1997. The Australian Greenhouse Office notes that methane recovery for electricity generation from landfills increased rapidly after 1993, but with only 10% recovery by 1997 it will evidently be many years before landfills decrease their greenhouse gas emissions per tonne of waste to levels comparable with those offered immediately on start-up of the proposed waste-to-energy facility.

A rough estimate of the percentage of methane recovery at landfills in the Perth region can be made, based on the annual quantities of MSW going to landfills, and electricity generated using landfill gas. The total 1997 MSW to landfills was almost 1,500,000 tonnes (DEP, 1998), and Western Power purchased 43.2 GWh of electricity from landfill gas generation at Perth area landfills (Western Power, 1999). Based on the likely methane generation rate from the likely composition of Perth MSW, as estimated in the full report (ESR, 2000E), using IPCC defaults for methane generation, suggests about 12% of the methane generated in Perth area landfills is recovered and used for electricity generation. There is probably additional methane which is collected and flared, rather than used in the generation engines, so that the total methane recovery may be as much as about 24% of the methane generated in all of the landfills. However, it should be noted that the economic life of landfill gas recovery and generation systems is typically 10-15 years, which is only a small proportion of the time over which methane will continue to be generated in landfills. Accordingly, the true rate of recovery of total methane generation potential placed in landfills is likely to be much lower than indicated by estimates such as this, which only consider recoveries during the period of economic recovery.

"Business as usual" in relation to electricity generation appears to be continued reliance on fossil fuelled generation facilities, with increasing emphasis on achieving high generation efficiencies, including co-generation facilities to maximise use of low-grade heat. These directions are accompanied by energy conservation measures aimed at limiting the rate of growth of demand for electricity.

Currently, less than 1% of electricity generated on the WA grid is from renewable sources. The Energy Minister (Barnett, 1999) has recently announced a Green Power policy, to encourage the development of renewable electricity generation. This would allow consumers to elect to pay a premium for "green" electricity, to support the development of renewable power sources, which are expected to provide about 4.5% of electricity generation by 2010.

In 1999, Western Power achieved greenhouse gas savings totalling 565 kt $CO_2$-e (carbon dioxide equivalent), with 74% of this coming from improvements in generation efficiency from co-generation schemes, and 7% from electricity from landfill gas. The carbon intensity from operations was 0.956 kt $CO_2$-e/GWh for Western Power's electricity sales throughout WA. This measures the amount of fossil carbon dioxide emission per unit of electricity produced. The carbon intensity for the South West Interconnected System (SWIS), into which the WTE&W plant would be supplying, was 0.993 kt $CO_2$-e/GWh.

***"No regrets"***

The key "no regrets" action is simply the establishment of the proposed WTE&W facility.

In 1997 almost 1,500,000 tonnes of MSW was placed in landfills in the Perth area (DEP, 1998). The annual capacity of the GOWA WTE&W plant will be 1,200,000 tonnes when fully developed.

This will provide a major improvement in the situation in relation to greenhouse gas emissions from management of solid wastes on a shorter timescale than any possible alternative. If the estimate here of 24% recovery of landfill gas for the Perth landfills is reasonable, the WTE&W plant will result in a decrease in greenhouse gas emissions by a factor between 1.5 and 9.4 for each tonne of MSW combusted, from start-up of the plant. This estimate uses the standard, default approach used by the Australian Greenhouse Office for greenhouse gas emission inventories, of counting the total emissions from waste placed in a landfill, over its long emission lifetime, as occurring at the time of placement. The range of factors for the decrease depends on whether landfills are credited with a carbon sequestration adjustment, whether waste to energy is credited with enhanced steel recovery, and whether 100 year or 20 year global warming potential factors for methane are used in the calculation. This would result in a reduction of greenhouse emissions by between 165 and 2,100 kt $CO_2$-e per year. To continue to place MSW in landfills is to continue to accumulate potential for emissions of methane extending into the future.

Electricity from the WTE&W plant will be produced with about 80% of the greenhouse gas emissions from the most efficient natural gas-fired combined-cycle turbine systems and about a third of those for typical coal-fired power stations, per GWh. This results from a substantial proportion of the total energy in MSW coming from biomass, which is a renewable, greenhouse-neutral fuel. Its greenhouse carbon intensity from operations is about 0.316-0.434 kt $CO_2$-e/GWh (depending on whether enhanced steel recovery is credited), compared with 0.993 kt $CO_2$-e/GWh for 1999 for the SWIS (Western Power, 1999a). Making allowance for the decreased electricity generation resulting from energy used in the multiple effect desalination system, the WTE&W plant will generate about 700 GWh, when operating at its design annual receipt of 1,200,000 tonnes of MSW. Depending on whether or not an enhanced steel recovery credit is allowed, this electricity will be generated at a greenhouse emission 0.56-0.68 kt $CO_2$-e/GWh lower than current SWIS electricity supply. This results in an annual greenhouse gas emission saving in the range 390-470 kt $CO_2$-e from generation with lower greenhouse gas emission costs. When this is combined with the benefit of methane emissions avoided at landfills, the total annual greenhouse gas emissions saving for the WTE&W plant operating at its design capacity is 900-1320 kt $CO_2$-e, for a 100 year GWP factor of 20 for methane, which might possibly be calculated as high as 2,800 kt $CO_2$-e for a 20 year GWP factor of 55.

Table 9-22 summarises the greenhouse gas emissions savings offered by the WTE&W plant.

***Table 9-22 Greenhouse gas emission benefits from 1.2m tonne WTE&W plant***

| **Carbon intensity from operations** | | Carbon dioxide equivalent emissions (kt $CO_2$-e/GWh) | | |
|---|---|---|---|---|
| Gas combined-cycle | 48% efficiency | 0.385 | | |
| 1999 SWIS generation | | 0.993 | | |
| Waste-to-energy | Excl steel recovery | 0.434 | | |
| Waste-to-energy | Incl steel recovery | 0.316 | | |
| **Greenhouse gas savings from electricity generation from WTE&W plant, with desalination plant** | | | Greenhouse savings (kt $CO_2$-e/yr) | |
| Saving in greenhouse emissions compared with SWIS average | Excl steel recovery | 0.559 | 390 | |
| | Incl steel recovery | 0.677 | 470 | |
| **Landfill (1.2m tonnes )methane emissions avoided** | | | GWP factor | |
| | | | 20 | 55 |
| | | Maximum estimate | 850 | 2330 |
| | | Minimum estimate | 510 | 1990 |
| **Total greenhouse emissions benefit** | | Maximum estimate | 1320 | 2800 |
| | | Minimum estimate | 900 | 2380 |

For methane emissions from landfills, a 100-year GWP factor of 20 is appropriate, rather than the IPCC figure of 21. The IPCC figure is for methane emissions from fossil sources, where the carbon dioxide produced by atmospheric oxidation of the methane is also an enhanced greenhouse gas emission. For methane from landfills, the carbon is from biomass sources, so that the carbon dioxide ultimately produced is not counted as a greenhouse gas. Similarly, a 20-year GWP factor of 55 is appropriate rather than the IPCC figure of 56.

A substantial proportion of the fuel for the WTE&W plant is renewable biomass in the MSW. It would be reasonable to estimate the proportions of this biomass energy as the savings in greenhouse gas emissions per GWh compared with the carbon intensity of current operations for the SWIS. This indicates that 56-68% of the energy for the WTE&W plant can be considered to come from renewable biomass, corresponding to 390-475 GWh/year electricity from renewable sources. Alternative estimates, based on the proportions of plastic and other fossil carbon materials in MSW, together with their calorific values, suggests that the proportion of biomass energy may be up to about 80%, corresponding to 555 GWh/year. The 1999 total generation for WA was about 17,000 GWh, so that the WTE&W plant would supply 2.3-3.3% of this total generation from renewable sources. The WTE&W plant will provide a substantial proportion the increased generation from renewable sources to meet the Energy Minister's target of 4.5% well before 2010, so that other projects would allow the establishment of a higher target.

The proposed WTE&W plant offers a strongly viable means to achieve and exceed the Western Australian commitment to reducing per capita wastes to landfill, on a short timescale. Although it is obviously not possible to meet the year 2000 deadline, the project has the capacity to decrease wastes being disposed to landfill by over 1,200,000 tonnes per year, a reduction of 75% or more from the 1995 Perth regional level, within 3 years. Additional diversion of wastes from landfill will result from the composting facility to be established on site for greenwastes.

The proposed WTE&W project incorporates substantial elements of improved recycling, including enhanced steel recovery by magnetic separation from the bottom ash, and non-ferrous metals by eddy-current separation. Most recycling programmes integrate well with waste-to-energy projects, and the Kwinana project will encourage this. Improved recycling of plastics decreases the fossil carbon dioxide emissions from the plant, and is therefore desirable. However, there are economic and practical limitations on the quantities and types of plastics that can be recycled. However recycling of paper does not provide greenhouse emissions benefit overall, whereas combustion of paper in waste-to-energy plants does provide clear benefit.

***"Beyond no regrets"***

The WTE&W Project will take all reasonable measures to decrease its greenhouse gas emissions to a minimum. However, the only means of decreasing the already low levels of these emissions is by decreasing the amount of fossil carbon in the wastes burned, and by decreasing the small contribution from the formation of nitrous oxide during combustion. GOWA will support recycling of plastics and other fossil carbon-based products, as indicated above. It will also undertake investigations of the levels of nitrous oxide emissions, initially to establish whether the US EPA default emission factor is applicable to the WTE&W plant, and then to investigate whether there are practical means of decreasing this emission. However, these nitrous oxide emissions will be a very small contributor to greenhouse gas emissions compared with those from the alternatives to the WTE&W project.

GOWA believes that additional research is needed to establish the true greenhouse benefit or cost of recycling paper, compared with combustion in waste-to-energy plants. The full report (ESR, 2000E) sets out why GOWA believes that the benefits from combustion of this biomass fuel can considerably exceed those that have been estimated in the past to come from recycling of paper. However, it does recognise that the balance of benefits and costs depends on details of the sources of paper, energy sources used for paper production and for recycling of paper, and a number of other factors. GOWA commits to an active programme of investigation, including life-cycle analysis specifically for the Western Australian situation, to reliably establish, subject to peer review, the relative benefits and costs of recycling waste paper compared with waste to energy.

### *9.13.3 Greenhouse Management Agreements: the Greenhouse Challenge*

GOWA commits to entering into a Greenhouse Challenge Agreement with the Commonwealth Government. Because the Company is firmly convinced that its technology offers major greenhouse benefits for waste management and biomass energy production, it welcomes this opportunity of formal participation.

From start-up the WTE&W plant will achieve low greenhouse gas emissions compared with landfilling of wastes and fossil-fuelled electricity generation. Accordingly, there is limited scope for major emission reductions compared with those offered simply by establishment and operation of the plant. However, GOWA believes that there is much wider scope for application of its technology, and it sees the emission inventory, monitoring and reporting requirements of the Greenhouse Challenge as a valuable vehicle to formalise and communicate its investigations. One probable initiative that the Company will undertake addresses the key question relating to fossil carbon emissions from waste-to-energy plants. It will propose to assess the practicality of using carbon isotope methods as a means of monitoring the level of fossil carbon dioxide emissions from waste-to-energy plants, and, if possible to develop from this a practical, routine monitoring procedure.

As indicated in the previous section, GOWA is also committed to identifying the best environmental waste management approaches for particular situations, as exemplified by its proposal to undertake an assessment of the best approach to management of waste paper in the Western Australian context, using life-cycle analysis techniques. Such work has the potential to profoundly influence the management of solid wastes in Australia and elsewhere with major implications for greenhouse emissions from this sector.

### *9.13.4 Composition of MSW*

Both the greenhouse gas emissions from waste-to-energy plants and from landfills are affected to some degree by the composition of MSW going into them. The full report (ESR, 2000E) presents an assessment of the information currently available, which indicates that present MSW from the Perth area is likely to be of composition similar to that found in recent New Zealand MSW composition surveys. Within the likely range of the variability, the composition has only a modest effect on greenhouse gas emissions estimates.

### 9.13.5 *Annual greenhouse gas emissions estimates*

For a given composition of MSW, the annual greenhouse gas emissions from waste-to-energy plants can be calculated with some confidence. These are determined by the quantity of plastics, oil and tyres in the MSW burned, since these are the predominant forms in which fossils carbon is present. Carbon dioxide from biomass carbon (for example paper) is neutral with respect to greenhouse effects, and is not counted among the greenhouse gas emissions. Nitrous oxide, formed during combustion also makes a small additional contribution to the greenhouse gas emissions from waste-to-energy plants, and is included here.

Greenhouse gas emissions estimates for landfills are far less certain than those for waste-to-energy, and the full report (ESR, 2000E) presents a discussion of the many sources of uncertainty. As noted by the Australian Greenhouse Office in its 1997 National Greenhouse Gas Inventory report on emissions from solid waste disposal (AGO, 1999), "The uncertainty associated with estimates of emissions in the waste sector is high and estimated to be greater than 50%."

Table 9-23 sets out the estimates of greenhouse gas emissions from combustion of the design quantity of MSW (1,200,000 tonnes per annum) for the WTE&W plant, and for land filling of the same quantity of MSW. The WTE&W plant will recover additional steel compared with that normally recovered through kerbside and transfer station recycling schemes. This recovered steel will replace steel produced from raw materials, with greenhouse gas emissions, so that a credit for the additional recovery is appropriate.

Although Table 9-23 includes figures for 80% recovery of methane, to a considerable extent this is a theoretical calculation, because the long-term recovery of methane is almost certainly far lower than the recoveries quoted commonly, which are only for the period of economic landfill gas recovery. Landfills emit methane before methane recovery systems are installed, and continue to emit methane long after the economic recovery period is over. No information appears to be available about methane recoveries over the entire emission lifetime of landfills.

Landfills do, to some uncertain extent, act as greenhouse gas sinks, as a result of long-term storage of biomass carbon (carbon sequestration), some of which will not degrade over very long periods. However, the proportion of biomass carbon in MSW which can be considered not to degrade over the 100-500 year timescale appropriate for landfill and greenhouse considerations is very uncertain. At present, neither the Australian Greenhouse Office nor the IPCC take carbon sequestration in landfills into account for emission inventories. Table 9-23 provides estimates both including and excluding a credit for carbon sequestration.

***Table 9-23. Greenhouse gas emissions from MSW to waste-to-energy and to landfills.***

| | | Annual greenhouse gas emissions (kt $CO_2$-e/yr) | |
|---|---|---|---|
| **Waste-to-energy** | Excl steel recovery | 340 | |
| **Waste-to-energy** | Incl steel recovery | 248 | |
| **Landfills** | Methane recovery | GWP factor | |
| | | 20 | 55 |
| No carbon sequestration credit | 24% | 848 | 2332 |
| | 80% | 223 | 614 |
| With carbon sequestration credit | 24% | 507 | 1991 |
| | 80% | -118 | 273 |

Table 9-23 indicates that, at the present estimated rate of methane recovery (24%), continuation of landfilling will result in emissions estimates for inclusion in national greenhouse emission inventories between about 1.5 and 9.4 times greater than if the same quantity of MSW is used in the WTE&W plant, depending on which credits are included or excluded, and whether the GWP factor for methane is taken as 20 or 55. The different GWP factors correspond to 100 year and 20 year time horizons, and it can sometimes be appropriate to use the larger GWP factor if emissions will be mitigated over a short period. The 100-year factor is that most generally used in greenhouse gas emissions estimates at present. As noted previously, a figure of 20 is used here, rather than the more usual factor of 21, to allow for landfill methane not containing fossil carbon.

If it were possible to achieve high landfill gas recovery rates over the whole emission lifetime of a landfill, it would be possible to achieve low greenhouse gas emissions, to the extent that overall credits can be calculated, as shown for the 80% recovery case with carbon sequestration credit in Table 9-23. However, as discussed above, it is doubtful that this can be achieved.

This is the simplest of comparisons between the waste management approaches, and ignores the largest benefit, which is from electricity production, and this is much greater from WTE&W plant than from recovery of landfill gas and its use for generation, as discussed in the following sections.

### *9.13.6 Greenhouse gas benefits of electricity generation.*

As discussed in Section 9.13.2, the present overall average electricity generation supplying the SWIS has carbon dioxide-equivalent emissions of 0.993 kt $CO_2$-e/GWh. If electricity is generated by any method with lower greenhouse gas emissions, it will displace some of this "average emission" electricity generation, with an overall greenhouse gas emission saving.

Table 9-24 shows that a waste-to-energy plant (considered here to exclude the multiple effect desalination plant, to give parity in comparisons) produces electricity with carbon dioxide-equivalent emissions of 0.316-0.434 kt $CO_2$-e/GWh, very significantly lower than the WA average. If the Kwinana plant were not operating in co-generation mode with the multiple effect desalination plant, it would produce 783 GWh of electricity per year, at its design load of 1,200,000 tonnes of MSW per year.

***Table 9-24. Greenhouse gas emissions from electricity generation options.***

| | | | | Carbon dioxide equivalent emissions (kt $CO_2$-e/GWh) | | Electricity from 1.2 Mt of MSW (GWh) | % of that from WTE |
|---|---|---|---|---|---|---|---|
| **1999 SWIS generation** | | | | 0.993 | | | |
| **Waste-to-energy** | | Excl steel recovery | | 0.434 | | 783 | 100% |
| **Waste-to-energy** | | Incl steel recovery | | 0.316 | | 783 | 100% |
| **Landfills** | Generation deficit from | Methane recovery | % of gas flared | GWP factor 20 | 55 | | |
| No carbon sequestration credit | SWIS | 24% | 50% | 2.03 | 3.93 | 34 | 4.4% |
| | SWIS | 80% | 50% | 1.13 | 1.63 | 115 | 15% |
| With carbon sequestration credit | SWIS | 24% | 50% | 1.60 | 3.49 | 34 | 4.4% |
| | SWIS | 80% | 50% | 0.70 | 1.20 | 115 | 15% |

Table 9-24 also shows the current and possible future quantities of the electricity which might be generated from landfill sites with gas recovery and electricity generation systems. The present generation (shown as the 24% methane recovery rows) is 4.4% of the generation from the same quantity of MSW in the waste-to-energy plant. This means that the landfill option is forgoing replacement of some of the "average greenhouse cost" electricity currently being generated, and the loss of this saving should be debited to the landfill option. This is done in the columns under the heading "Carbon dioxide equivalent emissions" in Table 9-24 for the landfills. When this appropriate adjustment is made, and account is also taken of the methane emissions from the landfills, their performance in greenhouse gas emissions terms is very much worse than for the waste-to-energy system.

If genuine high recoveries of methane over the emission lifetime of landfills were possible, the percentages of the electricity generation available from waste-to-energy which could be obtained from landfilling with gas recovery would be significantly higher than for the current recovery rates in the Perth area. Data presented in the US EPA Landfill Profiles (US EPA, 1999) indicates that, typically, about 50% of methane recovered is used in electricity generation systems installed at landfills. This is because not all of the recovered gas is suitable for use in generation engines. Based on this percentage, Table 9-24 shows that, if genuine 80% methane recovery were possible, the total electricity generation would be 15% of that available from waste-to-energy.

In fact, Table 9-24 is very favourably biased towards landfills, because it is based on the methane recoveries over the period of economic recovery and generation of electricity only. If full account is taken of methane generation and emission over the entire lifetime of the landfill, the quantities of electricity generated are likely to be between 50% (2.2%) and 25% (1.1%) of those shown, and the proportions of methane released would be considerably higher than indicated by the recoveries shown. Accordingly, as a strategy for obtaining useful energy from the resource of the biomass content of MSW, and for reducing greenhouse gas emissions, landfilling is both a considerably less certain and a less efficient option than waste-to-energy.

Clearly, for existing landfills, methane recovery with electricity generation or other beneficial use is highly desirable, and beneficial from environmental and greenhouse perspectives. However, the information presented here indicates that continued landfilling of MSW is a poor option both for minimising the adverse effects of solid waste, and obtaining the maximum benefit from this resource.

## 9.14 WATER

### *9.14.1 Potential sources of water contamination from the site development*

***Hazardous and non-hazardous goods***

The proposed WTE&W development will store non-hazardous and hazardous liquids either used in the process or generated as part of the process. These include:

1. **Non-hazardous substances**, including calcium carbonate, urea, glass, compost and cement by-products that do not exhibit any intrinsically hazardous properties (not declared under the EDGA 1961.
2. **Dangerous goods**, including used oil, hydrazine, oils, acids and alkalis produced or used for the operation and maintenance of the power-generating equipment and plant at the site, declared under the EDGA, 1961.
3. **Municipal solid waste (MSW) and sewage sludge** received on site, as the primary fuels for the MSW combustors. Other materials to be used for supplementary fuel include used rubber tyres (non-hazardous) and used oil (included under 2) above).
4. Potentially ***hazardous waste*** materials received on site, which will be passed through the vitrification plant, including contaminated soils, dried sludges and waste dangerous goods.

The characteristics of these materials are discussed in EBG, 1999. A summary of the substances used or generated on site is provided in Table 9-25.

Table 9-25. Substances used or generated on site

| SUBSTANCE | PURPOSE | FORM | CONCENTRATION | QUANTITY USED OR STORED | DANGEROUS GOODS CLASSIFICATION | STORAGE LOCATION | STORAGE CONTAINERS |
|---|---|---|---|---|---|---|---|
| Activated carbon | Air emissions control | Solid | Not applicable | 160 t stored | 4.2 | Activated carbon silo | Steel silos |
| Bed ash fines | Generated from incineration process | Solid | Not applicable | 47 t per day | None Allocated | Dangerous goods store and concrete plant | Concrete bins |
| Calcium carbonate | Air emissions control | Solid | Not applicable | 370 t stored | None Allocated | Lime bins | Concrete bins |
| Calcium oxide or calcium hydroxide | Air emissions control | Solid | Not applicable | 320 t stored<br>10,000 l mixed | 8 | Calcium oxide silos | Concrete silos<br>Steel mixing tank |
| Chemicals, contaminated soils and sludges | Used in vitrification process | Solid or liquid | Various | 140 t per day | Various<br>3, 4, 5, 6, 8, 9 | Dangerous goods store | Plastic, glass or steel, concrete bins |
| Degreasing solvent | General purposes parts cleaner | Liquid | Not applicable | 220 l stored | 3 | Boiler workshop | Steel drums |
| Diesel | Fuel for plant vehicles | Liquid | Not applicable | 1,000 l storage | C1 | Underground storage tank | Steel tanks |
| Fly ash | Generated from incineration process | Solid | Not applicable | 68 t per day | None Allocated | Dangerous goods store | Concrete bins |
| Glass | Generated from vitrification process | Solid | Not applicable | 88,000 t per annum | None Allocated | Glass products area | Pallets |
| Hydraulic oils | General purpose hydraulic oils for plant and machinery | Liquid | Not applicable | 1,000 l stored | C2 | Boiler workshop | Steel drums |
| Hydrazine | Water treatment | Liquid | Not applicable | 400 l stored | 8 (3, 6.1) | Dangerous good store | 20-l drums |
| Hydrochloric acid | Recovered from vitrification process | Liquid | 10-22% | 40 t stored | 8 | Vitrifiers building | Steel tank |
| ID-204 Antiscalant | Antifouling agent | Liquid | Not applicable | 1000 l stored | 8 | MED plant | 220 l plastic drums |
| Laboratory reagents | Used for vitrifier testing | Various | Various | <0.1 t per annum | Various<br>3, 4, 5, 6, 8, 9 | Laboratory | Plastic and glass up to 5 l or 5 kg |
| Lubricating oil | General purpose lubricant for plant and machinery | Liquid | Not applicable | <0.1 t per annum | C2 | Boiler workshop | Steel drums |
| Municipal solid waste and sewage sludge | Main fuel source for incinerators | Solid | Not applicable | 12,672 t for 4 days | None Allocated | MSW plant | Purpose-built steel containers |
| Natural gas | Start up fuel for incinerators | Gas | Not applicable | 3500 GJ per year | 2.1 | None | Pipeline |
| Sodium hydroxide | Emergency neutralising | Liquid | 46% | 10 t stored | 8 | Vitrifiers building | Steel tank |
| Turbine oil | Boiler cooling system | Liquid | Not applicable | 32,000 l in use<br>1,000 l topper tank | 3 | Turbine oil cooling system | Steel cooling system |
| Urea | Air emissions control | Solid | Not applicable | 200 t stored<br>1,000 l mixed | None Allocated | Urea bins<br>Steel mixing tanks | Concrete bins<br>Steel mixing tanks |
| Used oil | Modulating fuel for incinerators | Liquid | Not applicable | 240 t storage | C2 | Used oil tanks | Steel tanks |

Spillage or leakage incidents involving these liquids may impact site drainage water quality, or groundwater quality via infiltration. Accidental releases may also impact human health of exposed site workers. Incidents resulting in a release may occur in a variety of ways, including:

- Vehicle movements, accidents, inadequate transportation, stowage and packaging, poor segregation;
- Substance transfer operations, including failure of pipes, hoses, valves and fittings, overfilling;
- Failure of storage facilities through inadequate design, construction, testing and maintenance;
- Poor segregation of dangerous goods classes at the storage facility;
- Inadequate site operating procedures, including housekeeping;
- Inadequate staff and operator training; and
- Inadequate emergency plan and poor implementation.

***Leachate***

Municipal Solid Waste (MSW) will be stored to a maximum of 6,300 tonnes of containerised and 6000 tonnes of bulk refuse, 640 tonnes of waste and hydrocarbons, and 900 tonnes of sewage or sludges. In addition, an enclosed composting plant will process up to 1400 tonnes of compost per day. This will require 150,000 tonnes of compost to be stored in long tilt slab wall bins for a 2 week curing phase. Leachate containing contaminants may be generated through infiltrating water contacting these stored wastes. Leachate egress may also impact site drainage or groundwater quality, and/or potentially human health.

### *9.14.2 Existing groundwater contamination*

Existing groundwater contamination is a legacy of the former landuse, and not one created or exacerbated by the proponent or the proposed development. However, GOWA understands that the purchaser of the site is likely to acquire the legal liability to manage groundwater contamination arising from on-site contaminant sources that impacts protected beneficial uses. The existing contamination may be divided into:

1. On-Site Sources, where groundwater contamination has arisen from on-site sources. These include:
    - Inferred arsenic /fluoride plume (sources removed by BP in 1988); and
    - Dissolved phase hydrocarbon plume (by virtue of its extent).
2. Off-Site Sources, where groundwater beneath the site has been impacted by the migration of contaminants onto the site from off-site sources. These include:
    - Evidence for elevated EC levels in groundwater in the north-east of the site; and
    - Organo-chlorine contamination on the south-eastern site boundary.

Protected beneficial uses that are likely to be applicable to groundwater beneath the site include:

- Landscape irrigation water for on-site use; and
- Industrial water (for cooling purposes).

The inferred presence of arsenic and fluoride in groundwater beneath the central part of the site may render it unsuitable for irrigation purposes at certain locations on site (Figure 9-16). The presence of hydrocarbon compounds in groundwater beneath the south western corner of the site represents a potential health and safety hazard to workers by contact and a potential flammable hazard to equipment and therefore is also undesirable for use for irrigation purposes. However, available monitoring on the downgradient (western) boundary indicates that no contaminant levels of concern are migrating from the site. Given the distance to the coastline, no impact on the marine environment from this inferred contamination is anticipated.

Groundwater on the western (downgradient) boundary is unsuitable for use as a source of fresh water for industrial cooling purposes due to an elevated EC, although brackish water may be useable for this purpose subject to treatment for corrosion and scaling. Groundwater within the dissolved phase hydrocarbon plume will also be unsuitable for industrial usage due to an elevated EC and the possible presence of floating oil (Figure 8-7).

The proposed development will not directly affect the existing groundwater contamination on-site. Neither will the presence of the existing groundwater contamination preclude the proposed development from occurring, since it will take place in the north of the site area away from the main extent of the contamination (refer Figure 9-18).

### *9.14.3 Surface water*

Rain falling on the site during construction and operation of the facility will generate runoff from the site. Run-off may become contaminated when it encounters sediment and contaminants present on sealed and unsealed surfaces or if it comes into contact with stored waste materials. Potentially contaminated stormwater requires some treatment prior to disposal to avoid impacts on the environment.

Clean surface water must also be disposed of in an acceptable fashion. Surface water must be managed to prevent discharge of contaminants from site or to groundwater. Because it requires a lower level of treatment, clean stormwater needs to be segregated from potentially contaminated stormwater and must be disposed of in manner that avoids impacts on the water environment. The sources of stormwater and other water that will result in surface water flows on the site, together with potential contaminants include:

- Roofs and roofed storage areas. All storage or processing areas, including the truck wash will be roofed, with no discharges to stormwater. These include:
    - — Compost processing area inside the compost building;
    - — Municipal solid waste (MSW) building;
    - — Dangerous goods store; and
    - — Other storage areas on site are not expected to be a significant source of stormwater contamination.
    - — Minor suspended sediments from accumulated wind blown dust and dirt;
- Paved roads, sealed yards and other trafficked areas:
    - — Suspended sediment from grit, dust and dirt;
    - — Trace metals, from vehicles;
    - — Minor hydrocarbons, from vehicles; and

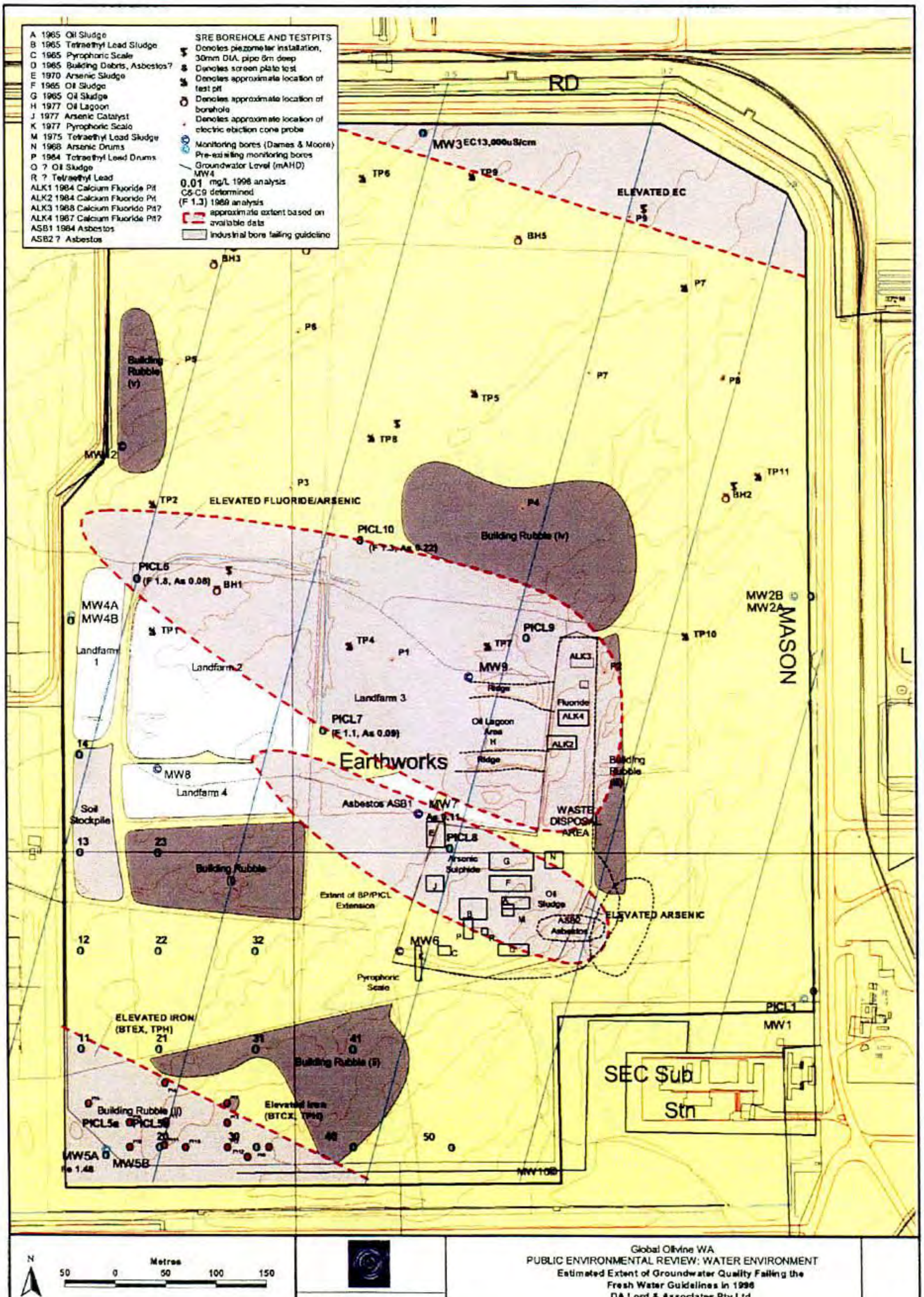
- Litter.

- Finished compost storage (i.e. outside the compost processing building as shown on drawing OL00850):
  - Suspended sediment;
  - Nutrients, (eg nitrogen); and
  - Leachate: (contaminated water derived from percolation of rainfall through compost). This is likely to have an elevated pH, conductivity, biological oxygen demand (BOD) and nitrogen concentrations.
- Aggregate storage yard:
  - Suspended sediment from aggregate particles.
- Unsealed areas within the confines of the facility (i.e. uncontaminated northern part of the site)-no significant contaminants expected.

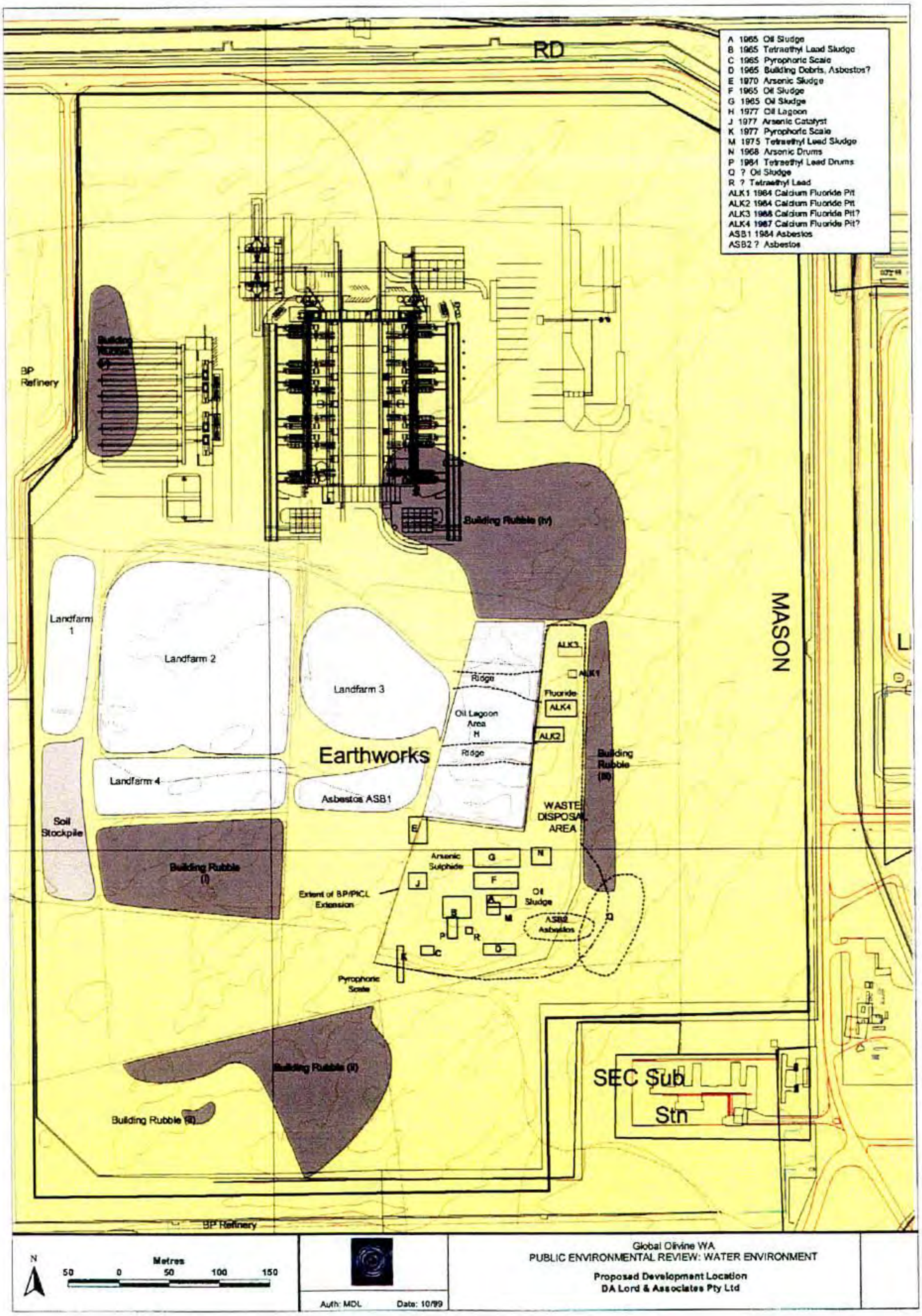
— The compost curing bins will be drained to a separate catch basin. The leachate collected will spread back over the curing compost. No leachate disposal is required.

In addition, there is a potential risk of minor spills of hazardous substances from storage facilities or from vehicle movements during substance deliveries.

*Figure 9-16. Estimated Extent of Groundwater Failing the Irrigation Water Guidelines.*



## *Figure 9-17. Proposed Development Location*



## 9.15 WASTE

### *9.15.1 Waste Management Strategy*

As set out in Section 4.2.1 the Commonwealth has implemented a hierarchy of waste management priorities. In order of importance these are;

1. Waste avoidance;
2. Waste reduction;
3. Waste reuse;
4. Waste recycling or reclamation;
5. Waste treatment; and
6. Waste disposal.

The WTE&W plant fulfils the Commonwealths' hierarchy of waste priorities by effectively reusing, recycling or reclaiming all waste currently landfilled. This is achieved by removal of directly recyclable products (ferrous and non ferrous metals) and creating useable by products (aggregate, compost, industrial chemicals, glass, electricity, potable water). International experience has proven that WTE plants do not impact on Council and government driven waste avoidance, reduction and recycling measures.

### *9.15.2 Suitability of recycled materials for uses: aggregate.*

The majority of the bottom ash generated in Europe is utilised for a variety of purposes including road and pavement construction, as fill for land reclamation and other projects, and as a construction material. A report by the UK Energy Technology Support Unit (ETSU, 1996), in co-operation with International Ash Working Group, summarises European ash use totalling in excess of 1,000,000 tonnes per year.

Olivine Ultra High Temperature Combustors (UHTCs) operate at higher bed temperatures than other MSW combustion systems, to the degree that the major fraction of the inorganic material in the original MSW is melted to form a basalt-like klinker. This happens to some degree in other MSW combustors, but the operational characteristics in Olivine UHTCs further enhances the suitability of the bottom (or bed) ash for a variety of possible uses. Firstly, the physical form of the bed ash makes it particularly suitable as an aggregate for concrete, or in roading. Secondly, the high temperatures minimise residual contamination from organic compounds, such as dioxins, and the associated melting decreases the leaching characteristics of heavy metals originally present in the MSW feed.

Bottom ash from the Olivine combustor in Bellingham, USA, has been tested in the US EPA EP Toxicity test procedure, an early equivalent of the current TCLP test, which demonstrated that the levels of leachable heavy metals were well below those requiring designation of the ash as a hazardous waste. However, these results are of limited assistance in estimating the likely levels of leachable heavy metals in the processed bottom ash produced from the Kwinana WTE&W plant. The products from bottom ash from the Kwinana UHTCs are expected to be significantly "cleaner" with respect to leachable heavy metals than the Bellingham bottom ash, because of the design and operation of the Kwinana plant, and also because of the post-combustion processing of the bottom ash.

The better design of the hearths for Kwinana promotes a higher degree of melting of the bottom ash constituents than the Bellingham design. This promotes incorporation of heavy metals into the klinker matrix, decreasing their leachability. It also results in smaller proportions of fines, and since the fines contribute much higher levels of leachable metals in proportion to their weight than larger materials, this factor will also decrease leachability of the bottom ash leaving the UHTCs.

When the bottom ash leaves the combustors at Kwinana, fines (less than 0.6 mm) will be separated from the klinker on a dry screen. Based on particle size analysis of ash from the Olivine (USA) Bellingham combustor, this fraction is expected to be not more than about 10-15% of the total weight of bottom ash, but surface area considerations indicate that it is likely to contain 80-90% of the total leachable metal content of the bottom ashes. This fraction of the bottom ash is fed to the vitrifiers, so that the predominant leachable metal fraction will be converted to non-leachable form in the vitrifier glass as discussed under "Vitrifier glass" below, or recovered in the vitrifier off-gas treatment system.

The initial screening also separates the sand fraction (0.6-5 mm) from the larger klinker. The particle size analysis of the Bellingham bottom ash indicates that this fraction in likely to be about 10-15% of the total weight of bottom ash, and surface area considerations indicate that it is likely to contain about 10% of the total leachable metal content of the bottom ashes. This fraction is intended for use in concrete manufacture. This would ensure very low levels of leachability of heavy metals, even if these were high in the original ash sand. This low leachability would result both from the very high pH levels in concrete, which suppress the solubility of heavy metals, and the impermeability of the concrete, restricting any leaching to surface layers which would quickly become depleted. Accordingly, there is no prospect of leachable heavy metals in sand or aggregate from the bottom ash producing any environmental problems from their use in concrete.

Subsequently, the larger material is crushed to produce aggregate. After crushing is complete, the klinker materials are washed on wet screens. The fines from this washing, together with the dry fines, are fed to the vitrifiers, where they are incorporated into non-leachable glass. The washing of the crushed klinker will also remove residual fine particulates, which are likely to be the major source of residual leachable heavy metals from the surface of the klinkers. The aggregate fraction is expected to be 75% or more of the total bottom ash (excluding the recovered metals), and not taking any account of the effect of washing, is estimated to contain less than about 5% of the total leachable heavy metal content of the original bottom ash.

Accordingly, the aggregates intended for a range of possible uses can confidently be expected to show very low concentrations of leachable heavy metals compared with either the Bellingham bottom ash, or with other bottom ash aggregates which have been used in a variety of applications including lightweight concrete manufacture, fill, roading base course and asphalt aggregate (Lahl, Dr U, Muell und Abfall, (1992), Mahoney PF and Muller JF, (1989), Mahoney PF, (1986), Steilen N, TL-MV-Ash, (1988)).

GOWA will routinely monitor product quality of bottom ash materials not used in concrete manufacture, and this will include testing of the levels of leachable heavy metals. Summaries of relevant testing will be provided to the DEP as a demonstration of the environmental safety of the product.

There is also no realistic prospect of adverse effects resulting from use of bottom ash aggregate as roading base course, where it would be covered by and/or mixed with other materials, and would be in contact with the underlying soil or materials such as clay. Almost all soils, and particularly clays, have a high capacity to absorb and immobilise heavy metals, and this would occur within short distances of infiltration into soils, of any water containing leachable metals from the bottom ash aggregate. In many road construction situations, where roads are sealed, the base course aggregate will be in a hydrologically isolated situation, and accordingly very little leaching is likely, even if there were quite high levels of leachable metals.

The Bellingham bottom ash on which the TCLP test was performed was not screened or washed, and therefore contained a substantial proportion of fines and all of whatever readily-leachable heavy metals were on the larger klinker. The combination of this with the less extensive melting at Bellingham, means that leaching tests on klinker products from the Kwinana plant can be expected to show very much lower levels of leachable metals than shown in the following Table 9-26, which presents the results for the Bellingham bottom ash.

***Table 9-26. Heavy metal concentrations from TCLP tests of Bellingham bottom ash.***

| Metal | Bellingham bed ash TCLP test | Leachable concentration in ash | ANZECC background soil level | ANZECC Environmental investigation level |
|---|---|---|---|---|
| | μg/l | mg/kg | mg/kg | mg/kg |
| Arsenic (As) | < 200 | < 4 | 0.2 - 30 | 20 |
| Cadmium (Cd) | 140 | 2.8 | 0.04 - 2 | 3 |
| Chromium (Cr) | < 100 | < 2 | 0.5 - 110 | 50 |
| Lead (Pb) | 1570 | 31 | 2 - 200 | 300 |
| Mercury (Hg) | < 5 | < 0.1 | 0.001 - 0.1 | 1 |
| Selenium (Se) | < 200 | < 4 | 0.1 - 1 | |
| Silver (Ag) | < 100 | < 2 | 0.02 - 1 | |

Only cadmium and lead gave concentrations above the detection limit in the TCLP Test.

Table 9-26 also presents the leachable concentration of the heavy metals in the original Bellingham ash, based on the quantity of leaching solution being 20 times the weight of the ash tested, as required in the TCLP test. The range of heavy metal concentrations in background soils from ANZECC/NHMRC (1992), and from Kabata-Pendias and Pendias (1984) for selenium and silver are also given, together with the ANZECC/NHMRC Environmental Investigation levels.

Comparison between the leachable concentrations from the TCLP tests and the total metal concentrations in soils is necessarily a very rough comparison, because the TCLP test will over-estimate leachable bottom ash aggregate concentrations in typical soil/rainfall situations (see below) and the total metal concentrations in soils will over-estimate leachable concentrations in soil situations also. Nevertheless, the comparison does suggest that, even if the full TCLP test quantity of heavy metals were leached from the ash, mixture with only small quantities of soil (for example the same quantity as the ash ) would result in overall soil concentrations not being changed greatly. This is particularly so when it is recognised that the proposed bottom ash aggregates from Kwinana can confidently be expected to have very much smaller concentrations of leachable heavy metals, as indicated by the TCLP test, than shown in Table 9-26. At the Bellingham ash TCLP leach levels, if all of the leached heavy metal were absorbed into the same weight of soil, that soil would not exceed the ANZECC/NHMRC Environmental Investigation Guideline Level for any metal, with the possible exception of cadmium, which might require up to about 4 times the weight of soil, depending on the existing concentration in the soil. However, the cadmium concentration absorbed onto the same mass of soil would be well below the ANZECC/NHMRC Health Investigation Level Guideline on 20 mg/kg.

Apart from consideration of the leachable metal content of the bottom ash products, the conditions of the TCLP test will also give an excessively high indication of the leachability of heavy metals from ash products in typical application situations. The TCLP test is designed primarily to indicate leachability in landfills, and the leaching solutions have a pH of 5.0 or lower to simulate landfill leachates. The ash product will be alkaline, and this greatly decreases the solubility of trace elements under the most likely leaching situation, from rainfall. This can be illustrated by comparison of experiments using distilled water (a reasonable substitute for rain water) reported by Kirby and Rimstidt (1994) for mixed bottom and fly ash, with the TCLP test results on the Bellingham fly ash. Because the fly ash is the dominant contributor of leachable heavy metals, the presence of the significantly larger quantity of bottom ash would not be expected to greatly affect heavy metal concentrations in solution, compared with those for fly ash only. The Bellingham fly ash TCLP tests gave concentrations of about 100 mg/L, whereas the Kirby and Rimstidt experiments found concentrations of about 0.05 mg/L or less, for similar ash/solution ratios, after one day's contact or longer. Differences in solubility of this order would be expected on the basis of solution chemistry of lead for pH values between 5.0 and over 7.0. These results strongly suggest that leaching of heavy metals from the bottom ash aggregates will be very much lower in realistic leaching exposure situations than in the TCLP test, so that the quantities leaching can be confidently expected to be of no environmental concern for the types of use currently proposed.

Uses which might have a greater likelihood of heavy metals leaching into aquatic ecosystems, such as use as drainage aggregate or as fill in situations where there may substantial water movement through the fill, will only be considered if, as appears quite possible, the concentrations of heavy metals under realistic leaching conditions are shown to be extremely low, and present no risk of exceeding guideline levels in the receiving water.

However, as indicated above, testing and assessment of the actual bottom ash products will be undertaken to establish what, if any, uses for these materials should be restricted to ensure the absence of any possible effects.

### *Dioxins*

There are no test results available for the dioxin content of bottom ash from an Olivine combustor. Because of the very high temperatures to which the ash is exposed, dioxin levels would be expected to be very low.

Information is available about bottom ashes from other MSW combustors, and these indicate dioxin concentrations of about 2-3 ng I-TEQ/kg. This is about the level of dioxins commonly found in rural soils in Europe and North America, and in urban soils in Australia and New Zealand. Accordingly, the levels of dioxins in bottom ash, even from combustors whose bottom ash is likely to contain considerably higher concentrations than those from the proposed Kwinana WTE, cannot be considered an environmental hazard.

### *Alternative disposal options*

The information presented above indicates that there are no possible adverse environmental effects which would result if the bottom ash were disposed of in landfill, in the unlikely event that it was not used otherwise. This would be the disposal option of last resort.

## *9.15.3 Vitrifier glass*

### *Leachability of glass.*

The key factor which might affect the safety and suitability for use of glass from the vitrifiers is considered to be the possibility of leaching of heavy metals from the glass. However, the concentrations reported in the leachates indicate that these are so low that special sampling and analytical precautions would be needed to avoid contamination unrelated to the vitrified glass indicating false high results. It is not clear that any published study yet found has detected any leaching of toxic elements from vitrified MSW ash product. The following study is that reporting testing with the lowest detection limits found so far.

The temperatures in the vitrifiers are so high (over 1300 °C in the glass melt) that there is no realistic possibility of any dioxins on the glass.

Schumacher (1994) presents results of leaching tests on glass from the electrically heated reducing vitrifier discussed above, in terms of the maximum percentage of the German drinking water standards for the particular elements. From these, and the German drinking water standards, the maximum concentrations in the leachate can be calculated. In all cases, the percentages of the drinking water standards were presented as "less than" values (presumably because of concentrations below the analysis method detection limit), so that the true percentages, and therefore the true leachate concentrations may have been substantially lower than the "less than" values given.

Table 9-27 gives the information from which the leachate concentrations are calculated, together with those concentrations and the ANZECC guidelines for protection of aquatic ecosystems. Guidelines for protection of aquatic ecosystems are usually the most stringent guidelines of those for any water use.

*Table 9-27. Leachate concentrations from reducing vitrifier glass.*

| Element | % of German DW standard | German DW standard | Leachate concentration | Guidelines for protection of aquatic eco-systems |
|---|---|---|---|---|
| | | mg/l | | |
| Zinc (Zn) | <0.4% | 2 | <0.008 | 0.005 - 0.05 |
| Copper (Cu) | <0.15% | 0.3 | <0.00045 | 0.002 - 0.005 |
| Lead (Pb) | <7% | 0.04 | <0.0028 | 0.001 - 0.005 |
| Nickel (Ni) | <2% | 0.05 | <0.001 | 0.015 - 0.150 |
| Cadmium (Cd) | <2% | 0.005 | <0.0001 | 0.0002 - 0.002 |
| Mercury (Hg) | <1% | 0.001 | <0.00001 | 0.0001 |

The maximum concentrations which might be present in leachates (although the true concentrations may be substantially lower) range between 40 times lower than the most stringent of the guidelines, and three times above (for lead) these most stringent guidelines. Since the concentrations in leachates themselves meet or only exceed by a modest factor the most stringent guideline concentrations, in spite of the acid conditions of the leaching test (pH 4) which may give higher concentrations than from contact with natural water, there is no reasonable possibility of adverse environmental effects from contact between the vitrified products and natural waters. If entire stream beds consisted of the product, they would almost certainly support a healthy aquatic ecosystem, provided other factors were satisfactory.

***Alternative disposal options***

Again, the information presented above indicates that there is no possible environmental effects which would result if they were disposed of in a cleanfill, in the unlikely event that it was not used otherwise. This would be the disposal option of last resort.

## 9.16 NOISE

### *9.16.1 Modelling Approach*

Noise level propagation to the surrounding noise sensitive areas has been modelled for construction and plant operation noise and assessed against the Environmental Protection (Noise) Regulations 1997. The sound power levels used in the predictive modelling were based on file data and measurements from a power station in Meremere, New Zealand. These sound power levels should be used as a guide for either the specification and/or during detailed design (see Appendix Q).

The construction phase is to be carried out during day time hours from Monday to Saturday (7.00am – 6.00pm). The plant operation will be continuous throughout the day and night times except for truck deliveries which will be restricted to between 0700 and 1900 hours.

The nearest residences are located to the north east in Hope Valley (approximately 2600 m) named "Location 1" and to the west in Medina (approximately 2500 m) named "Location 2".

The noise propagation was assessed at all surrounding noise sensitive premises and in particular Location 1, residence on Garden Road in Hope Valley and Location 2, residence on the corner of Tucker Street and Derbel Street in Medina.

The assessment has assumed that noise emissions from both construction and plant operation will be tonal such that the predicted levels have been adjusted by +5 dB(A). Furthermore, the Regulations require that the noise emissions do not 'significantly contribute' to an exceedance at the residence when other industry are also contributing. To ensure this, the assigned levels were effectively reduced by 5 dB(A). Thus, the tonality and contribution adjustments effectively add 10 dB(A) to the actual predicted/measured noise level at the residence.

***Construction Noise***

Noise emissions from construction activities are predicted to be 40 dB(A) and 39 dB(A) at Locations 1 & 2 respectively as shown on Figure 9-19. The assigned Day time levels, as per Regulation 8, at Locations 1 and 2 are 50 dB(A) and 45 dB(A) respectively. Thus, the noise emissions comply with the assigned levels of Regulation 8 at the nearest noise sensitive premises during the day time when construction activities will occur. It should be noted that the equipment used in the noise modelling was generic only and if there are significant changes once construction equipment is known, the modelling should be reassessed.

*Figure 9-18. Noise Emissions from Construction Activities*

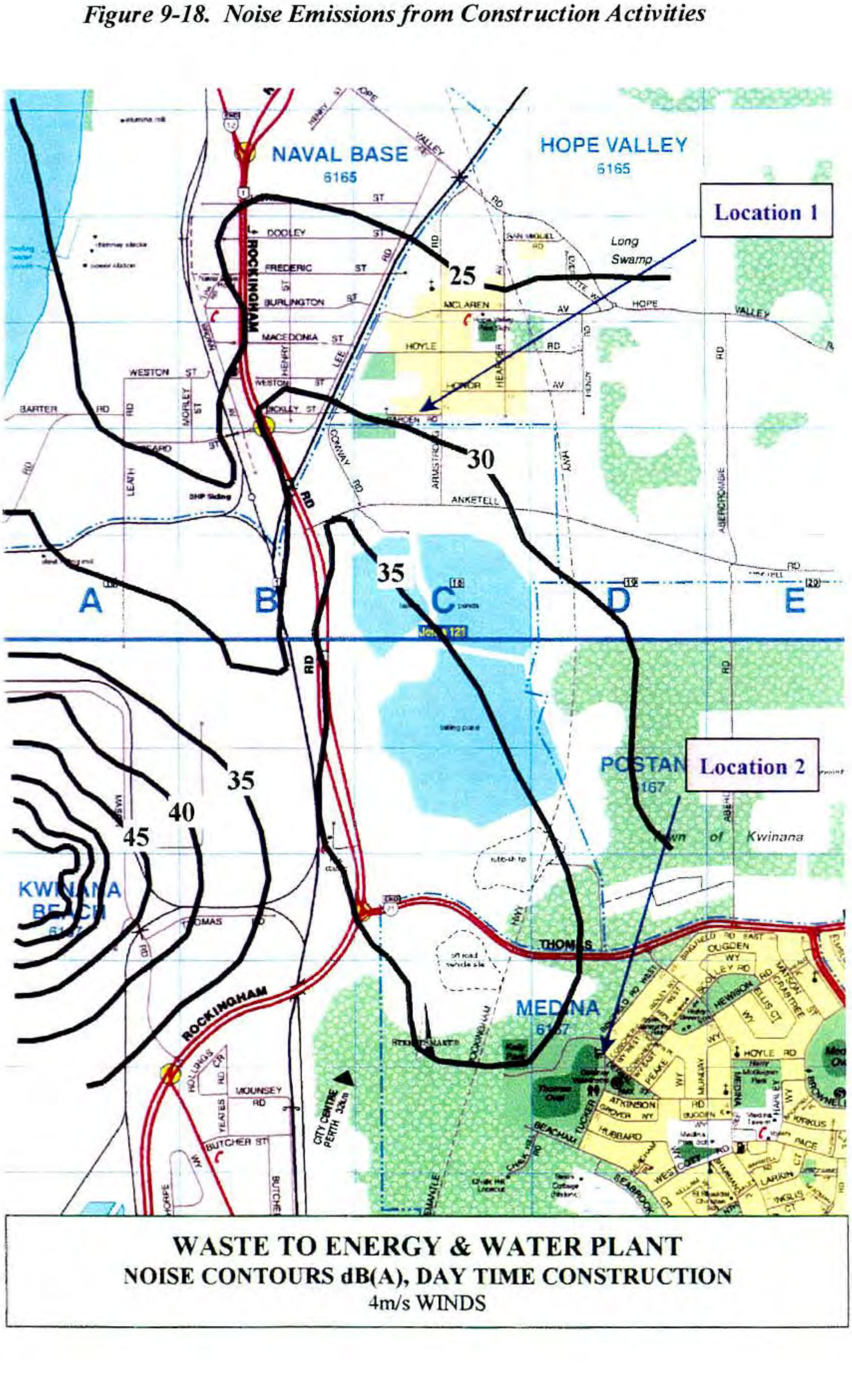
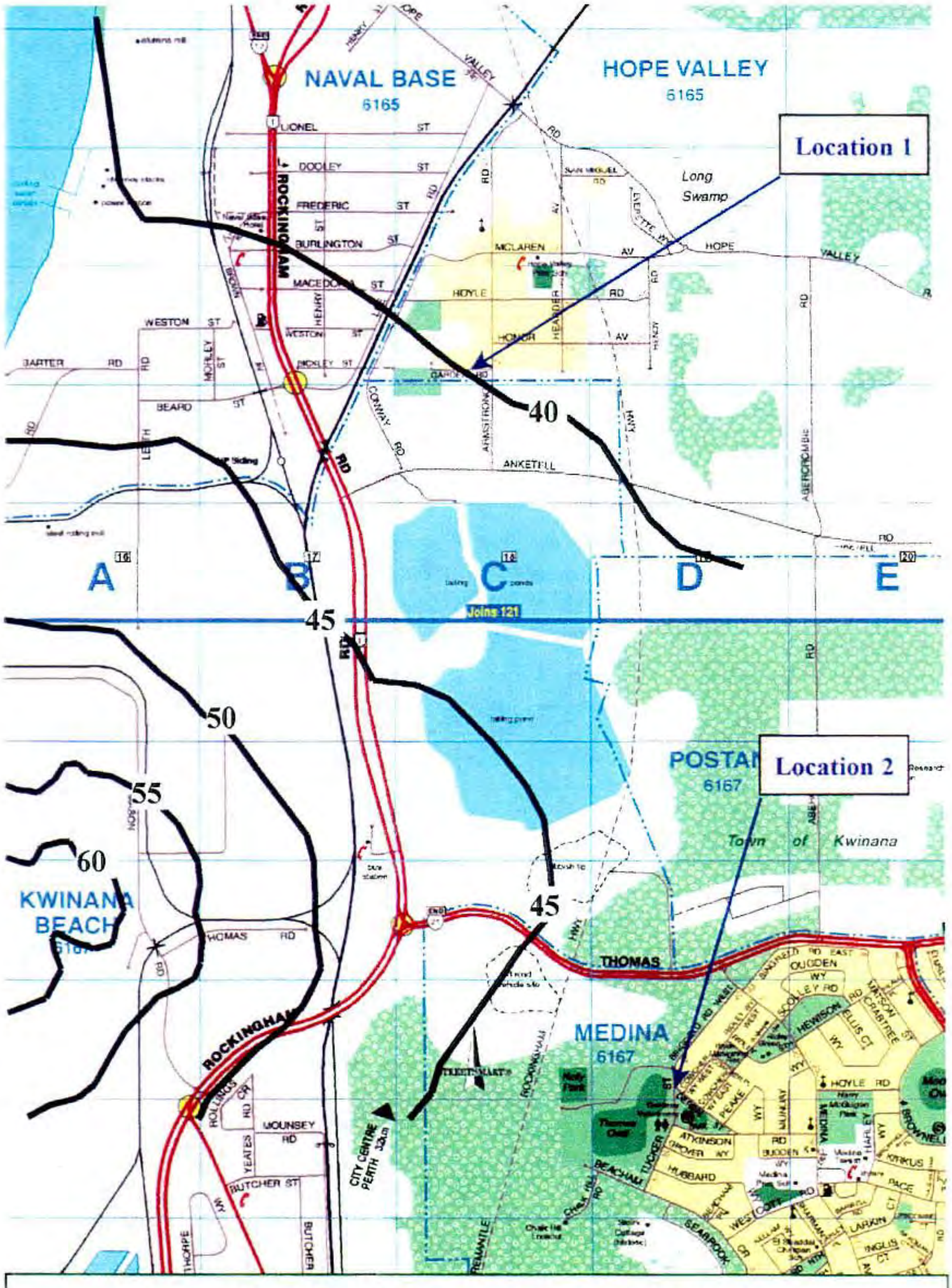
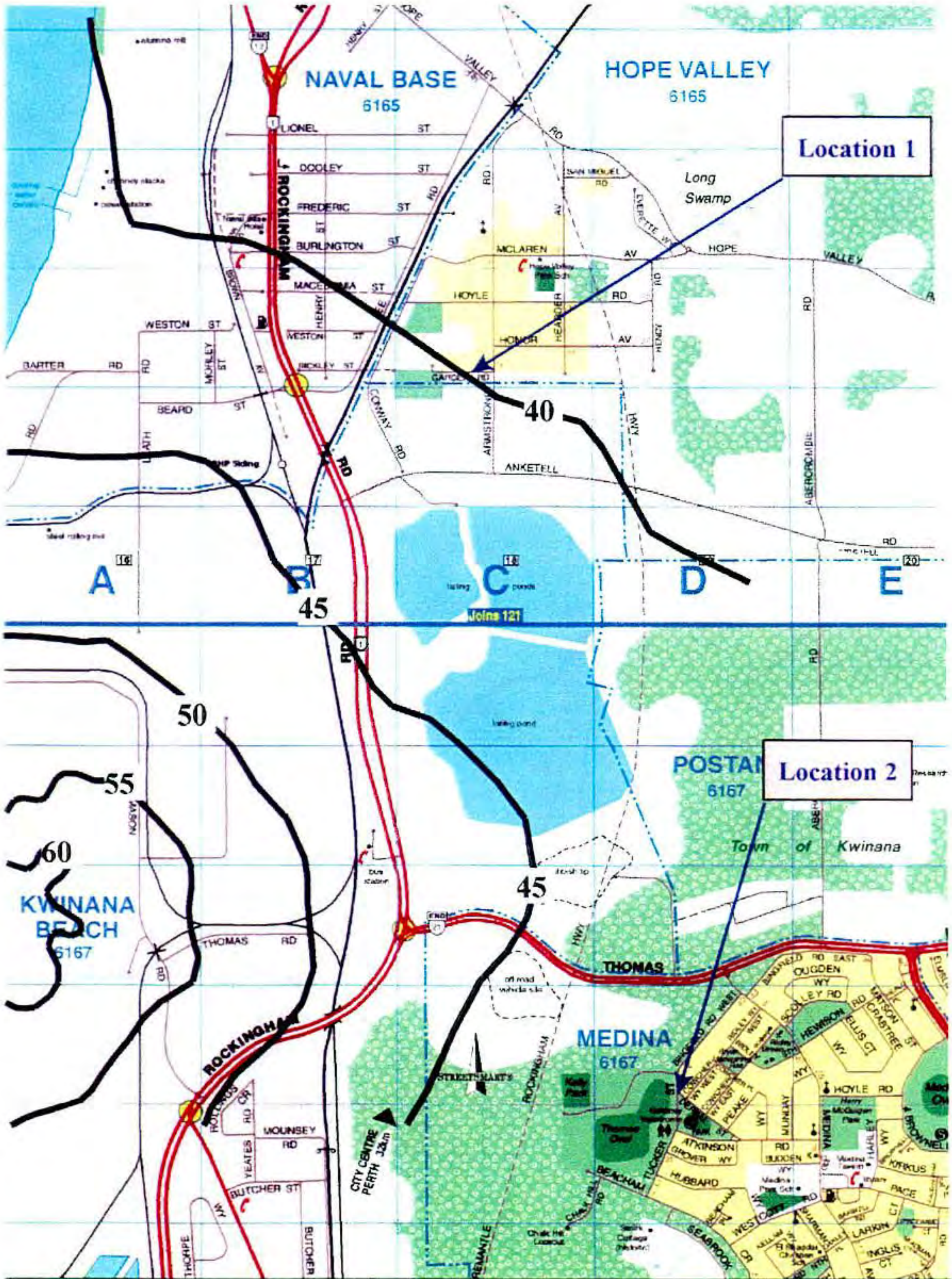


*Figure 9-19. Plant Operation Noise – Daytime*




**WASTE TO ENERGY & WATER PLANT**
**NOISE CONTOURS dB(A), DAY TIME PLANT OPERATION**
4m/s WINDS

*Figure 9-20. Plant Operation Noise - Night-time*




**WASTE TO ENERGY & WATER PLANT**
**NOISE CONTOURS dB(A), NIGHT TIME PLANT OPERATION**
3m/s WINDS AND 2°C/100m TEMPERATURE INVERSION

*Plant Operation Noise*

Noise emissions of the operating plant are predicted to be 47 dB(A) during both the day and night times at Location 1. At Location 2, the noise emissions are predicted to be 46 dB(A) during the night time and 47 dB(A) during the day time. This is shown on Figure 9-19 and Figure 9-20 respectively. The assigned noise levels for these locations are as follows:

| | *Day time* | *Night time* |
|---|---|---|
| *Location 1* | *50* | *40* |
| *Location 2* | *45* | *35* |

Therefore, the critical location and time is at Location 2 during the night period where the exceedance is 11 dB(A). Examining the results of the single point calculation shows that it is the Turbine Hall which is the dominant noise source and is required to be reduced by 12 dB(A) in order to achieve the Regulatory criteria. If the noise from the Turbine Hall is reduced by the required amount, the noise emissions will comply at all locations, at all times.

The 12 dB(A) noise reduction can be readily achieved by improving the building envelope of the Turbine Hall as described below, or an equivalent.

1. Construct the walls of concrete.
2. Construct the ceiling/roof as follows or an equivalent:
    - Metal deck roof
    - Bradford R2.0 Glasswool Batts over steel purlins under hard roof.
    - One layer of 13 mm thick plasterboard fixed to furring channels and hung from the purlins.
3. Any inlet and discharge silencers to meet a sound pressure level of 85 dB(A) at 1 metre.

Any other equivalent proposals to the above will be subject to acoustical assessment and the noise emissions at the residences recalculated (prior to construction) based on the final plant design.

The noise level at the boundaries of the neighbouring industrial premises also exceeded the criteria by up to 6 dB(A) including a tonality adjustment. The dominant source on all boundaries was again the Turbine Hall. If the above noise controls are undertaken, the boundary noise levels will also meet the Regulatory criteria.

The proponents' noise management commitments are summarised in Section 1.

## 9.17 LAND

### *9.17.1 Potential sources of land contamination from the proposed development*

The proposed WTE&W development will handle MSW and other waste materials. The development will produce waste aggregate from the UHT combustion process, and also glass waste from the vitrification process. Waste and hazardous chemical storage, and management of leachate produced from waste storage areas are discussed in Section 9.15.1. Section 9.15.1 also details management of incoming waste materials and waste products produced by the ultra high temperature combustion and vitrification processes.

### *9.17.2 Potential disturbance of existing contaminated materials*

The proposed plant development will occur in the north of the site area (refer Figure 9-18), north of and away from the identified extent of existing soil contamination on site. No disturbance of the contaminated soils will therefore occur directly from the proposed development. However, the proponent is aware that a residual impact from the existing contamination remains.

## 9.18 SOCIAL SURROUNDS – ROAD TRANSPORT

### *Traffic Generation and Assignment*

Population and workforce figures for the Kwinana and Rockingham region and associated journey to work studies indicate that the origin of the workforce will be typically 31% Rockingham, 27% Kwinana, 24% South West metropolitan region and 18% outside the south west metropolitan region (State Planning Commission 1991 **Road Reserves Review**).

It is not expected that there will be any major public transport services available for workers to access the Site particularly during the construction period. It is therefore assumed that 90% of the workforce will arrive by car with only 15% as passengers. It is also assumed that:

- the workforce will arrive and leave during a 1 hour period and that will occur during the normal peak for the local area;
- no heavy commercial traffic will be generated during the morning and afternoon peak hours;
- there will be one major plant site access from Mason Road; and
- that the plant traffic will be in addition to the current traffic utilising the road system.

It is expected that the construction phase will generate about 540 vehicles per day and the operational phase will generate about 450 vehicles per day, of this 340 will be trucks. These volumes allow for two way movements.

As a check, the traffic generation rate for the developed sections of the southern part of the Kwinana Industrial Area is typically 13 vehicles per hectare of site (CCD Australia 1990 **Kwinana Industrial Area Traffic Study**). At this rate the operational plant could generate about 420 vehicles per day. This correlates with the expected traffic generation.

The construction phase traffic is not much larger than the operational phase traffic and will only apply for a short period. It is not expected that the construction and operational situation will overlap for any significant period. The assessment of the impact is therefore based on the operational situation.

The assignment of the additional operational traffic to the local road network and the additional peak hour turning movements at the Mason Road, Rockingham Road, Patterson Road and Mandurah Road intersection are contained in Appendix L.

### *9.18.2 Traffic Impact*

***Road Network***

The increased volumes of development traffic are within the capacity of each road and are less than the normal annual increase in traffic. No significant adverse impact is expected.

***Mason Road Intersection***

Main Roads WA is currently reviewing the operation of the combined intersection at Mason Road, Mandurah Road, Rockingham Road and Patterson Road.

Proposals to increase capacity for turning and through traffic are being examined. An additional through lane on Rockingham Road and Patterson Road is being reviewed along with modifications to the signal phasing.

The additional development traffic through the intersection results in about a 1% increase in traffic movement. This is less than the expected annual increase.

The greatest increase is on Mason Road, particularly the left turn exit. There is however an existing left turn lane to accommodate the movement.

Even though the additional traffic volumes are low there is likely to be some impact on the operation of the intersection as it is currently near capacity. This would apply to any traffic increase not just that from the proposed development. The increase from the development traffic is not expected to significantly alter the current level of service at the intersection.

It appears however that any impact will be reduced once the proposed intersection improvements are implemented.

Main Roads WA advise that improvements are being considered for 2008. Advancing this program should be pursued.

The proposed intersection is expected to accommodate the additional development traffic. Recent SIDRA analysis, using the existing and predicted development traffic volumes, indicates that the intersection will operate at level of service D once the improvements are undertaken (Halpern Glick Maunsell December 1999 ***Mandurah Road-Mason Road Intersection***). This analysis is presented in the Appendix L.

***Peak Hour***

The peak hours are the constraining operating periods on the immediate road network. In the Kwinana Industrial Area major industries attempt to stagger their shift changeover periods and avoid major product movement during the peak hours to reduce the peak volume.

The proposed development should establish its workforce change over time and product delivery schedules to fit in with the operations of existing industries and continue the process of reducing the peak hour traffic volumes.

***Plant Access***

Plant access will be off Mason Road and security controlled.

The location of the access must be a sufficient distance south of the curve in Mason Road (BP private entry road) to provide adequate sight distance for turning traffic to safely enter and leave Mason Road.

All traffic movements to the Plant will be to the south on Mason Road and it would be appropriate to provide a left turn entry lane.

The geometric layout of the access must be sufficient to accommodate the B double truck turning movement.

***Summary***

The development of a waste to energy plant on Mason Road in the Kwinana Industry Area will generate additional traffic, however the distribution and volume of the traffic is considered to be within the capacity of the existing road and intersection network.

No significant adverse impacts are expected and the physical road pavements have been constructed to accommodate industrial traffic.

Proposed improvements by Main Roads WA to the Mason Road, Rockingham Road, Patterson Road and Mandurah Road intersection will assist with future traffic flow. Main Roads WA should be requested to undertake these improvements prior to the Plant becoming operational.

The plant site access will be located and designed to provide safe intersection sight distance and adequate turning geometry for large vehicles. A left turn entry lane is recommended.

## 9.19 SOCIAL SURROUNDS – PUBLIC HEALTH AND SAFETY

### *9.19.1 Introduction*

This section assesses the risk of any fatalities occurring off the WTE&W plant site as a consequence of hazardous events which may occur on-site. Hazards from neighbouring facilities that may pose a risk to WTE&W plant personnel are also considered. These considerations also suggest that the risks of on-site fatalities are also extremely low.

Further risk assessment and management activities will be undertaken as the more detailed design and development of the project proceeds. These will include assessment of the risks of injury or fatalities on-site as a result of hazardous events. Design features and operational procedures will be incorporated to eliminate such hazards wherever practically possible, and to minimise the residual risks of occurrence and consequences, for any which cannot be eliminated.

### 9.19.2 *WTE&W Plant Risks*

Assessment of the risks is approached by first identifying the worst possible hazardous events (Hazard Identification), and assessing whether there is any potential for off-site fatalities if these events were to occur (Consequence Analysis). In such an assessment, if any of the possible events could result in off-site fatalities, the probability of occurrence of those events would then be assessed to estimate the off-site fatality risk. For the WTE&W plant, none of the possible hazardous events would result in off-site fatalities, so that the assessment does not proceed past evaluation of the consequences of those events.

#### *Hazard Identification*

The hazards associated with the WTE&W Plant's design and operation, which have a potential offsite impact, are presented in Table 9-28.

***Table 9-28. Hazard Identification***

| Hazard No. | Functional/ Operational Area | Possible Initiating Events | Possible Consequences |
|---|---|---|---|
| 1 | Natural Gas Line | Loss of containment due to vehicle or machinery impact, corrosion, or fitting failure. | Fire, explosion, loss of natural gas supply to plant. |
| 2 | WTE&W Process– UHTC Chamber | Failure of Natural Gas line to pre-heat burners resulting in a loss of containment of natural gas. | Fire, explosion, impact on process and production. |
| 3 | WTE&W Process– UHTC Chamber | Loss of containment leading to resulting in exhaust gases being releases direct to atmosphere. | Release of exhaust gases containing $SO_2$ and $NO_x$ to atmosphere. |
| 4 | WTE&W Process– UHTC Chamber | Failure of Lime input mechanism resulting in decreased or no flow of Lime to UHTC Chamber. | Increase of Sulphur Oxides in exhaust gases and emissions to atmosphere. |
| 5 | WTE&W Process– UHTC Chamber | Failure of Urea input mechanism resulting in decreased or no flow of Urea to UHTC Chamber. | Increase of nitrogen oxides in exhaust gases and emissions to atmosphere. |
| 6 | WTE&W Process - Baghouse | Failure of Natural Gas line to burners resulting in a loss of containment of natural gas. | Fire, explosion, impact on process and production. |
| 7 | WTE&W Process - Vitrifier Offtake Gas Scrubbing System | Process equipment loss of containment. | Emission of toxic gases including $H_2S$, HCl and $NH_3$ to atmosphere. |
| 8 | Activated Carbon Silos and handling equipment | Generation of dust and static electricity.<br>Collection of dust in Silos' baghouses. | Fire, Explosion |
| 9 | On site vehicle incidents | Collision of road and/or rail vehicles | Personal injury and/or fatality limited to incident area and involving vehicle occupants and nearby pedestrians. |
| **Major hazards from neighbouring plants** | | | |
| 10 | Wesfarmers LPG Site | LPG loss of containment from operations and storage. | Fire, Explosion, BLEVE |
| 11 | TIWEST Plant | Chlorine and/or $TiCl_4$ loss of containment from process operations. | Toxic gas plume |
| 12 | TIWEST COGEN Plant | Natural gas release | Fire, Explosion |
| 13 | BP Refinery | HF loss of containment from operations and storage.<br>Hydrocarbon loss of containment from operations and storage. | Toxic gas plume<br><br>Fire, Explosion, BLEVE |

***Consequence Analysis***

Of the 13 hazards identified in Table 9-28, nine originate from the WTE&W plant's design and operation. Three of these hazards involve the loss of containment of natural gas (NG) (i.e. Hazard Nos. 1, 2 & 6). The latter two hazards consider the case where the failure of the NG supply pipelines to the plant equipment burners (i.e. the UHTC chamber and the baghouse). In these cases, and in keeping with good engineering practice, it is expected that the supply lines will be of small diameter and that isolation valves will be provided so that the potential inventory to fuel a fire will be small. Therefore, the consequences of these hazards are expected to be contained in the immediate area and given that escalation to other plant is minimised through design and operation, then these hazards pose minimal, if any, potential off site harm.

The potential incident of the main NG supply pipeline to the WTE&W plant (including metering station and valving) suffering a loss of containment and resulting in a fire and/or explosion (i.e. Hazard No. 1), has the potential for both on-site and offsite impacts. The level of consequence, both to on and off-site personnel, will be primarily dependent on the pipeline location. The consequences can be mitigated by good engineering design, such as isolation valves to reduce the available NG to fuel a fire, burying the pipeline and routing the pipeline away from hazardous areas.

The activated carbon silos, dust collectors and handling equipment (i.e. Hazard No. 8) pose a threat of fire and/or explosion due to dust generation and handling and the generation of heat within the activated carbon whilst in storage. Although it is expected that the heat radiation from a fire of an activated carbon silo will be limited to the immediate vicinity and not pose a threat to off-site personnel, this will be dependent on the location of the silos.[8]

Four of the identified hazards involve the loss of containment to atmosphere of toxic materials (i.e. Hazard Nos. 3, 4, 5, 7). The potential impact on personnel from these losses of containment is provided in Table 9-29, which incorporates the specific operating conditions, that have been used to determine the resulting emission potential harm.

The table shows that, as measured by the IDLH (Immediately Dangerous to Life and Health) thresholds, only loss of containment of the vitrifier offtake gas scrubbing process stream (i.e. Hazard No. 7) has the potential for offsite harm. The toxic components of concern are HCl and $H_2S$. The concentration of ammonia ($NH_3$) in the process stream itself is well below its IDLH threshold value.

The vitrifiers are housed in a separate building, and the off-gas will be treated in an annex to that building. The off-gas lines from the vitrifiers will be double-cased between the main vitrifier building and the annex, so that the only realistic possibility of releases of off-gas will occur in the annex. A number of design features and operational procedures will be incorporated to minimise the possible risks to staff working in the off-gas treatment annex, including, for example:

- A sloping roof leading to a continuously-operating ventilation off-take feeding into the UHTCs;

[8] The silos will be constructed with concrete and are isolated from other buildings and immediate human activity.

- Continuous sensing of high concentrations of hydrogen chloride and/or hydrogen sulphide, with automatic cut-out of vitrifier power and waste feeds, to quickly terminate off-gas releases
- Segregation of each off-gas treatment component into cubicles
- Identification of the circumstances and activities most likely to lead to possible off-gas releases, with specific safety precautions, such as requiring self-contained breathing apparatus, where the risks of hazardous release cannot be eliminated or controlled to negligible levels.

Ventilation of air from the top of the sloping annex roof will be particularly effective in controlling any off-gas release. Vitrifier off-gases are highly buoyant, even when at the ambient temperature, because of their hydrogen content. Pressures in the off-gas treatment system will be close to atmospheric pressure or under slight vacuum, so that releases will not be forceful. This means that any released off-gas will tend to retain its buoyancy and rise to the roof, where it will be collected and fully treated in the UHTCs, before significant exposure of people in the annex building is likely.

Because of these measures, required to protect WTE&W plant staff, any possible release off-site is extremely unlikely. However, as a means of demonstrating that off-site fatalities or injury will not result from possible vitrifier off-gas releases, modelling of the emissions from the possible vitrifier toxic releases (below) considers the direct outdoor release of off-gas as free jets. This is worst-case scenario because of the housing of the incorporated. The approach is considered acceptable because if this worst case scenario does not present any possibility of off-site fatalities, the absence of any such possibility from such a release inside a building is clearly proven.

The impact of a loss of containment of the vitrifier offtake gas scrubbing process stream, with direct outdoor release, has been assessed by modelling the resulting toxic plume for three weather scenarios (Wind speed 1.5 m/s and Atmospheric Stability Classes F and D, Wind speed 5 m/s and Atmospheric Stability Class D). The release concentration of HCl or $H_2S$ is taken to be the maximum concentration in the process stream. The modelling assumes rupture of the pipework, resulting in a continuous release at the total process stream flowrate. The resultant HCl and $H_2S$ cloud footprints are presented in Appendix R.

The HCl plume is buoyant due to its high temperature and the 50 ppm (IDLH) contour at ground level extends to approximately 50 m. The lower edge of the 50 ppm contour is above head height (2 m above ground) from about 90 m and this contour, at any height, extends for a total of approximately 250 m. The 500 ppm contour (potential fatality threshold) extends for a maximum of 50 m, and the lower edge of this contour rises above head height at about the same distance (50m). Given the location of the vitrifier units, even if outside, there would be no offsite fatalities due to the toxic effects of HCl.

Although $H_2S$ is denser than air, the identified release scenario is a buoyant plume due to the hydrogen in the gas stream. The 100 ppm (IDLH) contour extends approximately 50 m in all three weather conditions modelled. The lower edge of the contour does not rise above head height out to 50 m for the 5m/sec windspeed case, and rises above this at slightly shorter distances (35-40m) for the 1.5 m/sec windspeed cases. The 1000 ppm contour (potential fatality threshold) extends for approximately 6 m, and is below head height over this distance. Given the location of the vitrifier units, even if outside, there would be no offsite fatalities due to the toxic effects of $H_2S$.

The final hazard (i.e. Hazard No. 9) considers the potential for vehicle accidents (both road and rail) to occur. Although fatalities from a vehicle accident are a possibility, these events can be minimised by good traffic and vehicle speed control practices. Nevertheless, such incidents would be confined to the site and therefore pose minimal, if any, threat to off-site personnel except for normal traffic conditions in the Kwinana area.

None of the toxic release scenarios would cause fatalities offsite, although there is the potential for toxic gas releases to cause death or injury to on-site personnel. However, failure of multiple elements of control systems and procedures would be required in the extremely unlikely event of a significant toxic gas release for this potential to actually occur. Depending on the routing of the Natural Gas supply line and the location of the activated carbon storage silos there may be some offsite flammable effects, however these would be limited to areas immediately adjacent to the WTE&W site.

**Table 9-29. Hazardous Materials In Process Streams**

| Hazard No. | Material | Maximum Concentration | Process Stream | Pressure | Temperature | Threshold Concentrations | Consequence of Loss of Containment |
|---|---|---|---|---|---|---|---|
| 3, 4, 5 | $SO_2$ | 265 ppm | Combustor primary exhaust | 1.01 bar | 1700°C | IDLH – 100 ppm. Lethal concentrations are of the order of 700 to 1500 ppm for 30 minutes exposure. | Any release would rapidly disperse to below dangerous concentrations. Fatalities due to toxic effects are not considered credible, however injury to nearby workers could occur. |
| 3, 4, 5 | NO | 204 ppm | Combustor secondary exhaust | 1.07 bar | 80°C | IDLH – 100 ppm. Exposure to oxides of nitrogen between 100 and 150 ppm are dangerous for exposures of 30 to 60 minutes. | Fatalities due to toxic effects are not considered credible, however injury to nearby workers could occur. |
| 7 | HCl | 13 mol % | CPG Syngas | 1.01 bar | 1200°C | IDLH – 50 ppm. Lethal concentrations are of the order of 500 to 1300 ppm for 30 minutes exposure. | Fatalities could result due to loss of containment. |
| 7 | $H_2S$ | 2.8 mol % 28000 ppm | Syngas less Hg | 0.86 bar | 38°C | IDLH – 100 ppm. Concentrations of 1000 to 2000 ppm result in death in a few minutes. | Fatalities could result due to loss of containment. |
| 7 | $NH_3$ | 6 ppm | Syngas less Hg | 0.86 bar | 38°C | IDLH – 300 ppm. Prolonged repeated exposure to concentrations of up to 50 ppm produces no injury. | Release of ammonia at such low concentrations would have no effect. |

IDLH (Immediately dangerous to life and health) values are taken from the NIOSH Pocket Guide to Chemical Hazards (Ref 7)

### *Neighbouring Risk Contributors*

The Hazard Identification has determined 13 hazards that potentially pose a risk of harm to personnel. In this context, harm is defined as personnel injury and fatality. Four of the 13 hazards (i.e. Hazard Nos. 10, 11, 12 & 13) are imposed onto the WTE&W plant from neighbouring facilities. The risk imposed onto the WTE&W plant site is dependent on the site layout. For each hazard Table 9-30 considers the risk imposed for the worst case of the two proposed layouts i.e. Options 1 & 2 (Ref 1).

***Table 9-30.*** *Neighbouring Risk Contributors*

| Hazard No. | Description | Comments |
|---|---|---|
| 10 | Wesfarmers LPG – LPG fire, explosion, BLEVE | The risk associated with the LPG storage in insulated tanks is not expected to pose an unacceptable risk to WTE&W Plant as per Option 1. |
| 11 | TIWEST – $TiCl_4$ and chlorine toxic gas and fire/explosion. | A chlorine and TiCl4 are the major risk contributors from TIWEST operations. The annual individual risk contour of $1x10^{-5}$ would extend onto the southern end of the WTE&W site and is not expected to encroach onto the area used for the site's buildings as per Option 2. |
| 12 | TIWEST COGEN - NG fire, explosion, BLEVE | The annual individual risk contour of $1x10^{-5}$ and $1x10^{-6}$ is not expected to extend onto the WTE&W Plant facilities as per Option 2. |
| 13 | BP Refinery – HF fire and explosion | The individual risk contour of $1x10^{-5}$ per year is expected to extend onto the south-western corner of the WTE&W site but not onto the area used for site building's as per Option 2. |

### *Risk Assessment*

Based on the consequence analysis reported above, the level of individual risk that may be experienced at the WTE&W Plant site boundaries is likely to be very low and fall within EPA criteria.

## 9.20 SOCIAL AMENITY

Due to the location of the site within the Kwinana Industrial estate, there are few social amenity issues associated with the proposed development.

Insects and rodents will be controlled by ensuring that all MSW and green waste is stored within the main WTE building and compost building respectively. Bait will be regularly laid in each of the buildings to destroy any vermin transported to the site within the waste and escaping before the combustion process.

A professional pest control organisation will be engaged at least once a year to survey and report on vermin. If any problems are identified immediate action will be taken to eradicate the source.

As all waste will be stored within enclosed buildings no bird control will be necessary.

# 11. SUMMARY OF KEY CHARACTERISTICS

***Table 11-1. Summary of key characteristics***

| ELEMENT | DESCRIPTION |
|---|---|
| Waste to Energy Building | Roof Area – 17,200m$^2$.<br>Total floor area (upper-basement and upper-level)– 31,200m$^2$.<br>Fully enclosed and tightly sealed.<br>Constructed on a large concrete pad with internal drainage system.<br>Storage – approximately 6 days waste storage:<br>Direct truck access to upper basement (containers) and upper level (containers and loose MSW).<br>2 stacks approximately 70 m in height, each discharging treated flue gases from 6 UHTC's |
| 12 Ultra High Temperature Combustors | Processing an average of 1.2 million tonnes of MSW and maximum of 1.45 million tonnes of MSW per annum.<br>Constructed in two separate plants (6 units per plant) within the WTE building.<br><br>Producing approximately:<br>• 220,000 – 260,000 tonne of bed ash aggregate and ferrous and non ferrous metal clinker per annum;<br>• Approximately 35,000 tonne of bed fines per annum;<br>• Approximately 24,000 tonne of fly ash per annum.<br><br>Each UHTC will be fitted with the following:<br>• High Temperature Gas Scrubbing (reduces $SO_x$ and also expected to decrease de novo synthesis).<br>• Low Temperature Gas Scrubbing (reduces acid emissions and dioxins).Selective Non-Catalytic Reduction (SNCR) (reduces NOX ).<br>• Activated Carbon Injection (reduces remaining SOx, HCl, heavy metals and de novo synthesis dioxin).<br>• Fabric Filter (for control of particulate material).<br><br>Each UHTC will be fitted with plant and monitoring controls to ensure optimum combustion temperature and residence time and emissions monitoring. |
| Boilers | One water tube conventional boiler for each UHTC.<br>Two spare boilers to be stored on-site in boiler workshops. |
| 4 Turbo Generators | 780 GWh per annum average.<br>30MW capacity per turbo generator<br>Housed within a separate, enclosed turbine hall. |
| 4 IET PEM™ Melters | Processing approximately 100,000 tonnes per annum.<br>Housed within a separate, enclosed building.<br><br>Processing the following products into glass:<br>• Bed ash fines (up to approximately 94 tonne/day).<br>• Fly ash (approximately 68 tonne/day).<br>• Boiler ash.<br>• Hazardous wastes, excluding radioactive substances and explosives.<br>Each vitrifier will be fitted with the following:<br>• Water Scrubber<br>• Activated carbon filter<br>• LO-CAT Scrubber<br><br>Off-gas fuel vented to UHTC's after scrubbing and removal of by-products. |
| Glass Products Plant | Approximately 88,000 tonnes/annum average |
| 8 Desalinator Chains | Producing approximately 30 million tonnes per annum average.<br>Including:<br>• Water Treatment Plant<br>• Water Reservoir |

| ELEMENT | DESCRIPTION |
|---|---|
| | • Water Bottling Plant |
| Compost Plant | Processing approximately 56,000 tonnes green waste per and producing 30,000 tonnes compost per annum.<br>Housed within a separate, enclosed building.<br>Vented to UHTC's. |
| Concrete Plant | CON-E-Co proprietary packaged unit.<br>Approximately 80,000m$^3$ per annum.<br>Fitted with specification extraction hoods and bag filters. |
| Concrete Products Plant | For moulding of concrete products including olivine panels. |
| Bed Ash Aggregate Screening Plant | Approximately 220,000 – 260,000 tonnes per annum<br>Housed within a separate, enclosed building<br>24hr ash storage<br>Ventilated to UHTC's<br>Ash transfer point fitted with fabric filter. |
| Dangerous Goods Store | To store all hazardous wastes for vitrification and dangerous goods used on-site.<br>Designed in accordance with EDGA 1961. |
| Waste Deliveries | Waste deliveries by single unit, semi trailer and B-double trucks. |
| Road Access | One site access located to provide good visibility. |
| Truck Wash | Truck Wash facilities provided. |
| Cooling water inlet and discharge | Intake approximately 4.2 m$^3$/s.<br>Water discharge (summer) – approximately 3.34 m$^3$/s<br>Water discharge (winter) – approximately 1.42 m$^3$/s.<br>Water discharge temperature – approximately 32 °C (constant).<br>Water discharge salinity (summer) – approximately 48 ppt.<br>Water discharge salinity (winter) – approximately 60 ppt.<br>Cooling water anti-scalant concentration (summer) – approximately 3.4 ppm.<br>Cooling water anti-scalant concentration (winter) – approximately 8 ppm. |
| Ancillary Works | Stormwater drainage designed to separate clean and contaminated water;<br>Internal roading;<br>Truck wash;<br>Truck weighbridge<br>Main site office |
| Workforce | Construction – up to 300 people at one time (2 year period)<br>Operation – up to 50 people full time |

# 12. SUMMARY OF ENVIRONMENTAL FACTORS AND MANAGEMENT

*Table 12-1. Summary of environmental factors and management*

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| BIOPHYSICAL | | | | | | |
| Marine Environment | Marine water, Cockburn Sound | To ensure that the quality of marine water and sediment in Cockburn Sound are maintained or improved, by ensuring that the effluent quality at and beyond the boundary of the mixing zone comply with the following statutory and acceptable standards:<br>• The environmental quality criteria and environmental quality objectives recommended in the Southern Metropolitan Coastal Waters Study (1991–1994) report (DEP, 1996); and<br>• Standards recommended in the draft WA Water Quality Guidelines for Fresh and Marine Waters (EPA, 1993). | Discharge is located in proposed buffer zone (or zone of Moderate Ecological Value) on the eastern margin of Cockburn Sound. | Localised increase in the temperature and salinity of order of 0.5°C and 0.5ppt within 100 m of discharge.<br><br>Discharge of anti-scalant at an initial concentration of 5 to 8 ppm.<br><br>Possible increase in metal concentrations in sediments. | Conductivity-temperature-depth survey extent of plume.<br><br>Conduct eco-toxicity testing of discharge for impacts on marine organisms.<br><br>Conduct pre-discharge sediment contamination survey and periodic surveys following commencement of discharge. | No adverse environmental effects. |
| POLLUTION MANAGEMENT | | | | | | |
| Water | Groundwater quality | To ensure that the beneficial uses of groundwater can be maintained consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) | Vacant Lot that has been used for industrial waste disposal. The lot is surrounded by industrial development. | Accidental releases of hazardous and non-hazardous substances and any leachate associated with these. | Detailed design of all substance storage facilities in accordance with all relevant legislation and policies, standards and codes of practice.<br><br>Establish standard operating procedures for operations and activities involving all substances including waste acceptance procedures.<br><br>Develop and implement staff and contractor training.<br><br>Develop and implement the site Emergency Plan<br><br>Develop and implement the site Health and Safety plan for the facility operations involving | Off site surface water resources will be protected<br><br>Appropriate groundwater protected beneficial uses will be maintained<br><br>Management of hazardous and non-hazardous substances on site will meet The EPA's |

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| | | | | | substances.<br><br>Develop and implement monitoring and reporting policies. | objective |
| Air | Air quality | To ensure that gaseous emissions from the new plant in isolation and in combination from neighbouring sources and background concentrations:<br><br>Meet the air quality standards and limits stated in the Kwinana EPP and other relevant air quality standards/guidelines, including the NEPM for Ambient Air Quality (with advice sought from the DEP on specific pollutants as necessary);<br><br>Do not cause an environment or human health/amenity problem; and meet the requirement of Section 51 of the Environment Protection Act 1986, to take all reasonable and practicable measure to minimise all discharges. | Plant is within the Kwinana industrial area. Air in the surrounding area is significantly affected by existing emissions, but meets Kwinana EPP and NEPM standards | SOx, NOx, CO and acid gas emissions may increase existing levels.<br><br>Emissions of dioxins, and heavy metals may contribute to existing exposures and associated health risks<br><br>Emissions of PAH, chlorobenzenes, chlorophenols, benzene and aromatics may increase exiting levels | Emissions minimised by plant design and operation, continuous monitoring and fuzzy logic process control.<br><br>Review after 1 year with view to decreasing emission limits for SO2 and Nox.<br><br>CO emissions extremely low Dispersion modelling shows negligible increases for sulphur dioxide, carbon monoxide and acid gases, and minor increases for nitrogen dioxide<br><br>Health risk assessment completed<br><br>Excellent combustion conditions ensure negligible emissions | No significant deterioration in air quality.<br><br>Contribution to existing intakes negligible, and no increase in health risks<br><br>No change in existing levels |
| | Particulates/dust | To ensure that the dust levels from the project meet the air quality standards and limits stated in the Environment Protection (Kwinana) (Atmospheric Wastes) Policy 1992 Wastes) Policy 1992 and the NEPM for Ambient Air Quality.<br><br>Use all reasonable and practicable measures to minimise the discharge of particulate wastes. | Existing air quality meets Kwinana EPP requirements | UHTC stack emissions may increase existing ambient levels<br><br>Vitrifier emissions may increase existing ambient levels<br><br>Possible dust emissions from lime or limestone and ash handling | Baghouses ensure very small levels of particulate emissions<br><br>Vitrifier emissions are via UHTC's and gas scrubbing only.<br><br>All receivals in enclosed buildings<br><br>All ash processing in enclosed buildings with air extracted through dust extraction units to UHTC air supply. | No change in existing levels<br><br>No change in existing levels<br><br>Negligible dust emissions<br><br>No dust emissions from ash processing |

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| | | | | Possible dust emissions from concrete plant | Silos fitted with bag filters | No dust nuisance |
| | | | | | Cement silos equipped with bag filters, and transfer points with extractor hoods/bag filters | No dust nuisance |
| | | | | Possible fugitive dust emissions during construction | Dust management plan prepared, agreed and implemented | No dust nuisance |
| | Smoke/opacity | To ensure that: Smoke emissions meet the requirement of AS 3543 and opacity meets the National Guidelines for the Control of Emissions of Air Pollutants from New Stationary Sources (1985) AEC/NHMRC.<br><br>Meet the requirement of section 51 of the Environmental Protection Act 1986, to take all reasonable and practicable measures to minimise all discharges. | | Emissions from stacks may be visible | Baghouses ensure very small levels of particulate emissions and compliancy with requirements | Plumes will not be visible as a result of particulate emissions |
| | MSW Odour | To ensure that the discharges of odour are minimised to prevent odour nuisance at or beyond the boundary of the site. Specific requirements are described in;<br><br>Guidelines for the Storage, Processing and Recycling of Organic Wastes. Draft for Public Comment. Department of Environmental Protection Western Australia. 1997. | The site is surrounded by other industrial activity. | Odour nuisance | Fully enclosed buildings with induced draft ventilation. All ventilated air is incinerated at high temperature. | No effect. |
| | Greenhouse gases | To minimise greenhouse gas emissions in absolute terms and reduce emissions per unit product to as low as reasonably practicable. | Most MSW to landfills, with methane recovery probably about 25%. Most power generation from fossil fuels. High | Greenhouse gas emissions from combustion of plastics, tyres and other fossil carbon-based materials. | Integration of MSW combustion with materials recycling, electricity generation, and desalination plant to maximise use of biomass fuel in MSW. | Significant net reduction in greenhouse gas emissions |

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| | | To mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State Guidance No 12 "Minimising Greenhouse Gases"<br><br>Proponents are required to:<br>Take all 'no regrets' measures in construction and operation.<br>Take 'beyond no regrets' measures which are reasonable and practicable and<br>Commit to a program of investigation, research and reporting of and progressive implementation of 'no regrets' and 'beyond no regrets' measures. | greenhouse gas emissions. | Electricity generation from biomass fuel in MSW. | Avoidance of wastage of biomass fuel by placement of MSW in landfills.<br><br>GOWA to enter Greenhouse Challenge agreement with Commonwealth Government.<br><br>Investigation of isotopic methods to monitor fossil carbon dioxide emissions<br><br>Investigation of nitrous oxide emissions, with view to minimising this minor greenhouse gas emission | |
| Waste | Solid waste | To ensure wastes are managed in accordance with the DEP's waste management hierarchy (i.e., avoid, minimise, recycle, treat and dispose). | WA has commitment to reduce per capita waste to landfill by 50%.<br>Recycling programs in operation | Significant reduction in wastes to landfill | Operation of UHTCs to produce clinker aggregate | Enhanced recycling where soundly based on local life cycle analysis. |
| | | | | Enhanced recycling, including inorganic wastes (aggregates and glass), steel, non-ferrous metals and plastics, where practical and economic. | Magnetic and eddy current separation for metals<br>Establishment of composting facility for greenwastes<br>Lifecycle analysis project on paper recycling in WA. | |
| | | | | Possible environmental effects from leachable contaminants in aggregates or glass | Immediate use of aggregate restricted to concrete aggregate and roading<br>Regular leaching tests of aggregates to establish leachability of Kwinana UHTC product<br>Assessment of potential environmental affects prior to initiating other uses<br>Existing information shows no | No environmental effects from use of materials |

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| | | | | | detectable leaching from glass, but will be confirmed | |
| | | | | Ensure absence of effects if disposal is required as option of last resort. | Existing information demonstrates no effects from disposal to landfill for aggregates, or to clean fill for vitrifier glass | No environmental effects if last resort disposal required. |
| Water | Groundwater quality | To ensure that the beneficial uses of groundwater can be maintained, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) | Groundwater beneath the site has been extensively impacted by historical industrial waste disposal operations. | Existing groundwater contamination from on-site sources<br><br>Existing groundwater contamination from off-site sources | Existing groundwater contamination from on and off-site sources.<br>Develop and implement an appropriate groundwater environmental management plan. | Appropriate groundwater protected beneficial uses will be maintained. Management of groundwater contamination will meet the EPA's objective. |
| Water | Groundwater quality | To ensure that the beneficial uses of groundwater can be maintained consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) | Accidental releases of hazardous and non-hazardous substances and any leachate associated with these. | Detailed design of all substance storage facilities in accordance with all relevant legislation and policies, standards and codes of practice. | Off site surface water resources will be protected<br>Appropriate groundwater protected beneficial uses will be maintained | No environmental effects |
| | | | | Establish standard operating procedures for operations and activities involving all substances including waste acceptance procedures. | Management of hazardous and non-hazardous substances on site will meet the EPA's objective | |
| | | | | Develop and implement hazardous waste sampling and analysis plan | | |
| | | | | Develop and implement staff and contractor | | |

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| | | | | training.<br><br>Develop and implement the site Emergency Plan Develop and implement the site Health and Safety plan for the facility operations involving substances.<br><br>Develop and implement monitoring and reporting policies. | | |
| Water | Surface water quality | To ensure that surface water is managed to prevent discharge of contaminated water from site or to groundwater | The site is a vacant lot. The site is generally flat, and underlain by permeable sands with a high infiltration capacity. There is very little expression of surface water features. | Potentially contaminated stormwater from on site sources | Detailed design of on site stormwater system to effectively separate, treat and dispose of potentially contaminated and uncontaminated stormwater.<br><br>Develop and implement a stormwater management plan for the construction and operational phases of the facility. | Off-site surface water resources will be protected<br><br>Appropriate groundwater protected beneficial uses will be maintained<br><br>Management of on site surface water will meet the EPA's objective |
| Land | Site Contamination | To ensure that the site is assessed and managed in accordance with the ANZECC/NHMRC (1992) Guidelines for the assessment and management of contaminated sites. | Part of the site in the south and east of the Lot has been used for the disposal of refinery chemical wastes. Most of the contaminants except oil have been removed previously. | Contaminated soils are present at concentrations exceeding the ANZECC (1992) Environmental Investigation 'B' guidelines, and the NEPM Health Based Investigation Level 'F' guideline for industrial sites (NEPC, 1999). This material represents a potential risk to: | Develop and implement an appropriate Land Contamination Environmental Management Plan. | The existing land contamination can be managed to meet the EPA;s objective. |

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| | | | | • Human health of site contractors via dust inhalation/ingestion or dermal contact;<br>• Human health of contractors at neighbouring sites through dust inhalation;<br>• No significant risk is anticipated to the groundwater ecology. | | |
| Risk Management | Onsite operation hazards | The overall objectives in the management of hazardous industrial plant are:<br>To minimise the risk (i.e.: individual, societal and environmental) associated with new developments.<br>To ensure that hazardous industry and land-use planning in the vicinity meet acceptable criteria for individual fatality risk and that separation distances are established in the planning process.<br>To ensure the plant continues to operate in such a manner that the emissions and risks are managed within the accepted criteria and licence conditions. | The site is the abandoned PICL plant site and its neighbours include major hazardous facilities. | Emissions to atmosphere for process upset conditions and/or incidents on plant including fire. | Risk Management strategy for the future phases of the project developed and committed | Risk minimised to acceptable levels as per EPA criteria. |

| FACTOR | SITE SPECIFIC FACTOR | EPA OBJECTIVE | EXISTING ENVIRONMENT | POTENTIAL IMPACT | ENVIRONMENTAL MANAGEMENT | PREDICTED OUTCOME |
|---|---|---|---|---|---|---|
| | Hazards imposed from neighbouring facilities | The overall objectives in the management of hazardous industrial plant are:<br>To minimise the risk (i.e.: individual, societal and environmental) associated with new developments.<br>To ensure that hazardous industry and land-use planning in the vicinity meet acceptable criteria for individual fatality risk and that separation distances are established in the planning process.<br>To ensure the plant continues to operate in such a manner that the emissions and risks are managed within the accepted criteria and licence conditions. | The site is the abandoned PICL plant site and its neighbours include major hazardous facilities. | Emissions to atmosphere for process upset conditions and/or incidents on plant including fire. | Risk Management strategy for the future phases of the project developed and committed | Risk minimised to acceptable levels as per EPA criteria. |

# 10. MANAGEMENT OF IMPACTS

## 10.1 MARINE

There are unlikely to be any significant impacts on the marine ecosystem associated with the GOWA proposal. However, to confirm this finding GOWA will implement the following management plans to be finalised in consultation with the DEP and in light of comments received during the public review process.

### *10.1.1 Water quality management plan*

The primary aim of the water quality plan is to determine the level of dilution of the plume and the extent of influence to validate the modelling results. If the dilution and extent of influence is similar to or less than that predicted by the modelling then no further work will be undertaken. If the field study shows that estimates of dilution and extent of influence of the plume have been incorrect then further action may be undertaken following consultation with the DEP.

The validation will be performed in two stages:

- Firstly, prior to construction of the GOWA discharge, field data and corresponding meteorological data will be obtained such that the Western Power and/or the BP plume can be characterised and numerical modelling conducted for the conditions under which the field data were obtained. The field data and the model output will then be compared and the results presented to DEP Marine Branch for discussion.
- Secondly, following commencement of cooling water discharge, a fine scale CTD survey will be undertaken during measured wind conditions to establish the extent and dilution of the GOWA plume. The results of the survey will be reported to the DEP.

Additionally, testing of the discharge for toxicity to marine life at various concentration levels will be undertaken and the results reported to the DEP. Furthermore, prior to commencement of discharge, the proponent will have prepared a contingency plan to the satisfaction of the DEP which examines the risk of contamination of the discharge and procedures to be followed in the event that such contamination does occur.

### *10.1.2 Sediment quality management plan*

A sediment quality monitoring program will be developed in consultation with the DEP. The program will comprise of a baseline survey to be undertaken prior to commencement of cooling water discharge to establish typical levels of contaminants in the region and a schedule of surveys following commencement of discharge to establish the extent of any impacts.

Initially, the cooling water will either discharge from an existing shoreline drain or a new drain adjacent to the existing drain. As such, there may already be elevated contaminant levels in the sediments in the immediate vicinity.

If and when the cooling water is combined with the BP cooling water and the outlet moved to the western edge of the James Point harbour, the sediment monitoring program will be modified accordingly.

## 10.2 AIR

### *10.2.1 Stack Emissions*

The primary emphasis for management of the impacts of the WTE&W plant on air quality, and effects arising from discharges to air on land and marine ecosystems, must be on management and minimisation of emissions. The dispersion modelling, health risk and ecosystem effects assessments presented in the relevant Sections show that the emissions to air from the waste-to-energy plant will cause very small changes in existing environmental levels of any of the contaminants. This means that there is no realistic prospect of even the most sophisticated monitoring program being able to demonstrate any change between existing levels and those after establishment of the plant. The existing variability in air quality and in the levels of contaminants of possible concern in other environmental media will be considerably larger than the increments resulting from even the most extreme emissions from the WTE&W plant. Accordingly, there is no realistic prospect of detecting changes resulting from plant emissions, and of using the detection of such changes as a basis for management of air quality, health or environmental impacts.

The description of the proposal and technology of the WTE&W plant outlines the extensive range of design and operational approaches to be incorporated into the plant to control and optimise the combustion and air pollution control systems, in order to minimise emissions. All critical parameters are monitored continuously at appropriate locations in the process stream, with the data being used by a fuzzy logic system which controls and optimises the settings of all key equipment. More detailed descriptions of this monitoring and control system and procedures are provided in Section 3.14.

For some contaminants of possible concern, continuous monitoring systems are not available. However, monitoring of other parameters provides a reliable guide to ensure that the processes are controlled in a manner to minimise emissions of these contaminants. For example, carbon monoxide concentrations provide a good measure of the completeness of combustion achieved, and the continuous maintenance of low concentrations of carbon monoxide the destruction of dioxins and other "dioxin precursor" compounds.

### *10.2.2 Odour*

The principal odour management technique to be employed is full containment of potentially odorous air streams. There are two main odour sources in this proposal. These are the main MSW hall itself, that contains the waste prior to combustion, and the greenwaste composting plant. The dangerous goods store is a minor odour source.

All buildings are fully enclosed and provided with full ventilation. The air that is extracted is vented into the main MSW hall that is in turn ventilated at a rate of about 4 air changes per hour. The extraction of air from the MSW hall is vented into the combustors where it is used as primary and secondary combustion air. All the air requirements for combustion are met from the MSW hall ventilation.

The ability of the combustors to treat the odorous ventilation air will be checked using forced choice dynamic olfactometry. The odour strength of each individual source will be measured together with the odour emission rate from the combustors. On site odour observations will also be made according to a strict "odour jury" protocol to ensure that low level odours are minimal during access door openings and combustor maintenance.

Full details of the odour assessment protocols and methods will be prepared in an odour management plan. This plan will also include proposals for remediation if odour levels are found to be significant.

### *10.2.3 Dust*

No dust will be generated during the operation of the plant as all waste will be received within enclosed buildings ventilated to the combustor systems. Prior to construction a dust management plan will be finalised for the approval of the DEP.

## 10.3 WATER

### *10.3.1 Management of potential sources of water contamination*

***Hazardous goods management plan***

A Hazardous Goods Environmental Management Plan (EMP) will be developed and implemented for the site operations, in accordance with the requirements of the Explosives and Dangerous Goods Act, 1961 and amendments, and the DEP SCP. An outline of the Hazardous Goods EMP is provided in EBG, 1999, and summarised below.

***Proposed storage facilities***

The proposed hazardous and non-hazardous substance storage facilities are shown on Drawing OL00850. Operational procedures to be adopted for each material and storage facility are detailed in EBG, 1999, together with the design specification for each facility. These include:

- Activated Carbon Silos: conceptual design shown on Figure OL00850;
- Bed Ash Fines and Fly Ash Storage;
- Calcium Carbonate (Lime) Bins;
- Calcium Oxide and Hydroxide Silos: conceptual design shown on Figure OL00817;
- Boiler Workshop: storage of lubricating and hydraulic oils and degreasing solvents;
- Dangerous Goods Store: conceptual design shown on Figure OL01312. Storage of:
  - non-hazardous dry goods for preparation of the vitrifier mix;
  - waste dangerous goods prior to destruction via vitrification; and
  - dangerous goods used on site.
- Diesel Underground Storage Tank: design, implementation and operation to be in accordance with AIP, 1998;
- Glass Storage Area;
- Bulk Acid and Alkali Storage Tanks;
- Antiscalant Storage;

- Laboratory: storage of small quantities of reagents;
- MSW and Sewage Sludge: good materials handling and storage practices will be adopted;
- Natural Gas: in accordance with the EDGA 1961 and amendments and relevant Australian Standards;
- Turbine Oil Circulation System and Turbine Topper Tank: in accordance with AS 1940-1993 and DEP SCP;
- Urea Bins; and
- Used Oil Tanks: conceptual design shown on drawing OL00825, in accordance with AS 1940-1993 and DEP SCP.

### *10.3.2 Storage facility specifications*

The detailed design of the proposed substances storage facilities will be in accordance with the EDGA 1961 and amendments, the DEP guidance for the above ground storage of liquid chemicals and SCP, and the Australian Standard 1940-1993 for the storage and handling of flammable and combustible liquids. Where available, other relevant approved codes of practice will also be followed. General design principles are detailed in EBG, 1999, including:

- Construction materials (use of non-combustible/sealed materials); and
- Environmental Protection provisions (measures to prevent accidental releases of hazardous materials), including:
  - Bunding (for all above ground hazardous liquid storage), consistent with DEP SCP;
  - Dust and Odour control;
  - Drainage and stormwater control (refer Section 10.3.12;
  - Litter Control; and
  - Spillage Control.

### *10.3.3 Management of substances and mitigation of impacts*

The main elements for the management of hazardous substances are detailed in EBG, 1999. These may be summarised as:

- Facility layout designed to permit the safe and secure handling of hazardous materials; and
- Facility operations, including:
  - Transport regulations;
  - Materials Acceptance and Handling regulations;
  - Health and Safety requirements;
  - Training; and
  - Inspection, Monitoring and Reporting Procedures.

### *10.3.4 Leachate management plan*

Leachate may be generated from areas where waste is stored or handled. These include the Dangerous Goods Store, the MSW receiving building, and the Composting Plant. Wherever possible, buildings and storage facilities will be raised slightly above ground level to avoid ingress of stormwater. In a similar manner, access doors will be ramped to provide a bund against stormwater ingress and containment in case of spills. In general, containment measures will permit collection of leachate for destruction via injection in the UHT combustor.

### 10.3.5 Dangerous goods store

The dangerous goods store will be operated in accordance with the EDGA 1961 and amendments. Dangerous goods will be segregated as required, and bunds and other secondary containment measures will be provided. Bunds will be constructed using sealed concrete with a grade to promote flow to an internal sump for recovery of collected liquids. In liquid storage areas, the design, construction and maintenance of the bunds will be consistent with the requirements of the DEP SCP.

### 10.3.6 MSW receiving building

MSW and sewage sludge will be received, handled and stored completely inside the MSW building. Minor amounts of liquid leachate associated with MSW transported to the site will remain in the MSW receiving building and will not be part of the site drainage water flows. Because the MSW and sewage sludge will not be exposed to rainfall or stormwater from outside the building, the volume of liquids draining from the materials will be minor. Any liquids will remain inside the building and will be directed by internal drainage and grading to a sump, the contents of which can be pumped out and destroyed through direct injection into the combustors. The grade and slope of the floor will be designed to ensure liquids do not escape from the building through doors and other exits.

### 10.3.7 Composting plant

The composting plant will incorporate bunding to prevent the leakage of liquids from the building during handling, processing and storage. Bunds in these areas will be designed, constructed and maintained as for the hazardous substance storage facilities and in accordance with the requirements of the DEP SCP.

***Summary***

The management plan will achieve the stated objective to ensure that all environmentally hazardous liquids are controlled in order to maintain appropriate groundwater protected beneficial uses. Key hazardous substance characteristics are listed in Table 11-1. Hazardous substances environmental factors and management are listed in Table 12-1.

### 10.3.8 Management of existing groundwater contamination

The proposed development at its initial stage does not require any more than approximately 60% of the entire Lot 15 Mason Road site for its core business. The WTE&W Plant development will occur in the north of the site, and will not therefore directly disturb the contaminated soils (refer Figure 9-17 and DAL, 2000). In the event that LandCorp requires that GOWA only acquire 60% of the entire site, the area containing the contaminated material would be excluded from the development. In the event of this option (Option 1), responsibility for the management of this material and the existing groundwater contamination beneath this area would remain with LandCorp. However, GOWA would be willing to assist LandCorp in the development of an appropriate Environmental Management Plan (EMP) to address the existing groundwater contamination issue. Under Option 1, GOWA will develop and implement a groundwater contamination EMP that addresses contamination beneath the land area for which it is responsible.

Under site development Option 2, GOWA will be required to acquire the whole of Lot 15 Mason Road site and manage the existing groundwater contamination beneath the entire site.

A groundwater contamination EMP will be developed and implemented to meet the objectives of the EPA, to ensure that appropriate protected beneficial uses of groundwater can be maintained. An outline of the groundwater contamination EMP is provided in DAL, 2000, and summarised below.

***Further investigation***

A review will be undertaken of the existing groundwater monitoring, and bores will be replaced or enhanced where necessary. Further investigation will be undertaken to:

- Provide further definition of the proven or inferred areas of groundwater contamination;
- Allow comparison between current and former conditions;
- To provide appropriate data to permit a risk assessment to be undertaken if required;
- Obtain hydraulic data for the design of a groundwater recovery system; and
- Provide adequate groundwater monitoring locations.

The investigation will target the following issues:

### *10.3.9 Hydrocarbon plume*

- Review the adequacy of existing monitoring bores;
- Replace/enhance monitoring bores where necessary;
- Provide adequate monitoring to demonstrate the effectiveness of the BP installed cut-off and air sparging system to prevent any further contaminant migration onto site;
- Monitor changes in the dissolved phase contaminant plume since the 1998 survey reported in BP, 1999;
- Provide adequate data to permit a risk assessment to be undertaken, if necessary, to determine whether passive management via natural attenuation is an appropriate management strategy; and
- Provide on-going monitoring.

### *10.3.10 Inferred Arsenic/fluoride plume*

- Review existing monitoring bores, and identify requirements for additional investigation/monitoring locations;
- Determine the extent and nature of any contaminant plume that may be present;
- Provide adequate data to permit a risk assessment to be undertaken, if necessary, to determine whether passive management may be adequate, or whether remedial action is necessary;
- To provide hydraulic data for the design of a contaminated groundwater recovery system; and
- To provide on-going monitoring.

### 10.3.11 *Off-site sources of groundwater contamination*

Specifically the organo-chlorine plume and the potential EC plume:

- Review existing monitoring bores and identify requirements for additional investigation/monitoring locations; and
- Provide adequate monitoring to determine whether off-site sources are having an unacceptable impact on site groundwater quality.

***Risk assessment***

Following completion of the further investigation, the need for a groundwater risk assessment would be reviewed. The objectives of any risk assessment would be to:

- Determine the fate of identified groundwater contaminants and the extent of any impacts on groundwater resources;
- The need for groundwater remediation to manage any unacceptable impacts; and
- Assess whether passive remediation via natural attenuation is an appropriate management option.

***Groundwater remediation***

The requirement for and scope of groundwater remediation will be dependent on the results of the proposed risk assessment, and in addition the development option adopted for the site. It is anticipated that the results of a risk assessment may demonstrate that passive remediation through monitoring of natural attenuation may be an appropriate management plan for the dissolved phase hydrocarbon plume.

Should the results of the further investigation confirm that a substantial arsenic/fluoride plume is present, then remedial action may be warranted.

Under site development Option 2, GOWA considers that groundwater contamination which requires remediation may be managed through pumped recovery. Destruction of the contaminated water may occur through two routes, depending on the nature and degree of contamination of the recovered water. The WTE&W Plant utilises approximately 7 $m^3$/hour of water on a 24 hour basis for the preparation of a urea and lime slurry for wet and dry scrubbing of stack emissions. This water is lost by evaporation in the process. Other water with high concentrations of contaminants may be destroyed through injection directly into the combustor as part of the process for synthetic non-catalytic reduction of $NO_x$.

A program for the recovery of groundwater contaminants would be developed and implemented following commissioning of the WTE&W Plant. This program would eliminate or substantially reduce the existing contamination levels and render groundwater suitable for appropriate protected beneficial uses over a number of years.

***Summary***

The contaminated groundwater management plan will achieve the stated objective to ensure that appropriate groundwater protected beneficial uses can be maintained. Key groundwater characteristics are listed in Table 11-1. Groundwater environmental factors and management are listed in Table 12-1.

### *10.3.12 Stormwater management*

A detailed stormwater management plan will be developed prior to beginning construction on site and will be submitted for approval by the DEP and Water and Rivers Commission (WRC). The management plan will be implemented during the construction and operational phases of the facility. An outline of the stormwater management plan is provided in EBG, 1999 and summarised below.

The plan will address:

- Provision of a stormwater collection and disposal system to achieve an appropriate level of protection against flooding;
- Stormwater management will be restricted to the plant area (refer Appendix F), avoiding the contaminated areas of the site, that are deemed to be naturally drained;
- Clean stormwater disposal through recharge to groundwater via soakages, vegetated filter strips, grass swales or infiltration beds as appropriate. All roadways will be drained to catchment ponds to promote and maximise the infiltration of incidental rainfall;
- Minimise the generation and transport of contaminants in stormwater; and
- Provide appropriate treatment of potentially contaminated stormwater if required to mitigate off site environmental effects.

Conceptual stormwater management plans are contained in Appendix F.

***WTE& W Plant stormwater collection systems***

The following plant areas will incorporate specific stormwater collection systems:

- Roofs;
- Sealed areas (paved roads, parking etc);
- Composting Plant: Fully bunded adequate for the 1 in 100 year storm;
- Aggregate storage yard: A sediment basin/tank will be provided at the stormwater outlet; and
- Unsealed areas to incorporate earthworks shaping to prevent flooding.

These collection systems are shown on the stormwater plan attached as Appendix F.

***Disposal of clean stormwater***

Options for stormwater collection, treatment and disposal for different parts of the site are shown on plan PL206 attached as Appendix E.

Ground soakage capacity will be sufficient to dispose of the 1 in 20 year storm event. Protection of facilities against flooding from storms in excess of the 20 year event will be achieved by appropriate bunding or setting of floor levels. Soakage systems will incorporate provisions for sediment removal to maintain infiltration capacity.

### *Contaminated stormwater treatment requirements*

Proposed stormwater treatment and disposal requirements are summarised in Table 10-1 as follows:

***Table 10-1. Stormwater treatment requirements and disposal***

| SOURCE OF CONTAMINATION | TREATMENT REQUIRED | FINAL DISPOSAL |
|---|---|---|
| Paved areas | Trash and sediment removal | Ground soakage |
| Finished compost storage | Sediment removal and aeration | Make-up water, ground soakage or on site irrigation of landscaped areas |
| Aggregate storage | Sediment removal | Ground soakage |

### *Disposal of contaminated sediment*

Stormwater sediment collected in the sediment basins and removed periodically will be stored on site in the dangerous goods store and disposed of via UHT combustion vitrification as appropriate depending on the chemical composition of the materials.

### *Summary*

The management plan will achieve the stated objective to ensure that surface water is managed to prevent discharge of contaminated water from the site or to groundwater. Key stormwater characteristics are listed in Table 11-1. Stormwater environmental factors and management are listed in Table 12-1.

## 10.4 NOISE

### *10.4.1 Construction Noise*

The construction noise management plan will be in accordance with Regulation 13 of the Environmental Protection (Noise) Regulations 1997 as outlined below.

1. Work is carried out in accordance with Section 6 of AS2436-1981 GUIDE TO NOISE CONTROL ON CONSTRUCTION, MAINTENANCE AND DEMOLITION SITES.
2. The equipment used on site is the quietest reasonably available.

Prior to arrival on site, or on arrival, the equipment to be used will be measured by a suitably qualified acoustic consultant. These measurements will be compared to those used in the predictive modelling and the results reassessed. Where the noise emissions are similar or less than either those of the modelling or the prescribed standards of Regulation 8, the results will be reported to DEP. Where the noise emissions are higher than predicted and exceed the prescribed Regulation 8 standards, corrective action may be undertaken following consultation with DEP.

During the construction phase, a contact name and phone number will be published to allow residences with noise issues to raise their complaint, for it be recorded and for corrective action to be undertaken.

### *10.4.2 Operational Noise*

During the commissioning stage of the project, noise levels from the equipment will be measured by a suitably qualified acoustical consultant. The results of these measurements will be entered into the computer model with the results reassessed. Where the noise emissions comply with the prescribed standards of Regulation 8, the results will be reported to DEP. If the noise emissions exceed the criteria, further work will be carried out to determine the source of the noise, and the action that will be undertaken to reduce the noise emissions. Particular attention will be placed on the Turbine Hall to ensure the design will be as per the Herring Storer Acoustics report or equivalent. The Turbine Hall was noted as causing an exceedance at the nearest residences in the initial modelling.

## 10.5 LAND

A detailed contaminated land EMP will be developed prior to beginning construction on site and will be submitted for approval by the DEP. The management plan will be implemented during the construction and operational phases of the facility. An outline of the contaminated land EMP is provided in DAL, 2000 and summarised below.

Two options were outlined for the acquisition of the site by GOWA, as discussed in Section 10.3.8. Under Option 1, the area containing the contaminated materials would be excluded from the proposed WTE&W development, and responsibility for management of this material would remain with LandCorp.

Option 2 includes acquisition of the entire Lot 15 Mason Road site by GOWA. Under Option 2, GOWA understands that the EPA will require remediation of contaminated materials that pose an unacceptable risk to human health or the environment. This should be determined through a risk assessment process that recognises the proposed use of the land. Under the proposed development, the site will remain as an industrial facility for the foreseeable future.

The proponent will commit to remediate the site that is purchased as required by the site conditions prevailing on that site.

The proposed development will not directly disturb the identified contaminated materials. Under Option 2, it is proposed that access to the contaminated areas would be restricted from the site development area by fencing. Even so, contaminated materials with concentrations exceeding the ANZECC (1992) investigation levels, and the NEPM Health Investigation Level 'F' for industrial sites (NEPC, 1999) have been identified and therefore remedial action will be required.

The proponent considers that an adequate level of characterisation of the existing contamination is available to permit comparison to current guidelines applicable to industrial sites. The proponent will undertake to do further investigation during the course of remedial works as necessary and to remove all contaminated material at concentrations exceeding guidelines appropriate to an industrial site. The default clean-up level to be adopted will be the NEPM HIL 'F' level for commercial and industrial sites. The site will be validated according to the NSW EPA 1997 sampling design guidelines.

Under Option 2 for the proposed development, it is assumed by the proponent that soil contamination associated with the presence of PSH derived from the BP site has been adequately dealt with by BP, to the satisfaction of the EPA. No further work is proposed relating to soil contamination arising from this issue.

### 10.5.1 *Outline contaminated land environmental management plan*

Under Option 2 and based on the available site investigation data, a contaminated land EMP will be developed that will address:

- Identification of wastes that require remedial action;
- A remedial methodology and schedule;
- A site specific safety plan for all works;
- Appropriate monitoring during remedial works;
- Validation of the remedial action according to NSW EPA 1997; and
- On-going monitoring post-remedial activities.

### 10.5.2 *Site specific safety plan*

A detailed site specific safety plan will be developed as part of the EMP, that will address all issues identified in NEPC 1999, including:

- Key personnel and roles;
- Security and personal protective equipment;
- Physical and chemical hazards and environmental risks;
- Earthworks;
- Exposure monitoring;
- Decontamination procedures;
- Waste handling/disposal procedures; and
- Contingency plan for emergencies/spillages etc.

### 10.5.3 *Identification of contaminated materials*

In the absence of specific risk assessment data, it is assumed that all contaminated soils with concentrations exceeding appropriate guideline levels will require remedial action. Appropriate management will be implemented within the EMP for contaminated materials with concentrations below relevant guidelines. These may include for instance provision of a soil cover or burial.

### 10.5.4 *Excavation of contaminated soils*

Excavation of waste materials will be undertaken on a staged basis, with partially excavated areas covered over to minimise rainfall infiltration and dust generation. Access to excavation areas will be restricted by fencing and appropriate signage. Temporary storage of excavated contaminated soils if required will occur within the hazardous goods storage facility within the plant.

### 10.5.5 *Site run-off*

Little natural drainage is present on site due to the high infiltration capacity of the sandy soils. Any apparent drainage channels will be diverted away from excavation areas through earthworks. Infiltration in excavated areas will be minimised through the use of groundcovers.

### 10.5.6 *Dust control*

Dust minimisation methods will be implemented during excavation works.

### *10.5.7 Validation sampling*

Validation sampling and analysis of the following will occur:

- The eastern and southern parts of the site will be validated according to the NSW EPA 1997 sampling design guidelines.
- Excavated contaminated material to determine an appropriate destruction route.
- Excavation areas will be validated to determine removal of all appropriate contaminated material.
- Aggregates from the ultra high temperature combustion process will be validated as suitable for use as reinstatement materials within the excavation areas.

### *10.5.8 Transportation and handling of wastes*

A contaminated soil transportation and handling procedure will be implemented.

### *10.5.9 Waste destruction*

For soils that require remedial action, the proponent's preferred remedial option is for excavation of wastes with on-site destruction via ultra high temperature combustion and/or vitrification. This is consistent with option 1) of ANZECC (1992). GOWA considers this to be a more environmentally responsible option than removal to landfill, which does not dispose of wastes but merely relocates it geographically. It is understood from the proponent that:

- Contaminated soils containing mainly hydrocarbon compounds will be suitable for mixing with MSW in the UHT combustor;
- Contaminated soils containing heavy metal compounds, including arsenic, copper and lead etcetera will require treatment within the vitrifier process. This will also allow recovery of heavy metal and other components for recycling; and
- Washed non-leachable aggregate from the UHT combustor will be suitable to reinstate the excavated areas.

### *10.5.10 Monitoring*

Monitoring will be undertaken during the excavation works for health and safety purposes.

#### *Timescale for implementation*

Development of the Contaminated Land Environmental Management Plan will be commenced prior to the commencement of construction of the WTE&W Plant. The implementation of the EMP will commence post-construction of the plant. It is proposed that excavation and destruction of the contaminated materials will occur on a progressive basis following commissioning of the plant, to the treatment of approximately 12.5% of the contaminated materials per year. The proponent will commit to completing the remedial stage of the EMP within an eight year period of its implementation.

### *10.5.11 Summary*

The contaminated land EMP will achieve the stated objective to ensure that the site is managed in accordance with the ANZECC/NHMRC 1992 Guidelines for the Assessment and Management of Contaminated Sites. Key contaminated land characteristics are listed in Table 11-1. Contaminated land environmental factors and management are listed in Table 12-1.

## 10.6 SOCIAL SURROUNDS – PUBLIC HEALTH AND SAFETY

***Risk Management Strategy***

The risk management strategy recommended for the future stages of this project is outlined below. The intent of the proposed strategy is to ensure the WTE&W Plant's design and operation minimises the risk to personnel, the facility and the environment.

### *10.6.2 Project Safety*

Project Safety shall encompass the requirements of the WA Occupational Safety and Health Regulations, 1996.
Hazard identification processes to be used during the design and execution of the project include:

- **Hazard Register**
  A Hazard Register will be established via a Hazard Identification (HAZID) workshop and will be continually updated on the basis of hazards recognised during design reviews, hazard studies and changes. An independent person will be provided for the HAZID workshop.
- **Design Reviews**
  Safety design review workshops will be convened to review selected design, operability and construction aspects. An independent person will be provided for the design reviews.
- **Hazard Studies**
  Hazard Studies will be held for each stage of the project. This will include Hazard and Operability (HAZOP) studies during the detailed design stage, and Construction, Commissioning and Hand-over Hazard Studies. An independent person will be provided for the Hazard Studies.
- **Dangerous Goods Licence**
  A Dangerous Goods Licence will be attained for the WTE&W Plant's dangerous Goods storage and handling facilities as per the requirements of the WA Explosive and Dangerous Goods Regulations, 1992.

Risk assessment studies will be undertaken to identify and assess all significant hazards associated with the design, construction and operation of the WTE&W Plant. During the design process, risk reduction options will be identified and risk assessments will be carried out to demonstrate the risks from the WTE&W Plant are As Low As Reasonably Practicable (ALARP). The risk assessment will be either qualitative or quantitative depending on the nature and context of the hazard being considered.

## 10.7 SOCIAL SURROUNDS – TRAFFIC

The construction and operation of a new Waste to Energy plant on Mason Road in the Kwinana Industrial Area will increase traffic on the local road network. This increase is not expected to be significant nor exceed the capacity of the local road network.

The proponent makes the following commitments in regard to traffic impact of the proposed Waste to Energy Plant:

- Liase with established industries in the Kwinana Industrial Area and schedule workforce start and stop times and product deliveries to avoid immediate morning and afternoon peak periods for the Mason Road, Patterson Road, Rockingham Road, Mandurah Road intersection.
- Develop an entry to the premises off Mason Road that affords appropriate safe sight distance and accommodates safe entry movement for over dimensional vehicles. Provide the entry with a left slip lane and develop it in accordance with the Town of Kwinana and Austroad requirements.
- Negotiate with Main Roads WA to have the improvements to the Mason Road, Patterson Road, Rockingham Road, Mandurah Road intersection undertaken prior to the plant becoming operational.

# 13. PROPONENT COMMITMENTS

*Table 13-1. Summary of proponent commitments*

| NO | TOPIC | ACTION | OBJECTIVES | TIMING | ADVICE |
|---|---|---|---|---|---|
| 1. | Marine Water Quality | Undertake model validation exercise using results of field survey characterising Western Power and/or BP plumes. | Validate results of modelling. | Pre-construction of discharge | DEP |
| 2. | Marine Water Quality | Prepare risk assessment and associated contingency plan for the possibility of contamination of the cooling water with hazardous substances. | Develop understanding of risk of contamination of cooling water and appropriate contingency plan | Pre-construction of discharge | DEP |
| 3. | Marine Water Quality | Undertake field survey to determine dilution and extent of GOWA plume. | Demonstrate extent of influence GOWA plume. | Commissioning | DEP |
| 4. | Marine Water Quality | Undertake eco-toxicological testing of effluent to establish toxicity levels | Confirm assumption of low toxicity | Commissioning | DEP |
| 5. | Marine Sediment Quality | Undertake periodic surveys of sediment quality in vicinity of discharge | Establish level of impact on sediment quality | Pre- and post-construction | DEP |
| 6. | Marine Fauna Protection | Build screened intake structure such that intake velocities will result in minimal entrainment of pelagic fish.<br>Undertake study following commissioning to ensure that intake velocities meet the design criteria.<br>In the event that velocities exceed design criteria, develop and implement a contingency plan to the satisfaction of the DEP. | To minimise impacts on marine fauna. | Post-commissioning | DEP |
| 7. | Emissions control | Investigate and establish the lowest practical level of reliably achievable $NO_x$ emissions | Provide a basis for review of emission limits<br>Demonstrate and achieve lowest practical emissions | 1 year after commissioning | DEP |
| 8. | Emissions control | Investigate and establish the lowest practical level of reliably achievable sulphur dioxide emissions | Provide a basis for review of emission limits<br>Demonstrate and achieve lowest practical emissions | 1 year after commissioning | DEP |
| 9. | Dust/Odour | All wastes receivals in enclosed buildings, with air extracted to UHTCs | Ensure absence of release of dusts, odours or other airborne contaminants from wastes | During operations | |
| 10. | Dust control | Prepare, and agree dust management plan for plant construction | Avoid dust nuisances during construction | Plan agreed before start of construction | DEP |
| 11. | Dust control | Implement dust management plan for plant construction | Avoid dust nuisances during construction | During construction | DEP |
| 12. | Dust control | All ash processing in enclosed buildings with air extracted to UHTCs | Avoid dust emissions | During operation | |
| 13. | Dust control | Lime/limestone/cement vents fitted with bag filters | Minimised dust emissions during transfers | During operations and construction | |

| NO | TOPIC | ACTION | OBJECTIVES | TIMING | ADVICE |
|---|---|---|---|---|---|
| 14. | Emissions monitoring | Undertake continuous monitoring of emission gas flow, oxygen, temperature, opacity, carbon monoxide, sulphur dioxide, oxides of nitrogen and hydrogen chloride on the stacks | Demonstrate control of emissions from the plant | During operation | Monthly summaries to DEP |
| 15. | Emissions monitoring | Undertake co-ordinated opacity and particulate emissions testing | Establish relationship between continuously monitored opacity and particulate emissions | During operation | DEP |
| 16. | Emissions monitoring | Undertake weekly analyses of composite samples of baghouse filter cake | Provide demonstration of low emissions of heavy metals from the plant<br>Provide an alert and basis for trace-back of sources of increased heavy metal inputs to plant in wastes | During operations | DEP |
| 17. | Emissions monitoring | Undertake emissions testing on UHTC units for particulates, hydrogen fluoride, mercury and other heavy metals, and dioxins. | Demonstrate compliance with emissions limits | Within 2 months of commissioning each unit | DEP |
| 18. | Emissions monitoring | Undertake on-going emissions testing on UHTC units for particulates, hydrogen fluoride, mercury and other heavy metals, and dioxins. | Demonstrate compliance with emissions limits | Annually | DEP |
| 19. | Environmental monitoring | Monitor rainfall contaminants at plant site | Determine wet deposition rates, as demonstration of low impacts from plant at more distant sites | 1 year before start-up and 2 years after start-up | DEP |
| 20. | Environmental monitoring | Determine TSP and metal concentrations in ambient air at Hope Valley | Confirm/modify estimates of existing levels of metals in ambient air, used in health risk assessment. | 1 year before start-up and 2 years after start-up | DEP |
| 21. | Environmental monitoring | Determine dioxin concentrations in ambient air at Hope Valley | Confirm/modify estimates of existing levels and significance of contribution from WTE&W plant emissions from the health risk assessment | 1 year before start-up and 2 years after start-up | DEP |
| 22. | Environmental monitoring | Provide $NO_x$ monitor for Abercrombie Rd monitoring site | Assess existing $NO_x$ and $NO_2$ concentrations at site close to predicted maximum concentration increments from WTE&W plant emissions. | Within 3 months of confirmation of project proceeding | DEP |
| 23. | Odour | Undertake full survey of potential odour sources and discharges | Confirm adequacy of ventilation design | Post Construction | DEP |
| 24. | Greenhouse emissions | Enter into a Greenhouse Challenge Agreement with AGO | Formalise assessment and reporting of greenhouse gas emissions performance of project. | Within 6 months of project start-up | DEP and AGO |

| NO | TOPIC | ACTION | OBJECTIVES | TIMING | ADVICE |
|---|---|---|---|---|---|
| 25. | Greenhouse emissions | Estimate greenhouse gas emissions and report annually | Provision of data for national emissions inventory | Annually | DEP and AGO |
| 26. | Greenhouse emissions | Investigate means of determining fossil $CO_2$ emissions from WTE&W plant | Improve assessment of greenhouse gas emissions | Within 2 years of project start-up | DEP and AGO |
| 27. | Greenhouse emissions | Determine levels of nitrous oxide emissions from WTE&W plant | Improve assessment of greenhouse gas emissions | Within 1.5 years of project start-up | DEP and AGO |
| 28. | Greenhouse emissions | Investigate means of reducing nitrous oxide emissions, if significant | Minimise greenhouse gas emissions | Within 2 years of project start-up | DEP and AGO |
| 29. | Greenhouse emissions | Undertake Life Cycle Analysis for management of waste paper in Western Australia | Establish optimum environmental management for this resource | Within 2 years of project start-up | DEP and AGO |
| 30. | Waste reuse | Prepare and agree environmental management plan to demonstrate acceptability of vitrifier glass and bed ash aggregate material. | Establish acceptability of acceptability of vitrifier glass and bed ash aggregate material. | Pre-commissioning | DEP |
| 31. | Waste reuse | Undertake routine testing of bottom ash aggregate | In-house product quality control, including expected low levels of leachable heavy metals. | Ongoing, with summaries within 1 month of start-up of aggregate production, then annually | DEP |
| 32. | Waste reuse | Undertake leaching trials of vitrifier glass | Demonstrate the expected very low levels of leachable heavy metals, as a basis for suitability for potential uses | Within 1 month of start-up of vitrifiers | DEP |
| 33. | Waste reuse | Undertake dioxin testing of aggregate | Demonstrate low or negligible level of dioxins in the product | Within 1 month of start-up of aggregate production | DEP |
| 34. | Construction Noise | All equipment used during construction will comply with the sound power levels used in the noise modelling. If the equipment is markedly different from that used in the modelling, the model will be rerun and the noise impacts reassessed. | To minimise the impact of noise from construction of nearby residents | Construction | DEP |
| 35. | Operation Noise | Prior to construction remodel the final design to demonstrate compliance. | To ensure compliance with assigned noise levels. | Pre-construction | DEP |
| 36. | Operation Noise | All equipment will comply with the sound power levels used in the noise modelling. If manufacturers equipment varies significantly, the noise model will be rerun and reassessed. | Noise levels of plant operation will not significantly contribute to the assigned noise level as per the Environmental Protection (Noise) Regulations 1997. | Pre-construction | DEP |
| 37. | Operation Noise | Upon completion of construction, noise levels of equipment will be measured and checked for agreement with manufacturers data and compliance with the model/Regulations | Noise levels of plant operation will not significantly contribute to the assigned noise level as per the Environmental Protection (Noise) Regulations 1997. | Operation | DEP |

| NO | TOPIC | ACTION | OBJECTIVES | TIMING | ADVICE |
|---|---|---|---|---|---|
| 38. | Groundwater and soil contamination | Prepare contaminated soil and groundwater management EMP to satisfaction of DEP.<br>As part of the EMP preparation process, GOWA will assess current information and collect additional information as required. | To meet EPA objectives for the site. | Prior to commencement of construction | DEP |
| 39. | Groundwater and soil contamination | The plant will be designed, constructed and operated so as to maintain or improve the existing soil and groundwater quality. | To ensure that construction and operation of the plant does not result in further contamination of the site. | Prior to commencement of construction and during the operations phase. | DEP |
| 40. | Groundwater contamination | GOWA will design and implement a groundwater quality monitoring programme to the satisfaction of the DEP. | To provide sufficient information to determine whether the plant has any adverse impacts on groundwater quality. | Prior to commencement of construction and during the operations phase. | DEP |
| 41. | Groundwater contamination | In the event that the monitoring shows that the plant has had an adverse impact on groundwater quality, GOWA will design and implement a groundwater remediation plan to the satisfaction of the DEP. | To manage groundwater quality in a manner consistent with EPA objectives. | If monitoring shows that the plant has adversely impacted groundwater quality. | DEP |
| 42. | Accidental releases of hazardous and non-hazardous substances and leachate associated with any of these | Develop a hazardous and non-hazardous substance management plan which includes:<br>1. Location, size and elevations – COMPLETED<br>2. Plans for mechanical, structural, drainage, electrical, ventilation, fire-fighting system, signs – NEAR COMPLETION<br>3. Other specifications<br>Prepare and implement the approved Emergency Plan and Health and Safety Plan.<br>Establish site operating procedures (SOP) for activities involving hazardous and non-hazardous substances and wastes.<br>Establish technical training program for staff and contractors in SOP, hazardous substances, emergency response, heath and safety.<br>Establish and implement monitoring and reporting policies and procedures. | To ensure that the beneficial uses of groundwater can be maintained consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) | Complete detailed design of storage facilities and make application for dangerous goods license and obtain approval from DEP<br>Complete Emergency Plan before facility operation begins. Test Emergency Plan.<br>Complete Health and Safety Plan, implement during construction phase, and begin training staff.<br>Complete SOP before facility start-up and test SOP within 6 months of start-up.<br>Train permanent staff within 6 months of facility start-up.<br>Implement monitoring and reporting procedures at start-up and test within 6 months of start-up. | DEP, WRC, Chief Inspector dangerous goods or designate, representatives of emergency response agencies, Worksafe Western Australia |

| NO | TOPIC | ACTION | OBJECTIVES | TIMING | ADVICE |
|---|---|---|---|---|---|
| 43. | Water—Potentially contaminated stormwater from on site sources | Develop a stormwater management plan which includes:<br>1. Separation of potentially contaminated and uncontaminated stormwater<br>2. Reticulation of stormwater to appropriate treatment and on site disposal<br>3. Design of stormwater treatment and disposal devices<br>4. Develop stormwater management plan and forward for approval<br>5. Implement the approved stormwater management plan, including at a minimum:<br>6. Procedures during construction<br>7. Site cleaning and housekeeping program<br>8. Spills management and clean up procedures<br>9. Maintenance of stormwater collection, treatment and disposal devices<br>10. Monitoring of stormwater quality | To manage on site surface water to prevent discharge of contaminated water from site or to groundwater | Complete detailed design prior to construction<br>Implement management plan during construction | DEP, WRC |
| 44. | Traffic – Road Transport | Liase with established industries in the Kwinana Industrial Area and schedule workforce start and stop times and product deliveries to avoid immediate morning and afternoon peak periods for the Mason Road, Patterson Road, Rockingham Road, Mandurah Road intersection. | To minimise the peak volume of traffic through the Mason Road intersection. | Commencement of construction. | Main Roads WA. |
| 45. | Traffic – Plant Access | Develop an entry to the premises off Mason Road that affords appropriate safe sight distance and accommodates safe entry movement for over dimensional vehicles. Provide the entry with a left slip lane and develop it in accordance with the Town of Kwinana and Austroad requirements. | Safe turning movements into and out of the plant site. | Commencement of construction. | Town of Kwinana. |
| 46. | Traffic- Road Network | Negotiate with Main Roads WA to have government funding the improvements to the Mason Road, Patterson Road, Rockingham Road, Mandurah Road intersection made available and works undertaken prior to the plant becoming operational if possible. | Improve capacity of intersection. | Prior to commencement of operations. | Main Roads WA. |

| NO | TOPIC | ACTION | OBJECTIVES | TIMING | ADVICE |
|---|---|---|---|---|---|
| 47. | Risk Management | Undertake a risk management strategy recommended for the future stages of this project is outlined below. The intent of the proposed strategy is to ensure the WTE&W Plant's design and operation minimises the risk to personnel, the facility and the environment. This includes:<br>• Project Safety<br>• Hazard Register<br>• Design Reviews<br>• Hazard Studies<br>• Dangerous Goods Licence<br>• Safety Management System<br>Risk assessment studies will be undertaken to identify and assess all significant hazards associated with the design, construction and operation of the WTE&W Plant. | The overall objectives in the management of hazardous industrial plant are:<br>1. To minimise the risk (i.e.: individual, societal and environmental) associated with new developments.<br>2. To ensure that hazardous industry and land-use planning in the vicinity meet acceptable criteria for individual fatality risk and that separation distances are established in the planning process.<br>3. To ensure the plant continues to operate in such a manner that the emissions and risks are managed within the accepted criteria and licence conditions. | All project phases | DEP |
| 48. | Vermin Control | Engage a professional pest control organisation to survey and report on vermin. | To prevent vermin becoming a nuisance to neighbouring premises and prevent the spread of vermin borne disease. | Annually | DEP |

Note: Stringent air emission conditions will be imposed under the licence agreement to achieve a minimum of those standards set out in Table 3-3.

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# 15. APPENDICES

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# Appendix A.

# Status of MSW Management

## . Status of MSW Management in Several Countries

| Country | Current Disposal (%) | | | Comment |
|---|---|---|---|---|
| | Recycling[a] | Waste Combustion[b] | Landfill | |
| Austria | 24 | 11 | 65 | Aims to ban landfill of waste containing more than 5% organics by 2004. |
| Belgium | 3 | 54 | 43 | Aims to ban landfilling of combustible waste. |
| Canada | 29 | 4 | 67 | Aims to reduce reliance on landfill. |
| Denmark | 25 | 55 | 20 | Banning landfill of combustible wastes. Plans to increase recycling and waste combustion capacity. |
| Finland | 30 | 4 | 66 | Aiming to increase co-combustion capacity to reduce reliance on landfill. |
| France | 8 | 33 | 59 | Banning the landfill of combustible wastes by 2002. Expects by then to increase combustion capacity to 57% and recycling to 23%. Landfill tax of £20/t currently applies. |
| Germany | 18 | 36 | 46 | Aims to ban landfill of waste with greater than 3% carbon cont. by 2005. |
| Japan | 5 | 74 | 21 | Upgrading existing facilities for power generation. |
| Netherlands | 28 | 42 | 30 | Has banned landfilling of combustible waste. |
| Norway | 14 | 18 | 68 | Aims to ban landfilling of combustible waste. |
| Sweden | 19 | 47 | 34 | Aims to further reduce reliance on landfill by increasing recycling and combustion capacities. |
| Switzerland | 42 | 47 | 11 | Aims to ban landfilling of combustible wastes by 2005. |
| UK | 6 | 9 | 85 | Landfill tax of £7/t. Recycling target of 25% by 2000 and diversion from landfill target of 40% by 2005. |
| USA | 24 | 15 | 61 | No immediate changes foreseen. EPA states: WTE preferred option. |

[a] includes composting [b] primarily with energy recovery *Source: IEA Bioenergy*

# Appendix B

# Summary of Company Directors and Key Consultants

## DIRECTORS, MANAGEMENT & MAJOR CONTRACTOR'S PROFILES

### Directors

| | |
|---|---|
| Warwick John Davies | Warwick is the Chairman of the Company and its Managing Director. He has an extensive background in business development, engineering and marketing. He is Co-Director of Integrated Energy Systems Limited. He has 30 years experience in WTE technology, industrial development construction and design and build projects. He has a background in oceanography. |
| Michael Mayson | Business Manager. M.E. (electrical) MIPENZ Ex Business Manager, Powerco, Wanganui. Extensive business, engineering and analysis experience in the Electricity Industry. |
| Miles Hayward-Ryan | Miles is Chairman of the New Zealand holding company Olivine [NZ] Limited and NZ subsidiaries. He has 30 years experience as internal corporate legal advisor to major NZ public listed companies in various manufacturing, engineering, agricultural and heavy equipment, motor vehicles, domestic appliances, electronic and finance industries and consultancy experience in the legal, superannuation and investment industries. Directorships have included venture capital, television production and property companies. He is a practicing corporate lawyer. |

### Consultants

| | |
|---|---|
| Corliss M Smith | President Olivine Corporation USA. MS Mining Engineering, M.A. Economics. Expert in production and use of Olivine refractories and Olivine UHTC. |
| John Owen Gardner | M.E. John has a masters degree in mechanical engineering. He has previously been an engineer with Ceramco and Fletcher Testing Laboratories. |
| Don Steele | Nat.Cert.Eng. (UK), Mgt Cert. (NZ), City Guild P/Eng. (UK). Past power station manager. Training officer. |
| Dr Volker Schwarz | Principal in Eur-Asia Consultants, Palmerston North; PhD Chem Eng. Expert in by-products chemistry, combustion and process engineering. Previously employed at Lahmeyer, engineering consultants, Germany, where work included projects for World Bank |

| | |
|---|---|
| | on Waste-to-Energy, dangerous goods, and MSW management in Europe. |
| M.G. (Dany) Kodoor | Principal in Global Design Power Ltd, Auckland. BE, ME, Dip Indust Mangt, MIPENZ, Chartered Engineer. Electrical, and thermal design consultant. |
| Fritz Alber | NZCE, Ex Martin GmbH. Has worked on building and commissioning Martin incinerators in Europe. |
| Dr Desma Hogg | Environment Business Group Ltd, Auckland; PhD; Advisor on environmental science, dangerous goods and site contamination. |
| Dr Craig Stevenson | Institute of Environmental Science and Research, Auckland; PhD (Cantab), MSc Hons. Senior consultant environmental chemist. |
| Vera Hally | Institute of Environmental Science and Research, Auckland; MSc. Advisor on air quality. |
| Nick Roberts | Director, Barker & Associates Limited; Bplan (Auckland) MNZPI. Environmental Project co-ordinator. |
| Price Waterhouse | Chartered accountants, Auckland; auditors and tax consultants. |
| Spicer & Oppenheim | Chartered Accountants, accountant and financial advisors. |
| Christopher Baker | Finance Manager, Principal FiscalTech Ltd, a finance consultant. |

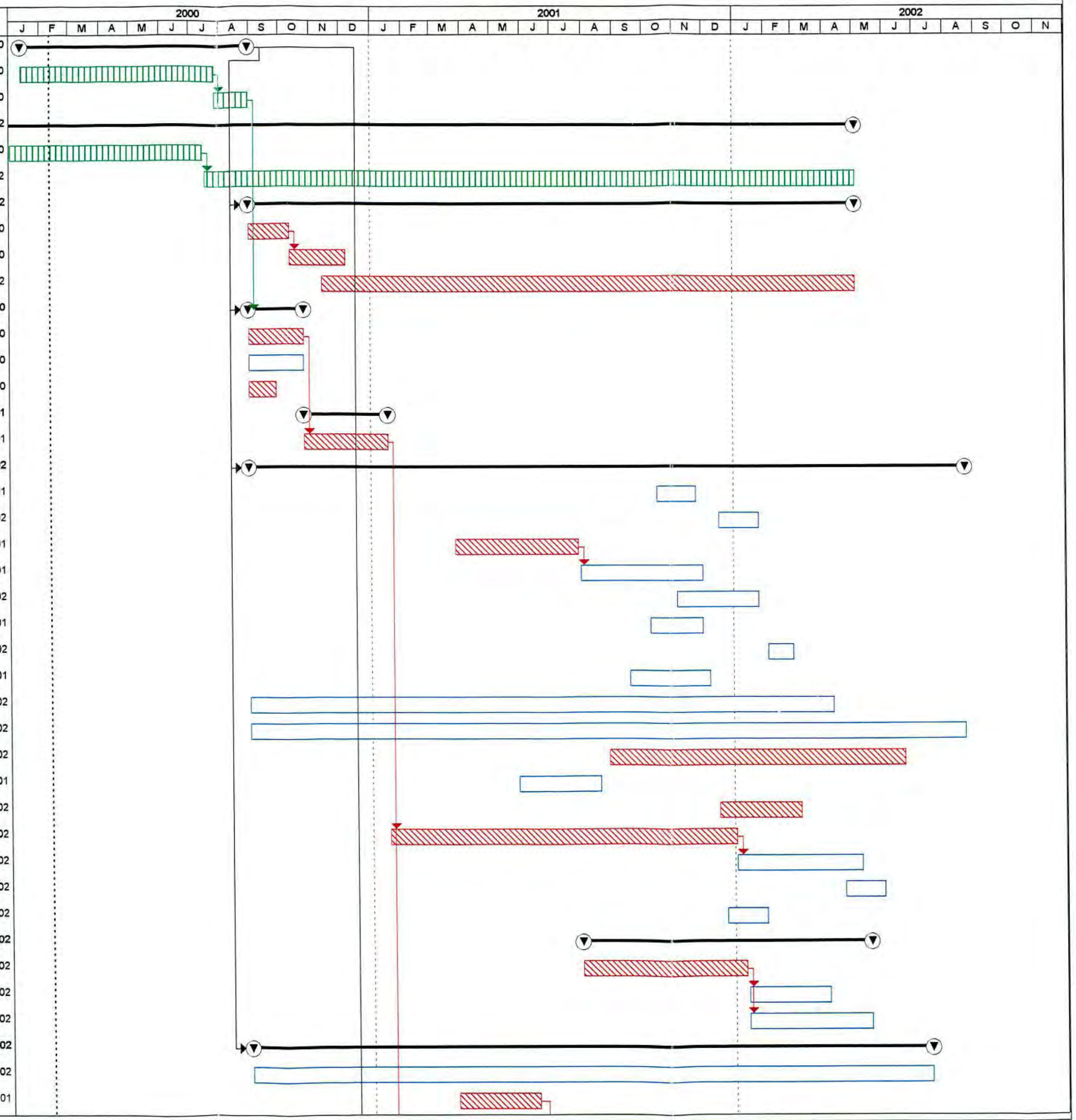
# Appendix C

# Project Timing

# Kwinnana project

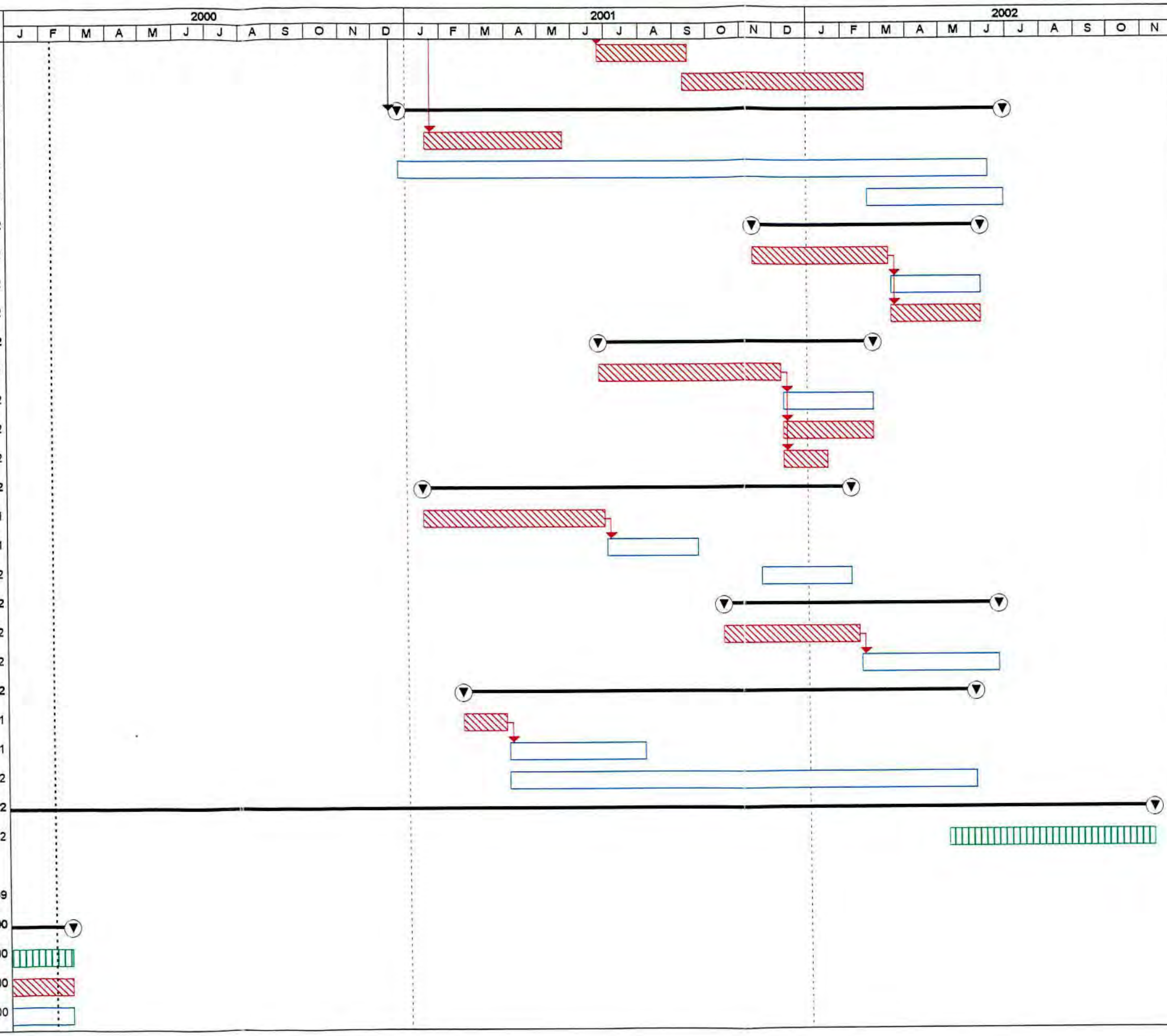


| ID | | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 1 | | Planning & consents | 165 days | Thu 13-01-00 | Wed 30-08-00 |
| 2 | | EPA consents | 140 days | Thu 13-01-00 | Wed 26-07-00 |
| 3 | | Permits | 25 days | Thu 27-07-00 | Wed 30-08-00 |
| 4 | | Preliminary | 644 days | Tue 16-11-99 | Fri 03-05-02 |
| 5 | | Final design & detailing | 174 days | Tue 16-11-99 | Fri 14-07-00 |
| 6 | | Construction supervision | 470 days | Mon 17-07-00 | Fri 03-05-02 |
| 7 | | General | 437 days | Thu 31-08-00 | Fri 03-05-02 |
| 8 | | Site preperation | 30 days | Thu 31-08-00 | Wed 11-10-00 |
| 9 | | Admin building | 40 days | Thu 12-10-00 | Wed 06-12-00 |
| 10 | | Roading/ landscaping/ services | 385 days | Mon 13-11-00 | Fri 03-05-02 |
| 11 | | Concrete plant | 40 days | Thu 31-08-00 | Wed 25-10-00 |
| 12 | | Building | 40 days | Thu 31-08-00 | Wed 25-10-00 |
| 13 | | Equipment | 40 days | Thu 31-08-00 | Wed 25-10-00 |
| 14 | | Yard | 20 days | Thu 31-08-00 | Wed 27-09-00 |
| 15 | | Prestress conc plant | 60 days | Thu 26-10-00 | Wed 17-01-01 |
| 16 | | Building | 60 days | Thu 26-10-00 | Wed 17-01-01 |
| 17 | | MSW | 515 days | Thu 31-08-00 | Wed 21-08-02 |
| 18 | | Activated carbon | 30 days | Mon 15-10-01 | Fri 23-11-01 |
| 19 | | Air supply | 30 days | Mon 17-12-01 | Fri 25-01-02 |
| 20 | | Bed ash building | 90 days | Mon 26-03-01 | Fri 27-07-01 |
| 21 | | Bed ash equipment | 90 days | Mon 30-07-01 | Fri 30-11-01 |
| 22 | | CaCO3 system | 60 days | Mon 05-11-01 | Fri 25-01-02 |
| 23 | | CaO -CaOH2 system | 40 days | Mon 08-10-01 | Fri 30-11-01 |
| 24 | | Chimney | 20 days | Mon 04-02-02 | Fri 01-03-02 |
| 25 | | Flyash | 60 days | Mon 17-09-01 | Fri 07-12-01 |
| 26 | | Furnace chain | 420 days | Thu 31-08-00 | Wed 10-04-02 |
| 27 | | Boiler | 515 days | Thu 31-08-00 | Wed 21-08-02 |
| 28 | | Furnace cover | 215 days | Mon 27-08-01 | Fri 21-06-02 |
| 29 | | Liquid fuel system | 60 days | Mon 28-05-01 | Fri 17-08-01 |
| 30 | | Outside building | 60 days | Mon 17-12-01 | Fri 08-03-02 |
| 31 | | Receiving hall building | 250 days | Thu 18-01-01 | Wed 02-01-02 |
| 32 | | Receiving hall equipment | 90 days | Thu 03-01-02 | Wed 08-05-02 |
| 33 | | Sewage sludge | 30 days | Mon 22-04-02 | Fri 31-05-02 |
| 34 | | Urea system | 30 days | Mon 24-12-01 | Fri 01-02-02 |
| 35 | | Turboalternators | 210 days | Mon 30-07-01 | Fri 17-05-02 |
| 36 | | Building | 120 days | Mon 30-07-01 | Fri 11-01-02 |
| 37 | | Turbines | 60 days | Mon 14-01-02 | Fri 05-04-02 |
| 38 | | Equipment | 90 days | Mon 14-01-02 | Fri 17-05-02 |
| 39 | | MED | 490 days | Thu 31-08-00 | Wed 17-07-02 |
| 40 | | Desalinator | 490 days | Thu 31-08-00 | Wed 17-07-02 |
| 41 | | Inlet canal | 60 days | Mon 26-03-01 | Fri 15-06-01 |



# Kwinnana project

| ID | | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 42 | | Outlet canal | 60 days | Mon 25-06-01 | Fri 14-09-01 |
| 43 | | Reservoir | 120 days | Mon 10-09-01 | Fri 22-02-02 |
| 44 | | **Vitrifier** | **395 days** | **Mon 25-12-00** | **Fri 28-06-02** |
| 45 | | Building | 90 days | Thu 18-01-01 | Wed 23-05-01 |
| 46 | | Vitrifier units | 385 days | Mon 25-12-00 | Fri 14-06-02 |
| 47 | | Annealing tunnel | 90 days | Mon 25-02-02 | Fri 28-06-02 |
| 48 | | **Bottled Water Plant** | **150 days** | **Mon 12-11-01** | **Fri 07-06-02** |
| 49 | | Building | 90 days | Mon 12-11-01 | Fri 15-03-02 |
| 50 | | Equipment | 60 days | Mon 18-03-02 | Fri 07-06-02 |
| 51 | | Office & Lunchroom | 60 days | Mon 18-03-02 | Fri 07-06-02 |
| 52 | | **Compost** | **180 days** | **Mon 25-06-01** | **Fri 01-03-02** |
| 53 | | Buiding | 120 days | Mon 25-06-01 | Fri 07-12-01 |
| 54 | | Equipment | 60 days | Mon 10-12-01 | Fri 01-03-02 |
| 55 | | Office | 60 days | Mon 10-12-01 | Fri 01-03-02 |
| 56 | | Yard | 30 days | Mon 10-12-01 | Fri 18-01-02 |
| 57 | | **Dangerous goods store** | **280 days** | **Mon 15-01-01** | **Fri 08-02-02** |
| 58 | | Building | 120 days | Mon 15-01-01 | Fri 29-06-01 |
| 59 | | Equipment | 60 days | Mon 02-07-01 | Fri 21-09-01 |
| 60 | | Tunnel | 60 days | Mon 19-11-01 | Fri 08-02-02 |
| 61 | | **Laboratory** | **180 days** | **Mon 15-10-01** | **Fri 21-06-02** |
| 62 | | Building | 90 days | Mon 15-10-01 | Fri 15-02-02 |
| 63 | | Equipment | 90 days | Mon 18-02-02 | Fri 21-06-02 |
| 64 | | **Switchyard & distribution bds** | **335 days** | **Mon 19-02-01** | **Fri 31-05-02** |
| 65 | | Yards | 30 days | Mon 19-02-01 | Fri 30-03-01 |
| 66 | | H.V. Equipment | 90 days | Mon 02-04-01 | Fri 03-08-01 |
| 67 | | Distribution bds | 305 days | Mon 02-04-01 | Fri 31-05-02 |
| 68 | | **Commissioning** | **779 days** | **Tue 16-11-99** | **Fri 08-11-02** |
| 69 | | Commission units as available | 135 days | Mon 06-05-02 | Fri 08-11-02 |
| 70 | | | | | |
| 71 | | **key** | 1 day | Tue 16-11-99 | Tue 16-11-99 |
| 72 | | **SectionSummary** | **74 days** | **Tue 16-11-99** | **Fri 25-02-00** |
| 73 | | Planning \ Design task | 74 days | Tue 16-11-99 | Fri 25-02-00 |
| 74 | | Building \ Civil engineering t task | 74 days | Tue 16-11-99 | Fri 25-02-00 |
| 75 | | Mechanical \ equipment supply task | 74 days | Tue 16-11-99 | Fri 25-02-00 |



# Appendix D

# PER Guidelines

Final - Copy

# Environmental Protection Authority
# Guidelines

## WASTE-TO-ENERGY AND WATER PLANT, LOT 15 MASON ROAD, KWINANA INDUSTRIAL AREA, KWINANA

(Assessment Number 1289)

| | |
|---|---|
| Part A | Specific Guidelines for the preparation of the Public Environmental Review |
| Part B | Generic Guidelines for the preparation of an environmental review document |
| Attachment 1 | Example of the invitation to make a submission |
| Attachment 2 | Advertising the environmental review |
| Attachment 3 | Project location map |
| Attachment 4 | Air Quality and Air Pollution Modelling Guidelines |

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

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

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

## 1. The proposal

Global Olivine WA (the proponent) intends to establish a Waste-to-Energy and Water plant at Lot 15 Mason Road, Kwinana Industrial Area, Kwinana. The proposed project area is indicated on the attached plan (Attachment 3).

The proposal includes high temperature combustion of waste, production of electricity, distillation of water, a plasma arc/vitrifier for the destruction of organic hazardous waste and conversion of inorganic waste into glass, a composting plant, a concrete/aggregate plant and an olivine panel manufacturing plant. A level of assessment of Public Environmental Review with a four week review period has been set by the Environmental Protection Authority (EPA).

Could you please supply the project officer with an electronic copy of the document for use on Macintosh, Microsoft Word Version 6, and any scanned figures. Where possible, figures should be reproducible in a black and white format.

## 2. Environmental factors relevant to this proposal

At this preliminary stage, the Environmental Protection Authority (EPA) believes the relevant environmental factors, objectives and work required are as detailed in the table below. These factors have been identified from information provided by the proponent so far. The EPA expects the proponent to take due care in ensuring that any other relevant environmental factors which may be identified during the preparation of the review document are addressed.

| **CONTENT** | | **SCOPE OF WORK** | |
|---|---|---|---|
| **Factor** | **Site specific factor** | **EPA objective** | **Work required for the environmental review** |
| **BIOPHYSICAL** | | | |
| Marine Environment | Marine water , Cockburn Sound | To ensure that the quality of marine water and sediment in Cockburn Sound are maintained or improved, by ensuring that the effluent quality and water quality at and beyond the boundary of the mixing zone comply with the following statutory and acceptable standards:<br><br>• the environmental quality criteria and environmental quality objectives recommended in the Southern Metropolitan Coastal Waters Study (1991-1994) report (DEP, 1996): and<br>• standards recommended in the draft WA Water quality Guidelines for Fresh and Marine Waters (EPA, 1993). | Detail potential impacts to the marine environment and proposed management measures.<br><br>Show that the discharge of cooling water and brine into Cockburn sound will not have an adverse effect on the water quality or marine environment of the Sound, in particular with regard to temperature, salinity and anti-corrosion and bio-cide compound content of the discharge.<br><br>Provide a full analysis of the discharge constituents, including anti-corrosion and bio-cide compounds. |

| POLLUTION MANAGEMENT | | | |
|---|---|---|---|
| Air | Air quality | To ensure that gaseous emissions from the new plant in isolation and in combination from neighbouring sources and background concentrations:<br>• meet the air quality standards and limits stated in the Kwinana EPP and other relevant air quality standards/guidelines, including the NEPM for Ambient Air Quality (with advice sought from the DEP on specific pollutants as necessary);<br>• do not cause an environmental or human health/amenity problem; and<br>• meet the requirement of Section 51 of the Environmental Protection Act 1986, to take all reasonable and practicable measures to minimise all discharges. | The proponent is responsible for identifying and quantifying all emissions to atmosphere from the proposal and surrounding sources with a potential to have non-trivial impact on the environment(including impact on human health, nuisance, amenity, vegetation and fauna).<br>Emissions identified so far:<br>• High temperature combustion plant and Plasma Arc/Vitrifier:<br>$SO_x$, $NO_x$, CO, acid gases, metals, PAH, chlorobenzones, chlorophenols, dioxins and furans<br>• Distillation plant:<br>odorous gases, non-condensable gas<br>Note: The proponent should refer to the Air Quality and Air Pollution Modelling Guidelines in Attachment 4 for a discussion of identification and modelling required.<br>Provide details of any potential impacts and how they will be managed.<br>Report results of Health Risk Assessment being undertaken, for expected and worst case emissions from plant.<br>Note: Health Department of Western Australia should be consulted for assessment protocol. |

| | | | |
|---|---|---|---|
| | Odour | To ensure that odour emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and<br><br>to use all reasonable and practicable measures to minimise the discharge of odours. | Show that odour emissions will meet acceptable standards from:<br><br>• High temperature combustion plant including:<br>stack emissions,<br>receival facilities, and<br>storage of raw materials.<br>• Composting plant including:<br>storage and processing of materials.<br>• Other likely sources of emissions.<br>Note: Draft guidelines for Storage, Processing and Recycling of Organic Waste are applicable. |
| | Particulates/Dust | To ensure that the dust levels from the project meet the air quality standards and limits stated in the Environmental Protection (Kwinana)(Atmospheric Wastes) Policy 1992 Wastes) Policy 1992 and in the NEPM for Ambient Air Quality.<br><br>(ii) Use all reasonable and practicable measures to minimise the discharge of particulate wastes. | Show that emissions are below acceptable levels and as low as practicably achievable from:<br><br>• High temperature combustion plant and vitrifier including<br>receival facilities, and<br>stack emissions.<br>• Bed ash plant<br>• Concrete/Aggregate plant<br>• Other likely sources.<br><br>Detail dust management plan for construction of plant. |
| | Smoke/ Opacity | To ensure that:<br>• smoke emissions meet the requirements of AS 3543 and opacity meets the National Guidelines for the Control of Emission of Air Pollutants from New Stationary Sources (1985) AEC/NHMRC<br>• meet the requirement of Section 51 of the Environmental Protection Act 1986, to take all reasonable and practicable measures to minimise all discharges. | Detail management to ensure smoke/opacity meet the guidelines and standards and are as low as practicable achievable. |

| | | | |
|---|---|---|---|
| | Greenhouse gases | To minimise greenhouse gas emissions in absolute terms and reduce emissions per unit product to as low as reasonably practicable.<br>To mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12 "Minimising Greenhouse Gases"<br>Proponents are require to :<br>• take all "no regrets" measures in construction and operation;<br>• take "beyond no regrets" measures which are reasonable and practicable' and<br>• commit to a program of investigation, research and reporting of and progressive implementation of "no regrets" and "beyond no regrets" measures. | Provide details of greenhouse gas emissions in comparison with other similar plants using the same or different technologies. Consider generation of greenhouse gases from alternative treatment of waste.<br>Provide details of efforts to reduce greenhouse gas emissions to best practice.<br>Quantify the greenhouse emission levels which would be considered "business as usual", "no regrets" and "beyond no regrets". Investigate the feasibility of other measures.<br>Provide details of any Greenhouse management agreements to be adopted, such as the Commonwealth Government's voluntary Greenhouse Challenge. |
| Water | Groundwater quality | To ensure that the beneficial uses of groundwater can be maintained, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) | Detail potential sources of groundwater contamination and proposed management measures including:<br>show all environmentally hazardous liquids stored in accordance with DEP's secondary containment policy, and<br>describe control of leachate from waste storage and composting areas. |
| | Surface water management | To ensure that surface water is managed to prevent discharge of contaminated water from site or to groundwater | Detail potential impacts on surface water and proposed management measures. |
| Waste | Solid waste | To ensure wastes are managed in accordance with the DEP's waste management hierarchy (ie. avoid, minimise, recycle, treat and dispose) | Detail the management strategy to meet EPA objective.<br>Show that where waste is re-used, it is suitable for the use (ie that aggregate and glass products do not contain leachable contaminants).<br>Detail alternative disposal options if re-use not feasible. |

| | | | |
|---|---|---|---|
| Noise | | To ensure noise emissions from the plants operations are as low as reasonably practical and comply with the Environmental Protection (Noise) Regulations 1997. | Undertake noise modelling to show that noise limits are met at the boundary of the premises and at noise sensitive premises in accordance with guidelines in EPA Guidance Note 8.<br>Consider noise management during the construction of the plant. |
| Land | Site contamination | To ensure that the site is assessed and managed in accordance with the ANZECC & NHMRC (1992) Guidelines for the assessment and management of contaminated sites. | Site may contain contamination from past use and neighbouring activities.<br>Detail soil investigation and management strategy. |
| | | | |
| **SOCIAL SURROUNDINGS** | | | |
| Social Surrounds | Road transportation | To ensure that the increase in traffic activities resulting from the project does not adversely impact on the social surroundings.<br>To ensure that the transport of wastes does not adversely affect the health and safety of the community. | Detail traffic management and the increase in traffic expected for both the construction and operational phases of the plant.<br>Detail transport management for hazardous wastes.<br>Note: Transport of Dangerous Goods must comply with the Dangerous Goods (Transport) (Road and Rail) Regulations 1999 as required by the Department of Minerals and Energy. |
| | Public health and safety | To ensure the risk is managed to meet the EPA's criteria for individual fatality risk and the Department of Minerals and Energy's requirements in respect of public safety. | Detail any aspect of the operations that may impact on public safety and safety at neighbouring sites (eg. storage of dangerous goods, explosion hazard, toxic gas release).<br>Note: Storage of Dangerous Goods must comply with the Dangerous Goods (Dangerous Goods Handling and Storage) Regulations 1992 as required by Department of Minerals and Energy.<br>Detail how risks will be managed, ie what risk reduction measures are planned.<br>Where risks exist, show that these do not exceed the EPA individual risk criteria, and meet DME's requirements. |

| | | | |
|---|---|---|---|
| Social Amenity | Vermin and pest control | To prevent vermin becoming a nuisance to neighbouring premises and prevent the spread of vermin borne disease. | Detail insect, rodent and bird control measures for storage of waste and composting facility. |

These factors should be addressed within the environmental review document for the public to consider and make comment to the EPA. The EPA expects to address these factors in its report to the Minister for the Environment.

In addressing the above factors the proponent should provide factual evidence to support predicted emission levels in the form of test results or comparisons with similar existing operations. Best practice levels should also be included to demonstrate that the proposal will be "best practice".

All components of the proposal should be fully described including emission points, possible environmental impacts and management measures.

All environmental aspects (as described in AS 14001 4.3.1) for all components of the proposal should be identified and described by means of a review in order to determine those which have significant environmental impacts.

# 3. Availability of the environmental review

## 3.1 Copies for distribution free of charge

Supplied to DEP:

| | |
|---|---|
| | • Library/Information Centre .... 9<br>• EPA members .... 6<br>• Officers of the DEP (Perth) .... 6 |

Distributed by the proponent to:

| | |
|---|---|
| Government departments | • Kwinana Branch (DEP) .... 2<br>• Department of Minerals and Energy .... 1<br>• Health Department .... 2<br>• Westrail .... 1<br>• Western Power .... 1<br>• Water Corp .... 1 |
| Local government authorities | • Town of Kwinana .... 2 |
| Libraries | • J S Battye Library .... 3<br>• The Environment Centre .... 2<br>• Town of Kwinana .... 2<br>• City of Cockburn .... 2<br>• City of Rockingham .... 2 |
| Other | • Conservation Council of WA .... 1<br>• Kwinana Industries Co-ordinating Committee .... 1<br>• Kwinana Watchdog Group .... 1<br>• IP14 Community Advisory Council .... 1<br>• Kwinana Industries Council .... 1<br>• ComNet .... 1 |

## 3.2 Available for public viewing

- J S Battye Library;
- Town of Kwinana; City of Cockburn; City of Rockingham
- Department of Environmental Protection Library.

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

## 1. Overview

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

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

Throughout the assessment process it is the objective of the Environmental Protection Authority (EPA) to help the proponent to improve the proposal so the environment is protected. The DEP administers the environmental impact assessment process on behalf of the EPA.

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

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

Information used to reach conclusions should be properly referenced, including personal communications. Such information should not be misleading or presented in a way that could be construed to mislead readers. Assessments of the significance of an impact should be soundly based rather than unsubstantiated opinion, and each assessment should lead to a discussion of the management of the environmental factor.

## 2. Objectives of the environmental review

The objectives of the environmental review are to:

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

## 3. Environmental management

The EPA expects the proponent to have in place an environmental management system appropriate to the scale and impacts of the proposal including provisions for performance review and a commitment to continuous improvement. The system may be integrated with quality and health and safety systems and should include the following elements:

- environmental policy and commitment;
- planning of environmental requirements;
- implementation and operation of environmental requirements;
- measurement and evaluation of environmental performance;
- review and improvement of environmental outcomes.

A description of the proposed environmental management system should be included in the environmental review documentation. If appropriate, the documentation can be incorporated into a formal environmental management system (such as AS/NZS ISO 14001). Public accountability should be incorporated into the approach on environmental management.

The environmental management program (EMP) is the key document of an environmental management system that should be adequately defined in an environmental review document. The EMP should provide plans to manage the relevant environmental factors, define the performance objectives, describe the resources to be used, outline the operational procedures and outline the monitoring and reporting procedures which would demonstrate the achievement of the objectives.

## 4. Format of the environmental review document

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

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

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

## 5. Contents of the environmental review document

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

## 5.1 The proposal

A comprehensive description of the proposal including its location (address and certificate of title details where relevant) is required.

### Justification and alternatives

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

### Key characteristics

The Minister's statement will bind the proponent to implementing the proposal in accordance with any technical specifications and key characteristics[1] in the environmental review document. It is important therefore, that the level of technical detail in the environmental review, while sufficient for environmental assessment, does not bind the proponent in areas where the project is likely to change in ways that have no environmental significance.

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

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

**Table 1: Key characteristics (example only)**

| Element | Description |
|---|---|
| Life of project (mine production) | < 5yrs (continual operation) |
| Size of ore body | 682 000 tonnes (upper limit) |
| Area of disturbance (including access) | 100 hectares |
| List of major components<br>• pit<br>• waste dump<br>• infrastructure (water supply, roads, etc) | refer plans, specifications, charts section immediately below for details of map requirements |
| Ore mining rate<br>• maximum | • 200 000 tonnes per year |
| Solid waste materials<br>• maximum | • 800,000 tonnes per year |
| Water supply<br>• source<br>• maximum hourly requirement<br>• maximum annual requirement | • XYZ borefield, ABC aquifer<br>• 180 cubic metres<br>• 1 000 000 cubic metres |
| Fuel storage capacity and quantity used | litres; litres per year |
| Heavy mineral concentrate transport<br>• truck movements (maximum) | • 75 return truck loads per week |

### Plans, Specifications, Charts

Adequately dimensioned plans showing clearly the location and elements of the proposal which are significant from the point of view of environmental protection, should be included. The location and dimensions (for progressive stages of development, if relevant) of plant, amenities buildings, accessways, stockpile areas, dredge areas, waste product disposal and treatment areas, all dams and water storage areas, mining areas, storage areas including fuel storage, landscaped areas etc.

Only those elements of plans, specifications and charts that are significant from the point of view of environmental protection are of relevance here.

Figures that should always be included are:

- a map showing the proposal in the local context - an overlay of the proposal on a base map of the main environmental constraints;
- a map showing the proposal in the regional context; and, if appropriate,
- a process chart / mass balance diagram showing inputs, outputs and waste streams.

The plan/s should include contours, a north arrow, a scale bar, a legend, grid co-ordinates, the source of the data, and a title. If the data is overlaid on an aerial photo then the date of the aerial photo should be shown.

**Other logistics**

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

## 5.2 Environmental factors

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

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

Items that should be discussed under each environmental factor are:

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

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

**Table 2: Environmental factors and management (example only)**

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

## 5.3 Environmental management commitments

Environmental management commitments

The final stage of the Environmental Impact Assessment (EIA) process is reached when the Minister for the Environment issues the Ministerial statement for the project, which is a set of legally enforceable conditions and procedures for the implementation of the project. One of the standard procedures is a requirement for the proponent to implement the commitments which have been made (by the proponent) during the EIA process. It is accepted practice for a consolidated list of the proponent's commitments to be attached to the Minister's statement.

## Commitment formatting

1. Commitment components

Commitments which address key environmental factors will be audited by the DEP, together with the environmental conditions. Unless the commitments are framed in a standard format, it may become difficult in practice to implement or audit them. By applying the principles of quality management, a standard format for the commitments has been arrived at. The format ensures that a chain of responsibility is established to facilitate compliance and that redundant, overlapping or non-enforceable commitments are avoided.

The required standard format for all commitments comprises a number of components as follows:

The proponent (**who**) will undertake an action (**what, how, where**) to meet an environmental objective (**why**) to a time frame (**when**), and on advice of somebody (**to whom**, eg. third party, government agencies such as Department of Conservation and Land Management, Department of Minerals and Energy, Water and Rivers Commission, Shire Council). With regard to 'whom' this need only be included if the expertise of a third party is relevant to implementing the commitment.

It is important for the consolidated list of commitments to be numbered correctly for easy reference in the implementation and auditing stages of the project. These should therefore be sequentially numbered 1, 2, 3, ... without use of subgroups such as 1.1, 1.2 or 2(i) or 2(a), 2(b).

2. Paragraph format

In applying the standard components (who, what, why, how, where, when, to whom) an example of a commitment in paragraph form is as follows:

*The proponent will prepare and implement a Dust Control Program which will minimise dust generation on-site and prevent dust emission from construction of the foreshore extension in order to protect the amenity of nearby land users. The Program will be prepared during the design (project planning) phase and will meet EPA dust control criteria (EPA, 1996), on advice of the Shire of Widgiemooltha. The approved Program will be implemented during the construction phase.*

However in writing the commitment in paragraph form, a confusing or clumsy sentence structure can result that may be difficult to interpret for future auditing purposes. Also it is difficult to verify that all components have been incorporated into every commitment. A paragraph format is therefore not the preferred format.

3. Tabular format

Due to the limitations of the paragraph format, it is preferable to format a commitment in tabular form. It is recommended that the table column headings be ordered as: 'commitment number', 'topic', 'action', 'objective', 'timing' and 'advice'. However table headings can be re-ordered if necessary.

The example in paragraph form on page 1 can therefore be written in tabular form as per examples 1 and 2 below. Note that the tabular format makes it easier to ensure that no component of the commitment is left out and that each action is recognised as a separate commitment. This format also permits the inclusion of additional clauses or more precise wording of clauses which can be difficult in a sentence structure. It is acceptable for table columns to be re-ordered if necessary. Finally, the tabular format provides an immediate audit framework for use by the proponent and the DEP, enabling efficient administration of environmental approvals.

Examples 1 & 2.

*The proponent' is committed to the following:*

| No. | Topic | Action<br>**(What/How/Where)** | Objective/s<br>**(Why)** | Timing<br>**(When)** | Advice<br>**(To whom)** |
|---|---|---|---|---|---|
| 1. | Dust management | Prepare a Dust Control Program for the foreshore construction site which addresses:<br>1) abc 2) xyz | • Minimise dust during the construction phase<br>• Maintain the amenity of nearby land users<br>• To meet EPA dust control criteria | Pre-construction | Shire |
| 2. | Dust management | Implement the approved Dust Control Program | Achieve the objectives of Commitment 1 | Construction | - |

Example 3.

| No. | Topic | Action | Objective/s | Timing | Advice |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 3. | Fauna protection | Undertake a trapping programme for capturing and relocating the Southern Brown Bandicoots | Minimise impact on Southern Brown Bandicoots | Pre-construction (prior to commencement of ground disturbance) | CALM |

Example 4.

| No. | Topic | Action | Objective/s | Timing | Advice |
|---|---|---|---|---|---|
| 4. | Vegetation | Revegetate disturbed areas with vegetation types indigenous to the area | • To minimise impact on local flora<br>• To achieve the completion criteria stated in CER (Section 5.1.1) | Post-construction (progressively during operations) | Kings Park Board |

Example 5.

| No | Topic | Objective | Action | Timing | Advice |
|---|---|---|---|---|---|
| 5. | Groundwater | Minimise impact on groundwater levels, surface water levels and surrounding vegetation | Groundwater drawdown shall not exceed 0.5 m at any boundary of the mine site | Operation | Water and Rivers Commission |

Example 6.

| No. | Topic | Action | Objective | Timing | Advice |
|---|---|---|---|---|---|
| 6. | Clean-up | Post-clean up activities will only proceed after demonstrating to (and gaining approval from) the DEP that the site clean-up criteria identified in the 1993 CER have been met | To achieve the soil quality objectives in the Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, Jan 1992 | Post-clean up (On completion of cleanup and prior to commencement of post-cleanup activities) | – |

## 5.4 Public consultation

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

## 5.5 Other information

Additional detail and description of the proposal, if provided, should go in a separate section.

## Attachment 1

*The first page of the proponent's environmental review document must be the following invitation to make a submission, with the parts in square brackets amended to apply to each specific proposal. Its purpose is to explain what submissions are used for and to detail why and how to make a submission.*

## Invitation to make a submission

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

[the proponent] proposes [the rezoning of land and the development of a Marina Complex in the City of Bunbury]. In accordance with the Environmental Protection Act, a [PER] has been prepared which describes this proposal and its likely effects on the environment. The [PER] is available for a public review period of [8] weeks from **[date]** closing on **[date]**.

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

### Why write a submission?

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

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

### Why not join a group?

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

### Developing a submission

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

When making comments on specific elements of the [PER]:

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

**Points to keep in mind**

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

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

Remember to include:

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

The closing date for submissions is: **[date]**

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: **[Project Officer name]**

# Attachment 2

## Advertising the environmental review

The proponent is responsible for advertising the release and arranging the availability of the environmental review document in accordance with the following guidelines:

### Format and content

The format and content of the advertisement should be approved by the DEP before appearing in the media. For joint State-Commonwealth assessments, the Commonwealth also has to approve the advertisement. The advertisement should be consistent with the attached example.

Note that the DEP officer's name should appear in the advertisement.

### Size

The size of the advertisement should be two newspaper columns (about 10 cm) wide by about 14 cm long. Dimensions less than these would be difficult to read.

### Location

The approved advertisement should for PER's and ERMP's, appear in the news section of the main daily paper's ("The West Australian") Saturday edition, and in the news section of the main local paper at the commencement of the public review period and again two weeks prior to the closure of the public review period.

### Timing

Within the guidelines already given, it is the proponent's prerogative to set the time of release, although the DEP should be informed. The advertisement should not go out before the report is actually available, or the review period may need to be extended.

## Example of the newspaper advertisement

Proponent Name

Consultative/Public/ Environmental Review/and Management Programme

TITLE OF PROPOSAL

(Public Review Period: **[date]** to **[date]**)

Proponent is planning to brief description of proposal.

A /Public Environmental Review (PER)/Environmental Review and Management Programme (ERMP) has been prepared by the company to examine the environmental effects associated with the proposed development, in accordance with Western Australian Government procedures. The PER/ERMP describes the proposal, examines the likely environmental effects and the proposed environmental management procedures.

Proponent has prepared a project summary which is available free of charge from the company's office address.

**Copies of the PER/ERMP may be purchased for $10 from:**

**Company Name**
**Street**
**Suburb/Town WA Postcode**
**Telephone: (08) 9xxx xxxx**

Copies of the complete PER/ERMP will be available for examination at:

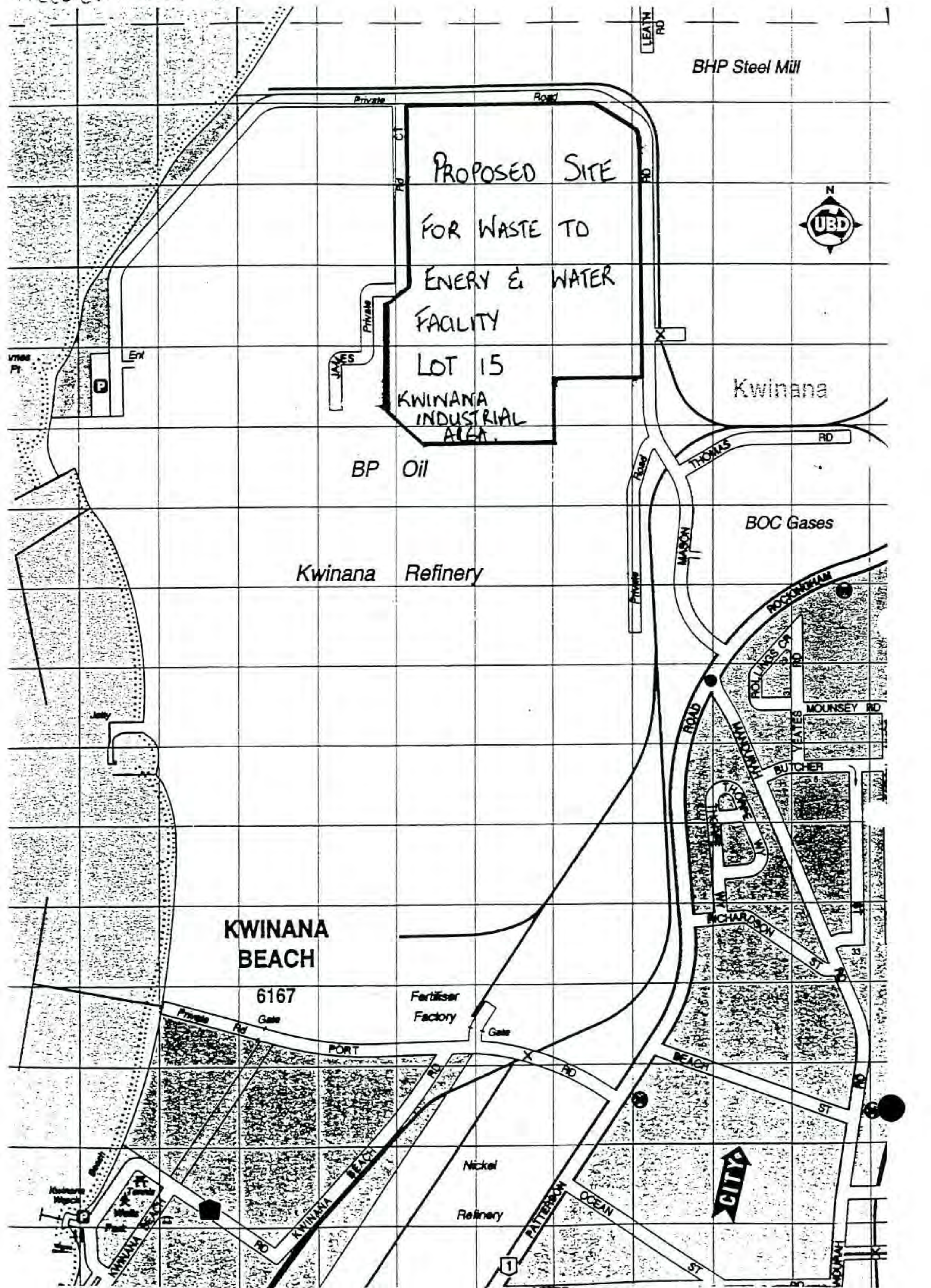
- Department of Environmental Protection
  Library Information Centre
  8th Floor, Westralia Square
  141 St Georges Terrace
  PERTH WA 6000
- Relevant local libraries
- Department of Environmental Protection
  Regional Office - if appropriate

Submissions on this proposal are invited by **[closing date]**. Please address your submission to:

Chairman
Environmental Protection Authority
8th Floor, Westralia Square
141 St Georges Terrace
PERTH WA 6000
Attention: Ann Barter

If you have any questions on how to make a submission, please ring the project officer, Ann Barter, on (08) 9222 7082.

Attachment 3



# WESTERN AUSTRALIA
# DEPARTMENT OF ENVIRONMENTAL PROTECTION

## Air Quality and Air Pollution Modelling Guidelines

1 The proponent is responsible for identifying and quantifying all emissions to atmosphere with a potential to have non-trivial impact on the environment (including impact on human health, nuisance, amenity, vegetation - natural and agricultural, fauna - natural and agricultural). Emissions of potential concern include $SO_2$, $NO_X$, volatile organic compounds, fluorides, hydrogen sulphide, particulates, odorous gases, heavy metals and other toxic compounds, unless these are trivial (to be justified). Additionally, the formation and impact of secondary pollutants such as photochemical smog should be assessed if applicable.

2 For all primary and secondary pollutants which cannot be dismissed as being trivial, the proponent must provide predictions of the impact of various emissions on the various elements of the environment, in the form of concentrations or rates of deposition over the range of time scales (averaging periods) normally considered for each pollutant, and assess the magnitude of this impact against guidelines/goals/standards determined from local and international literature and/or field investigations of environmental sensitivity. Data from experiments or justifiable extrapolations from published literature will also be required on the susceptibility of natural vegetation and crops. In the case of each such pollutant, the assessment must account for existing concentrations caused by other sources and therefore estimate the cumulative concentration. The assessment must consider not only emissions which are continuous in nature but also emissions which are intermittent, such as those associated with plant start-up/shut-down and plant upset conditions. Intermittent emissions which are insignificant in magnitude and/or very improbable in the lifetime of the plant may be screened out; the remaining emissions should be modelled together on a probabilistic basis to estimate the total plant impact. The proponent is invited to carry out "worst case" analyses (eg simplified conservative pollution modelling techniques) in order to prove to the DEP that comprehensive modelling procedures for particular pollutants are not warranted. The models and/or worst case calculation procedures must be adequately described, with reference to their source.

3 For pollutants requiring comprehensive modelling the proponent will need to obtain at least one (preferably two) year's data on the meteorology of the area, with high data recovery and verifiable data accuracy, plus data from field experiments as prove to be necessary, in order to obtain the following data set of 10-minute averages (longer averaging periods require justification):

- wind speed;
- wind direction;
- direction standard deviation;
- air temperature;
- relative humidity or a related parameter;
- surface layer sensible heat flux, moisture flux and friction velocity determined via methods acceptable to the DEP;
- mixing height (considering morning temperature inversions, nocturnal boundary layers, thermal internal boundary layers in onshore flow, and sea breezes), estimated or measured via methods acceptable to the DEP;
- strength of capping inversions above mixed layers, estimated by methods acceptable to the DEP; and
- atmospheric stability (a derivative of parameters mentioned above) estimated by a method acceptable to the DEP.

Apart from providing a data base for conventional dispersion modelling, the data mentioned above will be essential for analysis/modelling of the following important phenomena:

(a) trapping of plumes in mixed layers of limited height or, alternatively penetration of plumes through elevated temperature inversions;
(b) vertical plume dispersion in convective conditions; and
(c) fumigation of plumes into encroaching mixed layers (onshore and offshore winds). Investigations of this phenomenon will require estimates of wind direction shear in stable layers.

The proponent is invited to demonstrate to the DEP that complicated or costly monitoring programs and/or modelling procedures for particular meteorological parameters are not warranted.

NOTES:

(i) The data set described above would be the minimum necessary for comprehensive modelling; the proponent is responsible for assessing the full range of pollution dispersion issues and designing an appropriate monitoring program.

(ii) Where items of data are not based on the results of continuous monitoring (eg. based instead on intermittent field experiments or unverified hypotheses), the uncertainty of estimates must be offset by conservatism in these estimates.

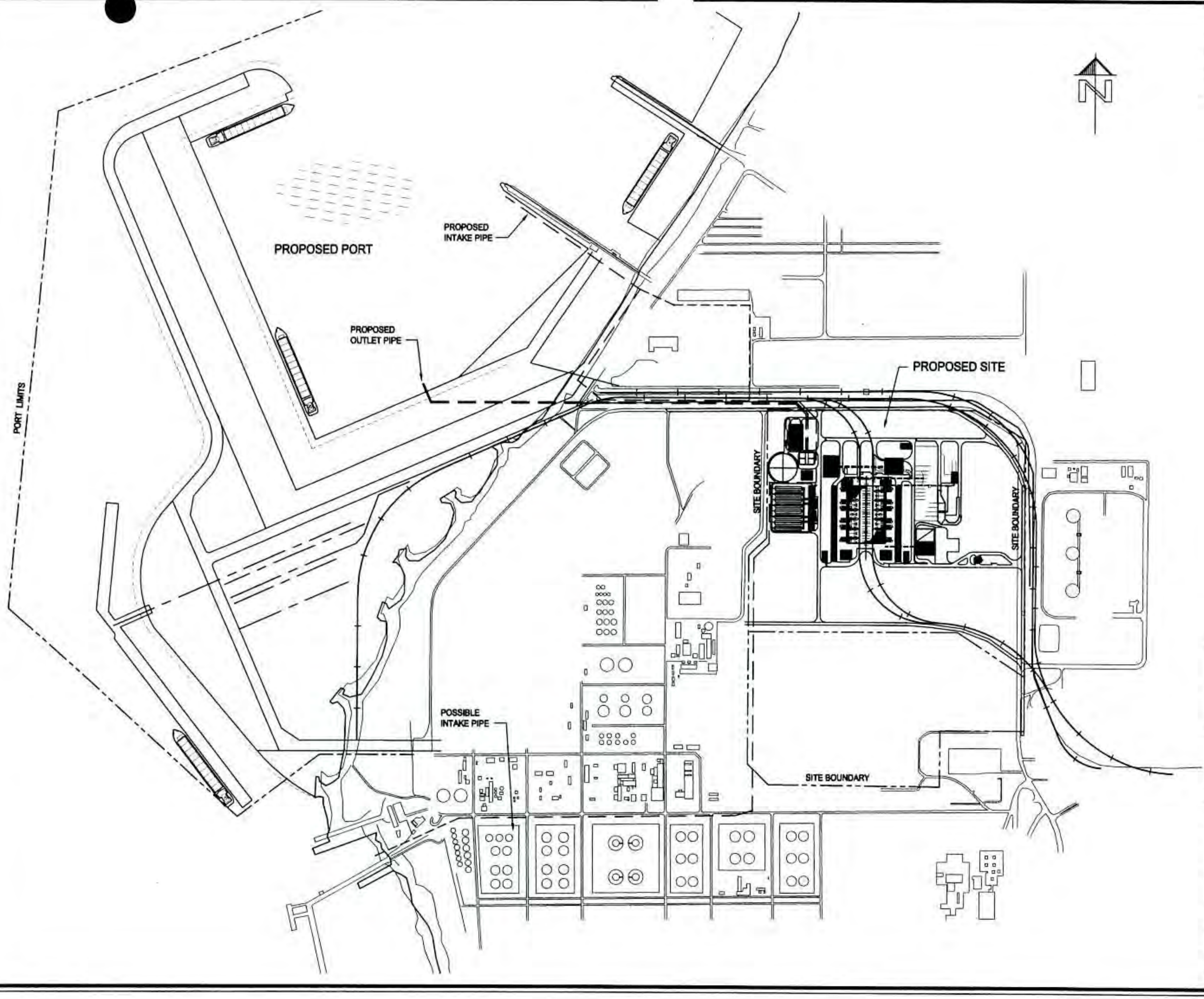
(iii) In the experience of the DEP, intermittent emissions (plant upsets etc) result in far more pollution complaints than normal emissions from operating industries. Hence it is important to properly assess intermittent emissions. The analyses employed for hazard and risk assessment may be applied to estimate the magnitude and probability of the relevant range of emissions. Screening of emissions cases must be based on the joint consideration of probability and magnitude of emission. The DEP is able to provide guidance on how to screen and model intermittent emissions.

KBF002AirModGuide240195KRa

# Appendix E

# Project Plans

Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)




| | | | |
|---|---|---|---|
| 1 | INITIAL ISSUE | RBL | 29.12.99 |
| REVISION | AMENDMENT / ISSUE | BY | DATE |

OLIVINE NEW ZEALAND
48 WAIAU STREET, TORBAY
AUCKLAND, NEW ZEALAND
Ph: - (0064) 9-473-5786

**BARKER & ASSOCIATES**

WASTE TO ENERGY PLANT
KWINANA, PERTH

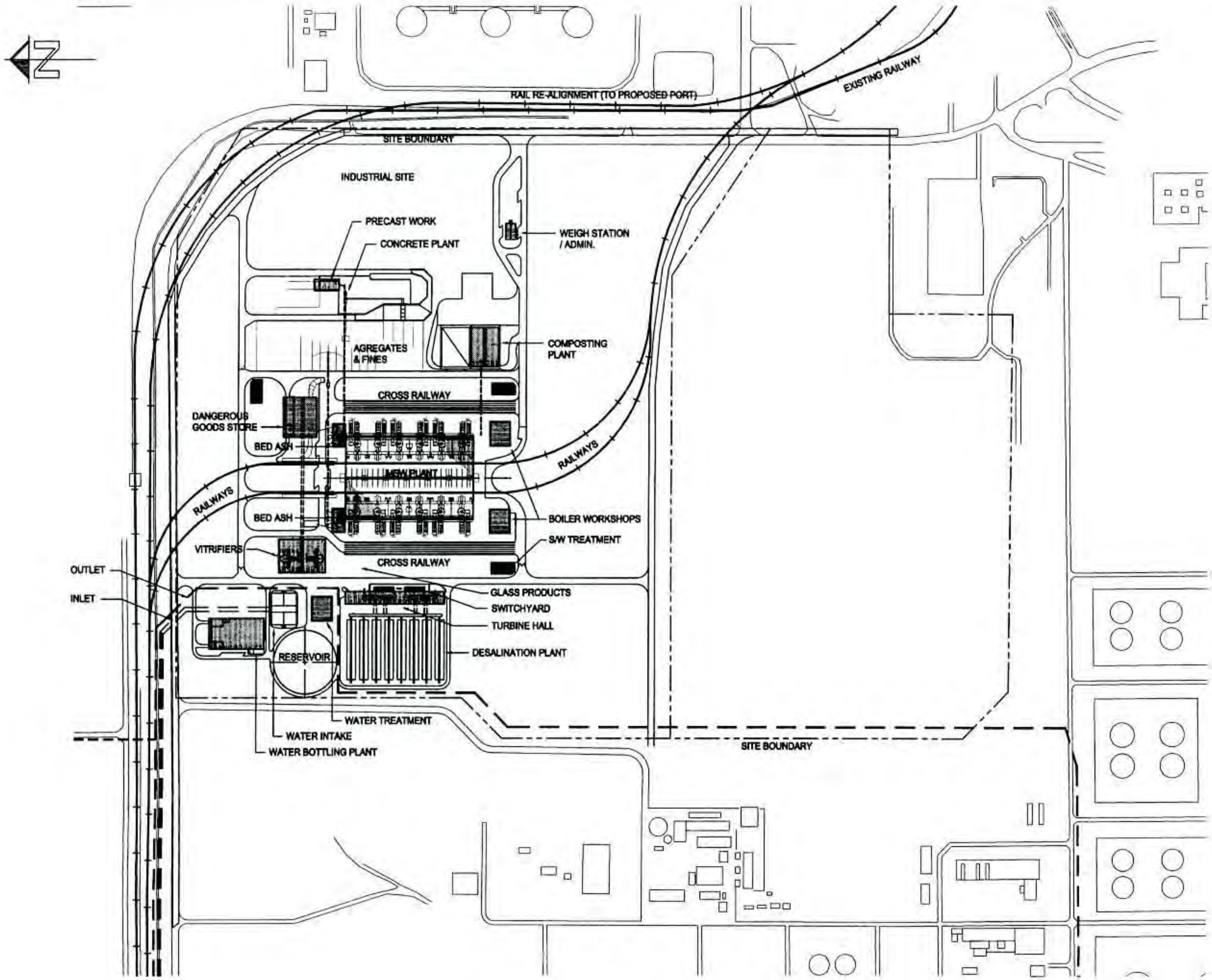
GENERAL LOCALITY PLAN
POST JAMES POINT

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

DRAWING SCALES A1=1:5,000 A3=1:10,000

PERTH / PL100 — REVISION 1

Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)




| | | | |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 28.12.?? |

OLIVINE NEW ZEALAND
45 WAIAU STREET, TORBAY
AUCKLAND, NEW ZEALAND
Ph: - (0064) 9-473-5798

BARKER & ASSOCIATES

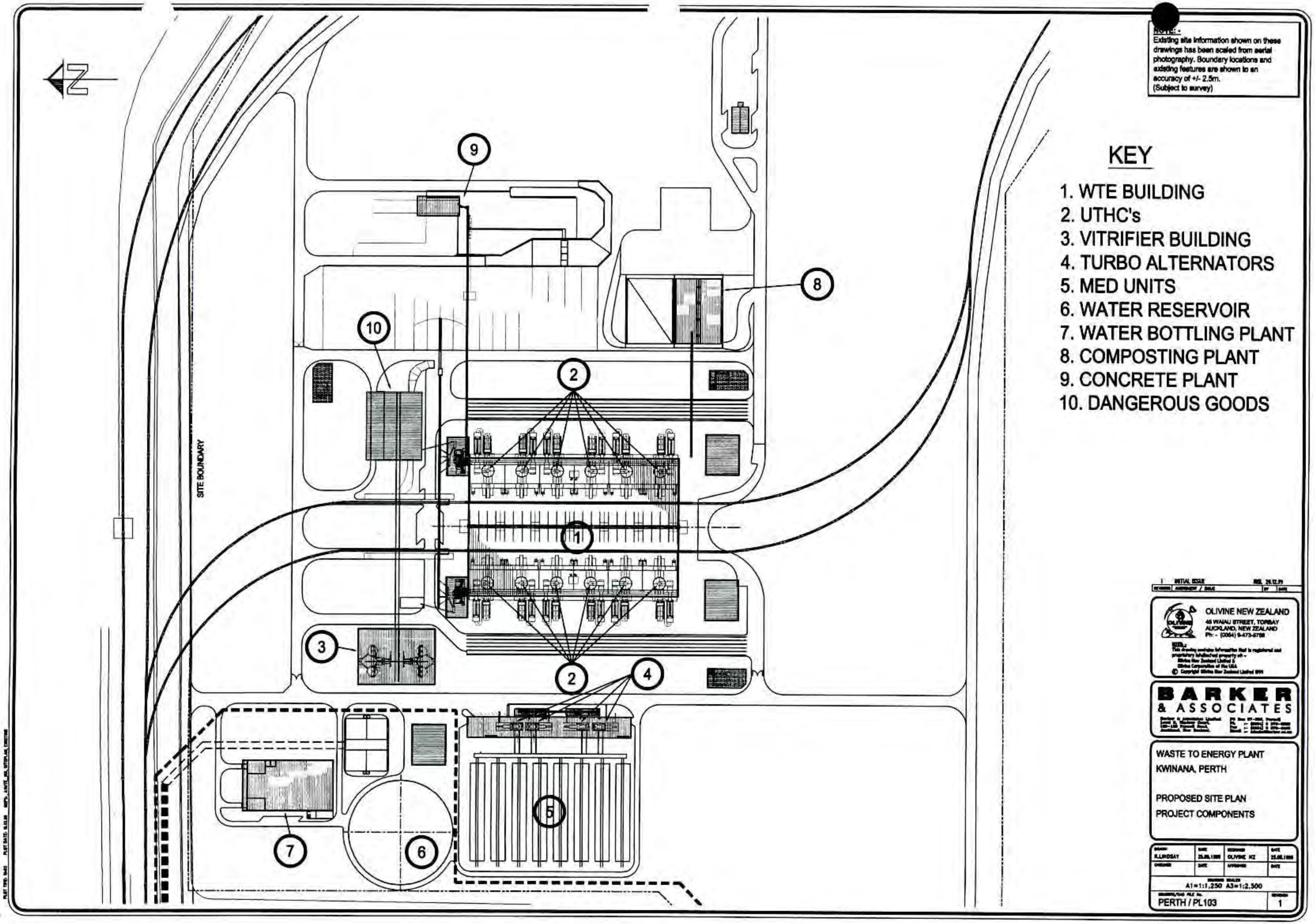
WASTE TO ENERGY PLANT
KWINANA, PERTH

GENERAL SITE LAYOUT

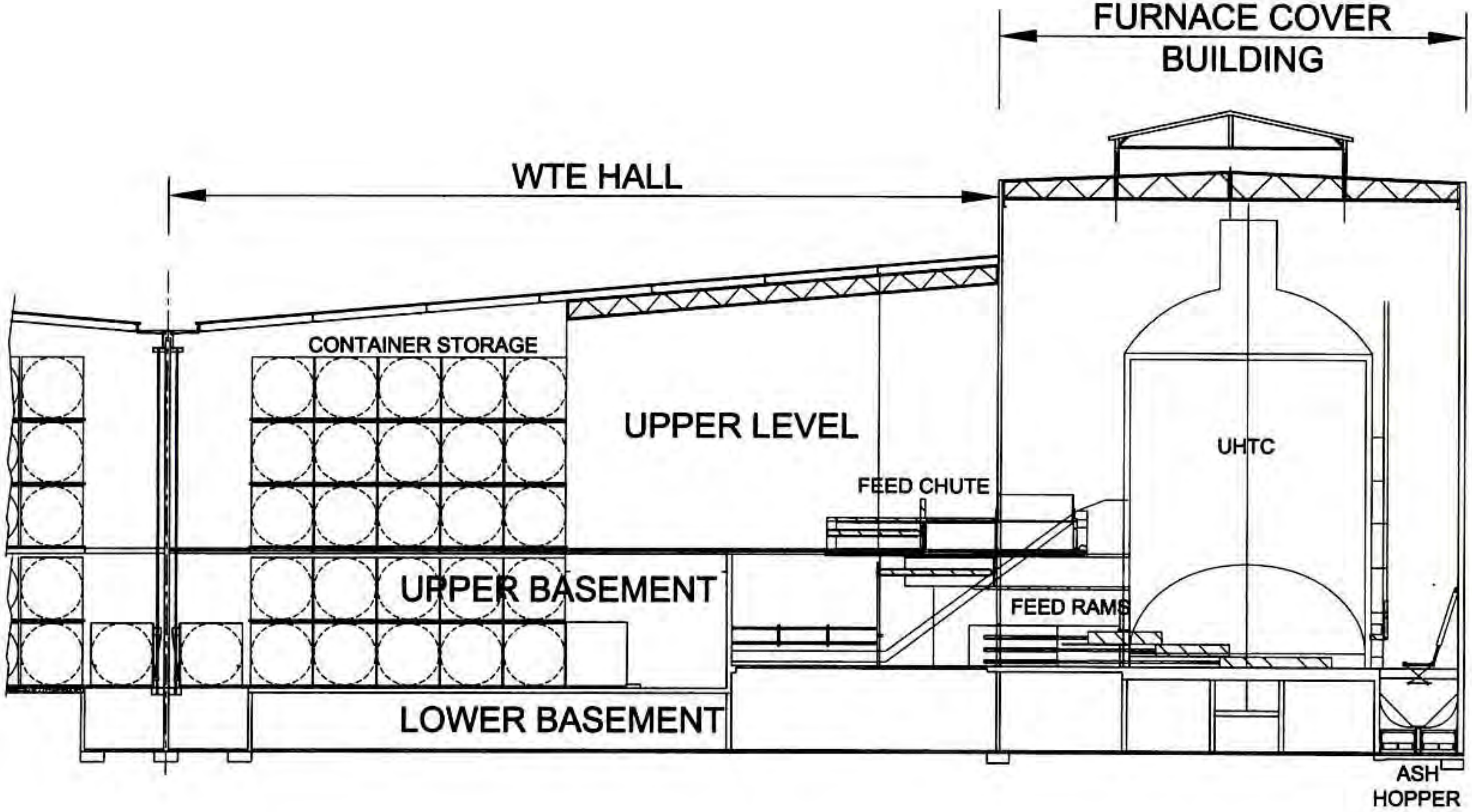
| | | | |
|---|---|---|---|
| R.LINDSAY | | OLIVINE NZ | |

A1=1:2,500 A3=1:5,000

PERTH / PL101 — 1


Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)
KEY
1. WTE BUILDING
2. UTHC's
3. VITRIFIER BUILDING
4. TURBO ALTERNATORS
5. MED UNITS
6. WATER RESERVOIR
7. WATER BOTTLING PLANT
8. COMPOSTING PLANT
9. CONCRETE PLANT
10. DANGEROUS GOODS
SITE BOUNDARY
1
2
2
3
4
5
6
7
8
9
10
1 INITIAL ISSUE
OLIVINE NEW ZEALAND
46 WAIAU STREET, TORBAY
AUCKLAND, NEW ZEALAND
BARKER
& ASSOCIATES
WASTE TO ENERGY PLANT
KWINANA, PERTH
PROPOSED SITE PLAN
PROJECT COMPONENTS
A1=1:1,250 A3=1:2,500
PERTH / PL103
1

Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)




| | | | |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |

OLIVINE NEW ZEALAND
45 WAIAU STREET, TORBAY
AUCKLAND, NEW ZEALAND
Ph: - (0064) 9-473-5788

BARKER & ASSOCIATES

WASTE TO ENERGY PLANT
KWINANA, PERTH

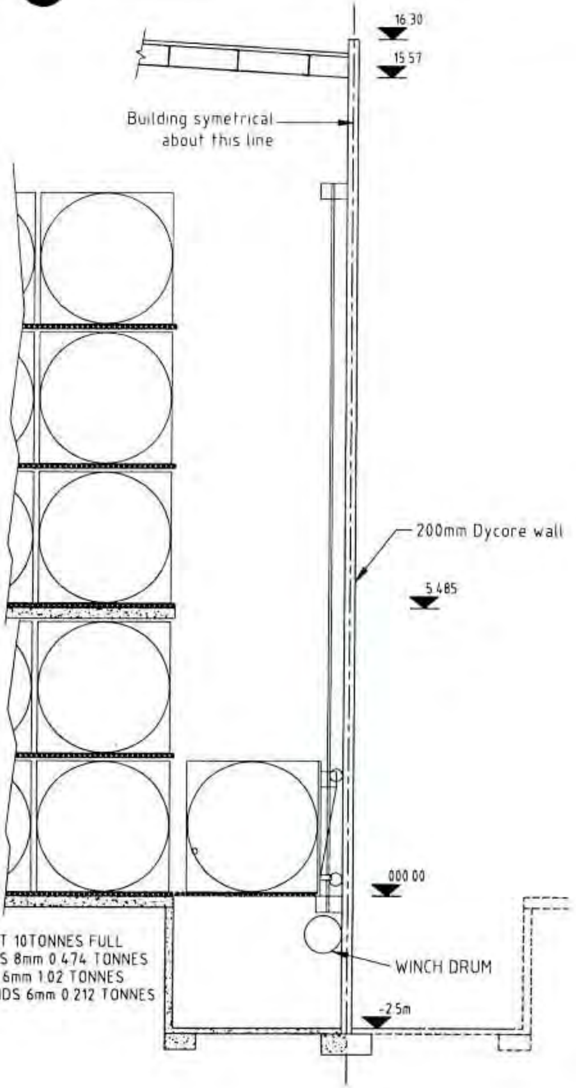
MSW PLANT
BUILDING SECTION

| | | | |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |

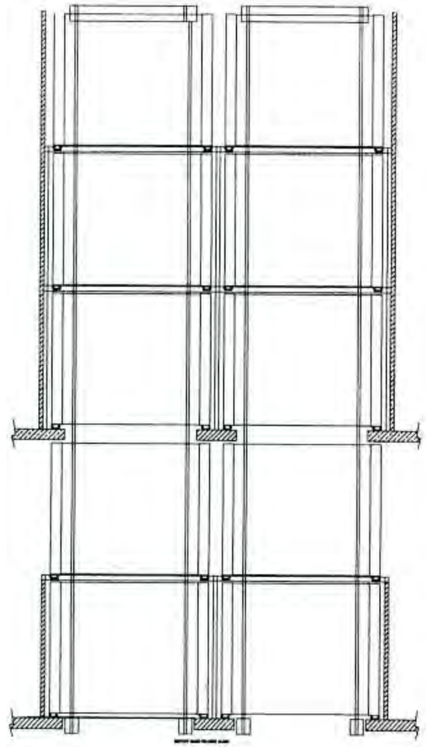
A1=1:100 A3=1:200

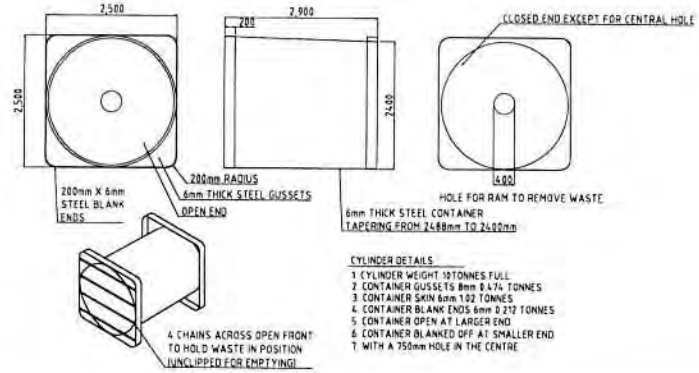
PERTH / PL200 — 1

**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)




CYLINDER WEIGHT 10TONNES FULL
CONTAINER GUSSETS 8mm 0.474 TONNES
CONTAINER SKIN 6mm 1.02 TONNES
CONTAINER BLANK ENDS 6mm 0.212 TONNES






CYLINDER DETAILS

1 CYLINDER WEIGHT 10TONNES FULL
2 CONTAINER GUSSETS 8mm 0.474 TONNES
3 CONTAINER SKIN 6mm 1.02 TONNES
4 CONTAINER BLANK ENDS 6mm 0.212 TONNES
5 CONTAINER OPEN AT LARGER END
6 CONTAINER BLANKED OFF AT SMALLER END
7 WITH A 750mm HOLE IN THE CENTRE

| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |

**OLIVINE NEW ZEALAND**
45 WAIAU STREET, TORBAY
AUCKLAND, NEW ZEALAND
Ph: - (0064) 9-473-6786



**BARKER & ASSOCIATES**

WASTE TO ENERGY PLANT
KWINANA, PERTH

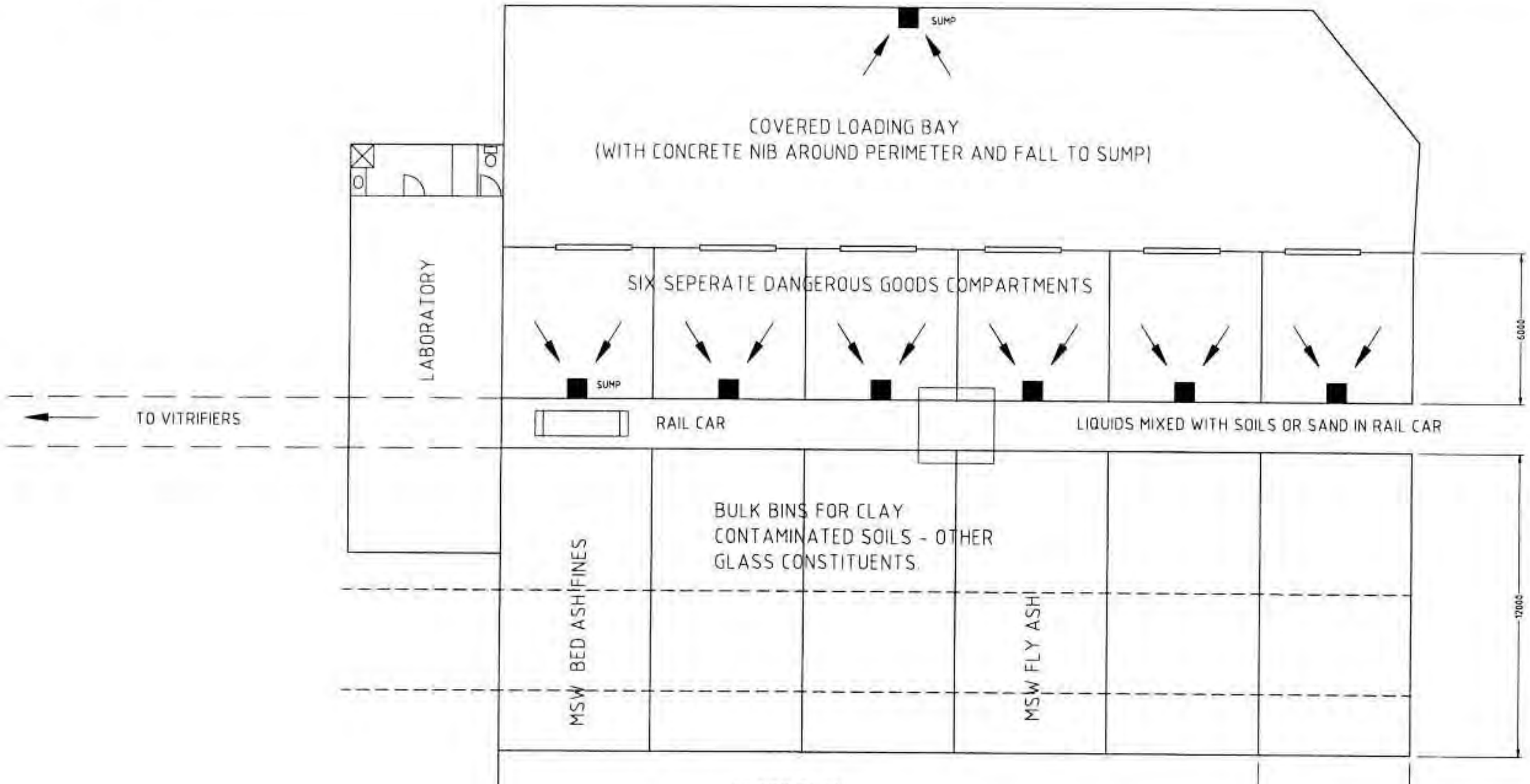
MSW PLANT
BIN STORAGE & LIFTING DETAILS

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

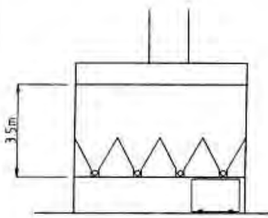
DRAWING SCALES
A1=1:50 A3=1:100

| DRAWING/CAD FILE No. | REVISION |
|---|---|
| PERTH / PL201 | 1 |

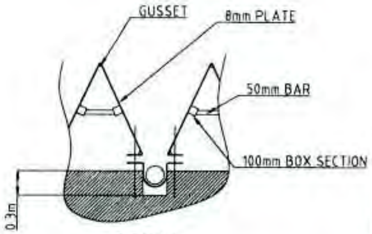
**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)



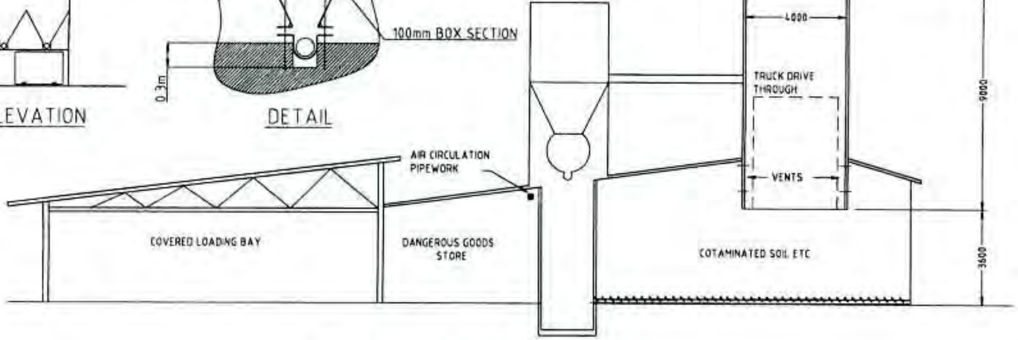

FLOOR PLAN




TYPICAL SIDE ELEVATION




DETAIL




TYPICAL CROSS-SECTION

NOTES:

TILT SLAB CONSTRUCTION -
CONCRETE ROOFS
DOUBLE CONCRETE FLOORS, IMPERVIOUS MEMBRANE BETWEEN FLOORS
AIR CHANGE EVERY 20 MINUTES- AIR TO INCINERATOR
TRUCK DRIVETHROUGH ONLY ONE DOOR AT A TIME
SUMPS ARE UNDRAINED - DESIGNED FOR SPILL AND WASHWATER CONTAINMENT

| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |


**OLIVINE NEW ZEALAND**
48 WAIAU STREET, TORBAY
AUCKLAND, NEW ZEALAND
Ph: - (0064) 9-473-6788





**BARKER & ASSOCIATES**


**WASTE TO ENERGY PLANT**
**KWINANA, PERTH**

**DANGEROUS GOODS STORE**
**PLAN AND SECTIONS**

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

DRAWING SCALES
A1=1:100 A3=1:200

DRAWING/CAD FILE No.
PERTH / PL202

REVISION
1

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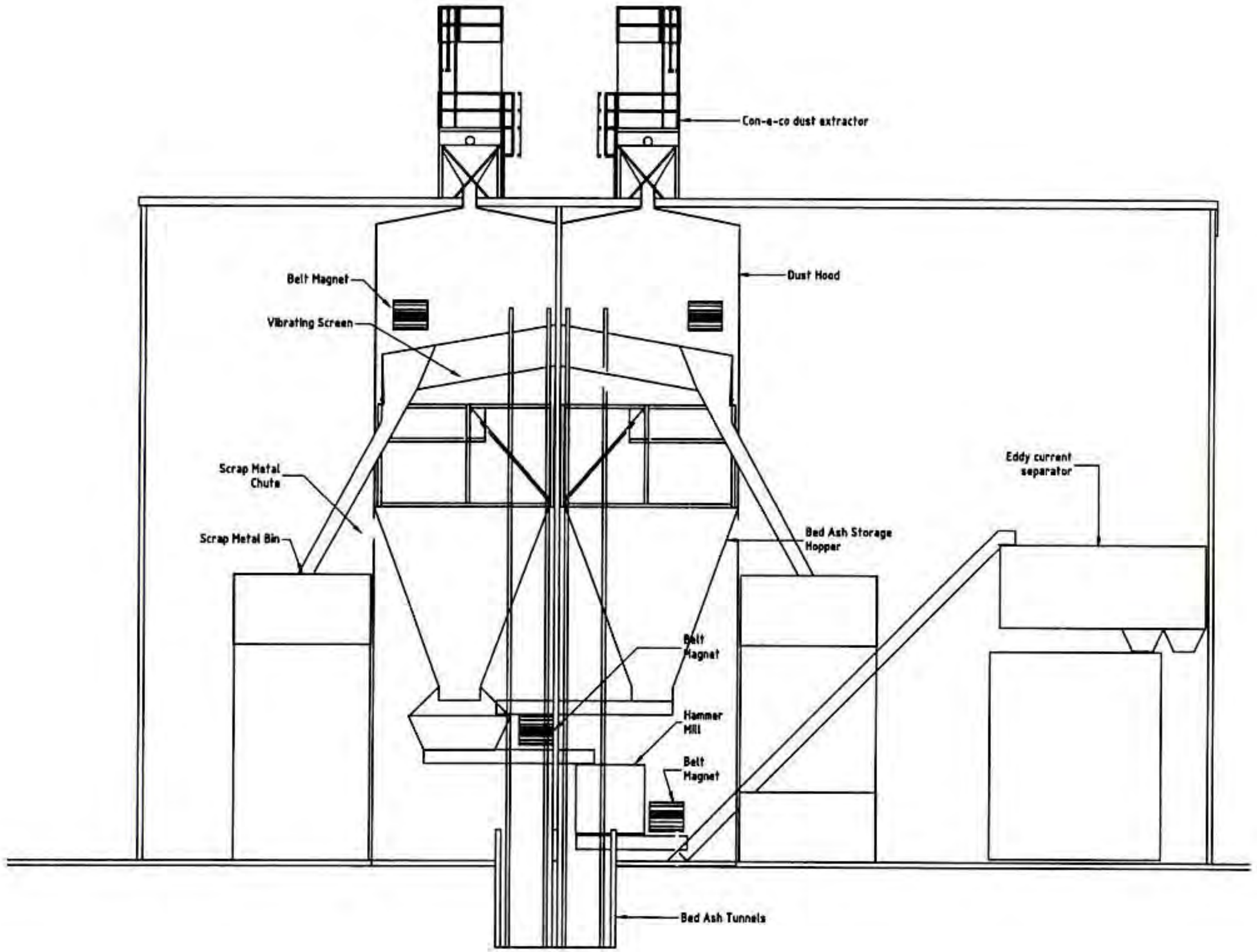
(Subject to survey)




1 INITIAL ISSUE RGL 20.12.99

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BARKER & ASSOCIATES

WASTE TO ENERGY PLANT
KWINANA, PERTH

ASH HOUSE PLANT

| | | | |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |

A1=1:75 A3=1:150

PERTH / PL203 | 1

**NOTE: -**
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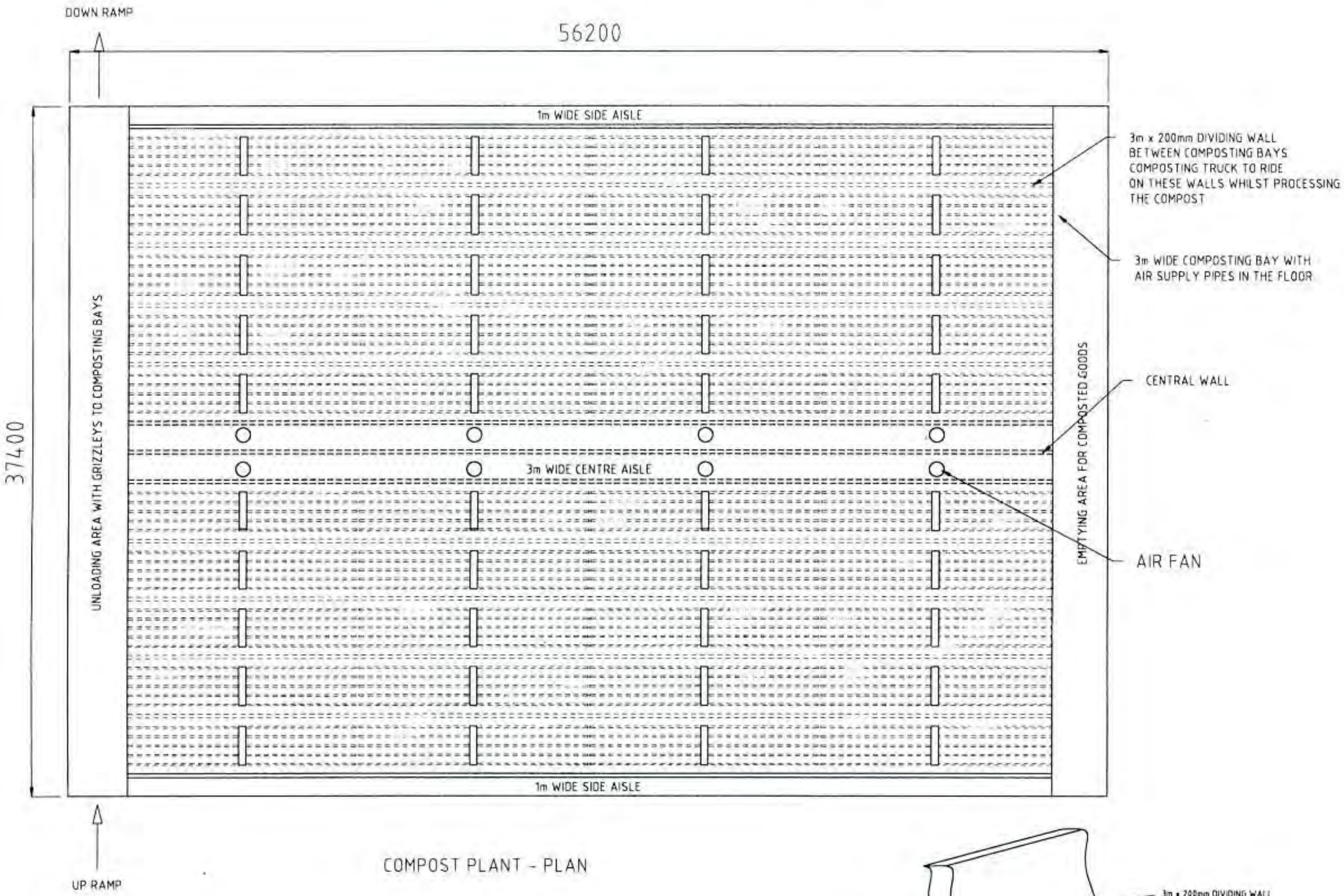
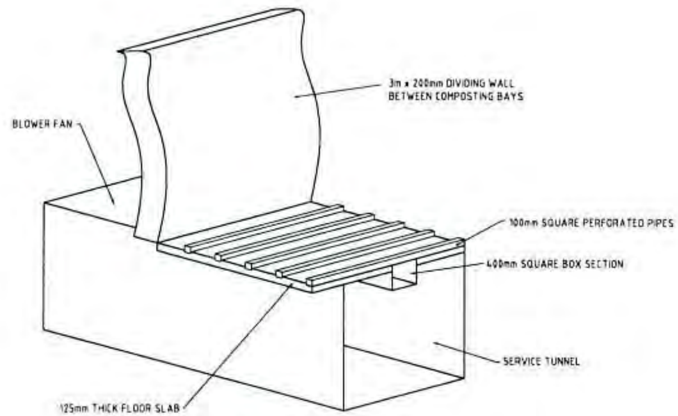
(Subject to survey)




COMPOST PLANT - PLAN




COMPOST PLANT - BED DETAIL

| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
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**WASTE TO ENERGY PLANT**
**KWINANA, PERTH**

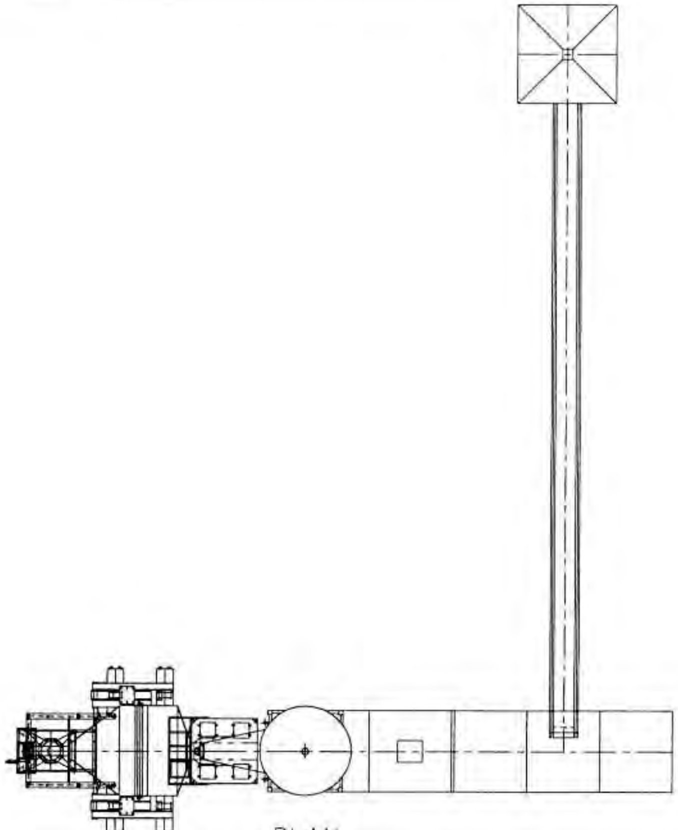
**COMPOSTING PLANT**
**PLAN & DETAIL**

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

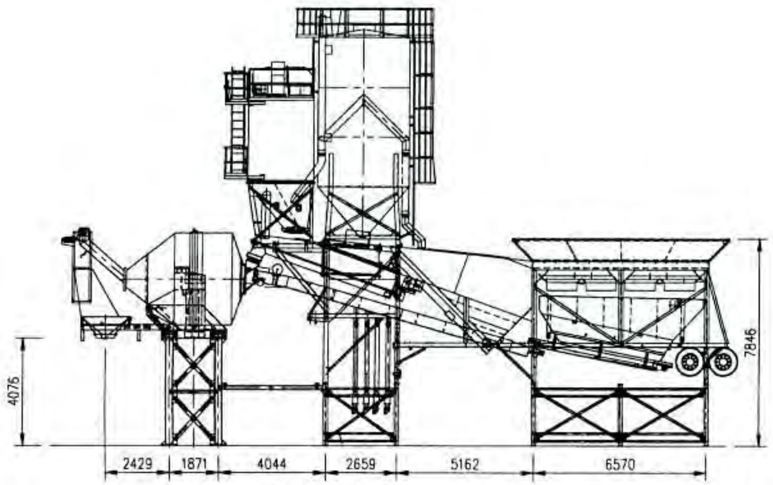
DRAWING SCALES
A1=1:125 A3=1:250

| DRAWING/CAD FILE No. | REVISION |
|---|---|
| PERTH / PL204 | 1 |

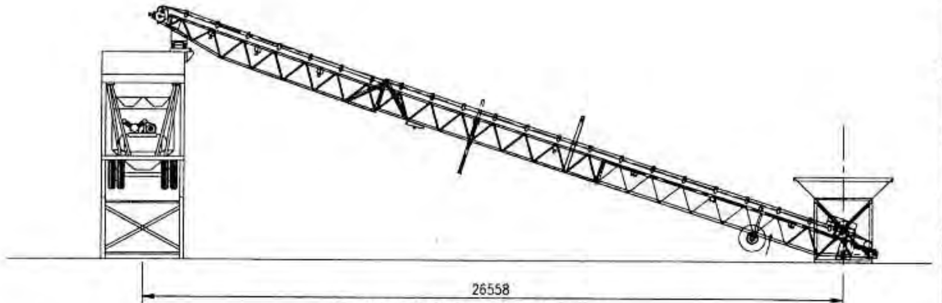
**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)



PLAN




ELEVATION




CONVEYOR ELEVATION

| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |

**OLIVINE NEW ZEALAND**
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AUCKLAND, NEW ZEALAND
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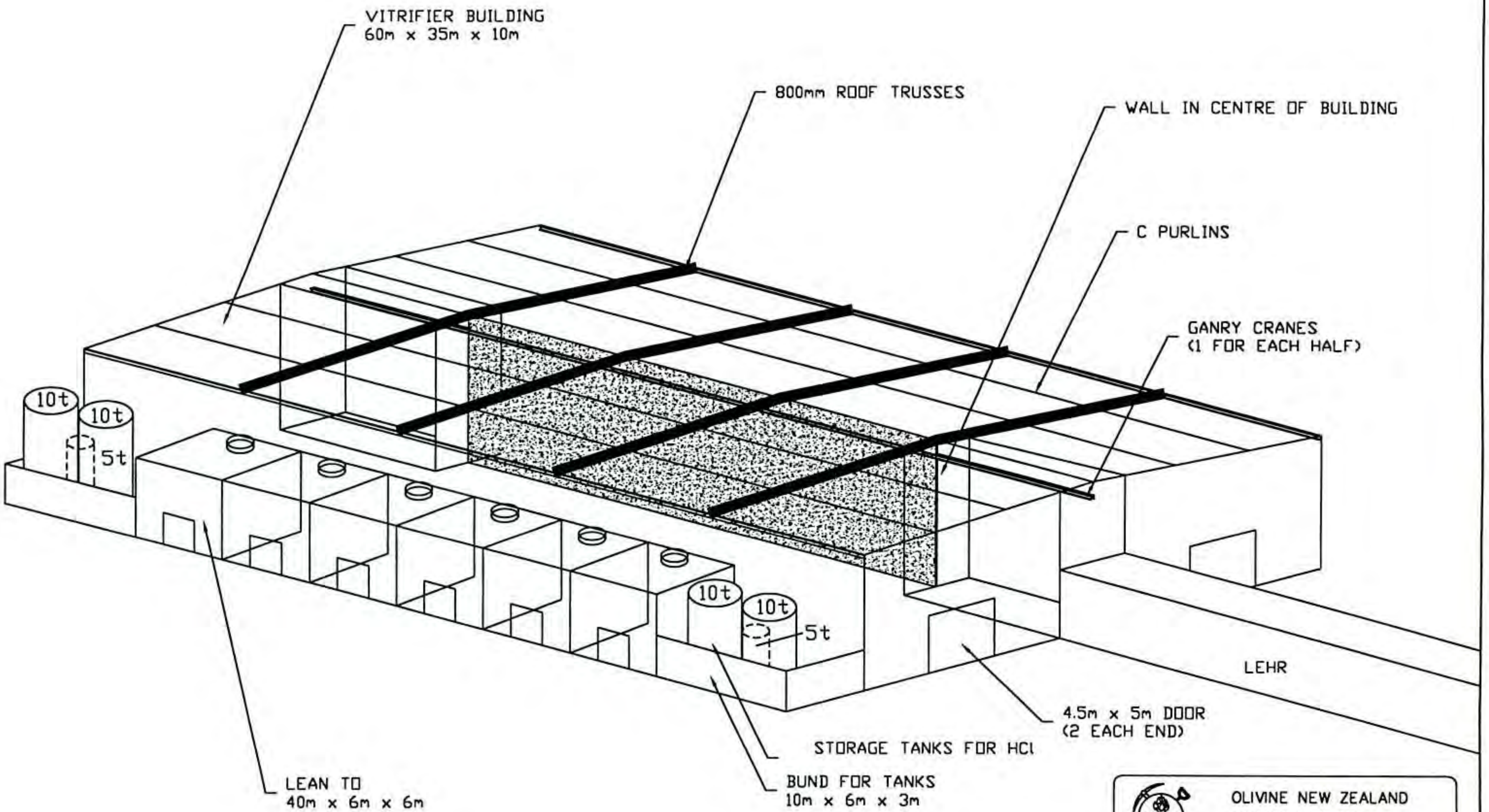
**WASTE TO ENERGY PLANT**
**KWINANA, PERTH**

**CONCRETE PLANT**
**PLAN & ELEVATIONS**

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

DRAWING SCALES
A1=1:200 A3=1:400

| DRAWING/CAD FILE No. | REVISION |
|---|---|
| PERTH / PL205 | 1 |



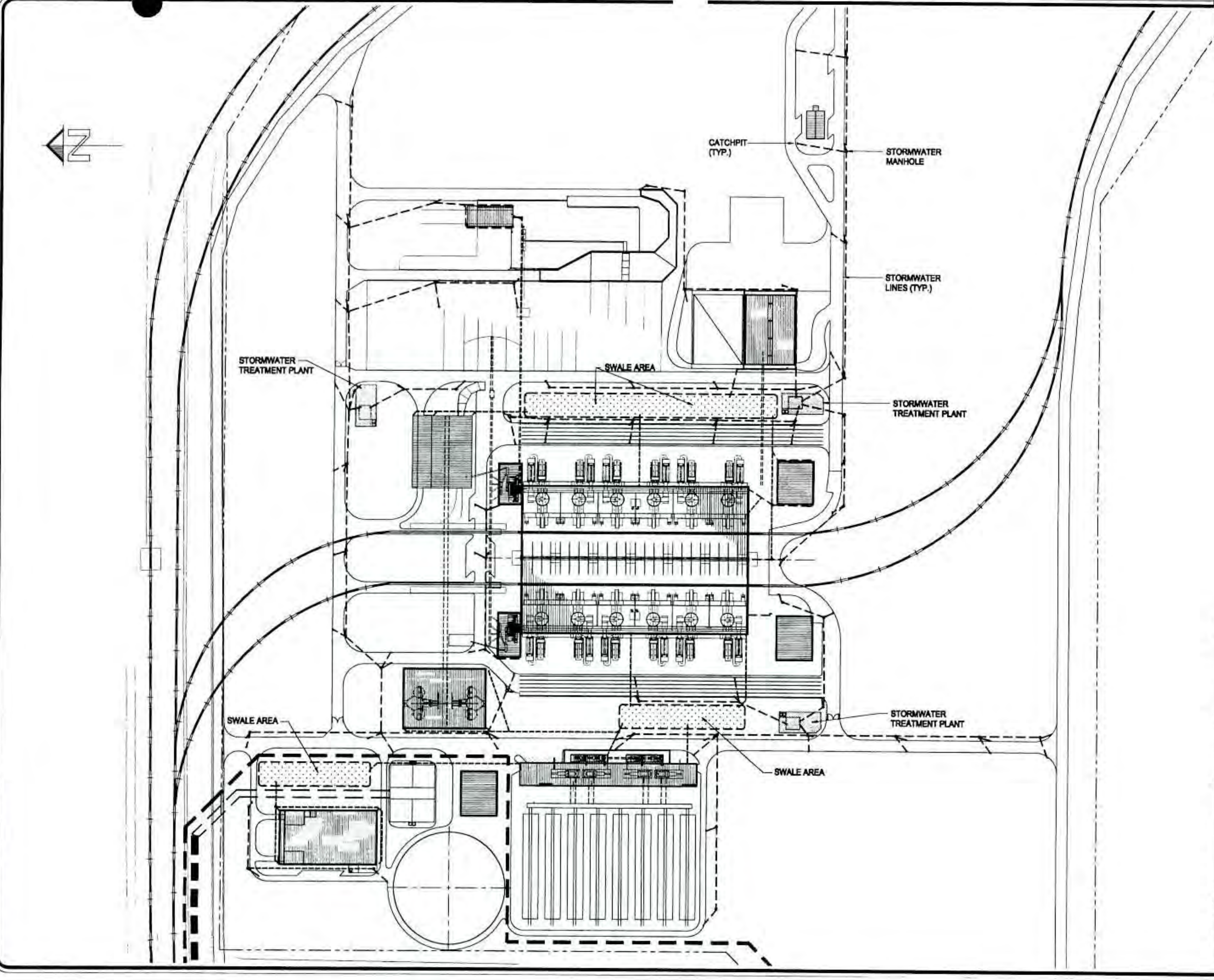

OLIVINE NEW ZEALAND
20 TUI STREET TORBAY
AUCKLAND, NEW ZEALAND
(09)473 5788



| | |
|---|---|
| SCALE NOT TO SCALE | DATE 14/08/99 |
| DESCRIPTION GO WA KWINANA WTE PLANT Vitrifier Building Roof | |
| DRAWN BY David Raven | DRAWING NO. OL00834 |

# Appendix F

# Stormwater Management Plans




**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)

| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |

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BARKER & ASSOCIATES

WASTE TO ENERGY PLANT
KWINANA, PERTH

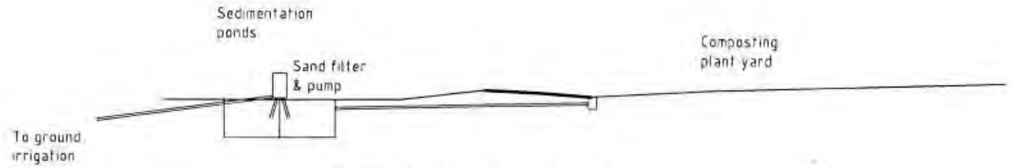
PROPOSED SITE PLAN
SHOWING STORMWATER
DRAINAGE LAYOUT

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 23.08.1999 | OLIVINE NZ | 23.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

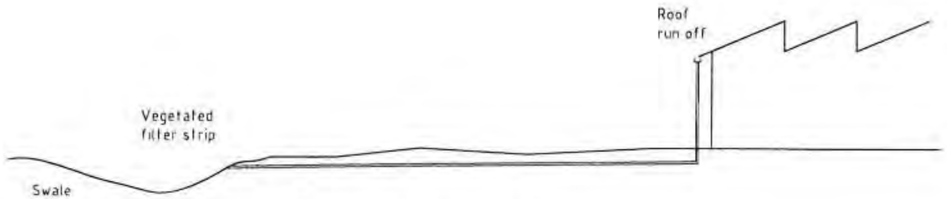
DRAWING SCALES
A1=1:1,250 A3=1:2,500

DRAWING/CAD FILE No. PERTH / PL102
REVISION 1

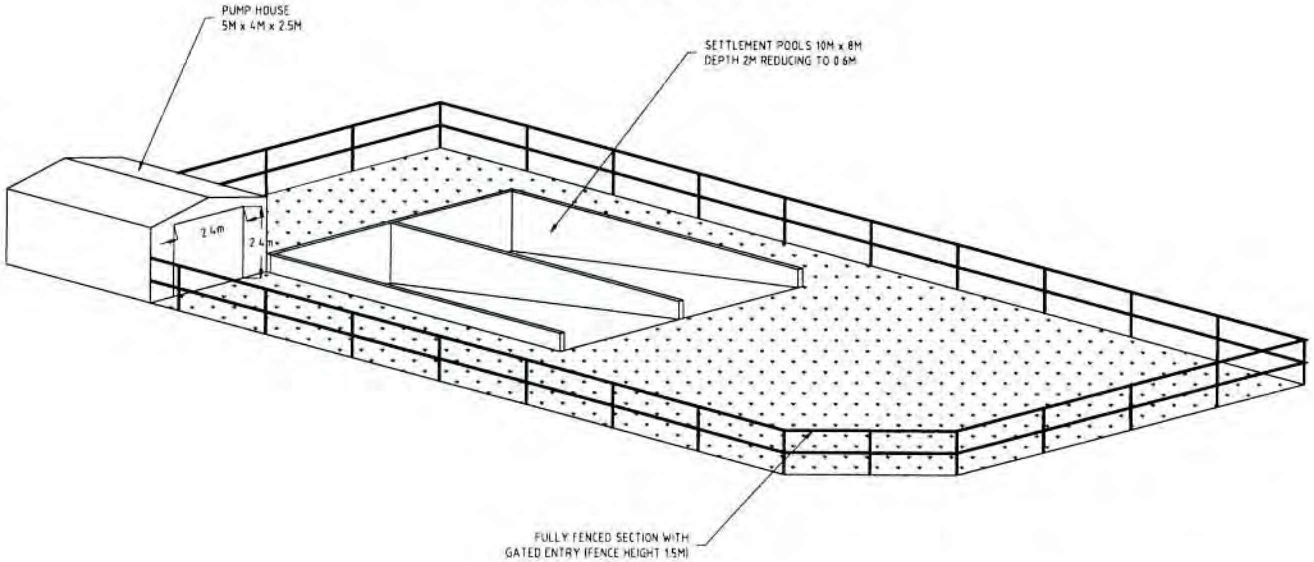

1) Discharge to Surface via Sedimentation Pond




2) Discharge to Irrigation




3) Discharge to Surface




**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
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| Revision | Amendment / Issue | By | Date |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |

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**BARKER & ASSOCIATES**

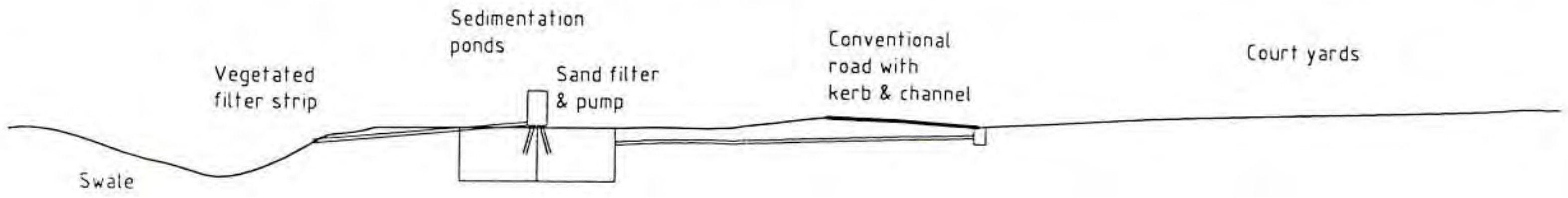
WASTE TO ENERGY PLANT
KWINANA, PERTH

STORMWATER DETAILS
SECTIONS & DETAILS

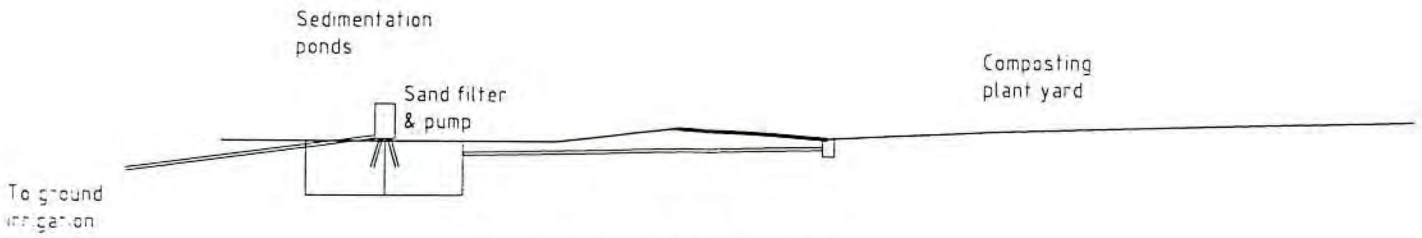
| Drawn | Date | Designed | Date |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| Checked | Date | Approved | Date |
| | | | |

Drawing Scales: A1=1: Not to Scale

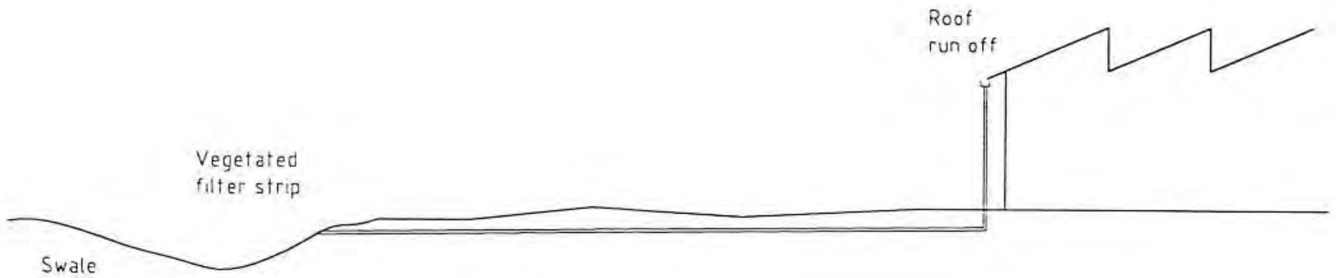
| Drawing/CAD File No. | Revision |
|---|---|
| PERTH / PL206 | 1 |



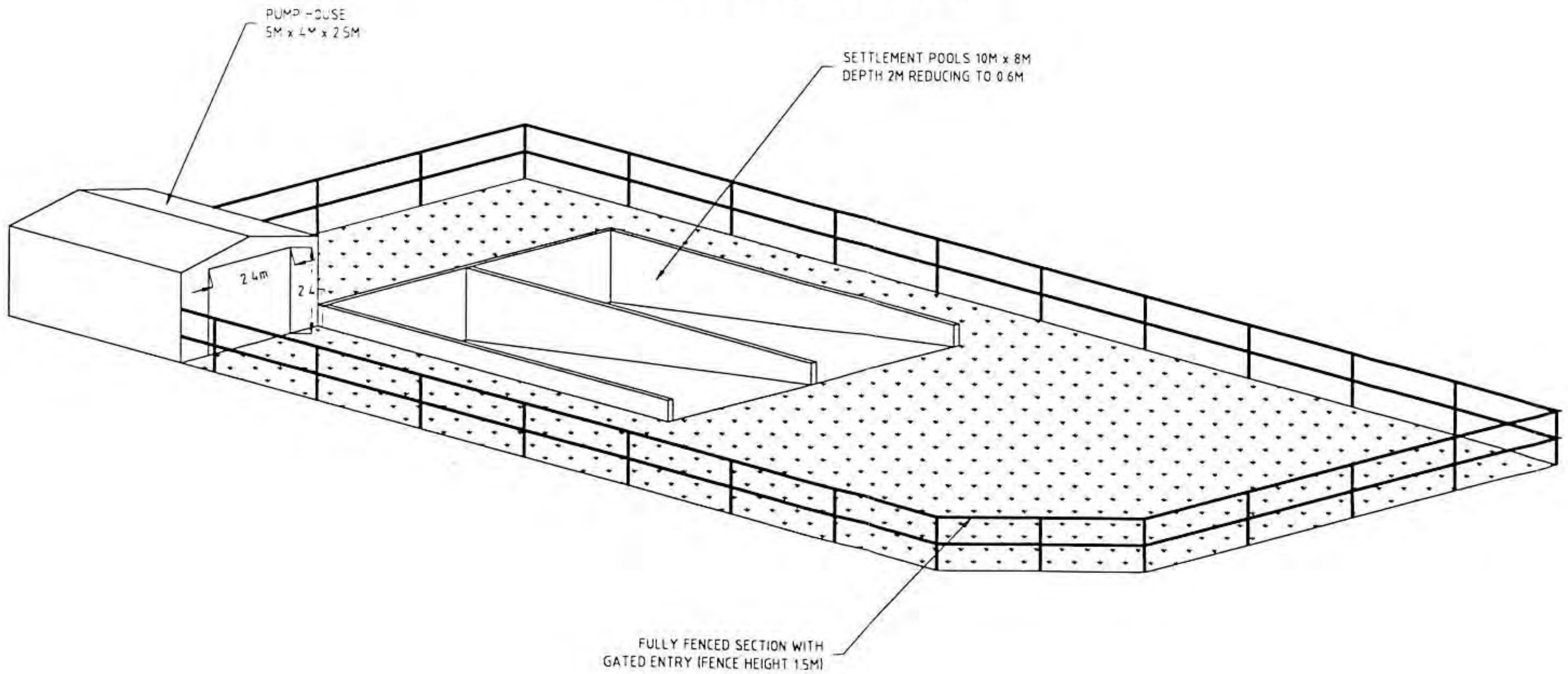

1) Discharge to Surface via Sedimentation Pond




2) Discharge to Irrigation




3) Discharge to Surface




**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)

| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |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AUCKLAND, NEW ZEALAND
Ph: - (0064) 9-473-5788





BARKER & ASSOCIATES
Barker & Associates Limited
Level 2, Windsor Court,
126-136 Parnell Road,
Auckland, New Zealand.
PO Box 37-806, Parnell
Ph :- (0064) 9 379-3680
Fax :- (0064) 9 379-8466
Email :- Admin@Barker.co.nz


WASTE TO ENERGY PLANT
KWINANA, PERTH

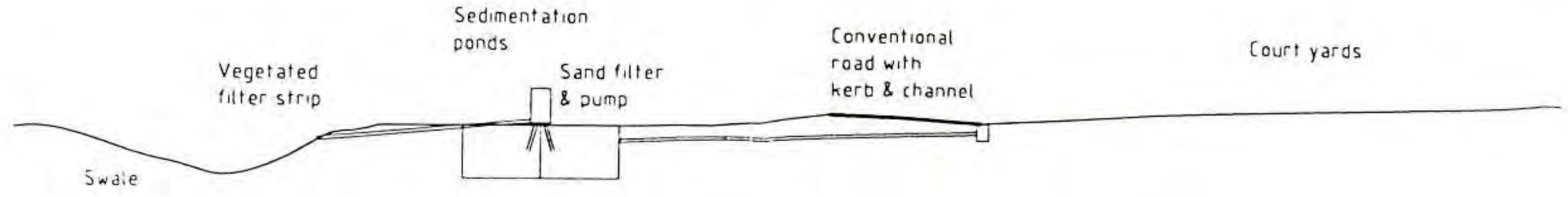
STORMWATER DETAILS
SECTIONS & DETAILS

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

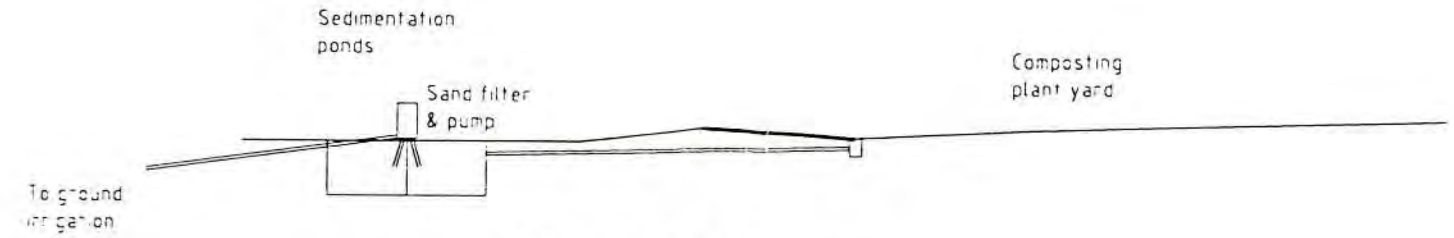
DRAWING SCALES
A1=1: Not to Scale

| DRAWING/CAD FILE No. | REVISION |
|---|---|
| PERTH / PL206 | 1 |

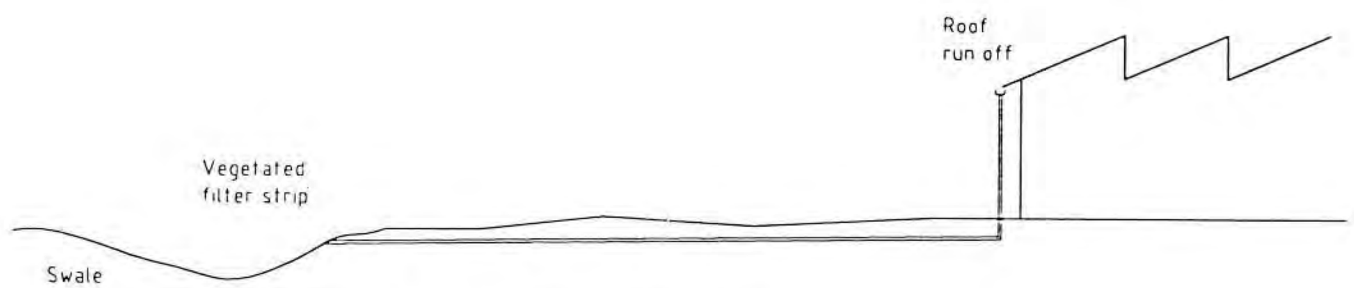
**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)



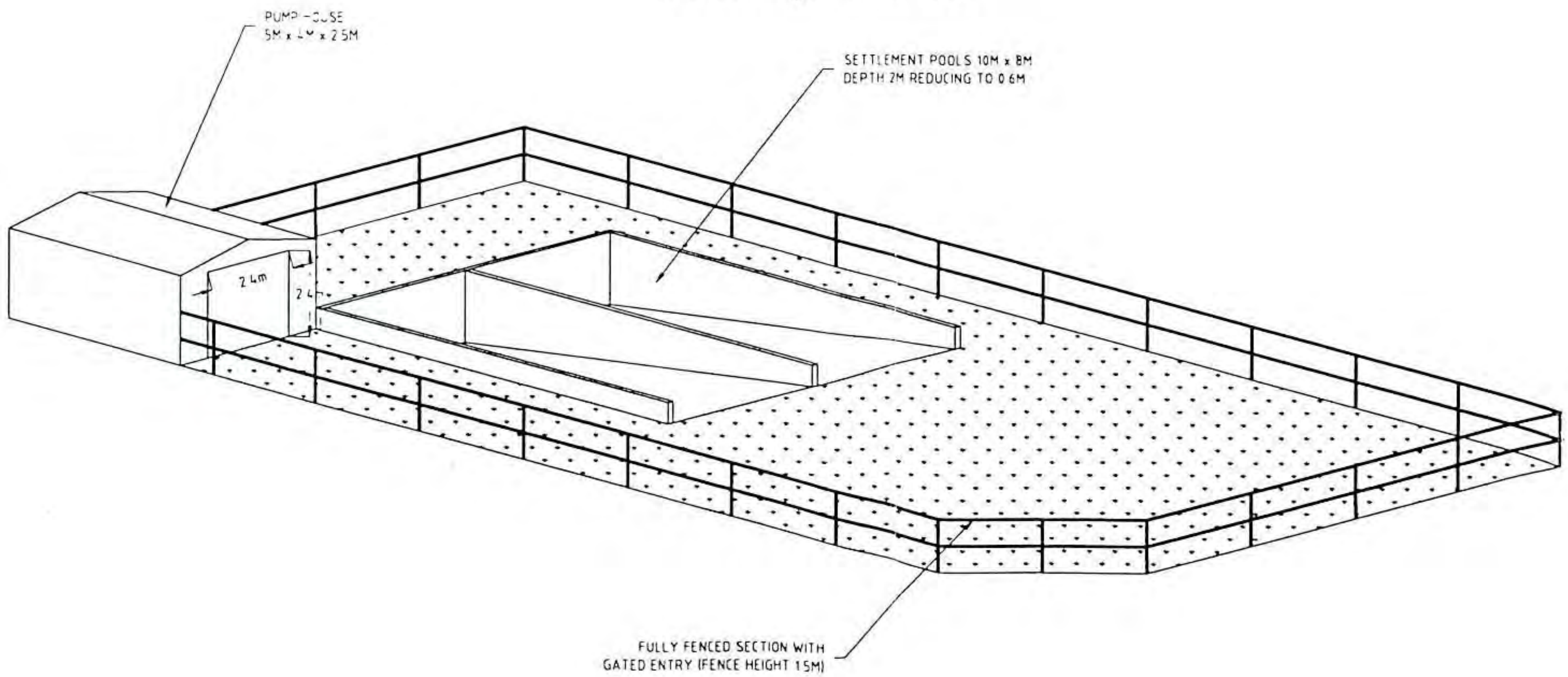

1) Discharge to Surface via Sedimentation Pond




2) Discharge to irrigation




3) Discharge to Surface




| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |

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WASTE TO ENERGY PLANT
KWINANA, PERTH

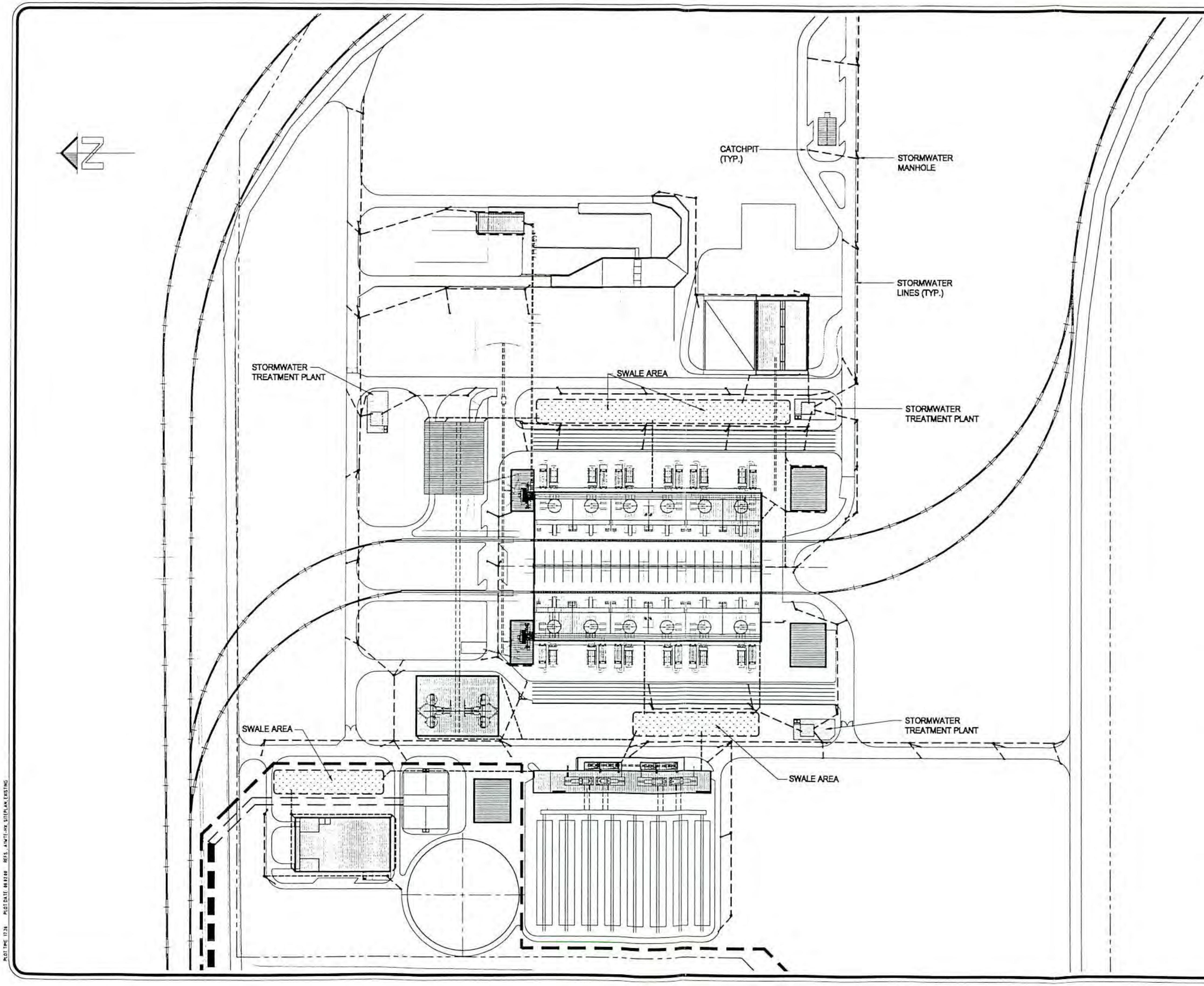
STORMWATER DETAILS
SECTIONS & DETAILS

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

DRAWING SCALES
A1=1: Not to Scale

DRAWING/CAD FILE No.
PERTH / PL206

REVISION
1




**NOTE: -**
Existing site information shown on these drawings has been scaled from aerial photography. Boundary locations and existing features are shown to an accuracy of +/- 2.5m.
(Subject to survey)

| REVISION | AMENDMENT / ISSUE | BY | DATE |
|---|---|---|---|
| 1 | INITIAL ISSUE | RGL | 20.12.99 |

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Ph: - (0064) 9-473-6788




BARKER
& ASSOCIATES
Barker & Associates Limited
Auckland, New Zealand


WASTE TO ENERGY PLANT
KWINANA, PERTH

PROPOSED SITE PLAN
SHOWING STORMWATER
DRAINAGE LAYOUT

| DRAWN | DATE | DESIGNED | DATE |
|---|---|---|---|
| R.LINDSAY | 25.08.1999 | OLIVINE NZ | 25.08.1999 |
| CHECKED | DATE | APPROVED | DATE |

DRAWING SCALES
A1=1:1,250 A3=1:2,500

DRAWING/CAD FILE No.: PERTH / PL102
REVISION: 1

# Appendix G

# Aon Insurance

AON

*Aon Risk Services*

*Insurance Brokers*

*Risk Consultants*

Aon Risk Services NZ Limited
Auckland Corporate
1184,Auckland
16th Floor, Quay Towers, 29 Customs Street West, Auckland
Telephone 09 309 2870
Fax 09 309 6541

11 November 1999

Mr. Warwick Davies
Olivine New Zealand Limited
45 Waiau Street
Torbay
**AUCKLAND 10**

Dear Warwick

**Global Olivine Western Australia**

First let me thank you once again for appointing the Aon group as your advisors on matters of insurance and risk management. It is not often that we have the opportunity to become involved in projects with the potential demonstrated by your Waste to Energy and Water system and we look forward to contributing to its success.

As discussed at our recent meetings, Aon is firmly of the opinion that there will be a ready market when it comes to insuring the plant at Kwinana and the liabilities associated with the plant's operation. We are also of the opinion that the nature of the operation removes the question marks that exist around current waste disposal and composting techniques, as far as sustainability of insurances is concerned.

The main reasons why we believe this will be the case are set out in summary below:

1/ The technology which is being used in the Olivine process, while refined and combined in an innovative fashion, is not new. Aon is already involved in the placing of insurance with respect to Olivine furnace technology.

In addition, we understand that the insurer we have identified as being the most likely to insure the plant, already insures the vitrification equipment that is to be incorporated into the system.

As such a market already exists that we can tap into.

2/ The design of the Olivine system provides insurers with a finite and to a large extent measurable exposure. Essentially, liability only exists while the plant is in operation. We believe that this will be a very attractive feature to insurers and will certainly be used as a selling point in our discussions with insurers.

This is in stark contrast to current waste disposal methods which are still, by and large, able to purchase insurance.

3/ The features that are likely to make the Olivine System so attractive to insurers, will allow for sustainability of insurance. Indeed, we believe that the inherent financial strength and attractive risk profile of the Olivine process lends itself to the formation of a captive insurance company backed up by quality international reinsurance companies. This would guarantee that cover was always in place.

These features are not nearly as evident in other waste disposal and composting techniques. The liabilities associated with these extend over significant periods of time and in the event of significant losses being associated with the risks being carried by the insurers, it is unlikely that an insurer will be happy to continue to carry such risks.

Given the nature of the risks that are inherent in the processes currently being used; gradual pollution and contamination associated with landfill, contamination of composting product due to the combining of sewerage sludge, paper etc. it is perhaps inevitable that losses will occur. Given this, a serious question mark must hang over the ability of such processes to sustain their insurance cover.

As discussed, we will be reporting to you in the near future regarding the recommended structure of your insurance programme in the initial stages of the development of your business. We are holding preliminary discussions with prospective insurers to enable us to set up these policies as soon as the project obtains the "green light".

Yours sincerely

Miles Stratford
**ACCOUNT MANAGER**

Encl:

# Appendix H

# Comparison Between Upper and Lower Mixing Levels

**COMPARISON OF LOWER AND UPPER LAYERS OF WELL-MIXED ZONE**

HYDROCARBONS

LOWER LEVEL CONCENTRATION HC:

| (DISTANCE FROM WALL) | | CONCENTRATION IN PPM | |
|---|---|---|---|
| 2' | 261 | 44 | 260 |
| 4' | 0 | 2 | 0 |
| 6' | 0 | 0 | 0 |
| 8' | 178 | 5 | 89 |

UPPER LEVEL CONCENTRATION HC:

| (DISTANCE FROM WALL) | | CONCENTRATION IN PPM | |
|---|---|---|---|
| 2' | 0.0 | 0.0 | 0.0 |
| 6' | 0.0 | 0.0 | 0.0 |
| 6' | 0.0 | 0.0 | 0.0 |
| 9' | 1.0 | 0.0 | 0.0 |
| 9' | 0.0 | 0.0 | 0.0 |

# Appendix I

# Integrated Environmental Technology

# Integrated Environmental Technologies, LLC

*1935 Butler Loop*
*Richland, Washington 99352*
*(509) 946-5700*

November 17, 1999

Warwick Davies
Managing Director
Olivine New Zealand Limited
20 Tui Street, Torbay
Auckland 10, New Zealand

Dear Mr. Davies:

This letter is intended to provide you with a status of our Plasma Enhanced Melter™ (PEM™) technology. We have made substantial progress since we last communicated.

First, our technology has been proven at three different sizes. We have sold four complete systems, two of which will be fully operational near the end of 1999 or early 2000. We have three additional customers that are in the final stages of making a decision to procure PEM™ systems.

As you are aware, I have now hired nearly all of the staff that were previously in the Battelle Vitrification Group. This gives Integrated Environmental Technologies, LLC (IET) over 100 years of cumulative experience in vitrification technology, design and operation. IET has now grown to 30 employees; most are engineers and scientists. No other company in the world possesses a team such as that at IET.

I also want to provide you with a status of the acceptance and regulatory approval of our technology in the United States. The PEM™ technology was granted a RCRA and TSCA permit in July 1999. This is the first RCRA/TSCA permit granted in the United States for a vitrification based technology such as the PEM™.

We are now scaling our technology for a possible plant which will process over 200 ton of waste in the state of Hawaii. The interest in this technology has spread around the world as we continue to be contacted by interested parties nearly every day.

If you would like additional information on the status of our PEM™ technology please give me a call at (509) 946-5700.

Sincerely,

Jeffrey E. Surma
Executive Vice President & COO

# Appendix J

# Engineering Due Diligence

**KERSLAKE AND PARTNERS**
**CONSULTING ENGINEERS**

**CIVIL, STRUCTURAL, ELECTRICAL, MECHANICAL, ENERGY AND BUILDING SERVICES ENGINEERS**

15 Te Puni Street
(off The Esplanade)
Petone, Wellington
New Zealand

PO Box 38-997, Wellington 6332
Phone: 64-4-568 4411
Fax: 64-4-568 4177
E-mail: Engineers@kerslakeconsulting.gen.nz

W.R. THESSMAN, B.E. (Civil), C.Eng., F.IPENZ, M.I.C.E., M.A.S.C.E., M.A.S.H.R.A.E., Regd.
G. PALLO, B.E. (Elect.), C.Eng., F.IPENZ, M.I.E.E., M.I.E.E.E., Regd.
J.C. MENZIES, C.Eng., M.I. Struct.E., M.IPENZ, Regd.
D.J. de LISLE, B.E. (Civil) Hons., M.Eng., M.IPENZ, Regd.

Your Ref: Our Ref: C/N 7475
GP:ac

17 November 1999

Olivine New Zealand Ltd
20 Tui Street
Torbay
AUCKLAND 10

**Attention: Warwick Davies**

Dear Warwick

Re: Kwinana Waste to Energy Project

We have recently carried out a technical review of the basic systems comprising a Waste to Energy Project proposed by Olivine New Zealand Limited.

While the majority of operations comprising the project employ well proven technologies in wide spread use, areas within the combustion region utilise proprietary techniques. As a result of our review of the project in general and the combustion area in particular, we are of the opinion that the process presented in the documentation made available to us and complemented by subsequent discussion, is technically viable. We also confirm that the values used in calculating thermal and mass flows are inherently within acceptable parameters for such an operation.

We have not in this review, examined the aspect of the project economics nor the operations of conventional proven technologies such as turbo alternators and multiple effect desalinators.

We understand that preliminary design of the project is virtually completed enabling the preparation of the banking feasibility study. We similarly understand that definitive design of some systems is well advanced and as with many projects of this scale, will continue up to the commencement of construction.

We would be pleased to provide further assistance in these investigations as appropriate.

Yours faithfully
KERSLAKE AND PARTNERS

Gerry Pallo

**Gerry Pallo**
Senior Partner
Lr Olivine re Kwinana Project

**KERSLAKE**
**AND PARTNERS**
**CONSULTING ENGINEERS**

~~18 Te Puni Street~~
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**CIVIL, STRUCTURAL, ELECTRICAL, MECHANICAL, ENERGY AND BUILDING SERVICES ENGINEERS**

Your Ref: Our Ref: C/N 7475
GP:ac

23 November 1999

Olivine NZ Limited
20 Tui Street
Torbay
AUCKLAND

**Attention: Warwick Davies**

Dear Warwick

**Re: Renewable Energy Commercialisation Program – Round 3 (RECP3)**

Attached please find our response to the questions on the Technical Referees Report CP3/4.

Yours sincerely
**KERSLAKE AND PARTNERS**

Gerry Pallo

**Gerry Pallo**
7475 lr w/comments on Report

Encls

ACENZ

KERSLAKE AND PARTNERS

## Renewable Energy Commercialisation Program – Round 3 (RECP3)

## Technical Referees Report

1. The Technology

Probability that the technology will perform as claimed in the application - 90%

- The majority of the plant units are proprietary items
- Most proprietary items have long proven in-service history
- Operational issues examined in previous plant have been further refined and developed
- Model testing of combustion air and extensive computer simulation of combustion has been performed
- The proposed construction techniques have been used on previous combustors

2. Competitiveness - Very High

- Competitive with land fills at present day prices
- Can safely handle industrial chemicals and toxic wastes
- Can handle and recycle metals and other non biodegradable refuse
- Can dispose of sewage sludge, tyres and other environmentally pollutant materials
- Produces a range of saleable by-products

3. Replicability - Wide Spread

- Similar plants could be built in most suitable industrial/commercial areas adjacent to a suitable source of MSW

4. Level of Innovation - High

- Innovation lies in two main areas
  (i) The combustion technology to achieve complete, low pollution burning
  (ii) The integration of simple sub processes to create a complete MSW handling/processing and conversion plant with high percentage of saleable by-products

5. Market Potential - Wide Market

- There is a potential for replication adjacent to every population centre exceeding ½ million

KERSLAKE AND PARTNERS

6. Technical Ability to Complete the Project - High

- Preliminary design of the overall project have been completed
- Sub systems have been designed or reviewed by specialist companies/consultants in these fields
- Details of design of 60% of sub systems completed
- The key personnel have significant expertise in general construction and have engaged specialist technical support

7. Contribution to Australia's Renewable Energy Industry - Significant

- The plant is fueled predominantly from waste products with the only use of fossil fuel being the burning of waste oils and plastics for disposal.
- Minor injections of ground lime rock are made into the high temperature combustor to assist the combustion process.
- The production of electricity from MSW which is predominantly a biomass fuel, mitigates production of the same amount from fossil fuels.

8. Any Further Comments

- The process has very low atmospheric polluting discharges.
- It does not suffer from leachate or methane gas discharge as do land fills
- The vitrifying process is capable of cost-effectively producing a high calorific producer gas from biomass fuels in a strong reducing environment which minimises $CO_2$ and Nitrogen from the producer gas. Ash is converted to glass in this process.
- The combustor operates well above the calcinating temperature of lime and due to the long residence times provides for effective sulphur gas removal prior to boiler entry. This provides longer life for the boiler and cleaner gas emissions when combined with conventional scrubbing.
- It can safety destroy industrial chemicals and toxic wastes and as such can be utilised as a plant for "cleaning up" contaminated areas, eg old chemical processing sites, plants, soils, etc, contaminated from major oil spills
- The plant has the capability to process any form of product be it liquid, solid, metallic, green material, non biodegradable, toxic, etc, into clean safe useful by-products.

Reference provided by: Gerry Pallo
Position: Senior Partner

Signature: Gerry Pallo

Organisation: Kerslake and Partners
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Fax: (04) 568 4177

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**ODYSSEY ENERGY LIMITED**

25 November 1999
Doc Ref: OKW- 060

Olivine NZ Ltd,
45 Waiau Street
Torbay
Auckland
North Shore

Attention: Warwick Davies

Dear Warwick:

Subject: Electrical System for Kwinawa Waste / Energy / Desalination Plant.

In response to your request for us to review the electrical design details and cost estimates for the above plant, we have examined the project documentation to date and report as follows.

In July 1999, Kerslake and Partners, consulting engineers prepared preliminary design and cost estimates for the project. Since then both Odyssey Energy Limited and Kerslake and Partners have been working together on the electrical design for the project. In this period we have peer reviewed Kerlake and Partners electrical design and details of the mechanical plant have been firmed up considerably. Whilst the main station connections to the local power network remain substantially the same as K & P envisaged, optimisation of the station plant has caused some changes to the 11kV, 3.3kV and 400V systems. This has not significantly increased the costs of the items included in the K & P estimates, but co-ordination of the various project disciplines has meant items not previously included in the electrical systems have been added. These additions account for the majority of the increase in cost, and it is recommended checks be made to ensure items have not been duplicated elsewhere in the overall estimates.

The attached spreadsheet details revised estimates for the electrical installation on the basis of information available as at 24 November 1999. Unless there are significant changes to the mechanical plant, we would expect these estimates to be accurate to within +/- 10% at project end. The costs are quoted in $NZ and at exchange rates current at 24 November 1999.

- The following comments should be read in conjunction with these estimates:
- 33/11kV Station Transformers. Increased rating to 10/12MVA with tap change on load to provide a regulated 11kV bus for station ring main feeders. These transformers will also be available for MED unit operation when the associated

turbine is out of service. (It is assumed vitrifier's will not be operated from station Transformer supply)

- 11kV Switchboard now split into five switchboards, comprising one regulated switchboard from 33/11kV Station Transformers and four unregulated 11kV switchboards to supply the semi unitised MED units and vitrifiers. The split is also necessary to control 11kV fault levels.

- Use of resin encapsulated 11kV / 400 V transformers in lieu of oil filled units. This increases the electrical content but removes a potential fire hazard, oil interception requirements, and allows location of the transformers alongside the switchboards.

- Increased ratings now apply for variable speed drives for MSW Furnace fans.

- The cost of the fans and associated motors is now included in the estimates.

- Lighting for the site and buildings is now included in these estimates. (Note: 3E Energy Limited have allowed for lights for hazardous locations, UL Listed for class 1 division 2)

- Increased size of 3.3kV switchboard to allow for additional pumps and station black start capability.

- With these changes, which are shown on the revised electrical single line diagram (see attached), a robust and reliable electrical system, with operational flexibility to ensure high availability will be provided.

- These estimates do not include the main generators, but an allowance has been made for an emergency shut down battery / charger system.

- SCADA and control system programming is included in the design fee, and a gross estimate is included for the equipment costs.

Since Odyssey Energy Limited was recently formed, and we may not be known to other parties I also attach a copy of the company profile and a CV for Roger Loveless, managing director.

Briefly, the company was formed by Roger in August 1997 after 26 years experience in the New Zealand electrical industry. This included thermal power station experience as follows:

- 2 years as assistant engineer at Marsden A power station, a 240MW plant located approximately 150km north of Auckland.

- 5 years as engineer / senior engineer during the construction of Huntly Power Station, a 1000MW plant located 90 kM south of Auckland.

- Design, feasibility study and project cost estimation experience relating to a number of other power stations whilst employed by the NZ Electricity Department and its successors.

Prior to forming Odyssey Energy, Roger was employed by DesignPower NZ Ltd in their Hamilton office. This office was closed in August 1997 prior to the sale of DesignPower to PB Power International and Roger was not prepared to relocate within NZ. (DesignPower NZ Ltd was a wholly owned subsidiary of ECNZ which was recently split into three competing State Owned Enterprises. It was sold in 1998 to PB Power International)

Yours sincerely,

R Loveless.

Roger Loveless.

Director

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HAMILTON

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**ODYSSEY ENERGY LIMITED**

17 December 1999
Doc Ref: OKW- 070

Olivine NZ Ltd,
45 Waiau Street
Torbay
Auckland
North Shore

Attention: Warwick Davies

Dear Warwick:

Subject: Kwinawa Waste / Energy / Desalination Plant.

I have assisted Olivine NZ Limited as a consultant over the last four years, firstly with DesignPower NZ Ltd, now owned by PB Power International, and for the last two years as director of Odyssey Energy Limited, a company I established in 1997.

Whilst I have no specific knowledge of the Olivine process, I have worked on a number of thermal power stations in New Zealand and elsewhere. My expertise is in the on site electrical power reticulation and grid connections. I also have an interest in the overall economics of large thermal power stations, having been involved with the operation and construction of various stations in New Zealand.

The initial project on which I worked with Olivine NZ was the conversion of the Meremere 210MW power station to a waste to energy plant. This plant was built in the early 1960's and prior to committing to this project DesignPower NZ Ltd assessed the viability of the plant on the basis of power price projections at the time. I was involved in preparing part of a report on the economic viability of the project by DesignPower. In this process Olivine NZ showed a very professional attitude to the project and their lifetime cost projections for the project were well prepared and gave a sound idea of the projects viability. On the basis of the original assumptions the plant was financially viable. However, as a result of major reforms in the NZ Electrical Industry, new investment was encouraged and three major gas fired power plants were built in New Zealand which have provided a surplus of generating capacity, temporarily forcing power prices to a very low level. Although other issues were not resolved, including some concerns as to the emissions, (Which would have been controlled to modern standards), it was the power price that was the major factor that prevented the project proceeding. This situation may change over the next few years as old thermal plant is retired, and there were no other reasons for the project not proceeding.

With the Kwinana proposal, the power price situation is far more stable than in NZ, and in addition the Federal Government has issued a directive to the states to move towards a 4% biomass generation target. This project would make a major contribution to this target in Western Australia.

The expertise in project costing and in the financial modelling gained on the Meremere proposal have been carried forward to the proposed Kwinana plant. I therefore have no doubt that the financial projections prepared by Olivine NZ Ltd for this proposal have been professionally developed and all details are within acceptable industry expectations.

In respect of the electrical components of the project Odyssey Energy Limited has provided assistance to Olivine NZ, as detailed in our review dated 25 November 1999. In preparing these technical and financial details, it was necessary to liaise with other project participants, and we have every confidence that the overall project is technically sound and that the financial projections accurately represent the viability of the project.

It should be noted that neither Odyssey Energy Limited, nor any of its director's have any financial interest in Olivine NZ Ltd, and that the above information is given in my capacity as a professional engineering consultant.

Yours sincerely,

Roger Loveless. B.Sc. C. Eng. M.I.E.E. M.I.P.E.N.Z.

Director

# Appendix K

# Modulation Table

## Olivine Furnace Throughput

| | |
|---|---|
| Furnace size | 9.6 metres diam |
| MSW calorific value | 11.5 GJ/tonne |

| | MSW Input | Thermal output | Net Electrical Output |
|---|---|---|---|
| Nominal | 11.0 tonne/hr | 127 GJ/hr | 6.5 Mw |
| Min | 8.3 tonne/hr | 95 GJ/hr | 4.7 Mw |
| Max | 13.8 tonne/hr | 159 GJ/hr | 8.2 Mw |

| No of Furnaces | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Contracted Throughput | Tonnes/pa | 193,482 | 290,223 | 386,963 | 483,704 | 580,445 | 677,186 | 773,927 | 870,668 | 967,409 | 1,064,150 | 1,160,890 |
| Maximum Contracted Throughput | Tonnes/pa | 193,482 | 290,223 | 386,963 | 483,704 | 604,630 | 725,557 | 846,483 | 967,409 | 1,088,335 | 1,209,261 | 1,330,187 |
| Tonnes/hr | min | 16.6 | 24.8 | 33.1 | 41.4 | 49.7 | 58.0 | 66.3 | 74.5 | 82.8 | 91.1 | 99.4 |
| | max ( 1 chain down) | 13.8 | 27.6 | 41.4 | 55.2 | 69.0 | 82.8 | 96.6 | 110.4 | 124.2 | 138.0 | 151.8 |
| | Nominal rating | 22.1 | 33.1 | 44.2 | 55.2 | 66.3 | 77.3 | 88.3 | 99.4 | 110.4 | 121.5 | 132.5 |
| | max contracted | 22.1 | 33.1 | 44.2 | 55.2 | 69.0 | 82.8 | 96.6 | 110.4 | 124.2 | 138.0 | 151.8 |
| | max | 27.6 | 41.4 | 55.2 | 69.0 | 82.8 | 96.6 | 110.4 | 124.2 | 138.0 | 151.8 | 165.7 |
| Catch-up (hours) one furnace down for | 3 days | 108 | 48 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Catch-up (hours) one furnace down for | 6 days | 216 | 96 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Min Net Electrical Output MW | | 9.4 | 14.1 | 18.8 | 23.5 | 28.2 | 32.8 | 37.5 | 42.2 | 46.9 | 51.6 | 56.3 |
| Nom Net Electrical Output MW | | 12.9 | 19.4 | 25.8 | 32.3 | 38.7 | 45.2 | 51.6 | 58.1 | 64.6 | 71.0 | 77.5 |
| Max Net Electrical Output MW | | 16.4 | 24.7 | 32.9 | 41.1 | 49.3 | 57.5 | 65.8 | 74.0 | 82.2 | 90.4 | 98.6 |
| Electrical Output Modulation MW (Max-Min) | | 7.1 | 10.6 | 14.1 | 17.6 | 21.2 | 24.7 | 28.2 | 31.8 | 35.3 | 38.8 | 42.3 |

Note:
The plant has been designed so that all plant functions are duplicated ie. ash railways, ash processing plant and plant controls. Individual chains have duplication of all critical components, ie. fans, instruments, hydraulic components, bags etc. Most of these can be replaced without shutting down. Any component involved in an unplanned outage that is not duplicated can be replaced within 3 days, inclusive of furnace hearth panels. A spare chain is available when 5 chains are in place. A spare boiler, economiser and baghouse will be available by end of year 3. Any of these can be replaced within 6 days to allow scheduled major maintenance to be conducted in the workshop on the substituted components.

# Appendix L

# Traffic Information

# TABLE 1

## COMMODITY INPUTS AND OUTPUTS

| COMMODITY | QUANTITY TONNES/YEAR | OPTION 1 TRUCKS/YEAR AT 9 TONNES/LOAD | OPTION 2 TRUCKS/YEAR AT 25 TONNES/LOAD | OPTION 3 TRUCKS/YEAR AT 45 TONNES/LOAD | OPTION 1 TRUCKS/ WEEKDAY AT 9 TONNES/LOAD (1) | OPTION 2 TRUCKS/ WEEKDAY AT 25 TONNES/LOAD (1) | OPTION 3 TRUCKS/ WEEKDAY AT 45 TONNES/LOAD (1) |
|---|---|---|---|---|---|---|---|
| Water | 365,000 | | | | | | |
| Steel | 32,000 | | 1,280 | 712 | | 5.12 | 2.85 |
| Non ferrous metals | 5,000 | | 200 | 112 | | 0.80 | 0.45 |
| Stainless steel | 5,300 | | 212 | 115 | | 0.85 | 0.47 |
| Hcl (Wesfarmers Refinery) | 7,000 | | 280 | 155 | | 1.12 | 0.62 |
| Sulphur (Wesfarmers Refinery) | 1,300 | | 52 | 29 | | 0.21 | 0.12 |
| Compost stock in | 80,000 | | 3,200 | 1,776 | | 12.80 | 7.12 |
| Compost stock out | 70,000 | | 2,800 | 1,556 | | 11.20 | 6.22 |
| Aggregates | 180,000 | | 7,200 | 4,000 | | 28.80 | 16.00 |
| Glass | 90,000 | | 3,600 | 2,000 | | 14.40 | 8.00 |
| **TOTAL TRUCKS PER WEEKDAY (1)** | | | | | - | **75.30** | **41.84** |
| New | 1,200,000 | 26,667 | 24,000 | 8,000 | 77.00 | 69.00 | 23.00 |
| **TOTAL COMBINED NEW TRUCKS PER DAY (2)** | | | | | | | **(3) 169.00** |

Note:
1. Assumes 250 week days per year.
2. Assumes 350 working days per year.
3. One way movement.

*Source: Global Olivine NZ Ltd, 1999*

# Appendix M

# Anti Scalent Chemical Data

# ID-204
Anti-Scalant Additive

# Data Bulletin

### Health and Safety

General and Handling Precautions.

ID-204 is an alkaline aqueous solution. In its neat form, it may be harmful if taken internally. The typical precautions for handling alkaline products should be taken. For example, protective clothing, goggles and plastic or rubber shoes should be worn. No special protective measures are necessary.

Contact with skin, eyes and clothing should be avoided. In case of any contact, flushing with large amounts of water is recommended.

### Purity of Water

In the production of potable water, products such as ID-204 are active in the bulk incoming feed and circulating water. They are subsequently eliminated in the blow-down from the system, assuring that the evaporated water is largely free of contaminants and chemical additives. Of primary importance: the potable quality of this water is guaranteed.

### Environmental Compliance

ID-204 meets stringent specifications. Its active ingredients appear on the approved list of the United States Food and Drug Administration – Section 173.310. Furthermore, the ingredients also have the approval of the Environmental Protection Agency for use in potable water-producing evaporators.

### Classification

ID-204 has been classified as an irritant for supply and as a corrosive for conveyance. The following chart shows that it has been labelled accordingly.

International Hazard Classification

| Class | UN No. | Hazard Rating | Hazard Label | Authority |
|---|---|---|---|---|
| 8 | 1719 | Corrosive Liquid Package Group II | Corrosive Diamond | IATA |
| 8 | 1719 | 8070 | Corrosive Diamond | IMCO |

ID-204's Brussels Tariff Number is 38.23.9220/7.

As a polymeric, ID-204 is not ECOIN-registered. The CAS number is 2809-21-4.

### Storage

ID-204 is available in 220 liter non-returnable plastic drums made of high density polyethylene.

### Labelling

ID-204 drums contain standard labels, detailing accident and first aid precautions, in accordance with UN No. 1719.

### Shelf Life

The minimum shelf life is 2 years.

Drums should be well sealed when not in use and stored in a cool, ventilated area.

After storage of several months, it is recommended that contents of drum be mixed before using. Mixing can be carried out by any convenient hand ladle or by rolling the drum.

SI 2001 ISO 9001

I.D.E. technologies ltd.

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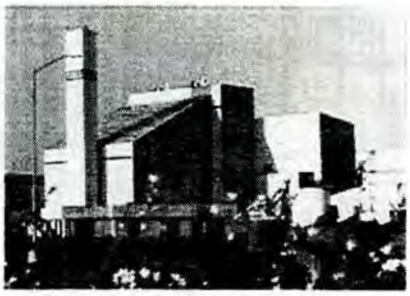
Member of ICL Group

# Appendix N

# Spokane WTE Plant

Waste to Energy Plant

# Waste To Energy Plant



Basic Information

History of Project

Description of Facilities

Pictorial Tour

FAQs

Ash Management, Metals Recovery

CDL, Non-processibles

Compatability of WTE and Recycling

Superfund Landfills

Facility Tours

Litter Control/Indiscriminate Dumping

Home

Spokane Regional
Solid Waste System

# Waste to Energy Plant

## Compatability of WTE and Recycling

People often express concern that use of waste-to-energy technology will prevent recycling or that the plant operators and the recyclers will be in conflict over the materials. This is not the case -there is more than enough garbage to go around!

Waste-to-energy and recycling are compatible, and recycling generally increases the efficiency of the plant. Problems only arise when the WTE plant is over-sized, and the Spokane facility is not. Some of the ways that recycling benefits waste-to-energy:

**Removal of Metals and Glass-**
Increases the Btu value per ton of remaining garbage by about 10%.
Reduces abrasion wear in the furnace.
Reduces weight of ash. Typically five hundred pounds of ash includes:

1. 58 lbs. of iron (currently recovered and recycled post-burn)
2. 375 lbs. of aggregate (glass, non-Fe metals, rocks, etc.) and,
3. 67 lbs. of fly ash

**Removal of Vehicle Batteries-**
Keeping vehicle batteries out of the waste stream greatly reduces the lead going through the plant. Annually U.S. manufacturers use over 1 million tons of lead and 72% of it is in car batteries.

**Removal of Yard Wastes-**
Leaves and grass are not good fuels unless they are very dry. Fresh grass and leaves have a high moisture content and actually lower the Btu value of the garbage. Yard waste contains a relatively high concentration of Nitrogen which, when burned, results in emissions of Oxides of Nitrogen at levels higher than those produced from "" garbage. This is of some concern, but the primary reason we want these materials separated from garbage is so that it can be composted. Composting results in the return of nutrients to the soil which is a higher and better use than any type of disposal. See Benefits of composting for more information.

**Removal of Paper-**
Recycling paper does lower the Btu value of the remaining waste, but only by 1 or 2%. This loss is easily offset by the benefits gained from recycling other commodities.

**Capacity-**
Handling as much of the material as we can through recycling and composting means less waste for disposal, and our WTE plant is nearing capacity.

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**Spokane Regional Solid Waste System**

residue, and combined ash each quarter by collecting two (2) eight hour composite samples of each waste stream on seven consecutive days. Each of these composite samples (42 each quarter) is sampled for arsenic, barium, cadmium, lead, mercury, selenium, chromium, copper, nickel, zinc and silver by an independent testing laboratory. Once per year a quarterly composite sample will also be analyzed for dioxins and dibenzo-furans. The results of the quarterly testing are submitted to Ecology.

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**Spokane Regional Solid Waste System**

# Waste to Energy Plant

### History of Project

## Problem

Environmental concerns associated with continued landfilling, new Washington State solid waste regulations and federal actions directly affecting Spokane area landfills have led the City and County to jointly develop a comprehensive program for regional solid waste reduction, recycling, recovery of energy, and residue disposal. This cooperative effort has resulted in the Spokane Regional Solid Waste System, which includes the Waste to Energy Facility, North County Transfer Station, and Valley Transfer Station. Each of these facilities has a recycling center and household hazardous waste turn-in area on site. Ash produced from the waste to energy process is sent to an ash monofill at Rabanco's Roosevelt Regional Landfill in Klickitat County, WA. In addition, there is an active cell at the Northside Landfill that is available for bypass and nonprocessible materials collected by the System. These facilities are intended to provide long-term, environmentally sound solid waste disposal for both the City of Spokane and the other incorporated and unincorporated areas of the County.

## System Planning

In response to the *Final Report and Water Quality Management Plan to Preserve Spokane's*
*Sole-Source Aquifer* (April, 1979), a consortium consisting of the City, County, and The Washington Water Power Company, hired Morrison-Knudsen in 1982 to conduct a feasibility study of various solid waste management systems. They looked at 10 different scenarios and ranked them according to environmental and economic criteria. The final report was completed in 1983, and it recommended that a waste to energy facility be included as part of the new Regional Solid Waste System.

In 1983, the County developed the Comprehensive Solid Waste Management Plan to address the solid waste management and disposal needs of the Spokane area. The Comprehensive Plan was adopted in 1984 by the County, the City and all other incorporated cities in the County (with the exception of the Town of Rockford). It was also subject to environmental and public review and subsequent conditional approval in 1986 by the Washington State Department of Ecology. The Comprehensive Plan recommended a County-wide approach to solid waste management with the preferred method of disposal incorporating waste reduction and recycling activities, a waste to energy facility, recycling/transfer stations and a regional residue landfill. The Plan was updated in 1992 and 1998. It is presently in the process of another update, which is due in 1997.

## System Development

The waste to energy elements, including size, site selection, energy market analysis and overall feasibility, were developed for the City and County in a Project Definition Report prepared by HDR Engineering in 1985. A Draft Environmental Impact Statement for the System was prepared based upon the State Environmental Policy Act. Public hearings were held and a Final EIS was issued in 1986. The environmental documents were challenged and the Spokane County Superior Court ruled in favor of the System on all issues.

A detailed contractor selection process commenced with the issuance of a Request for Qualifications (RFQ) in May, 1986. Sixteen responses were received, and five vendors were invited to respond to the Request for Proposals (RFP), issued in December, 1986. Four vendors submitted proposals and Wheelabrator (formerly Signal Environmental Systems) was selected as the preferred vendor. After successful negotiations, the City and County entered into the Construction and Service Contracts with Wheelabrator Spokane Inc. in November, 1987 (Amended and Restated in 1989) for construction and operation of the waste to energy facility.

A Conditional Notice to Proceed for construction of the waste to energy facility was issued on February 10, 1989. Only tasks that were of a nonpermanent nature, such as landclearing, could be performed until the last remaining permit (the Prevention of Significant Deterioration [PSD] Permit) was obtained. This permit became final on January 2, 1990, and on January 3, 1990, the Final Notice to Proceed was issued. Construction began immediately and Wheelabrator finished the project ahead of schedule. The " Burn" took place on September 5, 1991. Acceptance testing was performed on the waste to energy facility between November 8 and November 15, 1991, during which the facility demonstrated compliance with the full acceptance standards. On February 17, 1992, the waste to energy facility was officially accepted by the City Council.

Concurrent with construction of the waste to energy facility, the North County Transfer Station was constructed by Citadel; theValley Transfer Station was constructed by Lydig; and the recycling center at the waste to energy facility was constructed by Garco. All the facilities were completed on schedule and opened to the public on December 23, 1991.

Century West Engineering was hired in mid-1987 to site and develop an ash landfill. During the Landfill Siting and Development Study, a site search identified 228 potential sites in Spokane County. Owners of 54 of these sites volunteered to have their property evaluated. This was narrowed down to 14, and ultimately the following three sites were selected for further consideration: Lance Hills, Grove Road, and Malloy Prairie.

However, during the process of selecting one of these sites as the preferred site, two other options were introduced. They included out-of-county disposal via long haul at existing regional landfills and expansion of the existing Marshall Landfill. An RFP was issued and three proposals were submitted. They were from the Rabanco Regional Landfill in Klickitat County, WA; Waste Management's Landfill in Gilliam County, OR; and Finley Buttes Landfill in Morrow County, OR. The Marshall Landfill did not submit a proposal on expansion of its landfill. Ultimately it was decided that long haul was the best option and a contract was executed with Rabanco on July 26, 1991.

The last component of the System to be implemented was a regional composting facility. An RFQ/P was issued on March 31, 1992, and proposals were received from Ecocycle Composting and O. M. Scott & Sons. Scott's was selected as the preferred vendor and a contract for composting services was executed with them on July 6, 1993. A site was selected, with Scott's approval, just south of the North County Transfer Station. The Regional Compost Facility began operating in November, 1993.

## Financing

Pursuant to recommendations of the Comprehensive Solid Waste Management Plan 1984 Update and the Morrison-Knudsen Feasibility Study, the City of Spokane borrowed $50 million on a short-term bond anticipation note in December 1984. The timing was significant because of pending tax law changes which would become effective in January, 1985. The advantage of borrowing these funds prior to January, 1985, was that the interest earned over and above the interest due on these notes (arbitrage) could be used for solid waste project development. During the four-year life of these bonds, the total revenue earned from the arbitrage was approximately $4,700,000.

The arbitrage funds were used to support the Spokane Regional Solid Waste Disposal Project in developing the feasibility of a waste to energy facility, the environmental review process, and procurement process. Waste reduction/recycling, school programs, litter control programs, and ash residue disposal options were also supported by these funds.

Permanent long-term financing was secured in January, 1989, at which time the $50 million short-term notes were paid off. The City of Spokane borrowed $105,250,000 in revenue bonds to finance the cost of acquisition and construction of the waste to energy facility, two transfer stations, recycling centers, household hazardous waste turn-in sites, and a landfill cell for disposal of bypass and nonprocessible materials. Spokane County received $8 million of the revenue bonds for landfill closure expenses.

In addition to the revenue bonds, the System was financed by a $60 million Referendum 39 Grant from the Department of Ecology. The City Council approved acceptance of this grant on November 17, 1986, and the County Commissioners approved it on November 18, 1986. On November 24, 1986, the $60 million grant, which provided 50% matching funds for eligible expenditures, was executed.

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Spokane Regional
Solid Waste System

# Waste to Energy Plant

## Superfund Landfills

In 1986, the EPA placed four Spokane County landfills (one City and three County) on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). The NPL identifies sites that appear to warrant remedial actions and setting priorities for future investigations and potential cleanup. Cleanup efforts are the responsibility of the landfill owners and certain other parties that have used the landfills, known as potentially responsible parties (PRPs). Following is a summary of each of these landfills:

- Northside Landfill (City). Closed in 1991, when the new Regional Solid Waste System came on line. The Record of Decision identifying selected cleanup activities was issued on September 30, 1989. Closure and remedial actions are completed at the closed portion of the site. Post-closure activities include operation and maintenance of the groundwater clean-up and gas extraction systems, maintenance of the final cover and landscaping, and long term groundwater monitoring.

- Colbert Landfill (County). Closed in 1986, after groundwater contamination was found. The Record of Decision requires the County to pump and treat contaminated groundwater. The remedial design and action are complete. The completion of the final cover and initiation of post-closure activities are scheduled to occur in 1996, or as funds are available.

- Mica Landfill (County). Closed in 1991, when the new Regional Solid Waste System came on line. The remedial design and action are complete. The post-closure activities were scheduled to start in mid-1994, or as funds are available.

- Greenacres Landfill (County). Closed in 1972. The final cover used at that time does not meet current State standards. The issue of whether the site needs to meet current State closure requirements is being discussed by the County and Ecology.

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Spokane Regional
Solid Waste System

# Waste to Energy Plant

## Ash Management, Metals Recovery

**Ash Management**
Annually Spokane's Waste to Energy Facility processes over 300,000 tons of MSW. The steam generated is piped to the Turbine-Generator to generate electricity for sale. The products of combustion include bottom ash, grate siftings and fly ash. The bottom ash is material which is noncombustible, or too large to be consumed during its time on the grates. Grate siftings are small particles that fall through the grates during the combustion process. Fly ash is very small particles of noncombustibles that are entrained in the flue gas and carried through the boiler gas passages.

Bottom ash is transported by the furnace grates to the Ram Ash Expeller where it is quenched, dewatered and deposited on the Bottom Ash Vibrating Transfer Conveyor. Grate siftings are combined with the bottom ash in the Ram Ash Expeller.

Slaked lime slurry reacts with the acid gases in the SDA. In addition to neutralizing the acid gases, this process produces a dry powder that falls to the SDA hoppers and becomes a portion of the fly ash.

The flue gas is drawn through the Fabric Filters, and the remaining fly ash and powder is deposited on the filter bags. Periodically a pulse of air is discharged into the bags, dislodging the collected material, which falls to the Fabric Filter hopper. The fly ash is conveyed to the Ash Conditioner and treated with phosphoric acid diluted with water, using the Wesphix process. The treated ash is a damp, dust free material containing lime, dirt, and complex metal compounds of low solubility. The fly ash is then combined with the bottom ash and conveyed to the Ash Handling Building. At the Ash Handling Building a rotating-drum magnetic separator removes ferrous materials from the ash stream. Ferrous materials are baled and recycled on the floor. At this point the ash is either deposited in trucks or stored in the building for later removal. Approximately three days capacity for ash storage exists in the Ash Handling Building. Reinforced concrete walls at the perimeter of the building provide 16 feet of storage depth.

The entire ash handling system is enclosed. The bottom two floors of the Boiler Building are sealed. The APC Building provides additional containment for the SDA system and Fabric Filter Modules. The conveyor galleries and Ash Handling Building are likewise enclosed.

The Regional System has executed a contract with the Rabanco Regional Landfill Company (RRLC) to have all combustion residues requiring disposal transported to and disposed of at the RRLC landfill in Eastern Klickitat County. This is a minimum ten year contract with the City having the option to extend it for three successive five year periods thereafter. Ash is top-loaded into 20 cubic yard custom designed Intermodal Containers which are lined with Teflon and are double sealed at the rear door. The WTE Facility uses 8-15 containers per day. Each container holds approximately 30 tons of ash. The containers are hauled by truck to the Burlington Northern Yardley Intermodal Hub and are loaded onto the train for transport to the RRLC. Empty containers are returned by the same method. The WTE Facility generates approximately 93,000 tons per year of combined ash. Approximately 10,000 tons of ferrous metals each year is separated from the ash, baled and recycled.

**Ash Sampling and Testing**
The Spokane Regional Solid Waste System samples bottom ash, fly ash/scrubber

# Appendix O

# Odour Modelling Information

Spreadheets For Inclusion into Appendices

| | Name | Description |
|---|---|---|
| 1 | Index | This sheet |
| 2 | MSW Hall | MSW Hall under normal operation |
| 3 | MSW Hall(2) | MSW Hall with one furnace down |
| 4 | MSW Hall(3) | MSW Hall with one door open |
| 5 | Compost Plant | Compost plant ventilation |
| 6 | Vitrifier | Vitrifier plant ventilation |
| 7 | DG Store | DG Store ventialtion |
| 8 | Totals | Totals as per table in text |

# MSW Hall Normal Operation

| | Design wind Speed | 10 m High Building | 20 m High Building |
|---|---|---|---|
| | | 10 | 20 |
| Exposed site | 10 | 7.2 | 7.9 |
| | 12.5 | 9.1 | 9.9 |
| | 15 | 10.8 | 11.9 |
| Sheltered Site | 10 | 4.1 | 5.2 |
| | 12.5 | 5 | 6.5 |
| | 15 | 6.1 | 7.8 |

**Coefficient Interpolation for Intermediate Wind Velocities**

| 10m | | 20 m | |
|---|---|---|---|
| Slope | Int | Slope | Int |
| 0.72 | 0.033333 | 0.8 | -0.1 |
| New wind | 8 | New wind | 8 |
| New Coeff | 5.793333 | New Coeff | 6.3 |
| **Average for 15m** | **6.046667** | | |

| Item | Number | Length | Height | Lineal Length | Coeff* | Opening |
|---|---|---|---|---|---|---|
| | | m | m | m | m2/m | m2 |
| **Doors** | 12 | 2.4 | 3 | 64.8 | 0.002 | 0.1296 |
| **Doors** | 4 | 4.2 | 3.6 | 31.2 | 0.002 | 0.0624 |
| **Windows** | 0 | | | 0 | | 0 |
| **Walls** | 0 | 162 | | 0 | 0.01 | 0 |
| **Walls** | 0 | 67 | | 0 | 0.01 | 0 |
| **Roof** | 2 | 162 | | 324 | 0.01 | 3.24 |
| **Vent Opening** | 1 | | | | | 29 |
| Height | | 15 | | | **Total** | 32 |

Note * Infiltration areas From Warren Springs "Odour Contol"
Calculations do not include consideration of heat removal required

**Conversion Table**

| | | |
|---|---|---|
| 1 atm | 406.788 | in WG |
| 1 in WG | 249.0240617 | Pa |
| 1 mm WG | 9.804096916 | Pa |
| 1 Pa | 9.87E-06 | atm |
| 1 atm | 1.033 | kg/cm2 |

| | | | | | |
|---|---|---|---|---|---|
| **Total Infiltration area** | 32.432 | m2 | Volume | m3/hr | 705,980 |
| **required Flow Rate** | 196.11 | m3/s | Volume | m3/s | 196.1 |
| | 705980 | m3/hr | Overall Velocity thru opening | m/s | 6.0 |
| | | | Static VP | Pa | 22.0 |
| **Actual Room Volume** | 162810 | | | | |
| **Equipment Volume** | | | | | |
| **Room Volume** | 162810 | m3 | | | |
| **required ACH** | 4.3 | ACH | Assumes all ventillation air passes through MSW hall | | |
| **Actual ACH** | 4.3 | ACH | | | |

1190.2887 FPM
0.0883 in WG

| | | | |
|---|---|---|---|
| Entry Loss | 1.49 | | |
| Total DP | 32.8 | Pa | 0.131609 in WG |
| Total DP | 0.000323 | atm | |
| Total Load | 3.34 | kg/sq m | |

# MSW Hall One Furnace Down

| | Design wind Speed | 10 m High Building | 20 m High Building |
|---|---|---|---|
| | | 10 | 20 |
| Exposed site | 10 | 7.2 | 7.9 |
| | 12.5 | 9.1 | 9.9 |
| | 15 | 10.8 | 11.9 |
| Sheltered Site | 10 | 4.1 | 5.2 |
| | 12.5 | 5 | 6.5 |
| | 15 | 6.1 | 7.8 |

**Coefficient Interpolation for Intermediate Wind Velocities**

| 10m | | 20 m | |
|---|---|---|---|
| Slope | Int | Slope | Int |
| 0.72 | 0.033333 | 0.8 | -0.1 |
| New wind | 8 | New wind | 8 |
| New Coeff | 5.793333 | New Coeff | 6.3 |
| **Average for 15m** | **6.046667** | | |

| Item | Number | Length m | Height m | Lineal Length m | Coeff* m2/m | Opening m2 |
|---|---|---|---|---|---|---|
| **Doors** | 12 | 2.4 | 3 | 64.8 | 0.002 | 0.1296 |
| **Doors** | 4 | 4.2 | 3.6 | 31.2 | 0.002 | 0.0624 |
| **Windows** | 0 | | | 0 | | 0 |
| **Walls** | 0 | 162 | | 0 | 0.01 | 0 |
| **Walls** | 0 | 67 | | 0 | 0.01 | 0 |
| **Roof** | 2 | 162 | | 324 | 0.01 | 3.24 |
| **Vent Opening** | 1 | | | | | 27.5 |
| Height | | 15 | | | **Total** | **31** |

Note * Infiltration areas From Warren Springs "Odour Contol"
Calculations do not include consideration of heat removal required

| Conversion Table | | |
|---|---|---|
| 1 atm | 406.788 | in WG |
| 1 in WG | 249.0240617 | Pa |
| 1 mm WG | 9.804096916 | Pa |
| 1 Pa | 9.87E-06 | atm |
| 1 atm | 1.033 | kg/cm2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Total infiltration area** | 30.932 | m2 | Volume | m3/hr | 705,980 | | FPM |
| **required Flow Rate** | 196.11 | m3/s | Volume | m3/s | 196.1 | | 1248.0099 |
| | 705980 | m3/hr | Overall Velocity thru opening | m/s | 6.3 | WG | 0.0971 |
| | | | Static VP | Pa | 24.2 | | |
| **Actual Room Volume** | 162810 | | | | | | |
| **Equipment Volume** | | | | | | | |
| **Room Volume** | 162810 | m3 | | | | | |
| **required ACH** | 4.3 | ACH | Assumes all ventilation air passes through MSW hall | | | | |
| **Actual ACH** | 4.3 | ACH | | | | | |

| | | | |
|---|---|---|---|
| Entry Loss | 1.49 | | |
| Total DP | 36.0 | Pa | 0.144683 in WG |
| Total DP | 0.000356 | atm | |
| Total Load | 3.67 | kg/sq m | |

# MSW Hall One Door Open

| | Design wind Speed | 10 m High Building | 20 m High Building |
|---|---|---|---|
| | | 10 | 20 |
| Exposed site | 10 | 7.2 | 7.9 |
| | 12.5 | 9.1 | 9.9 |
| | 15 | 10.8 | 11.9 |
| Sheltered Site | 10 | 4.1 | 5.2 |
| | 12.5 | 5 | 6.5 |
| | 15 | 6.1 | 7.8 |

**Coefficient Interpolation for Intermediate Wind Velocities**

| 10m | | 20 m | |
|---|---|---|---|
| Slope | Int | Slope | Int |
| 0.72 | 0.033333 | 0.8 | -0.1 |
| New wind | 8 | New wind | 8 |
| New Coeff | 5.793333 | New Coeff | 6.3 |
| **Average for 15m** | **6.046667** | | |

| Item | Number | Length | Height | Lineal Length | Coeff* | Opening |
|---|---|---|---|---|---|---|
| | | m | m | m | m2/m | m2 |
| **Doors** | 12 | 2.4 | 3 | 64.8 | 0.002 | 0.1296 |
| **Doors Open** | 1 | 4.2 | 3.6 | 1 | 15 | 15 |
| **Windows** | 0 | | | 0 | | 0 |
| **Walls** | 0 | 162 | | 0 | 0.01 | 0 |
| **Walls** | 0 | 67 | | 0 | 0.01 | 0 |
| **Roof** | 2 | 162 | | 324 | 0.01 | 3.24 |
| **Vent Opening** | 1 | | | | | 27.5 |
| Height | | 15 | | | **Total** | **46** |

Note * Infiltration areas From Warren Springs "Odour Contol"
Calculations do not include consideration of heat removal required

**Conversion Table**

| | | |
|---|---|---|
| 1 atm | 406.788 | in WG |
| 1 in WG | 249.0240617 | Pa |
| 1 mm WG | 9.804096916 | Pa |
| 1 Pa | 9.87E-06 | atm |
| 1 atm | 1.033 | kg/cm2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Total Infiltration area** | 45.8696 | m2 | Volume | m3/hr | 705,980 | | FPM | |
| **required Flow Rate** | 196.11 | m3/s | Volume | m3/s | 196.1 | | | 841.5910 |
| | 705980 | m3/hr | Overall Velocity thru opening | m/s | 4.3 | WG | | 0.0442 |
| | | | Static VP | Pa | 11.0 | | | |
| **Actual Room Volume** | 162810 | | | | | | | |
| **Equipment Volume** | | | | | | | | |
| **Room Volume** | 162810 | m3 | | | | | | |
| **required ACH** | 4.3 | ACH | Assumes all ventillation air passes through MSW hall | | | | | |
| **Actual ACH** | 4.3 | ACH | | | | | | |

| | | | | |
|---|---|---|---|---|
| Entry Loss | 1.49 | | | |
| Total DP | 16.4 | Pa | 0.065794 | in WG |
| Total DP | 0.000162 | atm | | |
| Total Load | 1.67 | kg/sq m | | |

# Danderous Goods - Ash - Soils Store

| | Design wind Speed | 10 m High Building 10 | 20 m High Building 20 |
|---|---|---|---|
| Exposed site | 10 | 7.2 | 7.9 |
| | 12.5 | 9.1 | 9.9 |
| | 15 | 10.8 | 11.9 |
| Sheltered Site | 10 | 4.1 | 5.2 |
| | 12.5 | 5 | 6.5 |
| | 15 | 6.1 | 7.8 |

**Coefficient Interpolation for Intermediate Wind Velocities**

| 10m Slope | Int | 20 m Slope | Int |
|---|---|---|---|
| 0.72 | 0.033333 | 0.8 | -0.1 |
| New wind | 8 | New wind | 8 |
| New Coeff | 5.793333 | New Coeff | 6.3 |
| **Average for 15m** | **6.046667** | | |

| Item | Number | Length m | Height m | Lineal Length m | Coeff* m2/m | Opening m2 |
|---|---|---|---|---|---|---|
| **Door** | 6 | 2.4 | 2.4 | 28.8 | 0.002 | 0.0576 |
| **Windows** | | | | 0 | | 0 |
| **Walls** | 2 | 36 | | 72 | 0.00 | 0 |
| **Walls** | 2 | 18 | | 36 | 0.00 | 0 |
| **Roof** | 2 | 36 | | 72 | 0.01 | 0.72 |
| **Vent Opening** | 1 | | | | | 0 |
| Height | | 5 | | | **Total** | **0.7776** |

Note * Infiltration areas From Warren Springs "Odour Contol"
Calculations do not include consideration of heat removal required
**Additional Inlet Vent may be required**

| Conversion Table | | |
|---|---|---|
| 1 atm | 406.788 | in WG |
| 1 in WG | 249.0240617 | Pa |
| 1 mm WG | 9.804096916 | Pa |
| 1 Pa | 9.87E-06 | atm |
| 1 atm | 1.033 | kg/cm2 |

| | | |
|---|---|---|
| **Total infiltration area** | 0.8 | m2 |
| **required Flow Rate** | 4.7 | m3/s |
| | 16926.8 | m3/hr |
| **Actual Room Volume** | 3240 | |
| **Equipment Volume** | | |
| **Room Volume** | 3240 | m3 |
| **required ACH** | 5.2 | ACH |
| **Actual ACH** | 5.2 | ACH |
| No of DG Bays | 6 | |
| Flow Rate per bay | 2821 | m3/hr |
| Flow Rate per bay | 0.784 | m3/sec |
| volume per bay | 144 | m3 |
| **ACH** | **20** | |

| | | | | |
|---|---|---|---|---|
| Volume | m3/hr | 16,927 | | |
| Volume | m3/s | 4.701888 | | FPM |
| Overall Velocity thru opening | m/s | 6.046666667 | | 1190.288714 |
| Static VP | Pa | 22.0 | WG | 0.088328243 |
| Duct Velocity | m/s | 10 | | 1968.503937 |
| Duct Area required | m2 | 0.47 | | 0.241583648 |
| Duct diam | m | 0.77 | | |
| Nominal Duct diam | m | 1.2 | | |
| Entry Loss | | 1.49 | | |
| Total DP | | 32.8 | Pa | 0.131609 in WG |
| Total DP | | 0.000323 | atm | |
| Total Load | | 3.34 | kg/sq m | |

# Compost Plant

| | Design wind Speed | 10 m High Building | 20 m High Building |
|---|---|---|---|
| | | 10 | 20 |
| Exposed site | 10 | 7.2 | 7.9 |
| | 12.5 | 9.1 | 9.9 |
| | 15 | 10.8 | 11.9 |
| Sheltered Site | 10 | 4.1 | 5.2 |
| | 12.5 | 5 | 6.5 |
| | 15 | 6.1 | 7.8 |

**Coefficient Interpolation for Intermediate Wind Velocities**

| 10m Slope | Int |
|---|---|
| 0.72 | 0.033333 |
| New wind | 8 |
| New Coeff | 5.793333 |

| Item | Number | Length m | Height m | Lineal Length m | Coeff m2/m | Opening m2 |
|---|---|---|---|---|---|---|
| **Door** | 4 | 4.2 | 3.6 | 31.2 | 0.002 | 0.0624 |
| **Windows** | | | | 0 | | 0 |
| **Walls** | 0 | 50 | | 0 | 0.01 | 0 |
| **Walls** | 0 | 37.5 | | 0 | 0.01 | 0 |
| **Roof** | 2 | 50 | | 100 | 0.01 | 1 |
| **Vent Opening** | 1 | | | | | 3 |
| **Height** | | 5 | | | **Total** | **4.0624** |

Note * Infiltration areas From Warren Springs "Odour Contol"
Calculations do not include consideration of heat removal required

**Conversion Table**

| | | |
|---|---|---|
| 1 atm | 406.788 | in WG |
| 1 in WG | 249.0240617 | Pa |
| 1 mm WG | 9.804096916 | Pa |
| 1 Pa | 9.87E-06 | atm |
| 1 atm | 1.033 | kg/cm2 |

| | | |
|---|---|---|
| **Total Infiltration area** | 4.0624 | m2 |
| **required Flow Rate** | 23.5 | m3/s |
| | 84725 | m3/hr |
| **Actual Room Volume** | 9375 | |
| **Equipment\Product Volume** | 2160 | |
| **Room Volume** | 7215 | m3 |
| **required ACH** | 11.7430 | ACH |
| **Actual ACH** | 11.7430 | ACH |

| | | | | |
|---|---|---|---|---|
| Volume | m3/hr | 84,725 | | |
| Volume | m3/s | 23.5 | | FPM |
| Overall Velocity thru opening | m/s | 5.8 | | 1140.419948 |
| Static VP | Pa | 20 | WG | 0.081082022 |
| Duct Velocity | m/s | 10 | | 1968.503937 |
| Duct Area required | m2 | 2.353484 | | 0.241583648 |
| Duct diam | m | 1.731054 | | |
| Nominal Duct diam | m | 1.8 | | |

| | | | |
|---|---|---|---|
| Entry Loss | 1.49 | | |
| Total DP | 30.1 | Pa | 0.120812 in WG |
| Total DP | 0.000297 | atm | |
| Total Load | 3.07 | kg/sq m | |

# Vitrifier Building

| | Design wind Speed | 10 m High Building | 20 m High Building |
|---|---|---|---|
| | | 10 | 20 |
| Exposed site | 10 | 7.2 | 7.9 |
| | 12.5 | 9.1 | 9.9 |
| | 15 | 10.8 | 11.9 |
| Sheltered Site | 10 | 4.1 | 5.2 |
| | 12.5 | 5 | 6.5 |
| | 15 | 6.1 | 7.8 |

**Coefficient Interpols**

| 10m | | 20 m | |
|---|---|---|---|
| Slope | Int | Slope | Int |
| 0.72 | 0.0333333333333332 | 0.8 | -0.0999999999999996 |
| New wind | 8 | New wind | 8 |
| New Coeff | 5.79333333333333 | New Coeff | 6.3 |
| **Average for 15m** | **6.04666666666667** | | |

| Item | Number | Length m | Height m | Lineal Length m | Coeff* m2/m | Opening m2 |
|---|---|---|---|---|---|---|
| Door | 4 | 5 | 4.5 | 38 | 0.002 | 0.076 |
| Windows | | | | 0 | | 0 |
| Walls | 0 | 60 | | 0 | 0.01 | 0 |
| Walls | 0 | 35 | | 0 | 0.01 | 0 |
| Roof | 2 | 60 | | 120 | 0.01 | 1.2 |
| Vent Opening | 1 | | | | | 1.6 |
| Height | | 15 | | | Total | 2.876 |

Note * Infiltration areas From Warren Spring
Calculations do not include considerali

**Conversion Table**

| | | |
|---|---|---|
| 1 atm | 406.788 | in WG |
| 1 in WG | 249.024061673402 | Pa |
| 1 mm WG | 9.80409691627568 | Pa |
| 1 Pa | 0.000009867 | atm |
| 1 atm | 1.033 | kg/cm2 |

| | | |
|---|---|---|
| **Total Infiltration area** | 2.876 | m2 |
| **required Flow Rate** | 17.3902133333333 | m3/s |
| | 62604.768 | m3/hr |
| **Actual Room Volume** | 31500 | |
| **Equipment Volume** | | |
| **Room Volume** | 31500 | m3 |
| **required ACH** | 1.98745295238095 | ACH |
| **Actual ACH** | 1.98745295238095 | ACH |

| | | | | |
|---|---|---|---|---|
| Volume | m3/hr | 62604.768 | | |
| Volume | m3/s | 17.3902133333333 | | FPM |
| Overall Velocity thru opening | m/s | 6.04666666666667 | | 1190.28871391076 |
| Static VP | Pa | 21.9958577785756 | WG | 0.0883282427841187 |
| Duct Velocity | m/s | 10 | | 1968.50393700787 |
| Duct Area required | m2 | 1.73902133333333 | | 0.241583647782064 |
| Duct diam | m | 1.4880157024501 | | |
| Nominal Duct diam | m | 1.5 | | |
| Entry Loss | | 1.49 | | |
| Total DP | | 32.7738280900777 Pa | 0.131609081748337 | in WG |
| Total DP | | 0.0003233793617647 atm | | |
| Total Load | | 3.34050880703035 kg/sq m | | |

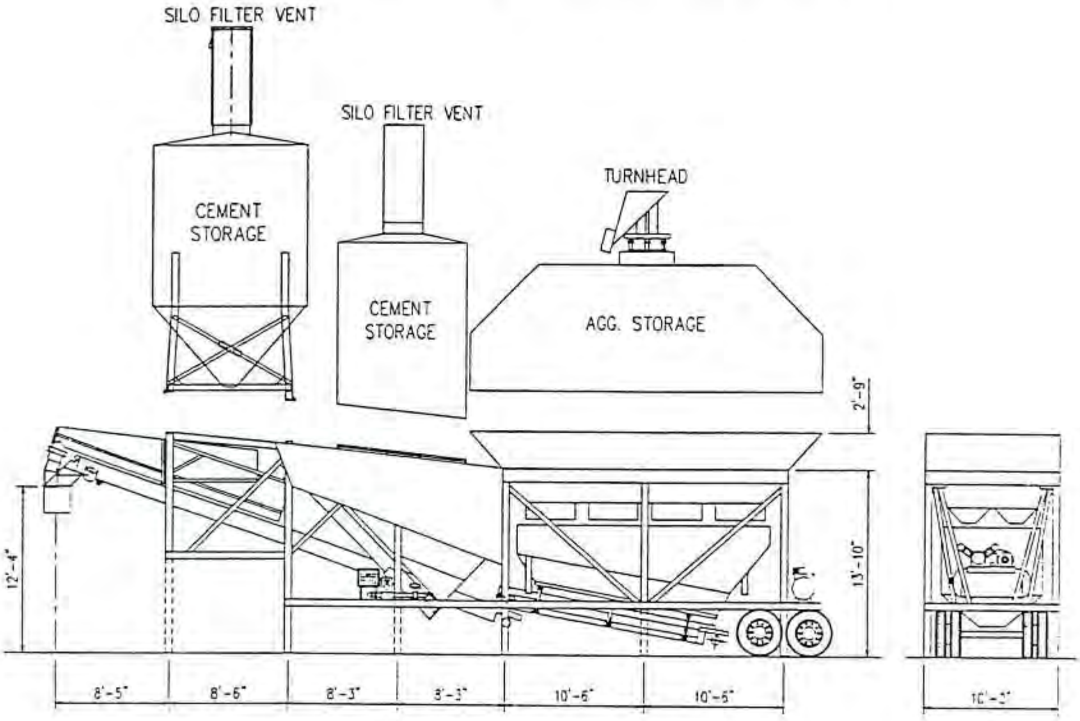
# Total Ventilation Requirements

| | Room Volume | Additional Vent Opening m2 | Air Flow m3/s | Air Flow m3/hr | Fresh Air Changes per Hour ACH |
|---|---|---|---|---|---|
| **MSW hall (no loose MSW or containers)** | 162810 | 29 | 196.1 | 705980 | 4.3 |
| **Compost building** | 7215 | 3 | 23.5 | 84725 | 11.7 |
| **Dangerous goods Store** | 3240 | 0 | 4.7 | 16927 | 5.2 |
| **Vitrifier building** | 31500 | 1.6 | 17.4 | 62605 | 2.0 |
| **Total** | **204765** | **33.6** | **241.7** | **870237** | |

# Appendix P

# CON-E-CO Plant Specifications

# LO-PRO® Model 10S




## SPECIFICATIONS

**PRODUCTION CAPACITY:**
Theoretical capacity — 150 to 300 cubic yards per hour (110 to 225 cubic ʼneters per hour)

**BATCHER CAPACITY:**
Aggregate — 10 cubic yards (7.6 cubic meters)
Cement — 10 cubic yards (7.6 cubic meters)
Scales — Suspension hopper type with load cells or dials
Note: oversized batcher for batching 10 cubic yards for 4 of 8 gates

**AGGREGATE BATCHER CONVEYOR:**
30" wide (762 mm) with 10 horsepower drive.
Optional 36" (914 mm), 15 horsepower.

**AGGREGATE DISCHARGE CONVEYOR:**
30" wide (762 mm), 35" trough with 10 horsepower drive. Optional 36" (914 mm), 15 horsepower

**CEMENT BATCHER RECIRCULATING SCREW:**
14" diameter (360 mm), 15 horsepower.
Optional 18" diameter (460 mm), 20 horsepower

**CEMENT FEEDER SCREWS:**
Two 9" diameter (230 mm) with 15 horsepower drive. Operational 12" diameter (300 mm), 20 horsepower.

**CEMENT AERATION:**
5 horsepower, high volume, low pressure blower.

**HIGH PRESSURE AIR COMPRESSOR:**
7.5 horsepower with 80 gallon (0.30 cubic meters) receiver. Optional 10 horsepower, 120 gallon (0.45 cubic meters).

**ELECTRICAL:**
:5 amp, 3-phase with 120 VAC transformer for control voltage. All motors are TEFC. All motor circuit wiring protected by individual circuit breakers. Electrical components housed in a NEMA 12 dust tight steel enclosure. Wiring in conduit. Minimum service size: 100 KVA.

**BATCH CONTROL SYSTEM:**
Semi-automatic cut-off of cement by presets on digital readouts. Push-button for electric over air on gates. Optional fully automatic CON-E-CO Series computerized batch control system.

**WATER METER:**
CON-E-CO, 2" diameter (50 mm) all electronic stainless steel turbine. 25 to 300 gallons (87 to 1,064 liters) per minute. Optional 3" diameter (77 mm) with up to 500 gallons (1,740 liters) per minute.

**TRANSPORTATION SYSTEM:**
Rear-mounted 36,000 lb. (16,330 kg) capacity tandem axle with eight (8) 9:00 x 20 12-ply tires, wheels, air brakes, heavy duty spring suspension, tail and break lights, and fifth wheel rub plate with king pin.

**STORAGE BIN CAPACITIES:**

| | |
|---|---|
| AGGREGATE | HEAPED VOLUME<br>50 to 270 cubic yards<br>38 to 200 cubic meters |
| CEMENT I | GROSS VOLUME<br>860 to 2860 cubic feet<br>24 to 80 cubic meters |
| CEMENT II | GROSS VOLUME<br>1340 to 4190 cubic feet<br>37 to 116 cubic meters |

**DIMENSIONS:**
Towing length .......................... 50'0" (15.240 mm)
Towing height .......................... 14'0" ( 4,270 mm)
Towing width ........................... 10'0" ( 3,050 mm)
Empty weight, total .................. 44,000 lbs. (19,958 kg)
Shipping volume ...................... 8,400 cubic feet (237 cubic meters)

**NOTES:**
In accordance with CON-E-CO's policy of constantly improving its products, the above specifications are subject to change without notice. CON-E-CO assumes no responsibility for foundation design. Consult factory for column loadings.

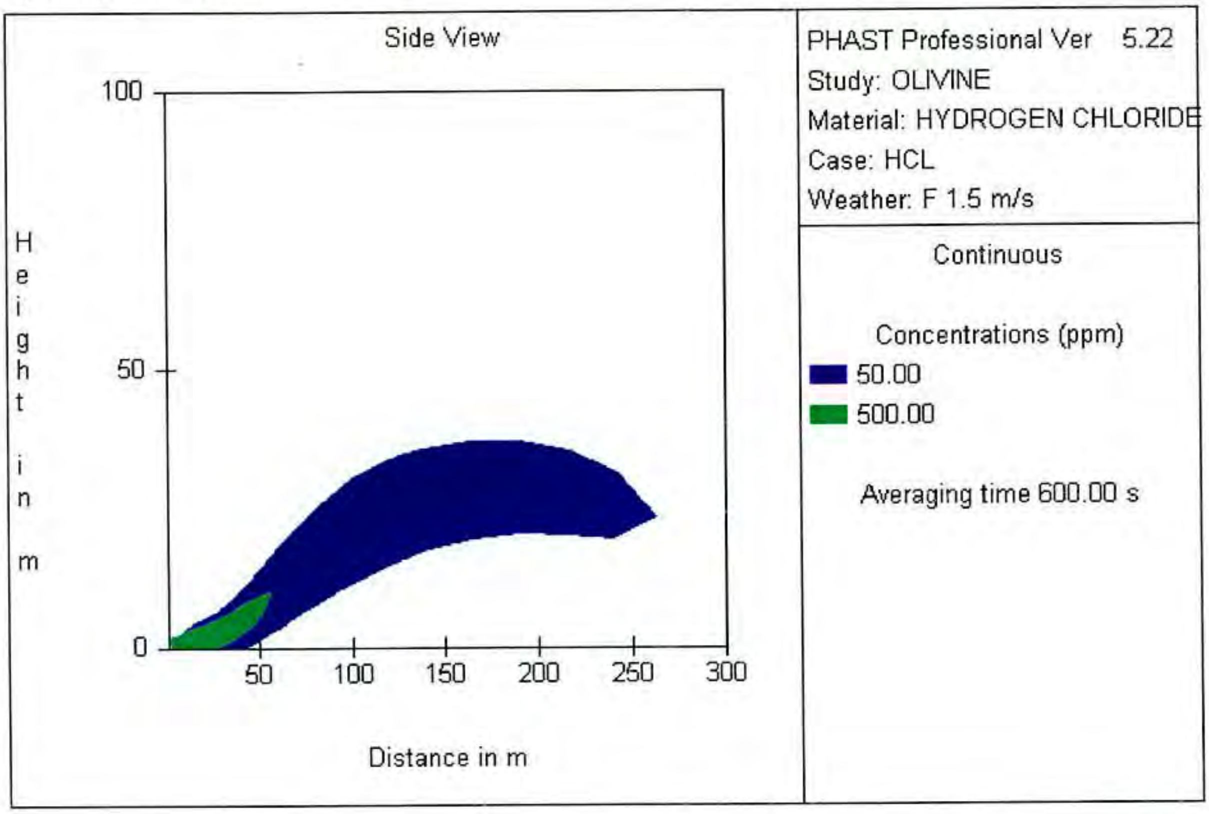
# Appendix Q

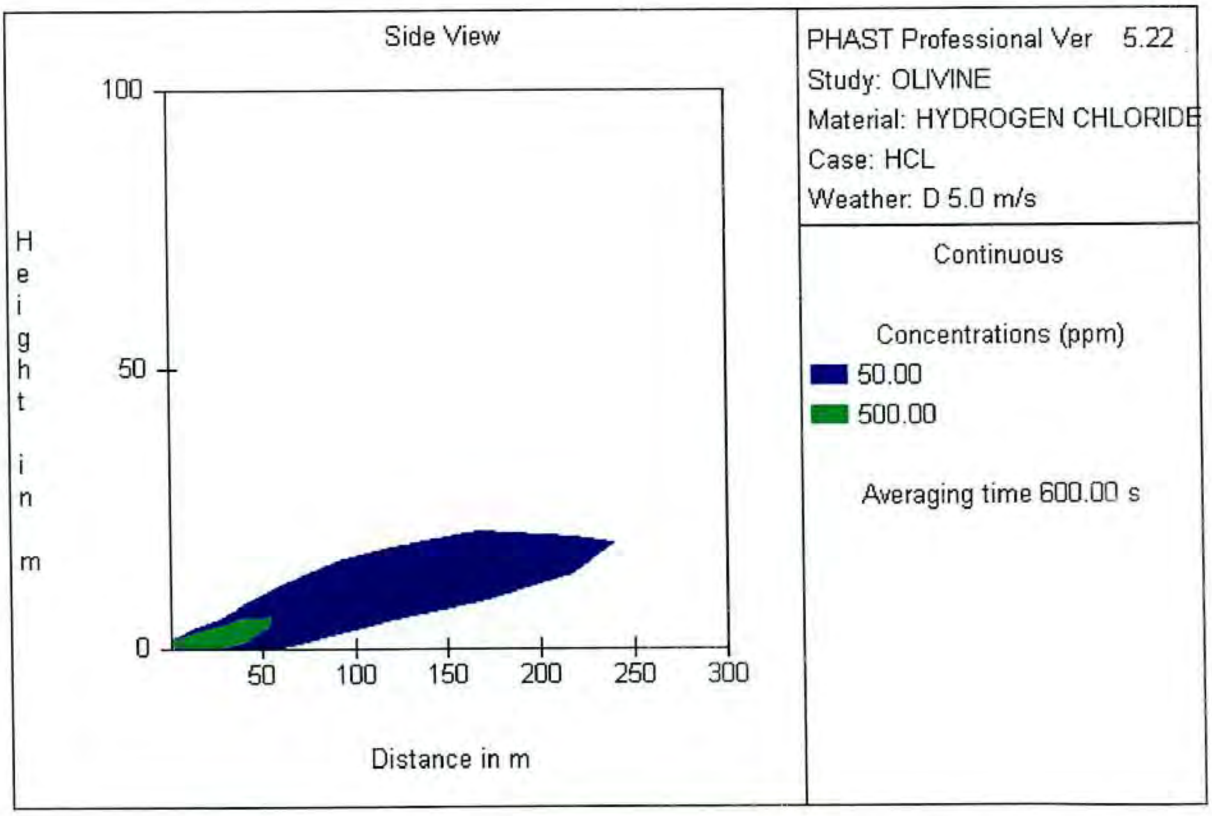
# Sound Power Levels and Predictive Noise Modelling

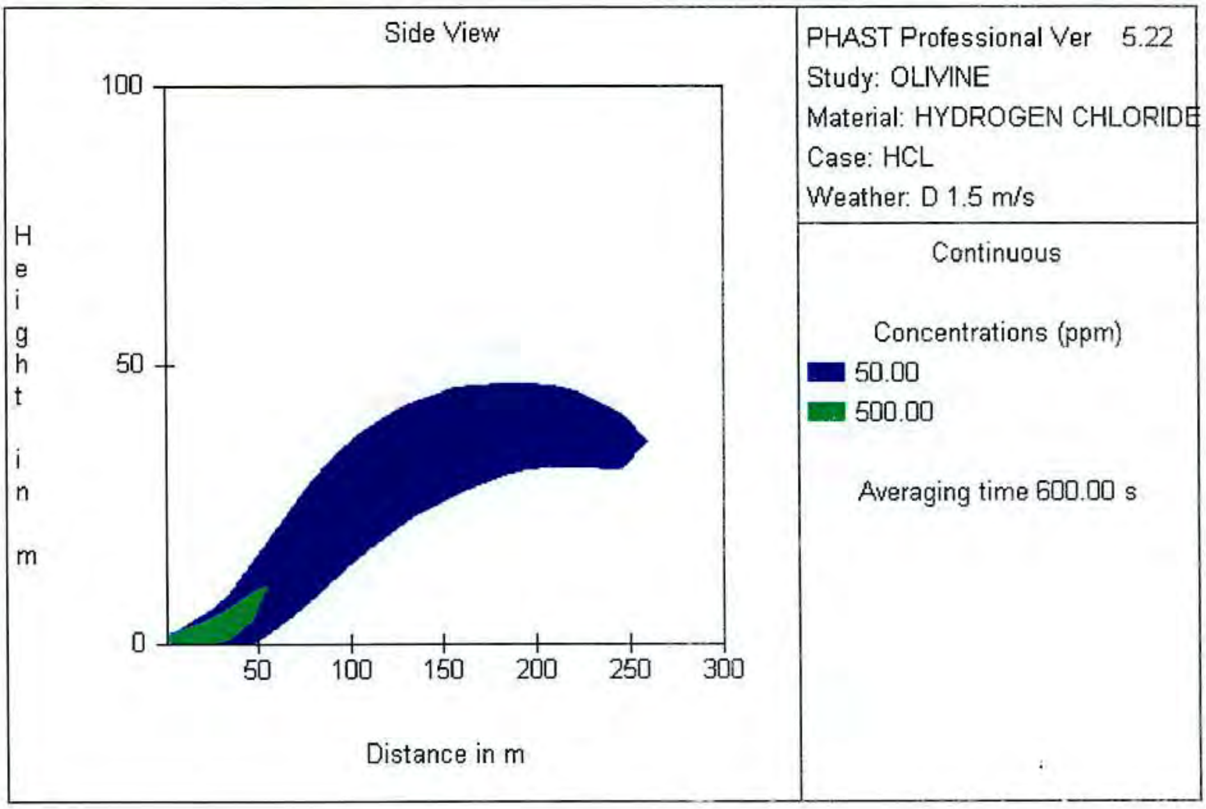
# Appendix R

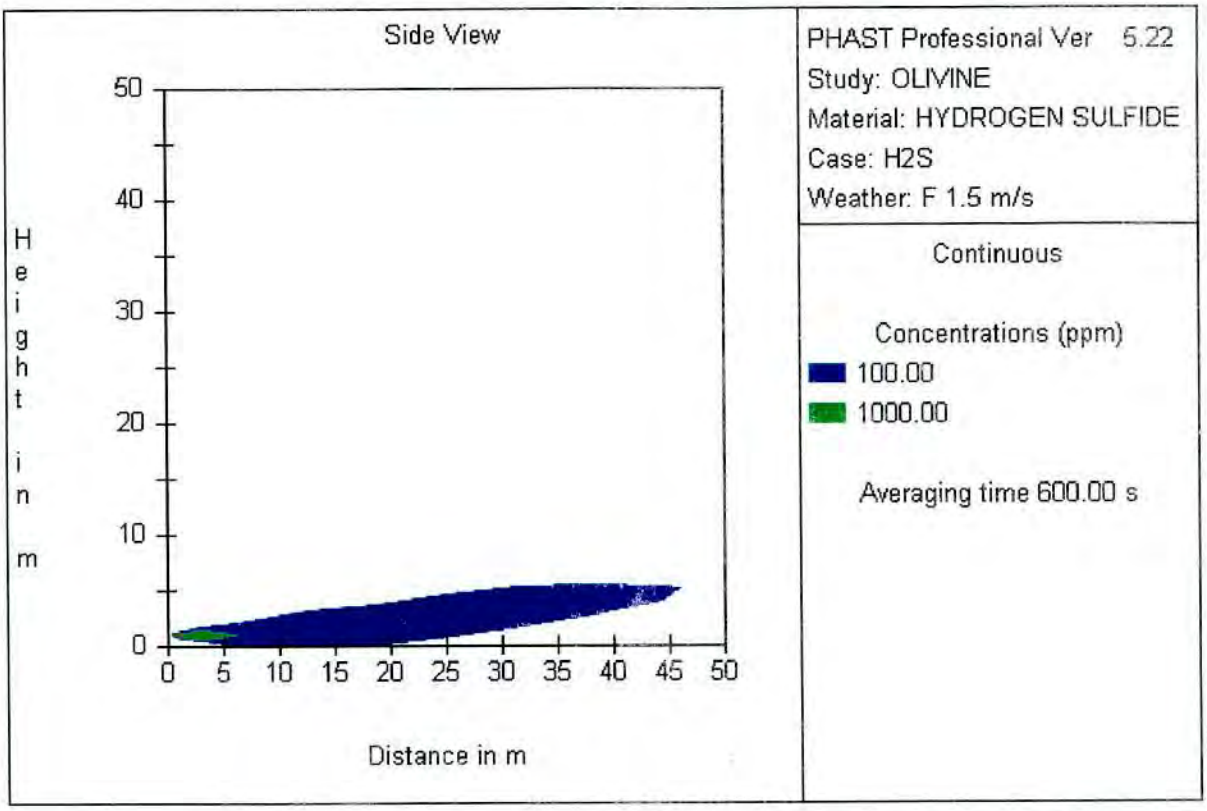
# HCl and H2S Cloud Footprints

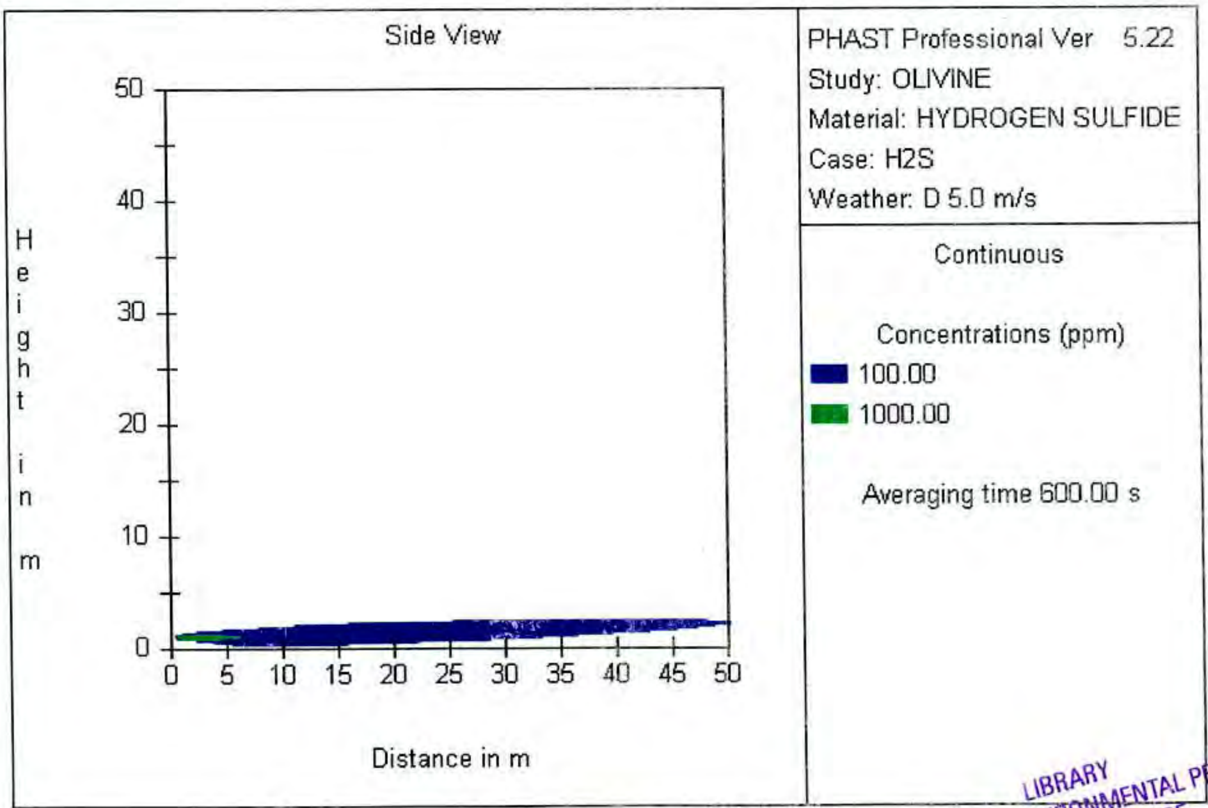
## Hydrogen Chloride




Side View
100
50
0
Height in m
50
100
150
200
250
300
Distance in m
PHAST Professional Ver 5.22
Study: OLIVINE
Material: HYDROGEN CHLORIDE
Case: HCL
Weather: D 1.5 m/s
Continuous
Concentrations (ppm)
50.00
500.00
Averaging time 600.00 s


Side View
Height in m
Distance in m
0
10
20
30
40
50
0
5
10
15
20
25
30
35
40
45
50
PHAST Professional Ver 5.22
Study: OLIVINE
Material: HYDROGEN SULFIDE
Case: H2S
Weather: F 1.5 m/s
Continuous
Concentrations (ppm)
100.00
1000.00
Averaging time 600.00 s


Side View
Height in m
Distance in m
0
10
20
30
40
50
0
5
10
15
20
25
30
35
40
45
50
PHAST Professional Ver 5.22
Study: OLIVINE
Material: HYDROGEN SULFIDE
Case: H2S
Weather: D 5.0 m/s
Continuous
Concentrations (ppm)
100.00
1000.00
Averaging time 600.00 s