

## **Public Environmental Review**

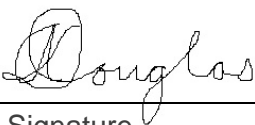
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### **Kwinana Waste to Energy Project**

**Assessment No.:** 1945  
**Version:** FINAL  
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## Document Control

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**Filenames:**

Main Document

Phoenix Energy – Kwinana WTE PER Document FINAL

Part B – Appendices

Phoenix Energy - Kwinana WTE PER Doc FINAL - Part B\_A4

# 1 Invitation to make a submission

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The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. Both electronic and hard copy submissions are most welcome. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

Phoenix Energy Australia Pty Ltd on behalf of the Proponent, Kwinana WtE Pty Ltd, proposes to build a world scale Waste to Energy facility in the Kwinana Industrial Area. The proposed facility will generate renewable electricity and recover other resources from up to 400,000 t/yr of residual Municipal Solid Waste, otherwise destined for landfill disposal. In accordance with the Environmental Protection Act 1986 (EP Act), a Public Environmental Review (**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 6 weeks from 9 June 2014 closing on 21 July 2014.

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.

## 1.1 Where to get copies of this document

Printed and CD copies of this document may be obtained from:

Phoenix Energy Australia Pty Ltd  
Lot 14, Leath Road,  
Kwinana, WA, 6167  
Telephone no (08) 9528 1064

Hard copies of the PER main document may be purchased for \$10 (including postage and packaging) and a hard copy of the Part B Appendices document may be purchased separately for \$10 (including postage and packaging). Alternatively, a CD version containing electronic copies of both documents is available free of charge (including postage).

Copies may also be downloaded from Phoenix Energy's website ([www.phoenixenergy.com.au/projects/](http://www.phoenixenergy.com.au/projects/)).

## 1.2 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. Electronic submissions will be acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the Freedom of Information Act 1992 (FOI Act), and may be quoted in full or in part in each report.

## 1.3 Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining 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

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(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.

#### 1.4 Developing a submission

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

When making comments on specific elements of the **PER**:

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

#### 1.5 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: 21 July 2014**

The EPA prefers submissions to be made at: <https://consultation.epa.wa.gov.au>

Alternatively, submissions can be

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, EAST PERT, WA 6892; or
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth; or

If you have any questions on how to make a submission, please ring the Office of the EPA on (08) 6145 0803.

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**Appendix E – MHIEC Global WtE Plant Delivery Record**

**Appendix F – Air Quality and Odour Impact Assessment Report**

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**Appendix I – Preferred EPC contractor’s Environmental Management Manual and Certificate of Conformity**

**Appendix J – Letter from PMET regarding ash and Brixx™ testing frequency and testing requirements**

**LIST OF ABBREVIATIONS**

APC	Air Pollution Control
As	Arsenic
BAT	Best Available Techniques (BREF, 2006)
BAQS	Background Air Quality Study
BREF	Reference Document on the Best Available Techniques
CAG	Community Advisory Group
Cd	Cadmium
CEMS	Continuous Emissions Monitoring System
Co	Cobalt
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
CO <sub>2</sub> -e	Carbon Dioxide equivalent
Cr	Chromium
CrVI	Chromium 6
Cu	Copper
DER	Western Australian government Department of Environmental Regulation (formerly the Department of Environment and Conservation (DEC) and formerly the Department of Environment Protection, (DEP))
DMA	Decision Making Authority
DoH	Department of Health
DSD	Department of State Development
DST	Decision Support Tool
EfW	Energy from Waste (or Waste to Energy)
EMRC	Eastern Metropolitan Regional Council
EPA	Environment Protection Authority of Western Australia
EPC	Engineering Procurement Construction
EPP	Environment Protection (Kwinana) (Atmospheric wastes) Policy 1999
ESP	Electrostatic Precipitator
GHG	Greenhouse Gas (typically expressed as CO <sub>2</sub> -equivalent emissions)
GLC	Ground Level Concentration
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
Hg	Mercury
ICR	Incremental Carcinogenic Risk
ID	Induced Draft
ITEQ	International Toxicity Equivalent

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IED	Industrial Emissions Directive (European Directive 2010/75/EU)
IRC	Incremental Carcinogenic Risk
KIA	Kwinana Industrial Area
KIC	Kwinana Industries Council
KWRP	Kwinana Wastewater Reclamation Plant
MGB	Mobile Garbage Bin
MHIEC	Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.
Mn	Manganese
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
Ni	Nickel
NGA	National Greenhouse Accounts
NO <sub>x</sub>	Oxides of Nitrogen
NO <sub>2</sub>	Nitrogen Dioxide
NSW	New South Wales
OEH	Office of Environmental Heritage
OEHHA	Californian Office of Environmental Health Hazard Assessment
OEPA	Office of the Environment Protection Authority of Western Australia
Pb	Lead
PCDD	Polychlorinated dibenzo- <i>p</i> -dioxins (dioxins)
PCDF	Polychlorinated dibenzofurans (furans)
PM <sub>x</sub>	Particulate Matter of X micron diameter and below
PMET	Pittsburgh Mineral & Environmental Technology, Inc.
ROC	Reactive Organic Compounds
RRC	Rivers Regional Council
SMRC	Southern Metropolitan Regional Council
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
SO <sub>2</sub>	Sulphur Dioxide
SOP	Standard Operating Procedure
SWIS	South West Interconnected System
TEQ	Toxic Equivalent
Tl	Thallium
TSP	Total Suspended Particulate
TCLP	Toxicity Characteristic Leaching Procedure
USA	United States of America
US EPA	United States Environment Protection Agency

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V	Vanadium
WARR	Waste Avoidance and Resource Recovery Act 2000
WID	Waste Incineration Directive (2000/76/EC directive on the incineration of waste)
WRATE	Waste and Resources Assessment Tool for the Environment
WtE	Waste to Energy (or Energy from Waste)

**UNITS OF MEASUREMENT**

°C	degrees Celsius
g	grams
g/s	grams per second
ha	Hectares
K	degrees Kelvin
km	kilometres
kL/yr	kilolitres per year
kWh/t	kilowatt hours per tonne
m	metres
m <sup>3</sup> /h	cubic metres per hour
mg/Nm <sup>3</sup>	milligrams per normal cubic metre
µg/Nm <sup>3</sup>	micrograms per normal cubic metre
m/s	metres per second
mm	millimetres
MW <sub>e</sub>	MegaWatt of electricity
ng ITEQ/Nm <sup>3</sup>	nanograms international toxicity equivalents per normal cubic meter
tpd	tonnes per day
t/yr	tonnes per annum

## 2 Executive Summary

### 2.1 Introduction

Phoenix Energy Australia Pty Ltd (Phoenix Energy) has prepared this Public Environmental Review document on behalf of the proponent, Kwinana WTE Project Co Pty Ltd (ACN 165 661 263). As the project developer, Phoenix Energy is delighted to detail its proposal to build Australia's first world scale mass combustion type waste to energy (WtE) facility, and describe how all potential environmental impacts will be addressed and managed. The consideration of environmental impacts and their management will span the entire project lifecycle, from design, through to construction, and throughout the operational life of the facility.

#### 2.1.1 Project Overview

The Kwinana WtE project will be a critical component of WA's long-term waste management infrastructure. The facility will utilise the tried and proven, market leading Martin GmbH reverse acting grate combustion technology to process up to 400,000 t/yr of residual Municipal Solid Waste (MSW) into clean, base load renewable electricity. The process will recover energy in the form of electricity and employ Best Available Techniques to ensure that any emissions to the atmosphere are continually in compliance with world's best practice emission limits. In addition, solid residues from the combustion process will be further processed into bricks and pavers in an on-site Brick Plant and/or sold for use as a construction aggregate. This combination of process technologies will not only deliver one of the cleanest forms of base load electricity, but it will also divert 100% of the feedstock (MSW) away from landfill. This will simultaneously reduce WA's reliance on both fossil fuel fired base load electricity generation and landfill disposal. Because of the significance of the project to Western Australia, it has been endorsed by the State

Government as a Level 2 project under the State's Lead Agency Framework, managed by the Department of State Development (DSD).

While this proposal is the first of its kind in Australia, it will join the ranks of hundreds of similar scale or larger WtE facilities using the same tried and proven combustion technology, which has been in commercial operation around the globe for decades.

#### 2.1.2 Location

The proposed facility will be located off Leath Road, Kwinana Beach, in the heart of the Kwinana Industrial Area (KIA); approximately 40km south of Perth, Western Australia [please refer to **Attachment 1** in section 16 ATTACHMENTS, p185]. The location is ideal due to its zoning (for Heavy Industry), existing buffer between the site and existing residential areas, heavy vehicle access routes and proximity to existing waste management infrastructure, to which it will be integrated or will largely replace.

#### 2.1.3 Proposal Schedule

Construction works on the proposal are expected to commence, pending receipt of the Works Approval in accordance with the *Environment Protection Act 1986 Part V*, in early-2015, with completion expected in late-2016.

#### 2.1.4 The proponent

The proponent for the proposal is Kwinana WTE Project Co Pty Ltd. Phoenix Energy Australia Pty Ltd is acting on behalf of the proponent. Phoenix Energy has developed relationships with tier-one engineering, legal, commercial and plant operations and maintenance service providers, as summarised below. Phoenix Energy draws on any or all of these partners during the project development process. Table 1 provides a summary of our key project development and delivery partners.

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Table 1 - Kwinana WtE Project Development and Delivery Partners

Project Team Member Name	Description
Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd. (MHIEC)	Mass combustion technology provider and regional license holder of the Martin GmbH reverse acting stoker grate furnace system, and EPC contractor
Covanta Energy Corporation (Covanta)	A global WtE plant owner and Operations & Maintenance (O&M) service provider. Covanta currently own or operate 44 WtE facilities across the US, Europe and Asia
John Holland	Our preferred EPC contractor. John Holland is currently collaborating with Phoenix Energy on WtE projects in Australia
Minter Ellison	Provides legal, contractual, environmental and regulatory advice
Hatch Associates	Owner’s engineer and EPCM contractor
Deloitte	Deloitte has global expertise in commercial evaluation and financial modelling of WtE projects. Deloitte has developed the project financial model used to establish the commercial viability of the Kwinana WtE project.

## 2.2 The Proposal

### 2.2.1 Key Characteristics

Table 2 - Key Characteristics Summary Table

Elements	Description
<b>General</b>	
Proponent	Kwinana WTE Project Co Pty Ltd Lot 14, Leath Road, Kwinana Beach
Project Description	Construction and operation of a Waste to Energy facility for the recovery of energy and other resources from waste
Project Location	Lot 14, Leath Road, Kwinana Beach, in the Kwinana Industrial Area (KIA)
Construction & Commissioning Period	Approximately 24 months
Life of Plant	More than 20 years
<b>Footprint</b>	
Total site area	3.479 ha
Vegetation Clearing	Up to 1 ha, for buildings, roadways and fences.
<b>Key Inputs</b>	
Waste volume and type	Up to 400,000 t/yr of Residual Municipal Solid Waste (MSW) to be processed in two 606 tpd Martin grate lines (each consisting of an integrated stoker grate boiler system, an ash discharger, air pollution control system, ID fan and flue) operating in parallel, with a single multi-flue stack containing twin flues.



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Elements	Description
Water requirement	Up to 175,000 kL/yr at full capacity, to be sourced from the existing Water Corporation scheme water connection, the availability of which is confirmed in <b>Appendix H</b> .
Electricity	The facility will generate its own electricity
<b>Key Outputs</b>	
Gross Electricity Generation Capacity	Estimated to be 36 MW <sub>e</sub>
Air Emissions	<p>Emissions to the air may include oxides of nitrogen, acid gases, carbon monoxide, particulate matter, volatile metals, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, and odour.</p> <p>Air Pollution Controls along with continuous monitoring, and periodic sampling and testing of the flue gas in each of the two flues contained within the multi-flue stack, to ensure compliance with European Waste Incineration Directive 2000/76/EU (recast as 2010/75/EU) emission limits.</p>
Process waste	Bottom ash and fly ash with Air Pollution Control reaction products will be segregated and characterised to maximise reuse opportunities, which will include conversion into bricks and pavers and/or use of the bottom ash as a construction aggregate. However, in the event of a market failure for some or all of the by-products available for sale, the residual process waste will be characterised, subjected to leach testing and then disposed of in an appropriate landfill.
Waste water	The project will have zero process wastewater discharge.
Stormwater	Stormwater harvested on-site will be managed in a dedicated stormwater management system, typically consisting of oil/water separation and an infiltration basin designed to City of Kwinana standards for the Kwinana Industrial Area.
Sewage/grey water	A reticulated sewage connection is not available in the KIA. As such, all sewage will be handled on-site in a sewage handling system which meets the City of Kwinana standards for design and operation of septic systems in the KIA.

2.2.2 Key Components

The project will comprise the following key components:

- waste receiving area;
- two fully automated, Martin-Mitsubishi grate (stoker) furnaces or lines;
- steam system with electricity generation;
- flue gas cleaning Air Pollution Control system (one per line);
- flue gas stack with twin flues;
- steam system;
- brick making plant;
- control room;
- laboratory;

- administration offices;
- roads; and
- car park.

The Kwinana WtE plant will initially accept ~300,000 t/yr of residual MSW feedstock with spare design capacity to absorb growth in the waste streams up to 400,000 t/yr. This growth is expected to be associated with increasing population growth in the corridor south of the Perth metropolitan area, whilst also being mindful of the community’s efforts to reduce per capita waste generation rates.

Handling of up to 400,000 t/yr of MSW will include on-site storage of up to nine operating days’ worth of waste material in a purpose built, fully enclosed, cement lined storage

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bunker. Vehicles will unload into a cement lined bunker in a fully enclosed building. The bunker would be sized to provide the storage capacity required to allow the plant to operate continuously, including over weekends, and also to provide additional capacity to accommodate both planned and unplanned maintenance events. This building would operate under slight negative air pressure with air drawn from the tipping hall directly to the combustion chamber via the grate. This is a design feature of a modern combustion type WtE facility, to minimise dust and odour. The main plant and equipment are contained within a fully enclosed building to reduce noise.

The process will involve the combustion of MSW in a purpose built moving grate/stoker

mass combustion system with best available air pollution control techniques employed to clean the flue gases prior to emission to the atmosphere via a multi-flue stack with twin flues. The stack height will be chosen to meet the ground level concentration limits for criteria pollutants as set out in the National Environmental Protection Measure – Air Quality Standards and Goals (NEPM), and the Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992, for sulphur dioxide and total suspended particles. The plant will employ continuous analysis and monitoring, as well as sampling and testing, of its stack emissions.

Fly ash and bottom ash will be processed into bricks or pavers in an on-site brick making plant, and/or sold as construction aggregate.

### 2.3 Demonstrate compliance with Advice and Recommendations

The EPA has recently released Advice to the Minister for Environment on the Environmental and Health Performance of Waste to Energy Technologies (EPA Report 1468, April 2013).

The advice is based on six key principles:

- Only proven technology components should be accepted for commercially operating waste to energy plants.
- The expected waste input should be the main consideration for the technology and processes selected.
- Proposals must demonstrate best practice that, at a minimum, meets the European Union's Waste Incineration Directive standards for emissions at all times.

- The waste sourced as input must target genuine residual waste that cannot feasibly be reused or recycled.
- Continuous emissions monitoring must occur where feasible, and non-continuous emissions monitoring must be required for all other emissions of concern.
- Residual by-products must be properly treated and disposed of to an appropriate landfill, except where it is demonstrated that they can be safely used elsewhere with acceptable impacts to the environment or human health.

Kwinana WtE Project responses demonstrating compliance with each of the 21 recommendations by the EPA to the Minister for Environment are provided in Table 3.

Table 3 – Kwinana WtE project responses to the 21 recommendations by the EPA

EPA Recommendation	Kwinana WtE Project Response
<p><b>Recommendation 1</b></p> <p>Given the likely community perception and concern about waste to energy plants, a highly precautionary approach to the introduction of waste to energy plants is recommended.</p>	<p>The Kwinana WtE PER seeks to draw upon actual data from reference sites which are of a similar scale and nature to the proposal in order to give the EPA, other decision making authorities, and the wider community confidence in the robustness of the technology and its environmental credentials. It is noted that approximately 1000 communities globally are being served by similar WtE facilities (Whiting et al, 2013), which are generating clean renewable energy in close proximity to major waste producing population centres.</p>
<p><b>Recommendation 2</b></p> <p>As part of the environmental assessment and approval, proposals must address the full waste to energy cycle – from accepting and handling waste to disposing of by-products, not just the processing of waste into energy.</p>	<p>This PER document covers the entire waste to energy cycle from receipt of each load of MSW at the plant gate, to the generation of renewable electricity and the dispatch of a load of bricks made from the ash by-products of the combustion process. The PER also covers the contingency of landfill disposal, where: (a) in the event of a market failure for some or all of the by-products available for sale, the combustion residues will be characterised, subjected to leach testing and sent to an appropriate landfill site for disposal, or (b) in the event that characterisation and testing of the bottom ash and fly ash indicates that it is unsuitable for brick making or use as a construction aggregate, the unsuitable residues will be subjected to leach testing and sent to an appropriate landfill site for disposal. In addition, this proposal seeks to enhance community awareness and education with respect to waste generation and the importance of effective source separation, to keep recyclables (and potentially green waste, where collection services exist) out of the residual waste feedstock to the plant.</p>
<p><b>Recommendation 3</b></p> <p>Waste to energy proposals must demonstrate that the waste to energy and pollution control technologies chosen are capable of handling and processing the expected waste feedstock and its variability on the scale being proposed. This should be demonstrated through reference to other plants using the same technologies and treating the same waste streams on a similar scale, which have been operating for more than twelve months.</p>	<p>Both Martin GmbH and its Asia Pacific partner MHIEC have extensive reference lists of WtE facilities processing MSW of similar size or larger than the proposal. The Martin GmbH WtE Plant reference list attached in <b>Appendix D</b> identifies some 407 operating and approved reference sites globally. Of those which have been operating for 12 months or longer, there are around 36 plants processing more than 400,000 t/yr and 117 plants processing between 200,000 t/yr and 400,000 t/yr. Most of these facilities are operating in Europe, the USA or Japan, under stringent local emission regulations. Of the 10 potential reference facilities with one or more 600 tpd (or similar size) lines, and operating for more than 12 months, the single line, 600 tpd MHIEC-Martin Tokyo-Kita reference plant has been selected as the primary reference facility for benchmarking the proposal. The reasons for selecting this particular facility are as follows:</p> <ul style="list-style-type: none"> <li>▪ While the extensive Martin reference list (see <b>Appendix D</b>) demonstrates that the proposed scale, with respect to overall plant throughput, does not present an issue for the proposal, the line size is a more appropriate measure for benchmarking the Air Pollution Control system performance</li> <li>▪ The Tokyo-Kita plant has a similar APC system to that proposed for the Kwinana WtE plant (including a Baghouse and SCR for NOx abatement), it has a reverse acting type grate system and has a proven track record (with an operational start date of 1998)</li> <li>▪ It was built by technology provider MHIEC and air emissions data is readily available in the public domain (please refer to <a href="http://www.union.tokyo23-seisou.lg.jp.e.de.hp.transer.com/gijutsu/kankyo/toke/chosa/sokute/h24kekka.html">http://www.union.tokyo23-seisou.lg.jp.e.de.hp.transer.com/gijutsu/kankyo/toke/chosa/sokute/h24kekka.html</a>).</li> </ul>

EPA Recommendation	Kwinana WtE Project Response
<p><b>Recommendation 4</b></p> <p>Waste to energy proposals must characterise the expected waste feedstock and consideration made to its likely variability over the life of the proposal.</p>	<p>This document provides an estimate of the expected composition of the residual MSW feedstock. As community awareness regarding the importance of recycling increases with time and education, it is expected that fewer recyclable plastic, glass and metals wastes will be presented at the kerbside. Furthermore, the provision of new green waste collection services through the introduction of a third bin will reduce green waste in the feedstock. Even so, the WtE technology selected for the proposal is the most flexible and proven technology for recovering energy and resources from residual MSW. As such, the community can have confidence that the proposal will meet the community's expectation of the provision of a cleaner waste management services and a more environmentally friendly alternative to landfill disposal.</p>
<p><b>Recommendation 5</b></p> <p>The waste hierarchy should be applied and only waste that does not have a viable recycling or reuse alternative should be used as feedstock. Conditions should be set to require monitoring and reporting of the waste material accepted over the life of a plant.</p>	<p>This proposal targets residual waste i.e. the residual or general waste bin in a 2 or 3 bin municipal waste collection system. Each waste truck will be logged at the gate to confirm that the vehicle is part of a kerbside collection fleet and therefore its contents are suitable for processing under the site license conditions and requirements. Random spot checks on loads will be carried out.</p>
<p><b>Recommendation 6</b></p> <p>Waste to Energy operators should not rely on a single residual waste stream over the longer term because it may undermine future recovery options.</p>	<p>The waste supply agreement will cover multiple municipalities. This will ensure that the proposal receives sufficient MSW feedstock over its operating life, and, is therefore reliant on growth in waste streams resulting from population growth, rather than growth in per capita waste generation rates.</p>
<p><b>Recommendation 7</b></p> <p>Regulatory controls should be set on the profile of waste that can be treated at a waste to energy plant. Plants must not process hazardous waste.</p>	<p>The proposal will handle and process non-hazardous residual MSW.</p>
<p><b>Recommendation 8</b></p> <p>In order to minimise the discharge of pollutants, and risks to human health and the environment, waste to energy plants should be required to use best practice technologies and processes. Best practice technologies should, as a minimum and under both steady state and non-steady state operating conditions, meet the equivalent of the emissions standards set in the European Union's Waste Incineration Directive (WID) (2000/76/EC).</p>	<p>Having already selected the best available WtE technology, the proposal will rely on the expertise of its project partners and best practice guidelines such as the European Commission (2006) Integrated Pollution Prevention and Control (IPPC) <i>Reference Document on the Best Available Techniques (BREF) for Waste Incineration</i> in making the final selection and sizing of technologies associated with the flue gas cleaning Air Pollution Control (APC) system. The combustion control system and APC will be designed to ensure that the facility operates within European WID/IED emission limits, considered to be the international benchmark for WtE facilities, covering both normal operation and short-term non-steady state operating conditions.</p>

EPA Recommendation	Kwinana WtE Project Response
<p><b>Recommendation 9</b></p> <p>Pollution control equipment must be capable of meeting emissions standards during non-standard operations.</p>	<p>In addition to the comment to Recommendation 8 above, the plant will employ state-of-the-art automated control systems to constantly monitor the process performance and take pre-emptive and/or corrective action to ensure that even under non-standard operations the process will either (a) remain compliant with its emissions limits or (b) take action to bring the operating line or the entire plant to a safe shutdown condition.</p>
<p><b>Recommendation 10</b></p> <p>Continuous Emissions Monitoring must be applied where the technology is feasible to do so (e.g. particulates, TOC, HCl, HF, SO<sub>2</sub>, NO<sub>x</sub>, CO). Non-continuous air emission monitoring shall occur for other pollutants (e.g. heavy metals, dioxins and furans) and should be more frequent during the initial operation of the plant (minimum of two years after receipt of Certificate of Practical Completion). This monitoring should capture seasonal variability in waste feedstock and characteristics. Monitoring frequency of non-continuously monitored parameters may be reduced once there is evidence that emissions standards are being consistently met.</p>	<p>The proposal includes a Continuous Emissions Monitoring System (CEMS), for each operating line, for those components where proven and reliable online measurement technology makes it feasible to do so, in accordance with the European WID/IED. For other potential pollutants, the proposal will comply with the European WID/IED non-continuous air emission monitoring requirement for testing of two samples annually. However, as is typical best practice, the proposal will employ quarterly sampling and testing, for a period of two years after receipt of the Certificate of Practical Completion, for non-continuous air emission monitoring.</p>
<p><b>Recommendation 11</b></p> <p>Background levels of pollutants at sensitive receptors should be determined for the Environmental Impact Assessment process and used in air dispersion modelling. This modelling should include an assessment of the worst, best and most likely case air emissions using appropriate air dispersion modelling techniques to enable comparison of the predicted air quality against the appropriate air quality standards. Background monitoring should continue periodically after commencement of operation.</p>	<p>Both DER and NEPM pollutant monitoring is undertaken at sites around the Kwinana Industrial Area, due to the presence of existing heavy industry. The air quality assessment has taken into consideration available monitoring data on background levels of pollutants. This item is addressed in sections 10.2.1.5.4 (page 98) 10.2.1.5.5 (page 102), 10.2.1.5.8 (page 116) and 10.2.1.5.10 (page 119).</p>

EPA Recommendation	Kwinana WtE Project Response
<p><b>Recommendation 12</b></p> <p>To address community concerns, proponents should document in detail how dioxin and furan emissions will be minimised through process controls, air pollution control equipment and during non-standard operating conditions.</p>	<p>Dioxin and furan emissions are readily controlled to barely detectable levels in the emissions from modern WtE facilities. Typical best practices, which will be employed in the design and plant operation include:</p> <ul style="list-style-type: none"> <li>▪ Pre-mixing of the waste to reduce the likelihood of high concentrations of chlorinated wastes being fed to the grate,</li> <li>▪ Automated control of the combustion temperature, to ensure that flue gas temperatures are maintained at 850 °C (minimum) for at least 2 seconds, as required by the European WID/IED,</li> <li>▪ The provision of air pollution control technology to capture dioxins and furans, as a minimum to meet the European WID/IED emission limit, before the flue gas is emitted to the atmosphere via the multi-flue stack, and</li> <li>▪ The sizing of the multi-flue stack will ensure that the minute amounts of dioxins and furans, which may be present in the flue gas after scrubbing and cleaning, are fully dispersed, even under worst case meteorological conditions.</li> </ul>
<p><b>Recommendation 13</b></p> <p>Proposals must demonstrate that odour emissions can be effectively managed during both operation and shut-down of the plant.</p>	<p>Odour is readily managed by:</p> <ul style="list-style-type: none"> <li>▪ Ensuring all putrescible waste is transported in fully enclosed vehicles</li> <li>▪ Fully enclosing the waste bunker and tipping hall within a building, with fast acting roller doors on entry and exit doors and on the waste truck unloading bays</li> <li>▪ Drawing air from the waste bunker and tipping hall for use as combustion air for the process. This creates a slight negative pressure, so that air preferentially enters the building. Odours are destroyed by the high temperature combustion</li> <li>▪ Operating procedures, to ensure that: (a) waste is not loaded into the waste bunker while the plant is not operating, and (b) waste is not left in the waste bunker when the plant is not operational. Note that since the Facility will have two lines operating in parallel to facilitate operation 365 days per year, one line will typically be operating at any point in time, thus maintaining a continuous requirement for combustion air. Full plant shutdowns, typically only for major planned maintenance activities, are planned and prepared for well in advance.</li> </ul> <p>This item is addressed in section 10.1.2.9 Proposed Management and Mitigation Measures (page 92).</p>
<p><b>Recommendation 14</b></p> <p>All air pollution control residues must be characterised and disposed of to an appropriate waste facility according to that characterisation.</p>	<p>A key objective of the proposal is to send zero waste to landfill disposal. As such, the project will utilise opportunities to recycle APC residues to the grate for treatment for either heat recovery or combination with bottom ash for brick making. Combustion residues sent to the Brick Plant will be characterised in accordance with the requirements of the Brick Plant technology provider.</p> <p>However, in the event of a market failure for some or all of the by-products available for sale, the combustion residues will be characterised, subjected to leach testing and sent to an appropriate landfill site for disposal.</p>

EPA Recommendation	Kwinana WtE Project Response
<p><b>Recommendation 15</b></p> <p>Bottom ash must be disposed of at an appropriate landfill unless approval has been granted to reuse this product.</p>	<p>The proposal seeks approval to combine bottom ash and other solid by-products/residues of the combustion and flue gas cleaning systems with various additives, to facilitate the on-site production of bricks and pavers for sale. Alternatively, or in addition, the proposal seeks approval to market the bottom ash as an aggregate, for use in construction applications or as an input for the preparation of building products (by others). In addition, there is substantial evidence from both Japan and Europe, that bottom ash is being utilised for construction purposes (e.g. Danish Topic Centre on Waste and Resources (2006)). Please refer to section 10.1.1.6.8.1 Proposed measures for the management and mitigation of solid wastes (page 82). The proposed by-products will be marketed to both public and private sectors as alternative construction products.</p> <p>However, in the event of a market failure for some or all of the by-products available for sale, the combustion residues will be characterised, subjected to leach testing and sent to an appropriate landfill site for disposal.</p>
<p><b>Recommendation 16</b></p> <p>Any proposed use of process bottom ash must demonstrate the health and environmental safety and integrity of a proposed use, through characterisation of the ash and leachate testing of the by-product. This should include consideration of manufactured nanoparticles.</p>	<p>Please refer to response to recommendation 15.</p> <p>All process residues (bottom ash and fly ash with APC reaction products) will be subjected to periodic characterisation as required by the brick plant technology provider (please refer to <b>Appendix J</b> for a letter addressing process residue testing requirements from the brick plant technology provider), to ensure the integrity of the process, to confirm the appropriate blend of additives and to ensure the quality of the products.</p> <p>All by-products leaving the site will be subjected to periodic composition and leach testing, as well as quality control testing to ensure that they meet or exceed their applicable building product standards and technical specifications. Note that the production of bricks and pavers will provide a highly effective means for containing and eliminating the potential dispersion of manufactured nanoparticles.</p>
<p><b>Recommendation 17</b></p> <p>Long term use and disposal of any by-product must be considered in determining the acceptability of the proposed use.</p>	<p>Please refer to response to recommendations 15 and 16.</p>
<p><b>Recommendation 18</b></p> <p>Standards should be set which specify the permitted composition of ash for further use.</p>	<p>Please refer to response to recommendations 15 and 16.</p> <p>Note that the beneficial use of ash from the combustion of municipal waste as a construction aggregate is common place in Europe and Japan.</p>
<p><b>Recommendation 19</b></p> <p>Regular composition testing of the by-products must occur to ensure that the waste is treated appropriately. Waste by-products must be tested whenever a new waste input is introduced.</p>	<p>Please also refer to response to recommendations 15 and 16.</p> <p>Those by-products which leave the site will be subjected to periodic composition testing, leach testing and quality compliance testing (in the case of construction products).</p>

EPA Recommendation	Kwinana WtE Project Response
<p><b>Recommendation 20</b></p> <p>Waste to energy plants must be sited in appropriate current or future industrial zoned areas with adequate buffer distances to sensitive receptors. Buffer integrity should be maintained over the life of the plant.</p>	<p>The proposed site is in the heart of the Kwinana Industrial Area (KIA), the home of some of Australia’s heaviest industries and also the subject of some of Australia’s toughest regulations and regulatory scrutiny. Not only is the area appropriately zoned for the proposal, it also has existing buffer zones in place, which are expected to remain over the life of the proposal and beyond, therefore mitigating the risk of future urban encroachment.</p>
<p><b>Recommendation 21</b></p> <p>For a waste to energy plant to be considered an energy recovery facility, a proposal must demonstrate that it can meet the R1 Efficiency Indicator as defined in WID.</p>	<p>The European Commission’s 2011 Guidelines on the interpretation of the R1 energy efficiency formula for incineration facilities dedicated to the processing of MSW according to Annex II of Directive 2008/98/EC on Waste (or the Waste Framework Directive), states that for facilities dedicated to the processing of MSW can be classified as recovery operations “provided they contribute to the generation of energy with high efficiency to promote the use of waste to produce energy in energy efficient municipal waste incinerators and encourage innovation in waste incineration”. For installations permitted after 31 December 2008 the R1 Efficiency indicator is to be equal to or above 0.65. This proposal will use the same best practice design techniques, which allow the latest European WtE facilities to achieve an R1 efficiency factor equal to or above 0.65.</p>



## 2.4 Stakeholder Consultation

### 2.4.1 Consultation Strategy

Phoenix Energy seeks to engage with key project stakeholders (the community, industry, government and regulatory bodies) throughout the project lifecycle, to ensure that each project meets or exceeds international best practice for safety, the environment, sustainability, community consultation and commercial viability.

The key elements of an effective stakeholder engagement strategy are being proactive, timely and motivating people to make informed decisions, draw desirable conclusions and take desirable actions. Our philosophy is to lead stakeholders on a journey of discovery, rather than to tell them what we want them to know or think. In strict engagement terms this methodology is considered a 'Pull' rather than a 'Push' approach, e.g. allowing the stakeholders to pull through their own conclusions rather than trying to push or 'sell' other's conclusions. The expectation therefore is that the success of the engagement process and its longevity

is far greater than traditional engagement processes based on a marketing approach.

To date, Phoenix Energy has undertaken a number of preliminary consultation activities including identifying and engaging with those groups who are likely to take a particular interest in the project as well as organising three community forums to discuss the project. Phoenix Energy has also actively engaged with local municipalities providing project briefings to all executive teams. Phoenix Energy arranged a seminar, which included international experts such as Robin Davidov, the then Executive Director of the Northeast Maryland Waste Disposal Authority (whose members are Baltimore City and seven Counties in Maryland) and Professor Nickolas Themelis of Columbia University, Earth Engineering Center. Robin Davidov is one of a very few public sector waste management professionals to have developed, financed and managed three award winning waste-to-energy projects, four landfill gas-to-energy projects, a sludge composting facility and developed a number of solar projects.

## 2.5 Environmental Impact Assessment and Management

### 2.5.1 Impact Assessment

An environmental impact assessment has been undertaken in accordance with the Environmental Scoping Document (ESD) in **Appendix A**.

Each environmental factor associated with the proposal has been assessed in terms of:

- The EPA’s objective for that factor;
- Any applicable legislation, standards, guidelines or procedures;

- Potential sources of impact;
- An assessment of the potential impacts for that factor;
- Proposed management/mitigation measures; and
- An expected environmental outcome.

### 2.5.2 Management

A summary of each environmental factor, the potential impacts, their management and mitigation measures and predicted outcomes is provided in Table 4 below. Further details can be found in section 10 Environmental Factors and Management from page 62 onwards.

**Table 4 – Summary of Environmental Factors, Potential Impacts, their Management and Mitigation Measures and Predicted Outcomes**

#### Environmental Factor

**Storage and Handling Facilities:  
Terrestrial Environmental Quality and Inland Waters Environmental Quality**

#### EPA Objective

- To maintain the quality of land and soils so that the environmental values, both ecological and social are protected.
- To maintain the quality of groundwater and surface water, sediment and or biota so that the environmental values, both ecological and social, are protected.

#### Existing Environment

The site, situated in the heart of the Kwinana Industrial Area, currently consists of three developed sections associated with previous activities and a small section of uncleared vegetation of ~0.6 ha, primarily in the north east corner. The site has been subjected to detailed assessment and remediation activities by its former owner, to the satisfaction of the current land owner, Landcorp, on behalf of the Government of Western Australia. The site lies near the south-western edge of the Jandakot groundwater mound, a system which is recharged by infiltration of rain during the months of April to October. The overall direction of flow is to the north and northwest.

#### Potential Impacts

Potential impacts include:

- Incorrect storage and handling of waste on-site may lead to land, groundwater and surface water contamination and ecological impacts.
- Incorrect disposal of wastes not suitable for combustion and process residues may have additional environmental impacts.
- Impacts on groundwater levels.
- Stormwater will be generated via the construction of roofs and sealed surfaces.

### Environmental Factor

#### Significance of Impacts

- The risk of contamination due to spillages or poor storage and handling practices is low as waste will be transported in enclosed trucks, processed under cover in buildings and waste handling/storage areas will have impermeable floors, cement lined walls and sump collection points, as necessary.
- The environmental risks associated with incorrect disposal of wastes not suitable for combustion and process residues is assessed as low because:
  - The feedstock is residual MSW, which is a fairly predictable and consistent mixed waste stream, with very small quantities of undesirable components. As such, the technology is flexible enough to process the waste stream "as received" without the need for an additional upfront pre-sort,
  - The proposal includes an on-site brick making plant to convert all solid combustion residues into bricks and pavers and/or construction aggregate.
- Groundwater will not be extracted for use in this proposal.
- Generation of stormwater is not considered to be significant as it can be managed through the use of appropriate infrastructure on the site, including physical separation from handling and storage areas.
- The risk of contamination of ground water or soil due to the beneficial use of combustion residues (i.e. ash) as a construction products, such as bricks, pavers and aggregate, is low as combustion residues will be segregated according to their type (e.g. bottom ash and fly ash) prior to processing and solid by-products leaving the site will be subjected to a testing regime applicable to their end-use.

#### Proposed Management & Mitigation

Impacts will be managed through:

- All waste movements and handling on site will be in enclosed vehicles or enclosed buildings.
- All waste buffer storage will be in a sealed, cement lined bunker and enclosed in a building.
- Any solid combustion residues (i.e. ash) stored on site will be segregated according to their type (e.g. bottom ash and fly ash) in sealed, cement lined bunkers, enclosed in a building.
- All solid combustion residues (i.e. ash) will be handled within enclosed buildings and enclosed conveyors.
- The proposed on-site brick plant will generate value added products from solid combustion residues, in the form of bricks, pavers and/or construction aggregate. Solid products leaving the site will be subjected to testing to ensure their compliance with appropriate regulations for their use as construction products as well as to confirm that they are non-leaching i.e. to confirm that they will not pose a threat to human health or ground or surface water.
- The proposal will be designed for zero process waste to landfill. Bottom ash and fly ash with Air Pollution Control reaction products will be segregated and characterised to maximise reuse opportunities, which will include conversion into bricks and pavers and/or use of the bottom ash as a construction aggregate. In the event that characterisation and testing of the bottom ash and fly ash indicates that it is unsuitable for brick making or use as a construction aggregate, the unsuitable residues will be subjected to leach testing and sent to an appropriate landfill site for disposal. Furthermore, in the event of a market failure for some or all of the by-products available for sale, the residual process waste will be characterised, subjected to leach testing and then disposed of in an appropriate landfill.
- The proposal will be designed to have a zero process waste water discharge, with process water being re-used on site.
- The proposal will look to utilise stormwater as make-up to the process water system. As such it is proposed to store stormwater on-site, with stormwater in excess of process requirements and storage capacity being managed in an infiltration basin designed to City of Kwinana standards for the Kwinana Industrial Area.
- Sewage and grey water will be managed on site in a new septic system. The new septic system will be a nutrient retentive system (i.e. aerobic treatment units), to reduce nutrients and contaminants entering

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into the surrounding groundwater. The new system will be designed to operate in accordance with City of Kwinana design specifications for the Kwinana industrial Area.

### Predicted outcomes

The EPA objectives in relation to protecting the quality of soil, surface water and ground water will be met, with the proposal offering the potential for numerous net benefits relative to current landfill disposal practices.

### Storage and Handling Facilities:

#### Amenity – Odour

### EPA Objective

- To ensure that impacts to amenity are reduced as low as reasonably practicable.

### Existing Environment

The site is situated in the heart of the Kwinana Industrial Area with existing buffer areas.

### Potential Impacts

Putrescible waste will be stored and handled on site as buffer capacity to enable continuous operation (24 hours a day, 7 days a week and 365 days a year). The storage and handling of putrescible waste can result in undesirable odour emissions, which have the potential to impact on the local amenity.

### Significance of Impacts

- Odour emissions from putrescible waste such as MSW have the potential to be a significant issue unless appropriate management and mitigation measures are implemented.
- The risk associated with odour emission is considered to be insignificant, given that putrescible waste will be transported in enclosed vehicles and stored and handled on site in enclosed buildings maintained under constant negative pressure, with substantial separation distances to sensitive land uses.

### Proposed Management & Mitigation

- All waste movements on-site will be in covered vehicles.
- All waste stored on-site will be in a fully enclosed building, maintained under negative air pressure. This is achieved by drawing combustion air from the refuse storage and handling area of the building, so that any odour and dust is destroyed by the combustion process and then subjected to clean-up in the Air Pollution Control system.
- The building will be equipped with fast acting roller doors at the Tipping Hall entrance and exit, and each tipping bay will have its own automated door, which will be closed when not in use.
- With two lines operating in parallel, the refuse handling area will still be maintained under negative air pressure, even when one line is off-line for maintenance.
- Appropriate waste management and handling procedures will be employed, such as:
  - Running down the waste bunker inventory prior to a plant turnaround for a major maintenance event or equipment upgrade;
  - Temporarily divert waste deliveries away from the facility to an alternative disposal or processing destination, agreed prior with participating waste suppliers and local regulatory authorities;
  - Closing combustion air intake louvres and doors when the facility is shut down for a plant turnaround; and
  - After a plant turnaround, not accepting new waste for processing until at least one grate line has been warmed up using the natural gas fired auxiliary burners.

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#### Predicted outcomes

The EPA objective of protecting the local amenity from odour will be met at all times, with the proposal set to improve existing amenity by diverting putrescible waste away from landfill disposal.

### Combustion Facilities:

#### Air Quality

#### EPA Objective

- To maintain air quality for the protection of the environment and human health and amenity.

#### Existing Environment

- The site is situated in the heart of the Kwinana Industrial Area and within the Kwinana Industrial Area (KIA) air shed.
- Numerous other existing industrial sites are located within 5km of the site.
- The main contaminants of concern in the Kwinana airshed are:
  - Sulphur dioxide (SO<sub>2</sub>);
  - Oxides of nitrogen (NO<sub>x</sub>);
  - Particulate matter, heavy metals and volatile and semi-volatile organics;
  - Dioxins and furans;
  - Carbon Monoxide (CO);
  - Formaldehyde and other complex organic compounds;
  - Hydrogen chloride (HCl) and Hydrogen Fluoride (HF); and
  - Odour.

#### Potential Impacts

Potential impacts include:

- The facility will employ technology purpose built to recover energy and other resources from a mixed waste feedstock, such as source separated residual Municipal Solid Waste, which contains a mixture of materials. As such, the process has the potential to emit into the atmosphere a range of contaminants including heavy metals, particulate matter, dioxins, other toxic organic compounds and acid gases including sulphur dioxide, oxides of nitrogen, hydrogen chloride and hydrogen fluoride, via the flue gas stack, which may impact residential areas and neighbouring premises, the nearest of which is currently a building approximately 100 m to the south-east of the multi-flue stack (see **Attachment 4**, in Section 16 ATTACHMENTS from page 185).
- The plant is designed to handle and process putrescible material, which if not handled or managed appropriately, may result in fugitive odour emissions.
- Dust from construction activities.

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#### Significance of Impacts

- Emissions to the air from the flue gas stack have the potential to impact the surrounding air quality unless appropriate management and mitigation measures are implemented and the facility is well operated and maintained.
- Both the air dispersion modelling and the preliminary public Health Risk Assessments undertaken in relation to the proposal have concluded that a well-designed WtE plant, using Best Available Techniques, and a well operated and maintained facility will have negligible impact on both the environment and on public health, with respect to potential acute and chronic health issues, and the public health system.
- The risk associated with odour emission is considered to be insignificant, given that putrescible waste will be transported in enclosed vehicles and stored and handled on site in enclosed buildings maintained under constant negative pressure, with substantial separation distances to sensitive land uses.

#### Proposed Management & Mitigation

- The proposal is consistent with the EPA's 21 recommendations in that it matches the most appropriate technology to the waste stream and applies best practice techniques for both design and operation. The proposal will use of the preeminent WtE technology, the Martin GmbH reverse acting stoker grate, supplied along with the Air Pollution Control System and other major plant items, by the region's most experienced WtE technology provider, MHIEC, installed by a tier one EPC, John Holland, and operated by the world's largest dedicated WtE operations and maintenance service provider, Covanta.
- Automated combustion control and monitoring, along with the provision of natural gas fuelled auxiliary burners (not typically required during normal operation), will ensure that the combustion temperature is maintained at all times while refuse is on the grate, while the reciprocating movement of the grate bars and automated control of combustion air will ensure maximum energy recovery from carbon in the feedstock.
- The flue gas cleaning Air Pollution Control (APC) system will be designed using proven technologies, which meet or exceed the requirements of European Commission's (2006) Best Available Techniques for applications relating to the recovery of energy from waste.
- The inclusion of a Continuous Emissions Monitoring System (CEMS) to constantly monitor the performance of the combustion system working in tandem with the APC system, with feedback to the APC reagent injection systems and control room.
- Approach to limit alarms, to provide early warning to control room operators, to allow them to take pre-emptive action to address potential excursions in operating variables.
- Routine stack testing will be implemented to both confirm and supplement the CEMS.
- Redundancy of plant and equipment, such as duty/stand-by arrangement for critical items such as combustion air fans, CEMS, firewater and boiler feedwater pumps, along with a stand-by diesel generator, will ensure that the process is controllable at all times, even in the event of a disruption outside the control of the facility.
- Reporting of online CEMS results and regulatory compliance criteria on the facility website at all time.
- Appropriate design and sizing of each flue within the flue gas stack, using computer aided modelling, to ensure that the very small concentrations of residual pollutants are sufficiently dispersed and ensure that ground level concentrations are maintained well within accepted regulatory guidelines
- Development of a Construction Management Plan, which will detail dust control measures to be implemented during the construction phase of the project.
- Implementation of an Environmental Management System to ensure ongoing compliance with statutory requirements and continuous improvement of plant and operation.
- Handling and storage of putrescible waste in covered vehicles and a fully enclosed building maintained under negative air pressure (as described earlier for the Environmental Factor: Amenity – Odour).

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### Environmental Factor

#### Predicted outcomes

The EPA objectives for air quality and odour amenity will be met.

#### Both Facilities:

#### Amenity – Noise

#### EPA Objective

- To ensure that impacts to amenity are reduced as low as reasonably practicable.

#### Existing Environment

The site is situated in the heart of the Kwinana Industrial Area, with pre-existing buffer zones. The nearest sensitive receptor (the Naval Base Hotel) is approximately 2 km from the site. In 2010, the Kwinana Industries Council (KIC) commissioned an update to the KIC acoustic model to incorporate current KIC member acoustic model data, covering most existing major noise emitters in the KIA. The consultant also undertook a noise measurement program to compare measured levels with model outputs for reference locations throughout the Kwinana area, including residential areas. The KIC model can be used to generate overall KIC source predicted noise contours for use by individual members to facilitate the assessment of their own proposals and to determine the cumulative effects.

#### Potential Impacts

Potential impacts include:

- There are numerous adjacent heavy industrial premises, which could potentially be impacted by noise emissions from the proposal.
- Noise associated with the proposal and cumulative noise impacts, associated with the proposal in conjunction with existing noise emission sources, could impact neighbouring receptors and sensitive far field receptors, the nearest of which is approximately 2 km from the site.

#### Significance of Impacts

- Noise emissions from the proposal are dominated by on-site truck movements.
- Modelling indicates that a ~2.4m acoustic barrier along the east boundary would allow the proposal to be fully compliant with current regulations in relation to assigned levels for industrial receivers. The impact on the east boundary is significant because the ring road for truck movements on site is currently assumed to be adjacent to the east boundary and there is currently no easement between the subdivisions of Lot 14, along the east boundary of the site.
- Noise modelling has confirmed that the proposal is not expected to significantly contribute to existing cumulative noise levels at far field sensitive receptors.

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### Environmental Factor

#### Proposed Management & Mitigation

- The proposal will be designed to fully comply with the *Environmental Protection Noise Regulations 1997*. This will be achieved as follows:
  - The majority of plant and equipment will be housed within appropriately designed buildings.
  - For the few significant potential external equipment noise sources, equipment selection and attenuation will be undertaken on the basis of ensuring the facility will comply with assigned levels at the boundaries of neighbouring industrial sites, and will not significantly contribute to cumulative noise impacts at far field sensitive receptors, at all times of day and night.
  - The majority of on-site truck movements will only occur during a 2-hour mid-morning and mid-afternoon shift during weekdays.
  - Compliance with assigned noise levels for industrial receivers along the eastern boundary will be achieved by adjustments to plant layout, such as the re-location of the ring road or by the construction of an appropriately sized noise barrier, as proposed in the Acoustic consultant's report
- The maintenance of existing buffer zones around the KIA will mitigate risks associated with urban encroachment.
- The management of noise emissions throughout the construction period.

#### Predicted outcomes

International experience shows that the majority of these types of facilities are actually located within heavily populated urban areas (e.g. in Tokyo, London, Paris) rather than heavy industrial precincts such as the KIA. As such, the community can be confident that the EPA objectives for noise amenity will be met at all times.

### Other Environmental Matters:

#### Native Vegetation Clearing

#### EPA Objective

- With respect to the environmental factor, Flora and vegetation: To maintain representation, diversity, viability and ecological function at the species population and community level.
- With respect to the environmental factor, Terrestrial Fauna: To maintain representation, diversity, viability and ecological function at the species population and assemblage level.

#### Existing Environment

The site, situated in the heart of the Kwinana Industrial Area, is zoned Industrial. It currently consists of three developed sections associated with previous activities and a small section of uncleared vegetation of ~0.6 ha, primarily in the north east corner. The site has been subjected to detailed assessment and remediation activities by its former owner, to the satisfaction of the current land owner, Landcorp, on behalf of the Government of Western Australia. By observation, the remaining vegetation is possibly re-growth after the discontinuation of past land use activities and/or native vegetation in a degraded condition.

#### Potential Impacts

Potential impacts include:

- The potential for a loss of representation, diversity, viability and ecological function of flora and vegetation and terrestrial fauna, due to the likely clearing of a small parcel of native vegetation or re-growth, to make way for roads and buildings required for the proposal.



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## Environmental Factor

### Significance of Impacts

The impact of clearing such a small section of vegetation, which has been surrounded by heavy industry and a services easement for decades, is expected to be insignificant with respect to representation, diversity, viability and ecological function at the species population and community level for flora, vegetation and terrestrial fauna. Furthermore:

- the vegetation on the site is unlikely to be considered significant habitat for indigenous Western Australian fauna,
- the site is approximately 2.5 km from the nearest wetland and is hydrologically up-gradient, and
- the site is approximately 2.5 km from the nearest Bush Forever site.

### Proposed Management & Mitigation

The clearing of up to 1 ha of primarily degraded vegetation and re-growth, which is not considered to be significant habitat for indigenous fauna, for the purpose of constructing roads and buildings, will be undertaken in accordance with good construction practices and in accordance with statutory requirements.

### Predicted outcomes

Given the minimal extent of land clearing required for the proposal and the existing condition of the remaining undeveloped portion of this Industrial zoned site, the EPA principles and objectives will not be compromised by land clearing in relation to the proposed land use activity (i.e. for the construction of roads and buildings for the proposal).

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## 3 Introduction

### 3.1 The Proponent

Phoenix Energy Australia Pty Ltd (ACN 137 621 651) is a privately owned Australian WTE project development company and developer of the Kwinana Waste to Energy (WTE) Project. Phoenix Energy is issuing this PER document on behalf of the proponent, Kwinana WTE Project Co Pty Ltd (ACN 165 661 263).

Kwinana WTE Project Co Pty Ltd is a Special Purpose Vehicle (SPV), which is 100% owned by Kwinana WTE Pty Ltd (ACN 152 625 726), the holding company, both of which were incorporated specifically for this project. At this point in time Phoenix Energy Australia Pty Ltd is the sole shareholder of Kwinana WTE Pty Ltd. Globally it is common practice to establish a SPV for a project such as this, at a time in which the project has moved beyond feasibility stage. This allows the assets of the project to be quarantined within a single entity and to simplify the process of obtaining project financing and inclusion of other equity partners. However in keeping with best practice, appropriate parent company guarantees are established to underpin the project.

### 3.2 Background on the Kwinana WtE Project

#### 3.2.1 WtE Plant Description

The Kwinana WTE plant will consist of two fully automated, state-of-the-art Martin grate (stoker) furnaces or lines operating independently and in parallel. The moving grate stoker technology is the most prevalent WTE technology in the market and the majority, approximately 400 WtE plants globally; use Martin GmbH technology (see **Appendix D**). The Kwinana WtE plant will initially accept ~300,000t/y of Municipal Solid Waste (MSW) feedstocks with spare design capacity to absorb growth in the waste streams up to 400,000t/yr. Phoenix Energy is currently planning to have the Kwinana WTE plant fully operational by early 2017.

Residual MSW supplied by local governments will be the primary fuel source for the Facility. MSW delivered to the Facility is fed through the combustion system to produce heat. This heat is used in the Facility's boilers to produce high pressure steam which in turn is used to drive a turbine, producing electricity.

It is estimated that the Facility, which will be classified as a renewable energy generator, will export 32 MW<sub>e</sub> of electricity when operating at full capacity. The Facility will be connected to the South West Integrated (electrical grid) System (or SWIS) and Phoenix will enter into one or more long term power purchase agreements for the electricity generated at the Facility.

The Facility will also include a brick making plant, which will convert all solid residues into bricks, pavers and/or aggregate suitable for construction applications, as shown in Figure 1.



Figure 1 – Various applications for MSW ash residue

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3.2.2 Architecture

Internationally the trend for the architectural design of modern waste to energy plants has been based on a concept of integration into the local environs as well as ensuring that the plant ascetics are commensurate with

renewable energy and environmental soundness. Phoenix Energy has created the following concept design for the Kwinana Waste to Energy plant (Figure 2).

Figure 2 - Architectural concept design for the Kwinana WtE plant



As the Facility will be the first of its kind in Australia, it will naturally attract significant interest from the region and local communities. With that in mind the site will include visitor reception facilities, class room(s) and enclosed viewing platforms. Schools in the area will be offered free access to those facilities to enable studies on all waste management activities in line with the waste hierarchy. In addition some students will be able to access the plants sophisticated laboratory equipment, which would normally not be available in schools, to conduct research and experiments.

An added advantage of the plant's location is that local industries within the Kwinana Industrial Area are excited about the possibility to extend the education centre to include static and interactive displays of their own processes, thus providing students with a more comprehensive understanding of processes employed by industry as well as showcasing existing and planned future synergies with respect to resource

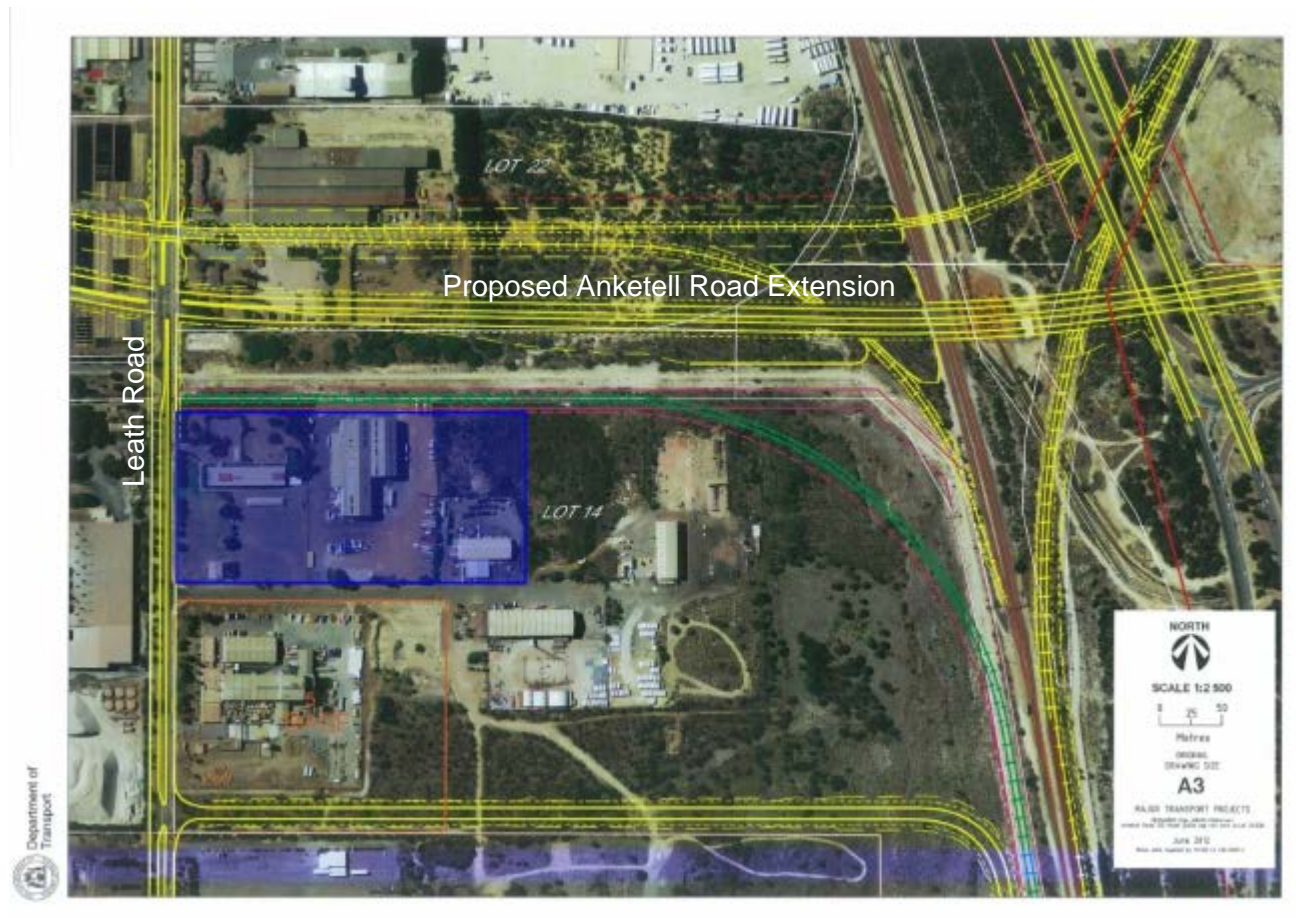
conservation, energy efficiency and waste minimisation.

3.3 Location

The site (at Lot 14, Leath Road, Kwinana Beach, WA, 6167) is an ideal location for a waste to energy Facility, with excellent road access for truck movements to and from the Facility, close proximity to electrical infrastructure and proposed rail infrastructure, in a location zoned for heavy industry, with existing buffer zones. The proposed site is located in the blue shaded area on the map shown in Figure 3, which has been supplied by the WA Department of Transportation. This map also indicates proposed future infrastructure developments affecting both road and rail in the vicinity of the proposed site.

Phoenix Energy has entered into a license agreement with Landcorp for the proposed site as a precursor to a long-term lease arrangement.

Figure 3 – Department of Transport Major Transport Projects map highlighting the location of the site along with proposed local road and rail infrastructure projects



### 3.4 Legal Framework

#### 3.4.1 Environmental Impact Assessment Process

The key legislation for the Proposal is the *Environmental Protection Act 1986 (WA)* (EP Act).

On 25 September 2012, the Proposal was referred to the EPA under section 38 of the EP Act. On 17 October 2012, the EPA determined that it would assess the Proposal at the level of Public Environmental Review (PER). The Proposal was designated EPA Assessment No. 1945.

The EPA advised that it would prepare the Environmental Scoping Document (ESD), which was completed and approved by the EPA on 3 of May 2013. A copy of the ESD is provided in **Appendix A**. The ESD provides an indicative timeline for the assessment process and states that there will be a six-

week public review period for the PER document.

The PER has been prepared in accordance with the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*. The purpose of the PER is to provide the EPA, the public and other Decision Making Authorities (DMAs) with a detailed understanding of the Proposal, its potential environmental impacts and the environmental management measures proposed for addressing each environmental factor identified in the ESD.

Following a six-week public review period, any issues raised in written submissions by the public and government authorities will be collated by the EPA and provided to the proponent for a response. The EPA will assess the PER document, the public submissions and the Proponent's response to submissions, and prepare a report on the

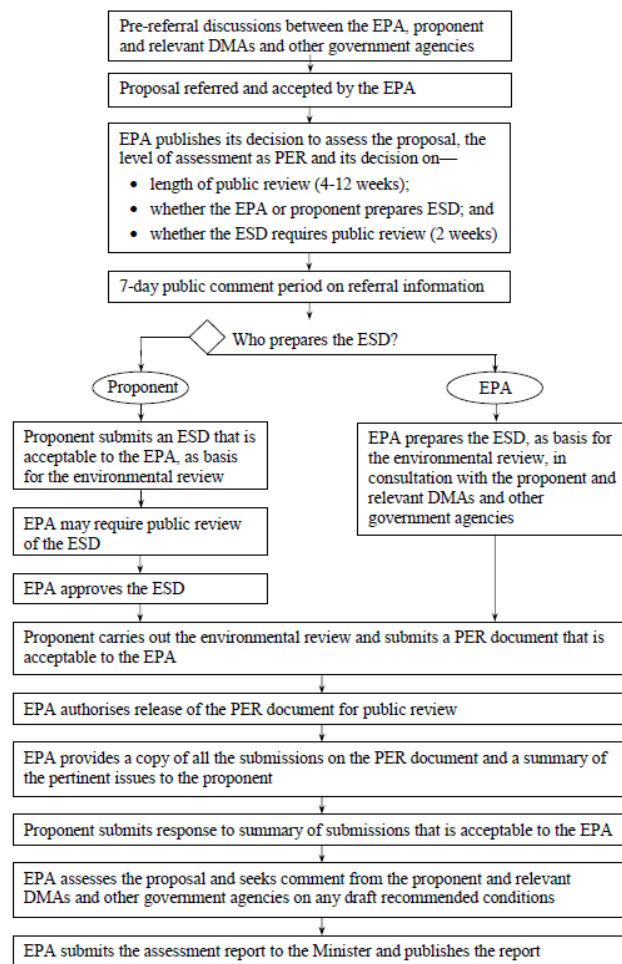
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outcome of its assessment of the Proposal. The EPA will provide the assessment report to the Minister for the Environment and the Minister will publish the EPA assessment report as soon as the Minister is reasonably able to do so after receipt. Any person may lodge an appeal against the findings or recommendations of the EPA assessment report within 14 days after the publication of the report.

At the end of the appeal period, the Minister for the Environment will, in consultation with other relevant decision making authorities, decide whether or not the proposal should be implemented and, if so, under what conditions.

The procedure for a PER level of assessment is shown in Figure 4.

Figure 4 — Outline of procedure for PER level of assessment (from Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012)



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## 3.4.2 Additional Approvals

The proponent requires the additional approvals outlined in Table 5.

Table 5 - Additional approvals required

Decision Making Authority	Relevant Legislation	Approval
Department of Environment Regulation	Part V of the Environmental Protection Act 1986 (WA)	Works Approval and Environmental Licence
City of Kwinana	Planning and Development Act 2005 (WA)	Planning Approval
City of Kwinana	Building Act 2011 (WA)	Building Permit

## 3.4.3 Relevant Legislation

Legislation that may be applicable to the Proposal is set out in Table 6.

Table 6 - Relevant Legislation

Legislation	Responsible Authority	Purpose
<i>Building Act 2011 (WA)</i>	City of Kwinana	Building permit
<i>Contaminated Sites Act 2003 (WA) and the Contaminated Sites Regulations 2006 (WA)</i>	Department of Environment Regulation	Remediation of contaminated site
<i>Dangerous Goods Safety Act 2004 (WA)</i>	Department of Mines and Petroleum	Management of dangerous goods, including storage, handling and transportation
<i>Environmental Protection Act 1986 (WA) and the Environmental Protection Regulations 1987 (WA)</i>	Environmental Protection Authority and the Department of Environment Regulation	Environmental assessment and impact project regulation
<i>Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992</i>	Department of Environment Regulation	Atmospheric waste management
<i>Environmental Protection (Controlled Waste) Regulations 2004 (WA)</i>	Department of Environment Regulation	Management of prescribed waste
<i>Environmental Protection (Noise) Regulations 1997</i>	Department of Environment Regulation	Management of noise and vibration
<i>Health Act 1911 (WA)</i>	Health Department	Human health
<i>Local Government Act 1995 (WA)</i>	City of Kwinana	Community
<i>Occupational Health and Safety Act 1984 (WA)</i>	Department of Commerce	Occupational health and safety

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Legislation	Responsible Authority	Purpose
<i>Planning and Development Act 2005 (WA) and Planning and Development Regulations 2009 (WA)</i>	City of Kwinana	Planning approval
<i>Waste Avoidance and Resource Recovery Levy Act 2008 (WA)</i>	Department of Environment Regulation	Waste management

## 4 Project Justification

### 4.1 Project justification and objectives

Broadly, the project can be justified on the basis that it provides a sustainable solution to two of the community's biggest challenges: (1) waste disposal (and indirectly, waste generation) and (2) base load renewable energy generation. The key objectives of the project include:

- Zero waste to landfill. The International Solid Waste Association notes that the use of WtE to process MSW is the most efficient way of reducing the volume of waste and thus the demand for landfilling (Kamuk, 2013)
- Maximising electricity generation from the feedstock, thus displacing base load fossil fired electricity generation
- Providing a national benchmark for sustainable waste management by minimising environmental impacts associated with the storage, handling and treatment of waste to generate renewable electricity and other saleable products such as bricks, pavers and recyclable metals. Internationally, WtE facilities can be situated close to urban areas, reducing the need for waste transportation (and electrical line losses), and are environmentally beneficial compared to landfilling (Kamuk, 2013)
- Providing a long-term, reliable waste management and renewable energy solution to the community, which is complementary to other waste management practices such as recycling and composting
- Engaging with the community and partnering with regional industry and waste management bodies to enhance education and awareness of waste management issues and drive reductions in waste generation and improvements in source separation behaviour by households
- Providing an acceptable return for shareholders to ensure the long-term

viability of the project, for the benefit of all stakeholders

WtE competes directly with landfill disposal and is complementary to recycling and recovery activities. A lifecycle type assessment has been carried out to compare the environmental risks and benefits of WtE with landfill disposal. This analysis is presented in section 10.1.1.6.2 on page 66, which presents the strongest justification for the proposal. Furthermore, section 10.1.1.6.1 on page 63 demonstrates how the project is aligned with the Western Australian Waste Strategy "Creating the Right Environment" (March 2012), and once operational, will provide an immediate boost to resource recovery and a major step towards the achievement of the State's waste diversion and resource recovery targets.

### 4.2 Alternatives considered

#### 4.2.1 Is the development needed?

Western Australia is taking positive steps to improve its waste management practices and increase landfill diversion through various means including: (a) source separation of recyclables and green waste (where a separate green waste collection service exists) from general MSW, by the householder and (b) investment in infrastructure to increase the recovery of those recyclable and compostable materials. While considerable investment has also been made in biological type Alternative Waste Treatment technologies, these have not been effective in delivering substantial reductions in waste volumes ultimately ending up in landfill. Furthermore, those facilities have caused community angst in relation to odour and their high operating costs. Experience on the east coast of Australia demonstrates that even those communities with highly developed waste management infrastructure (3-bin collection systems, Materials Recovery Facilities for separation of dry recyclables, and established markets for those recyclable materials) eventually reach a plateau in their diversion of residual waste away from landfill.



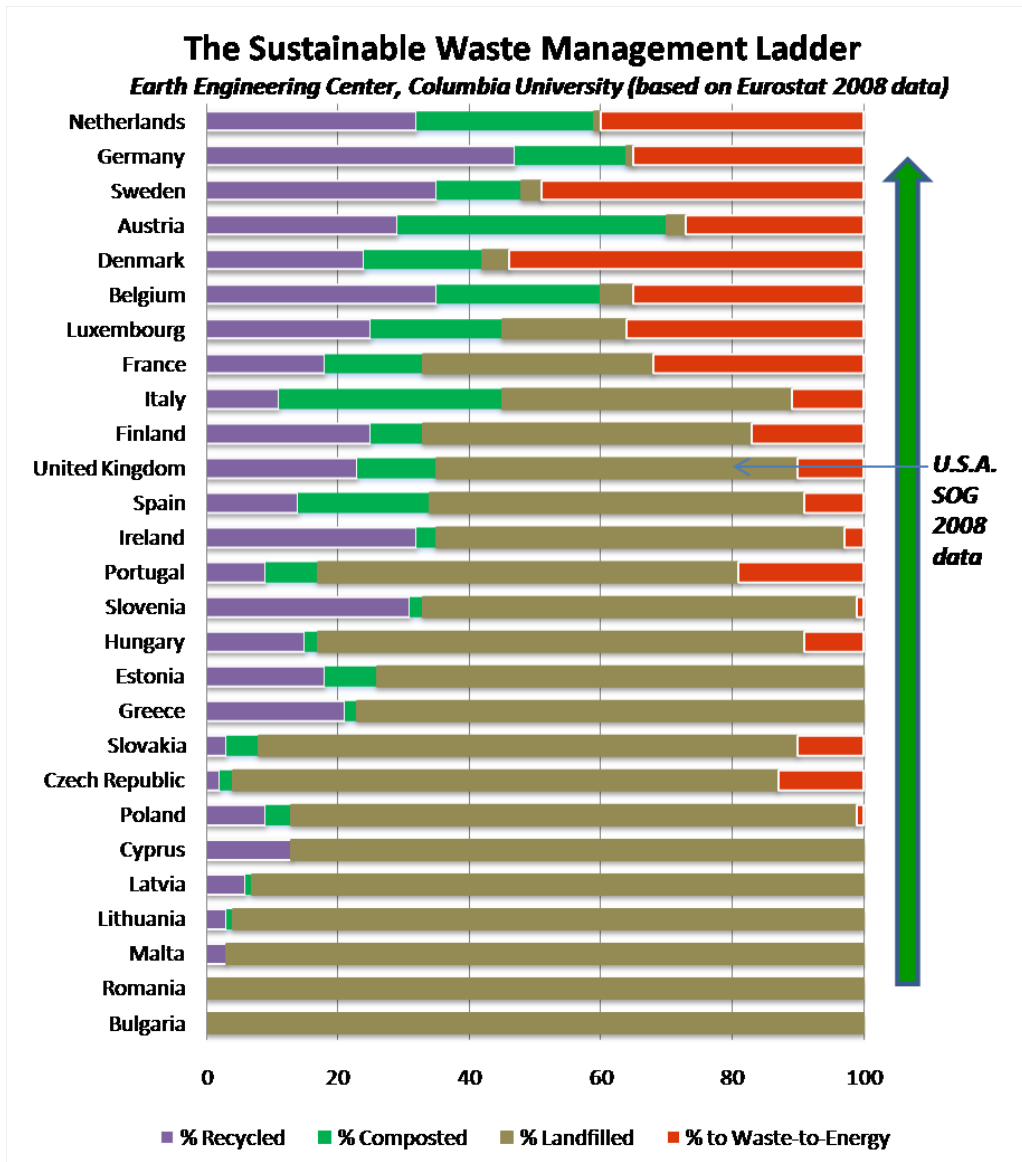
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Developed countries such as Japan, Germany, Denmark, Austria and the Netherlands who do not have land area available for landfill disposal of waste, have for many decades embraced the use of thermal WtE as the fourth element of a fully integrated, sustainable waste management system:

1. Recycling
2. Composting (of source separated organics i.e. not for MSW)
3. Thermal WtE – for residual MSW
4. Landfill – primarily for inert material, with no or limited energy recovery potential

This is illustrated in Figure 5 in the so-called Sustainable Waste Management Ladder developed by the Earth Engineering Center of Columbia University, using Eurostat published data. Those countries with the least reliance on landfill disposal have the highest install base of WtE capacity. Interestingly, those countries also have some of the highest levels of recycling in Europe, which provides a clear indication that with good community education and suitable markets for recyclable materials, WtE not only complements recycling and composting of source separated organics, but it enhances their overall effectiveness.

Figure 5 – The Sustainable Waste Management Ladder (Source: Earth Engineering Center, Columbia University)



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European and Japanese experience demonstrates that thermal WtE technologies are an essential element of any integrated waste management system, which seeks to maximise the recovery of energy and resources from waste, and minimise the requirement for landfill disposal.

Due to the intensive investment and deployment of thermal WtE capacity throughout Europe and the close proximity of the associated facilities to major population areas, the Europeans have lead the world in developing the most stringent guidelines for the operation of thermal WtE facilities, in order to minimise their environmental impact and health risk potential. Indeed, this has been the basis for the preparation of the emission limits established in the European Waste Incineration Directive (or WID), since recast as the European Industrial Emissions Directive (or IED).

#### 4.2.2 Alternative WtE Technologies

Phoenix Energy conducted a global search of Alternative Treatment Technologies including biological processes, gasification, pyrolysis and mass combustion and talked to plant owners, operators, academics and technology providers in order to identify the best and most appropriate WtE technology for a given feedstock (waste type). It became evident that mass combustion, and specifically the grate (stoker) technology, was the most prevalent form of WtE for processing residual MSW. Of the approximately 1000 facilities operating worldwide (Whiting et al, 2013 and Kamuk, 2013), Martin GmbH has the largest share of the market, with its moving grate (stoker) furnace technology.

The Martin grate technology has been in commercial operation since 1959. With reference to **Appendix D**, which contains the Martin GmbH reference list, the demonstrated suitability and flexibility of the technology to recover energy and other resources from mixed waste is clearly evidenced by:

- (a) the number of reference sites processing mixed waste streams such as MSW and Commercial & Industrial waste, the majority of which have minimal upfront pre-sorting (in some

cases, extra bulky items are removed and shredded or diverted), and

- (b) the number of reference sites which have been operating for many years (if not decades) despite inevitable changes in feedstock composition both over time and seasonally (throughout the year), in numerous countries.

With such an established technology and large install base, there is much data available on the operational and environmental performance of grate technology. Indeed the technology has been the subject of numerous academic, industry and health studies such as Whiting et al (2013) and Lamers et al (2013), which provide financial, regulatory, government, community and project stakeholders and decision makers with a both a high level of confidence in grate technology and a low level of risk, relative to competing technologies.

Even though the grate or stoker technology is the most prevalent WtE technology (Kamuk, 2013) and one of, if not the most established; technology providers continue to innovate and improve operational performance and control systems, to maximise energy recovery (i.e. carbon burn out), longevity of the components and reduce the production of oxides of nitrogen, a common pollutant for any combustion process.

In selecting the Martin grate technology, Phoenix Energy by default selected MHIEC as the regional technology partner and license holder. With a WtE project delivery record covering almost 200 WtE plants throughout the Asia Pacific region, 99 of which use the Martin grate technology, MHIEC is one of the most respected and experienced WtE EPC solution providers in the region. The MHIEC delivery record is attached as **Appendix E**.

#### 4.2.3 Alternative Sites

Phoenix Energy commissioned Hatch Associates to undertake a conceptual engineering study for the proposal, which included the consideration of a number of potential sites either in or adjacent to the Kwinana Industrial Area (KIA). A site within the KIA was seen as preferable because of

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the heavy industry zoning, existing buffer zones and heavy vehicle access. As the KIA is close to a number of existing landfills, the redirection of waste trucks to the KIA is not expected to significantly impact existing waste transportation distances or truck movements on major roads, such as Rockingham Road. In any case, this will be the subject of a traffic management study during the engineering design.

Another important aspect is the proximity to a suitable high voltage connection point for both electricity supply and export of net electricity generation into the South West

Interconnected System (SWIS), once the plant is fully operational. Furthermore, as the proposal will generate a significant quantity of high pressure steam, a location within the KIA may present future opportunities for a Combined Heat and Power (CHP) configuration, in which both steam and electricity are exported. A CHP configuration would also substantially increase the overall energy efficiency of the proposal and could be expected to boost the project R1 value well above the 0.65 target for efficient energy recovery (as defined in European Union's Waste Framework Directive 2008/98/EC).

## 5 Description of the Proposal

### 5.1 Technology Overview

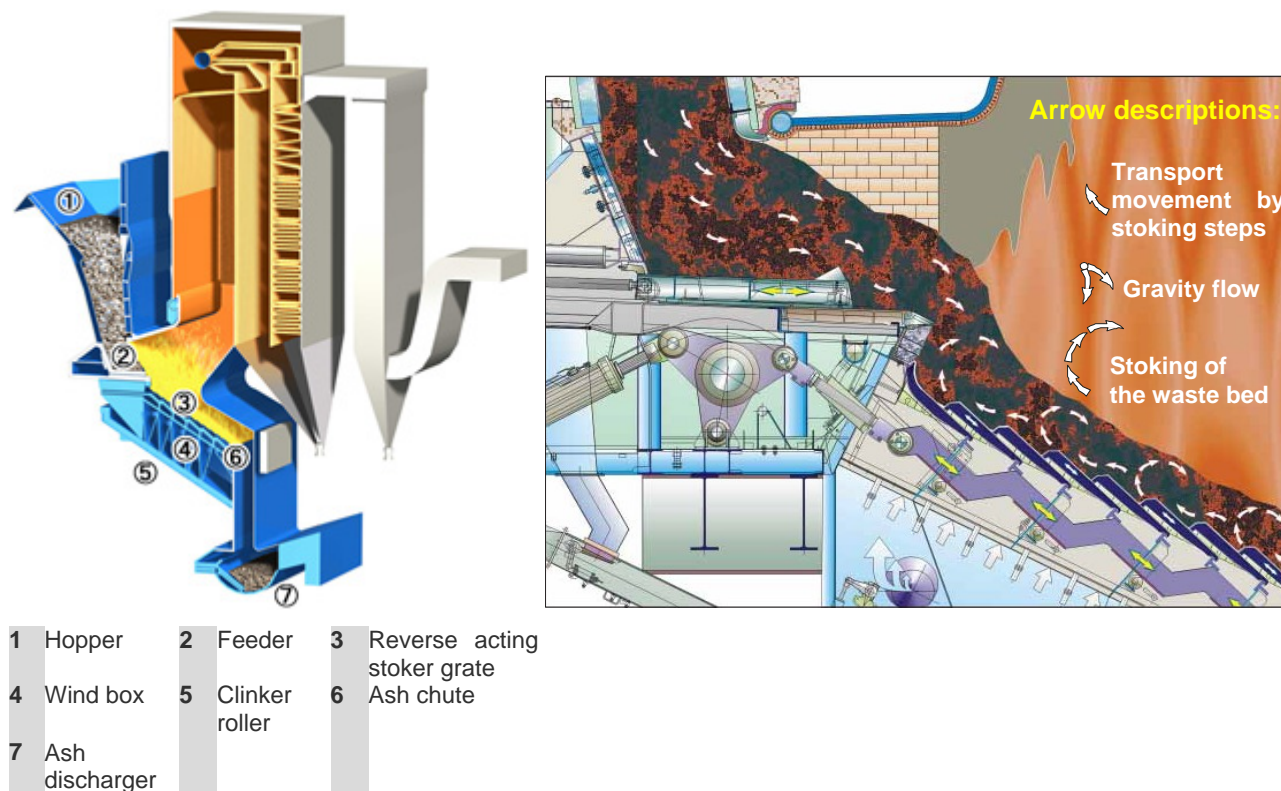
#### 5.1.1 Martin GmbH Grate Technology

In the 1920's Josef Martin (of Martin GmbH) invented the 'reverse-acting grate' that is based on the premise that fuel ignites more easily when an already existing glowing mass is pushed back underneath it. The concept was developed over time and the grate proved to be the solution to combustion of MSW. This system has been in commercial operation since 1959. Since that time improvements in boiler and flue gas clean-up designs have led to it becoming the dominant technology in the recovery of energy from waste. According to Whiting et al (2013), there are approximately 1000 such thermal WtE plants globally, with Martin GmbH the world leader with approximately 400 commercial reference sites world-wide (please refer to **Appendix D** for a reference

site listing for Martin GmbH and **Appendix E** for a Martin Grate plant delivery record for its license holder and Asia Pacific partner MHIEC). Of those sites which have been operating for 12 months or longer, there are around 36 plants processing more than 400,000 t/yr and 117 plants processing between 200,000 t/yr and 400,000 t/yr.

With on-going R&D and advances in grate furnace, boiler and steam turbine technology, these single step combustion processes can achieve very high electrical generation efficiencies for an MSW fuelled generator, with a clear advantage over the majority of two-stage processes (e.g. gasification followed by combustion) (Lamers et al, 2013). This is simply because some of the energy in the fuel is required to sustain the gasification reactions.

Figure 6 – The Martin-Mitsubishi Furnace system, with inclined stoker grate and boiler (left) and a representation of stoking action on the waste moving down the grate (right)

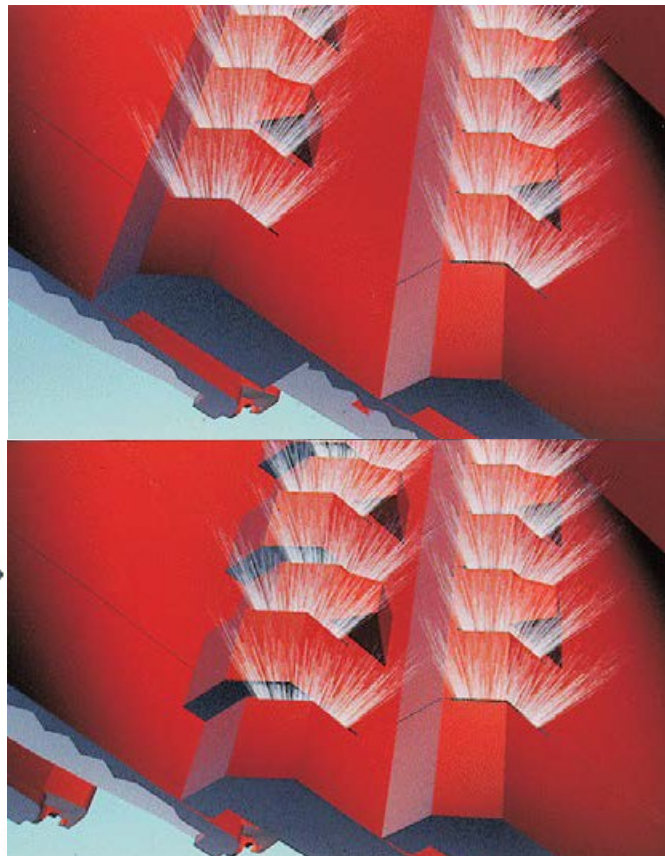
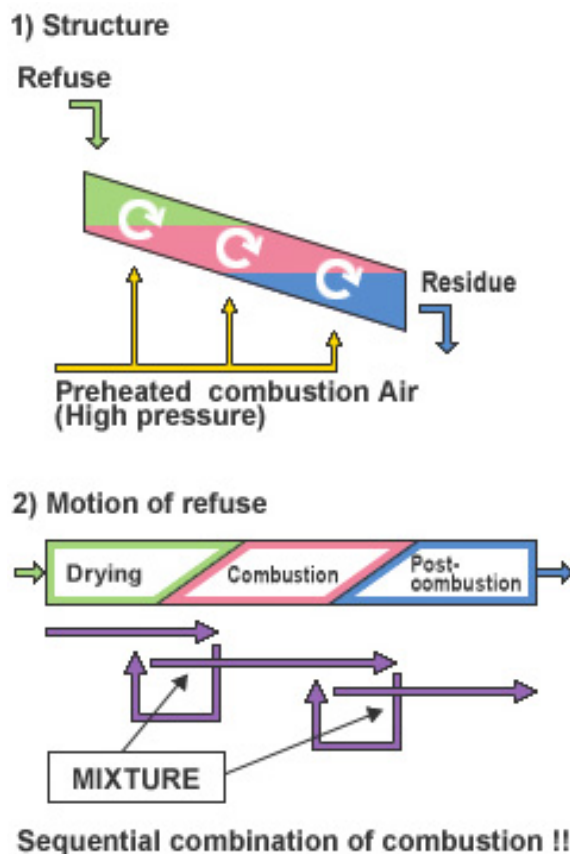


The Martin Grate reverse-acting stoker (depicted in Figure 6) consists of alternate fixed and reciprocating grate bar 'steps'. The reciprocating steps move slowly upwards against the downward flow of the waste to draw some of the hot ash back under the burning mass to achieve reverse agitation to assist the combustion process and ensure maximum carbon burn-out. This is important to maximise energy recovery from the waste

and also to control the properties of the ash for recovery and reuse.

Preheated combustion air is introduced below the grate and flows via the grate bars, as shown in Figure 7. New waste entering at the top of the grate, as depicted in Figure 6 and Figure 7, moves by gravity flow through a drying zone, followed by a combustion zone and finally into the post-combustion zone, for final carbon burn-out.

Figure 7 – An illustration of the drying, combustion and post-combustion zones for refuse on the grate is shown on the left, while the relative movement of the Martin GmbH grate bars and combustion air flow is shown on the right



Overfire air is introduced in the combustion zone above the grate to ensure precise control of the combustion process. The furnace combustion chamber is sized to ensure that the flue gases remain in the chamber for at least 2 seconds, while natural gas fired auxiliary burners ensure that the temperature remains above 850°C at all

times, to prevent the formation of dioxins and furans.

Two modern mass combustion type WtE plants which utilise a grate type stoker system to process MSW for electricity generation are shown in Figure 8.

Figure 8 – The Ariake WTE plant in Tokyo city (Left) and the Brescia WTE plant in Italy (Right)



### 5.1.2 Application to Kwinana WtE

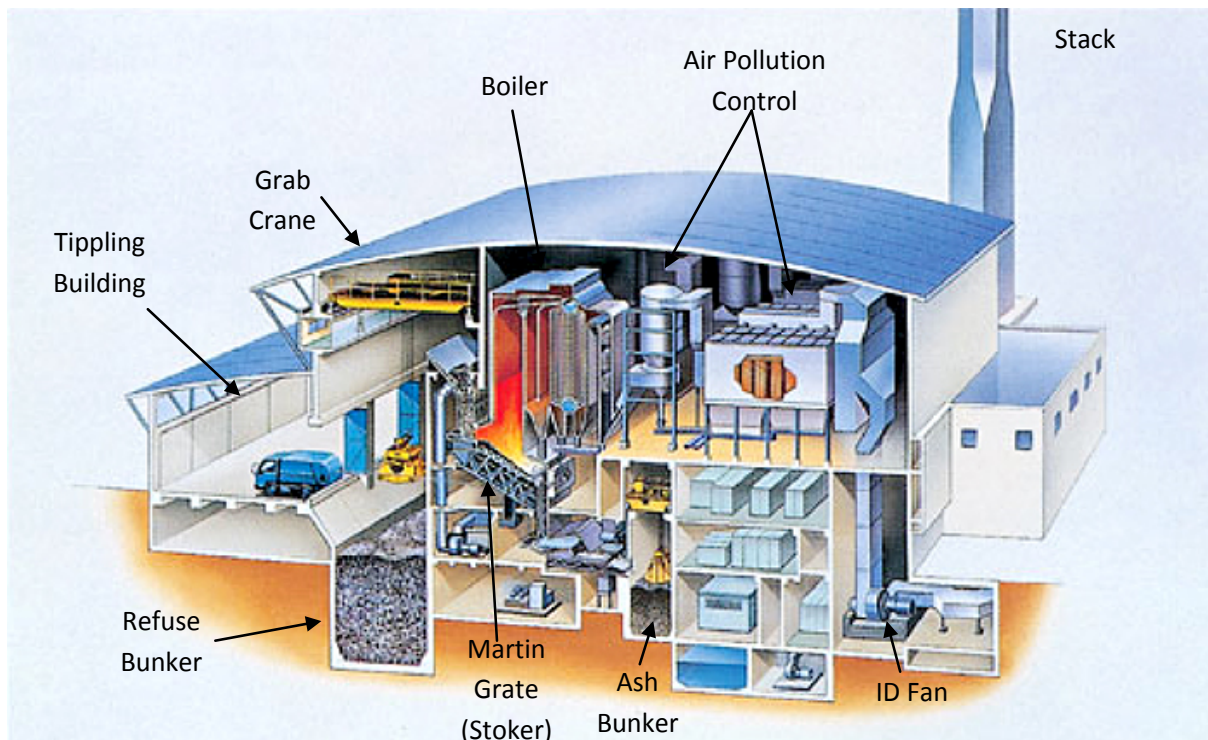
#### 5.1.2.1 Waste Receiving

Waste will be accepted from contracted councils in accordance with their current collection schedules and directly from the collection vehicles or transfer station trucks as the case may be. Upon arrival, the vehicles will be weighed on a weighbridge, screened for radioactive contamination and allocated an unloading bay within an enclosed tipping hall, if no radiation is detected. It is anticipated that 80-100 refuse truck movements will occur per shift, generally comprising one mid-morning shift and one mid-afternoon shift of not more than

two hours duration per week day. The trucks will typically be:

- 18m<sup>3</sup> 4 x 2 Side-loading collection vehicle, 4.4m wheel base and 15t GVM,
- 22m<sup>3</sup> 6 x 4 Side-loading collection vehicle, 5.0m wheel base and 22.5t GVM, or
- 5 or 6 axle articulated vehicles (Semi-trailers) and 42.5t GVM, for hauling compacted refuse from local or regional transfer stations.

Figure 9 – A Typical Martin-Mitsubishi Facility



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Feedstocks can also be delivered via rail, if such infrastructure exists near to the proposed site. In addition to the refuse trucks, 10-20 trucks and service vehicles per weekday are expected to be required for brick/paver dispatch, consumables and operations & maintenance activities.

As depicted in Figure 9, the vehicles will enter a tipping hall equipped with fast acting roller doors and unload into a bunker in a fully enclosed building. The bunker will be sized to provide the storage capacity required to allow the plant to operate continuously (24 hours a day, 7 days a week), including over weekends, and also to provide additional capacity to accommodate both planned and unplanned maintenance events. This building operates under slightly negative air pressure because air is drawn from the tipping hall directly to the combustion chamber via the grate. This is one of the innovative design features of a modern combustion type WtE Facility, to minimise odour. Furthermore, as the main plant and equipment are contained within a fully enclosed building, process noise is readily controlled.

The refuse bunker crane automatically mixes the waste received to assist in creating an 'average waste' across the bunker. When required by the sophisticated boiler control systems, the crane will collect waste in the grab and deposit it in the Feed Hopper.

This proposal does not include any upfront pre-treatment or pre-sorting of the waste feedstock for the following reasons:

- (a) it is not a requirement of the selected WtE technology,
- (b) the proposed feedstock is residual MSW sourced from mobile garbage bins, which has been subject to source separation by householders,
- (c) to save power and improve the overall reliability of the facility,
- (d) ferrous and non-ferrous metals are already easily recovered from the ash by-product,
- (e) uncertainty with respect to the availability of end-markets for any contaminated recycle recovered upfront, and
- (f) International best practice (for grate type facilities) is not to include upfront

pre-treatment, other than the removal of oversized objects.

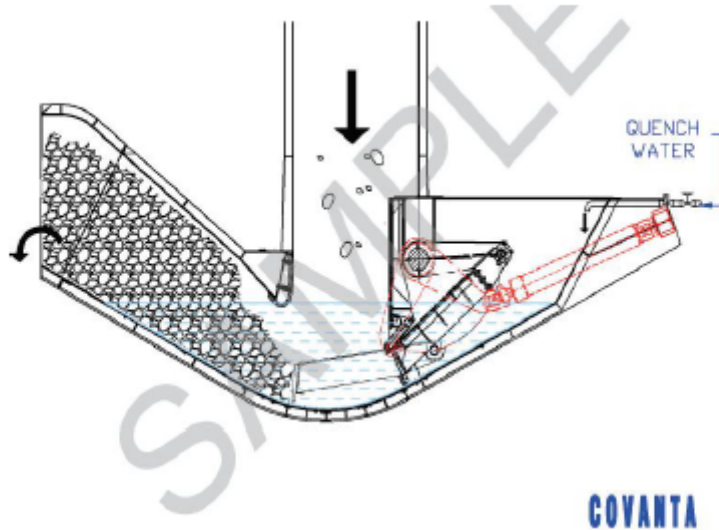
#### 5.1.2.2 Martin-Mitsubishi grate (stoker) furnaces

Most mass combustion plants which use the moving grate technology employ multiple grates which operate in parallel. The Kwinana WtE Project will have two grate lines operating independently and in parallel. Each grate line is usually designed to reflect the growth in feedstock processing rates, which can be expected to occur with time, as populations grow. This capacity along with the bunker storage capacity and the parallel operation of the lines contributes to a very high operational availability of approximately 90% of operating hours (Whiting et al, 2013). In the uncommon event that all operating lines are unavailable, waste streams which cannot be accommodated by the waste bunker (typically sized for 5-10 days storage capacity), would need to be temporarily diverted to an approved landfill.

The waste material flows under gravity down through the furnace on an inclined moving grate (stoker) system known as the Martin Grate. Ash remaining at the base of the grate after 60-70 minutes of combustion and mixing by the rows of grate bars, arranged in steps, is known as bottom ash. A report by the Danish Topic Centre on Waste and Resources (2006) notes that the composition of bottom ash depends on several factors including the type of waste (composition) and the processing technology.

The amount of organic carbon remaining in the bottom ash after its removal from the grate provides an indication of the operating performance of the grate, with a low level of residual carbon indicating a high level of energy recovery. In fact, the WID Article 6 (IED Article 50) 'Operating Conditions' requires that WtE plants shall be operated in order to achieve a level of energy recovery such that the 'bottom ashes Total Organic Carbon (TOC) content is less than 3% or their loss on ignition is less than 5% of the dry weight of the material'. Bottom ash is collected and cooled using a water quench within a water sealed ash discharger, depicted in Figure 10, which is integral to each grate/line.

Figure 10 – A typical Martin ash discharger showing the water seal, quench water and ram



The water seal in the ash discharger facilitates removal of the bottom ash from the grate system, whilst maintaining the negative air pressure under which the combustion chamber operates. The bottom ash handling system is sized such that items able to pass through the refuse feed chute will be able to be passed by the bottom ash handling system. The ash discharger feeds the ash into a cement lined bottom ash bunker equipped with a grab crane to load the ash onto a conveyor. The conveyor transports the residue to a metals recovery area where it is subjected to magnetic separation of ferrous metal followed by separation of non-ferrous metals via an eddy current separation system. The residual bottom ash is then conveyed to the brick plant via an enclosed conveyor.

#### 5.1.2.3 Energy recovery and power generation

Hot flue gases leaving the combustion chamber pass through a standard water wall boiler where superheated high pressure (HP) steam is generated through heat recovery. The HP steam (typically 60 bar and 450 °C, Kamuk, 2013) is sent to a standard steam turbine generator, to generate the electricity required to operate the plant, with the balance available for export to the grid. It is proposed to send any fly ash collected from the boiler system to the Brick Plant for processing into bricks and pavers.

#### 5.1.2.4 Flue gas cleaning Air Pollution Control (APC) system

The cooled flue gases leaving the boiler then pass through a series of scrubbing and cleaning processes, which comprise the Air Pollution Control system (see Figure 9). Both grate lines will have their own dedicated APC system. These proven processes are of a higher standard than typical fossil fuel fired large scale combustion processes. They are often referred to as Best Available (Air Pollution Control) Techniques and will ensure the WtE plant will meet the most stringent of air emission regulations applied internationally, namely the European Directive 2000/76/EC on the incineration of waste (also known as the Waste Incineration Directive or WID), since recast as the European Directive 2010/75/EU (also known as Industrial Emissions Directive or IED).

Kamuk (2013) notes that various treatment configurations exist including dry, semi-dry and wet processes, with the wet process consuming the most water and also necessitating waste water treatment. Most of the treatment configurations include processes based on the neutralising reaction between lime injected into the system and the acidic components in the flue gas. Activated carbon is also commonly added to remove dioxins and mercury (Hg). The lime reaction products, the activated carbon and any residual particulate material (fly ash) are



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collected in a baghouse filter. In order to lower water consumption and eliminate the need to discharge process waste water from the site, the Kwinana WtE Project will adopt a semi-dry APC system configuration.

All combustion processes produce oxides of nitrogen (NO<sub>x</sub>) (Kamuk, 2013). The amount of NO<sub>x</sub> produced is a function of temperature, fuel composition and combustion air supply. Kamuk (2013) identifies that the two most common systems for NO<sub>x</sub> removal from flue gases are: selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR). Liquid ammonia or urea is injected into the flue gas, though for the non-catalytic process, the injection point must be in a location in the furnace where the temperature is around 850-900 °C (Kamuk, 2013). In either case, the ammonia reacts with the NO<sub>x</sub> to reduce it to harmless nitrogen (N<sub>2</sub>). SCR is typically employed where lower NO<sub>x</sub> emission concentrations are desirable and has therefore been selected for the Kwinana WtE Project. The overall selection and performance of the various unit operations, which will make up the APC system, are discussed in more detail in section 10.2.1.6.1 Detail pollution control equipment, including its removal efficiency and expected down time. Compare efficiencies of pollution control equipment with world best practice. Show that hazardous pollutants (like dioxins) would be controlled to the Maximum Extent Achievable (MEA) (EPA Guidance Statement 55) on page 142.

It is proposed to send fly ash and solid APC reaction products collected from the flue gas cleaning APC system to the Brick Plant for conversion into bricks and pavers with properties equivalent to conventional bricks and pavers used for masonry applications.

### 5.1.2.5 Flue gas stack and Continuous Emissions Monitoring System (CEMS)

The facility will be equipped with a multi-flue stack, with a separate flue provided for each of the two grate lines operating in parallel. The cleaned flue gases are drawn by an induced draft (ID) fan and released into the atmosphere through an appropriately sized flue within the multi-flue stack. Each grate line is equipped with a dedicated Continuous

Emissions Monitoring System (CEMS). The CEMS facilitates continuous on-line monitoring of flue gas properties and composition, thus allowing the control system to track those pollutants which can be feasibly measured on-line, in order to make automatic adjustments to the combustion system and the injection rates for the various Air Pollution Control system reagents. For those pollutants for which online measurement is not currently feasible or sufficiently accurate, a sampling and testing regime will be established as part of the plant standard operating procedures, to ensure that the plant is constantly in compliance with its environmental obligations and to confirm the performance of the CEMS.

### 5.1.2.6 Metals Recovery and Brick Plant

The ash residue remaining after combustion typically represents less than 10% by volume of the feedstock. Bottom ash leaving the ash dischargers is held securely in a bottom ash bunker before being conveyed to a metals recovery area, which is expected to consist of a drum magnet, for ferrous metal recovery and an eddy current separator with vibrating screens, for non-ferrous metals recovery. After metals recovery, the residual bottom ash is conveyed to the on-site Brick Plant for further recovery.

Fly ash from the boiler and APC particulate removal system is also collected in a secure bunker before it is conveyed to the Brick Plant.

At the on-site Brick Plant, bottom ash is combined with recovered particulate matter (fly ash), solid reaction products from the Air Pollution Control system and other additives for processing into bricks and pavers. Phoenix Energy is planning to use the Pittsburgh Mineral & Environmental Technology, Inc. (PMET) Brixx™ process technology, which has been successfully applied to MSW WtE plant ash, to produce brick/paver products that meet ASTM C73-99.

The simplified flow diagram in Figure 11 illustrates the PMET Brixx™ 4-stage brick/paver making process:

1. Blending of raw materials including fly ash and bottom ash

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2. The combined materials are transferred into moulds and placed in a press
3. The bricks/pavers are cured (baked) in an autoclave (oven)
4. Bricks/pavers packaged for dispatch

In general, off-spec bricks and pavers can be recycled and reused in the process.

Besides face brick and paver applications, as illustrated in the photo in Figure 12, decorative tiles can also be produced.

Figure 11 – Simplified process diagram and description of the PMET Brixx™ Process

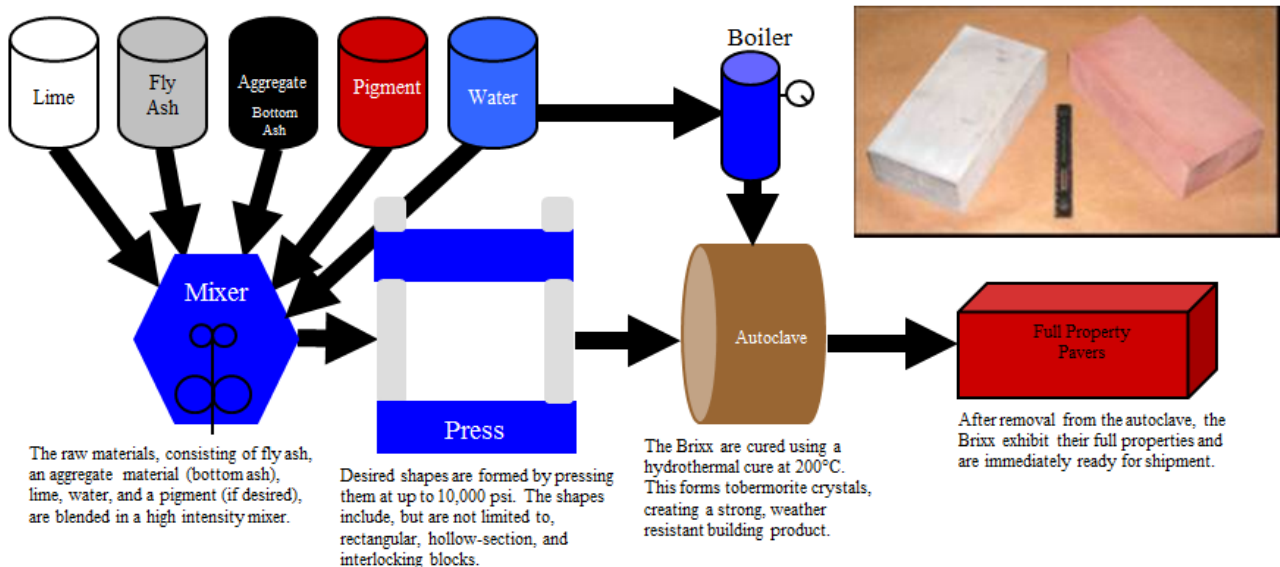


Figure 12 - “Green” Pavers made of 90% waste material using the PMET Brixx™ process



5.1.2.7 Potable, harvested rainwater and process wastewater

Rainwater will be harvested from roofs of buildings and sealed areas. This rainwater will be directed to storage tanks, from which process make-up water can be drawn for re-use on site. Rainwater in excess of process requirements and storage capacity will be filtered and dissipated in an infiltration basin, in accordance with City of Kwinana stormwater system design standards for the Kwinana Industrial Area. Further details regarding stormwater management can be

found in section 10.1.1.6.6 from page 80 and section 10.1.1.6.8.8.2 from page 86.

The facility’s water and wastewater system will be designed to provide suitable quality water for each process use.

Harvested rainwater and water from the existing Water Corporation scheme (potable) water connection will be the primary sources of water supply for the boiler makeup water system, fire protection system and other potable and non-potable process uses. The proposal also considered the option of utilising reclaimed water from the Kwinana Wastewater Reclamation Plant (KWRP).

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However, the relatively small water consumption rate associated with the proposal, which is at or below the minimum daily contracted water supply rate for the KWRP (before accounting for harvested rainwater) and the requirement to build a new 0.8-1 km supply pipeline, make that option unviable. Phoenix Energy met with Water Corporation in 2013 to confirm the availability of scheme water to the project. Water Corporation has written to Phoenix Energy in relation to the proposal (please refer to **Appendix H** for a copy of the letter). The letter confirms that the Water Corporation scheme water supply passing Lot 14 Leath road has the capacity to provide a secure water supply to both staff amenities and the process. Scheme water will supplement the expected use of harvested rainwater for process and utility system make-up water throughout the site.

An appropriate water treatment system will be provided for treating the boiler feedwater makeup. Boiler makeup water will be stored in a storage tank and pumped as needed to the condensate receiver as boiler makeup.

The process wastewater generated throughout the facility will be collected and reused, where appropriate. Collected wastewater, including boiler blowdown and boiler feedwater treatment reject water, will be used for quenching residue in the ash dischargers, lime hydration, scrubber temperature control and in the Brick Plant.

A chemical dosing system is provided to minimize corrosion of the condensate and boiler feedwater systems and to minimize corrosion, scaling and deposition in the boilers.

#### 5.1.2.8 Control room

The Kwinana WtE facility will use state-of-the-art automatic control systems throughout, to comply with its joint obligations of providing an energy recovery service to local municipalities whilst also operating as a large scale renewable electricity generator (power station). The facility will operate 24 hours a day, 7 days a week, 365 days a year, using multiple shift crews as well as day staff, to manage feedstock receipts, product dispatch and maintenance.



#### 5.1.2.9 Laboratory

As will be described in later sections of this document, the facility will be required to undertake a range of quality and emissions tests to ensure continuous compliance with its operating licenses. Some of these tests will be undertaken on-site in a purpose built laboratory.

#### 5.1.2.10 Administration offices

While the feedstock may be different from a typical fossil fuel fired power station, the facility will essentially be managed and operated as a large scale power station. However, because of the significance of the facility to the management of waste both locally and for the region, it is typical for such facilities to hold open days and conduct regular site tours, to assist with community education about waste management and source separation (i.e. choosing the correct bin for disposing of recyclable and non-recyclable household waste items). As such, it is proposed to re-use the existing office building on the western side of the site (please refer to **Attachment 3** in section 16 ATTACHMENTS from page 185) as the site Administration Building and to upgrade this building for use as a training and community education facility.

#### 5.1.2.11 Roads and car parking

The facility will include roads to facilitate truck movements, while a car park will be provided for both staff and visitor parking. The facility will be fully secured by a perimeter fence, with entry to and exit from the facility controlled via a security gate system.

## 6 Key Characteristics of the Proposal

### 6.1 Summary of the Proposal

Table 7 – Proposal Summary

<b>Proposal title</b>	<b>Kwinana Waste To Energy</b>
<b>Proponent name</b>	Phoenix Energy on behalf of Kwinana WTE Project Co Pty Ltd
<b>Project Location</b>	Lot 14, Leath Road, Kwinana Beach, in the Kwinana Industrial Area
<b>Short description</b>	This proposal is for a Waste to Energy facility to process up to 400,000 tonnes per annum of municipal solid waste, to produce electricity. The facility will include the construction of a Waste to Energy plant, a Brick Plant, control room, laboratory, administration offices, roads and a car park
<b>Total site area</b>	3.479 ha
<b>Construction &amp; Commissioning Period</b>	Approximately 24 months
<b>Life of Plant</b>	More than 20 years

### 6.2 Key Proposal Characteristics

#### 6.2.1 Key Proposal Characteristics Table

Table 8 – Key Proposal Characteristics Table

<b>Elements</b>	<b>Description</b>
<b>Key Inputs</b>	
Waste type	Residual Municipal Solid Waste (MSW)
Total waste volume	Up to 400,000 t/yr to be processed in two 606 tpd Martin grate lines (each consisting of an integrated stoker grate boiler, ash discharger, air pollution control system, ID fan and flue) operating independently and in parallel, with a single multi-flue stack containing twin flues.
Water requirement	Up to 175,000 kL/yr at full capacity, to be sourced from the existing Water Corporation scheme water connection, the availability of which is confirmed in <b>Appendix H</b> .
Electricity	The facility will generate its own electricity
<b>Key Outputs</b>	
Gross Electricity Generation Capacity	Estimated to be 36 MW <sub>e</sub>

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Elements	Description
Air Emissions	<p>Emissions to the air may include oxides of nitrogen, acid gases, carbon monoxide, particulates (PM10, PM2.5, including nano-particles), volatile metals, acid gases, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, and odour.</p> <p>Air Pollution Controls along with continuous monitoring, and periodic sampling and testing of the flue gas in each of the two flues contained within the multi-flue stack, to ensure compliance with European Waste Incineration Directive 2000/76/EU (recast as 2010/75/EU) emission limits.</p>
Process waste	<p>Bottom ash and fly ash with Air Pollution Control reaction products will be segregated and characterised to maximise reuse opportunities, which will include conversion into bricks and pavers and/or use of the bottom ash as a construction aggregate.</p> <p>However, in the event of a market failure for some or all of the by-products available for sale, the residual process waste will be characterised, subjected to leach testing and then disposed of in an appropriate landfill.</p>
Waste water	The project will have zero process wastewater discharge.
Stormwater	Stormwater harvested on-site will be managed in a dedicated stormwater management system, typically consisting of oil/water separation and an infiltration basin designed to City of Kwinana standards for the Kwinana Industrial Area.
Sewage/grey water	A reticulated sewage connection is not available in the KIA. As such, all sewage will be handled on-site in a septic system which meets the City of Kwinana standards for design and operation of septic systems in the KIA.
<b>Footprint</b>	
Vegetation Clearing	Up to 1 ha, for buildings, roadways and fences.

6.2.2 Physical Elements

Table 9 – Key Proposal Characteristics – Physical Elements

Element	Location	Proposed Extent Authorised
1. The Main Process Area will comprise the Waste to Energy Plant, a control room, boiler make-up water treatment and laboratory	<b>Attachment 3</b> , section 16 ATTACHMENTS from page 185	Clearing up to 1 ha within a 3.479 ha <sup>[1] &amp; [2]</sup> development envelope (note that most of the proposed site has already been cleared by the previous developments on this Heavy Industry zoned land).
2. Brick Plant	<b>Attachment 3</b> , section 16 ATTACHMENTS from page 185	See 1 above.
3. Car parks, roads and Services easements	<b>Attachment 3</b> , section 16 ATTACHMENTS from page 185	Clearing of up to 1 ha as described in (1) above, though much of the site has already been cleared due to earlier development. The proposal will seek to reuse existing facilities, services easements and connections, where feasible.

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Element	Location	Proposed Extent Authorised
4. Administration Building	<b>Attachment 3</b> , section 16 ATTACHMENTS from page 185	The proposal will seek to re-use the existing building on the west side of the site, as the plant Administration building, complete with training and education facilities.

**Notes:**

1.) It is expected that the existing Golden Girls canteen (located on the corner of Leath Road and Canteen Road, see **Attachment 3**) will be retained and will continue to operate independently of the WtE project, providing a food and beverage service to the precinct.

2.) With reference to **Attachment 3**, the site lease area is bounded by three significant easements. The wedge shaped easement to the west is associated with future works planned for Leath Road. The easement to the north is associated with a planned future rail extension to the port and the planned Anketell Road extension, while the access easement to the south is associated with the existing private road, known as Canteen Road.

**6.2.3 Operational Elements**

Table 10 – Key Proposal Characteristics – Operational Elements

Element	Location	Proposed Extent Authorised
1. Waste receiving for combustion	Main Building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	Handling of up to 400,000t/year of residual MSW and on-site storage of up to 10 operating days' worth of waste material in a purpose built, fully enclosed storage bunker, operating under a slight negative pressure to minimise fugitive odour emissions.
2. Two 606 tpd Grate furnaces with integrated water wall boiler	Main Building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	Handling up to 400,000t/year of residual MSW. Note that fly ash collected in the boiler will be deposited in a cement lined intermediate storage bunker, prior to its transfer to the Brick Plant (as described below).
3. Bottom ash cooling and handling	Main Building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	Bottom ash (estimated to be 56,000 t/yr, including 8000 t/yr of ferrous and non-ferrous metals) is cooled and stored in an intermediate cement lined storage bunker, prior to its transfer to the Brick Plant, via the metals recovery area.
4. Metals Recovery Area	Main Building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	An estimated 5440 t/yr & 2560 t/yr of ferrous and non-ferrous metals respectively are expected to be recovered from the bottom ash.
5. Two Flue Gas Cleaning Air Pollution Control Systems i.e. one per line (Fly Ash and APC system reaction products)	Main Building and/or adjacent to main building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	An estimated 4000 t/yr of fly ash (recovered heavy particulate carry-over) and APC neutralisation reaction products are to be stored in an intermediate cement lined storage bunker, prior to its transfer to the Brick Plant.

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Element	Location	Proposed Extent Authorised
6. Multi-flue Stack (with twin flues, one for each of the two parallel grate/boiler/APC/CEMS lines)	Adjacent to Main Building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	Estimated to be 466,000 m <sup>3</sup> /h, in total, consisting primarily of nitrogen, oxygen, water and carbon dioxide at stack exit conditions (assumed to be 132°C, 16% moisture and 8 vol% oxygen), with both lines operating at 100% capacity.
7. Steam System (Boiler Blowdown)	Main Building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	Modern WtE plants, in particular those with dry or semi-dry flue gas cleaning Air Pollution Control systems, tend to be net consumers of water, hence the boiler blowdown is expected to be reused on site.
8. Brick Plant	A Secondary Building (refer to <b>Attachments 3 &amp; 4</b> , section 16 ATTACHMENTS from page 185)	<p>An estimated 58,862 t/yr (including lime and pigment additives), equivalent to ~25,363,000 bricks &amp; pavers for sale per year.</p> <p>It is proposed that bottom ash and fly ash with solid Air Pollution Control reaction products will be periodically characterised, in accordance with the brick technology provider’s requirements (<b>Appendix J</b>), and processed to make bricks or pavers.</p> <p>Another by-product option for bottom ash includes marketing the material for reuse as a construction aggregate (e.g. for road base, brick making or cement making).</p> <p>All by-products will be subjected to periodic characterisation and leach testing, to confirm their compliance with applicable building product standards and specifications. By-products which fail the test will, in the first instance be re-processed, or alternatively, disposed of to an appropriate landfill.</p> <p>In the event of a market failure for some or all of the by-products available for sale, each combustion residue that cannot be exported from the facility for an approved reuse application will be characterised, subjected to leach testing and then disposed of to an appropriate landfill.</p>

## 7 Plans, Specifications and Charts

Please refer to section 16 ATTACHMENTS from page 185 of the PER document for the following attachments:

**ATTACHMENT 1** – Lot 14, Kwinana site – regional context map#1

**ATTACHMENT 2** – Lot 14, Kwinana site – regional context map#2

**ATTACHMENT 3** – Lot 14, Kwinana site – local context map overlaid with the conceptual overall plant layout

**ATTACHMENT 4** – Conceptual Plant Layout Drawing

**ATTACHMENT 5** – Conceptual Process Flow Diagram

**ATTACHMENT 6** – Simplified Conceptual Overall Facility Mass & Energy Balance

Where appropriate the actual site lease area is indicated on the site maps and layout drawings.

The process plant layout was initially prepared during the conceptual engineering study for the project, which was undertaken by Hatch Associates. The layout has been updated to reflect the key characteristics of the proposal under consideration in this Public Environmental Review:

- a proposed WtE full plant capacity of up to 400,000 t/yr,
- with two parallel lines each consisting of a MHIEC-Martin reverse reciprocating grate stoker furnace system, a boiler, an Air Pollution Control system, ID Fan, a Continuous Emissions Monitoring System and a flue, and

The conceptual process plant layout will be subject to change as the detailed design

progresses, with inputs from the various detailed design studies still to be undertaken (e.g. a building inspection to confirm the suitability of the existing Administration Building for reuse by the project as proposed, a geotechnical survey to confirm the allowable waste bunker depth, a traffic management study to optimise traffic flows both on and around the site, a constructability study, internal building design and layout, confirmation of the brick plant capacity once a more detailed waste characterisation has been undertaken etc.). As such, the plant layout, process flow diagram and the overall mass and energy balance should be considered to be preliminary. Nonetheless, these preliminary key drawings and attachments will remain consistent with the Key Proposal Characteristics and Phoenix Energy is committed to implementing Best Available Techniques for Waste to Energy facilities throughout the Facility.



## 8 Proposal Logistics

### 8.1 PER Assessment Timeframe

EPA Environmental Assessment Guideline No. 6 “Timelines for EIA of Proposals” addresses the responsibilities of proponents

and the EPA for achieving timely and effective assessment of proposals.

This timeline (Table 11) is agreed between the EPA and Phoenix Energy.

Table 11 – Agreed Milestones for the proposal

Key Stage of Proposal	Agreed Milestone
EPA approval of ESD Document	May 2013
Proponent submits first adequate draft of PER Document	13 February 2014
OEPA provides comment on first draft PER Document	16 May 2014
Proponent submits adequate revised draft PER Document	26 May 2014
EPA authorises release of PER Document	4 June 2014
Proponent releases approved PER Document	9 June 2014
Public Review of PER Document	21 July 2014
Response to Public Submissions	18 August 2014
OEPA assesses proposal for consideration by EPA	6 October 2014
Preparation and finalisation of EPA Report (including 2 weeks consultation on draft conditions with proponent and key Government agencies)	5 weeks from receipt of final information 17 November 2014

### 8.2 Overall Proposal Schedule

Phoenix Energy projects are engineered in a systematic and phased approach, based on the philosophy of identifying and mitigating risk, whilst developing and proving the business case to support a final investment decision, followed by safe, reliable and sustainable construction, commissioning, start-up and plant operation.

Please refer to the simplified Gantt chart in Figure 13 for a high level project planning schedule for the Kwinana WTE project. Note that conceptual engineering has already been completed for the proposal.

Figure 13 – Simplified Gantt Chart for the Proposal

Q3, 2012	Q2, 2013	Q4, 2013	Q3, 2014	Q1, 2015	Q4, 2016	Q1, 2017
	Finalise Waste Acquisition	Execute Waste Agreements				
	Finalise Site Leases					
	Develop grid Connections		Apply for generation license			
	Mobilise Project Team	Site establishment				
Initiate EPA PER Process			Part IV Ministerial Approval	DER Part V Works Approval		DER Part V License Approval
Community Advisory Group activated	On-going Community Engagement					
			Front End Engineering Activities	Complete Front End Engineering Design		
				Financial Closure & Commence Construction	Complete Construction & Progress Commissioning	Complete Commissioning & Handover to Operations

### 8.3 Logistics for recovered resources and energy

Ownership of the waste feedstock will pass from the supplier (typically a local council) to Kwinana WTE Project Co Pty Ltd once the waste delivery vehicles have been scanned to detect any radioactive contamination and approved for entry into the facility at the gate house. If the delivery is found to have an unacceptable level of radioactivity, the delivery will not be accepted at the facility.

Prior to financial closure, the project will seek to enter into a Power Purchase Agreement and/or bilateral trade agreements for the surplus electricity to be generated by the proposal.

The project will also make arrangements for the sale of recovered recyclable ferrous and non-ferrous metals and for the sale of bricks, pavers and/or construction aggregate.

## 9 The Receiving Environment

### 9.1 Climate

The nearest Bureau of Meteorology weather station is located at the Kwinana BP Refinery (BOM site No. 009064), which is less than

3km from the proposed site. Some current climate statistics for the area are provided in Table 12 below.

Table 12 – Key climate statistics for the site

Highest Mean Monthly Maximum Temperature	29.5°C (February)
Lowest Mean Monthly Minimum Temperature	10.6°C (July/August)
Highest Monthly Rainfall Total	155.7 mm (June)
Lowest Monthly Rainfall Total	9.1 mm (December)

### 9.2 Existing Site Condition

The image in Figure 14 shows that the site currently consists of three developed sections associated with existing or previous activities, and a small section of uncleared vegetation. The site is adjacent to a former blast furnace site and an associated capped landfill. The site has been subjected to detailed

assessment and remediation activities by its former owner, to the satisfaction of the current land owner, Landcorp, on behalf of the Government of Western Australia.

The site (shaded in blue) is bounded by Leath Road to its west, a private road (Canteen Road) to its south, the proposed Anketell Road and rail extension to the north, and other existing business premises to its east.

Figure 14 – Satellite image of Lot 14 Leath Road, showing the proposal boundaries in blue (Source: WA Department of Transport)



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With reference to **Attachment 3** in section 16 ATTACHMENTS from page 185; the site lease area is bounded by three significant easements. The wedge shaped easement to the west is associated with future works planned for Leath Road. The easement to the north is associated with a planned future rail extension to the port and the planned Anketell Road extension, while the access easement to the south is associated with an existing private road, known as Canteen Road.

### 9.3 Groundwater

The area, of which Lot 14 is a subdivision, lies near the south-western edge of the Jandakot groundwater mound. The system is recharged by infiltration of rain during the months of April to October. The overall direction of flow is to the north and northwest.

### 9.4 Terrestrial Flora and Vegetation

As can be seen in Figure 14 the majority of the site has already been cleared due to past land use. A small amount of native vegetation or re-growth (of <1 Ha) still exists in the north-east corner of the site. This native vegetation or re-growth is generally in a degraded condition, surrounded by existing heavy industry and a services easement. As such, it is not considered to be significant habitat for indigenous fauna, nor is it important for biodiversity in the region.

### 9.5 Noise Conditions

With reference to **Attachment 1**, the site is in the heart of the Kwinana heavy industry zone known as the Kwinana Industrial Area (KIA). In 2010, the Kwinana Industries Council (KIC) commissioned an update to the KIC acoustic model, covering the noise emissions of the majority of existing operating facilities within the KIA. This model was converted to a new software package (SoundPlan) and updated with current KIC client acoustic model data. The consultant also undertook a noise measurement program to compare measured levels with model outputs for reference locations throughout the Kwinana area, including residential areas. The KIC model

can be used to generate overall KIC source predicted noise contours for use by individual members (note that Phoenix Energy is an associate member of the KIC) to facilitate the assessment of their own proposals and to determine the cumulative effects.

As a major industrial precinct, the KIA receives special consideration in the recently released *Environmental Protection (Noise) Amendment Regulations 2013*, which amend the *Environmental Protection (Noise) Regulations 1997*. The regulations define Assigned Levels (dB) for industrial and utility premises receiving noise in the KIA. This is presented in section 10.3.1.5.1.2 Acoustic Criteria on page 161.

### 9.6 Air Quality

The following summary is an overview of the existing environmental policy and regulations, which are applicable to the KIA, as described on the EPA WA Environmental Protection Policies (EPP) web page entitled 'Summary: Kwinana – Atmospheric Wastes' (downloaded from [http://www.epa.wa.gov.au/Policies\\_guidelines/envprotecpol/Pages/1081\\_EnvironmentalProtectionKwinanaAtmosphericWa.aspx](http://www.epa.wa.gov.au/Policies_guidelines/envprotecpol/Pages/1081_EnvironmentalProtectionKwinanaAtmosphericWa.aspx) accessed September 2013).

The two relevant pieces of legislation are:

*Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999 (EPP)* and

*Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992*

Kwinana is a major heavy industrial area 30 km south of Perth, Western Australia. Most industry is concentrated in a strip of land about eight kilometres long bordering the Indian Ocean.

In the late 1970s emissions of sulphur dioxide from Kwinana industries caused significant pollution in nearby residential areas. The almost universal conversion to natural gas in 1984 virtually eliminated sulphur dioxide emissions associated with fuel combustion. However, with growth in demand and the cost of natural gas, plus the increase in sulphur dioxide emissions from other sources, the Environmental Protection Authority recognised the potential for the air quality

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around Kwinana to again become degraded and therefore established an Environmental Protection Policy (EPP) in 1992 to maintain acceptable air quality.

The Kwinana EPP was formally reviewed in 1999 and re-issued unchanged. The 1992 Regulations remain in force, and were amended in 1999 to reflect the policy title change.

The Policy defines three areas (Areas A, B and C), where:

- Area A is the area of land on which heavy industry is located;
- Area B is outside Area A and is zoned for industrial purposes from time to time under a Metropolitan Region Scheme or a town planning scheme;
- Area C is beyond Areas A and B, predominantly rural and residential.

Sulphur dioxide standards and limits were set for the three areas, increasing in stringency from Area A to Area C. The most important of these with respect to controlling air quality are the standards and limits averaged over 1-hour periods. Similarly, ambient standards and limits were established for total suspended particulates. The EPP provides for a redetermination of these limits as and when required, e.g. to accommodate new industries or variations to existing industry emissions.

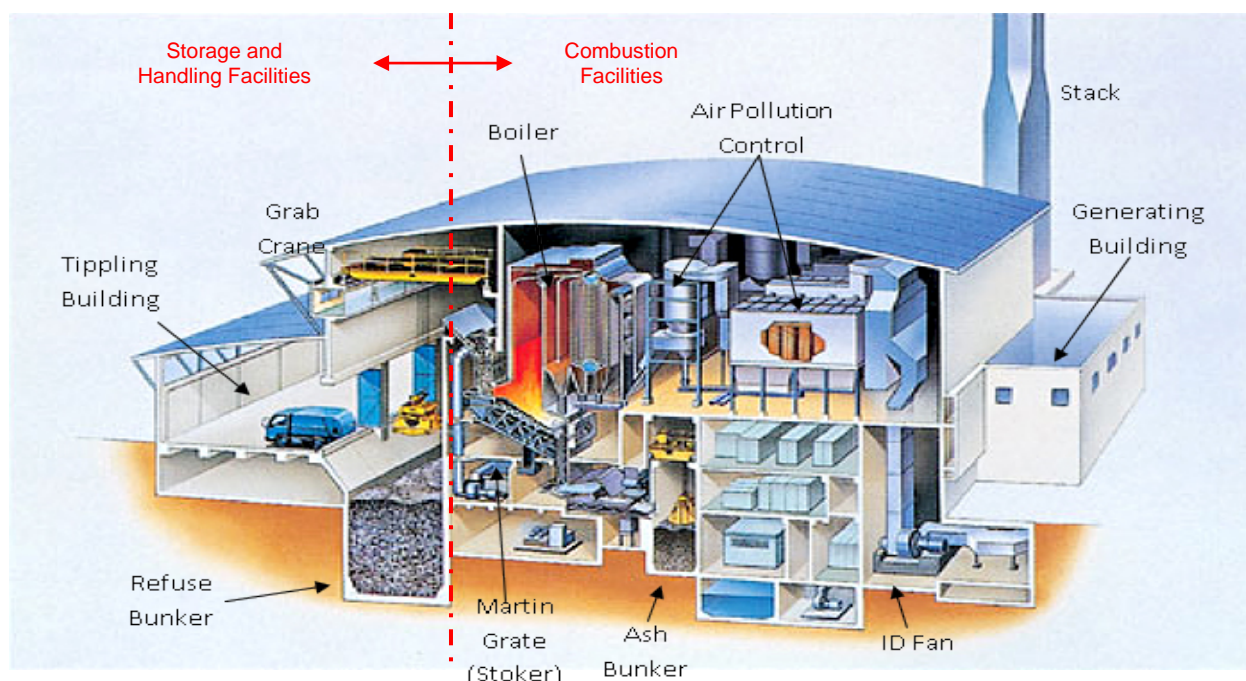
For other criteria pollutants, ground level concentration limits established in the *National Environmental Protection Measure (NEPM) – Air Quality Standards and Goals* are expected to govern the development of the proposal.

## 10 Environmental Factors and Management

For the purposes of the environmental impact assessment of the key environmental factors identified in the Environmental Scoping Document (ESD) in **Appendix A**, the ESD delineates the process plant into sections along with their key environmental factors as follows (please also refer to Figure 15):

- **Storage and Handling Facilities** – key environmental factors include:
  - Terrestrial Environmental Quality and Inland Waters Environmental Quality
  - Amenity – Odour
- **Combustion Facilities** – key environmental factors include:
  - Air Quality – Stack Emissions
- **Both Facilities** – key environmental factors include:
  - Amenity Noise
- **Other Environmental Matters** – key environmental factors include:
  - Native vegetation clearing

Figure 15 – Delineation of the WtE process plant for the purposes of environmental impact assessment



A summary table for the management of each environmental factor is provided in section 2.5 Environmental Impact Assessment and Management, beginning on page 26, in the **Executive Summary** at the beginning of this document.

## 10.1 Storage and Handling Facilities

2008/98/EC on Waste. European Commission

### 10.1.1 Terrestrial Environmental Quality and Inland Waters Environmental Quality

For the WtE plant Storage and Handling Facilities, the focus of this environmental factor is on how the feedstock and process wastes are handled and managed so as to minimise local and regional environmental impacts.

#### 10.1.1.1 EPA Objectives:

- To maintain the quality of land and soils so that the environmental values, both ecological and social are protected.
- To maintain the quality of groundwater and surface water, sediment and or biota so that the environmental values, both ecological and social, are protected.

#### 10.1.1.2 Key Environmental Principles:

- The principle of intergenerational equity
- The principle of the conservation of biological diversity and ecological integrity
- The principle of waste minimisation

#### 10.1.1.3 Applicable Standards, Guidelines or Procedures:

- Advice to the Minister for Environment on the Environmental and Health Performance of Waste to Energy Technologies
- Waste Strategy for Western Australia, Waste Authority, March 2012
- European Commission (2006). Reference Document on the Best Available Techniques for Waste Incineration. European Commission
- European Commission (2011). Guidelines on the Interpretation of the R1 Energy Efficiency Formula for Incineration Facilities dedicated to the Processing of Municipal Solid Waste According to ANNEX II of Directive

#### 10.1.1.4 Existing Environment

The site, situated in the heart of the Kwinana Industrial Area, currently consists of three developed sections associated with previous activities and a small section of uncleared vegetation of ~0.6 ha, primarily in the north east corner. The site has been subjected to detailed assessment and remediation activities by its former owner, to the satisfaction of the current land owner, Landcorp, on behalf of the Government of Western Australia. The site lies near the south-western edge of the Jandakot groundwater mound, a system which is recharged by infiltration of rain during the months of April to October. The overall direction of flow is to the north and northwest.

#### 10.1.1.5 Potential Sources of Impact

Potential impacts include:

- Incorrect storage and handling of waste on-site may lead to land, groundwater and surface water contamination and ecological impacts.
- Incorrect disposal of wastes not suitable for combustion and process residues may have additional environmental impacts.
- Impacts on groundwater levels.
- Stormwater will be generated via the construction of roofs and sealed surfaces.

#### 10.1.1.6 Assessment of Potential Impacts and Consistency with EPA Objectives and Environmental Principles

##### 10.1.1.6.1 Describe how the proposal would meet the waste hierarchy of waste avoidance, recovery and safe disposal

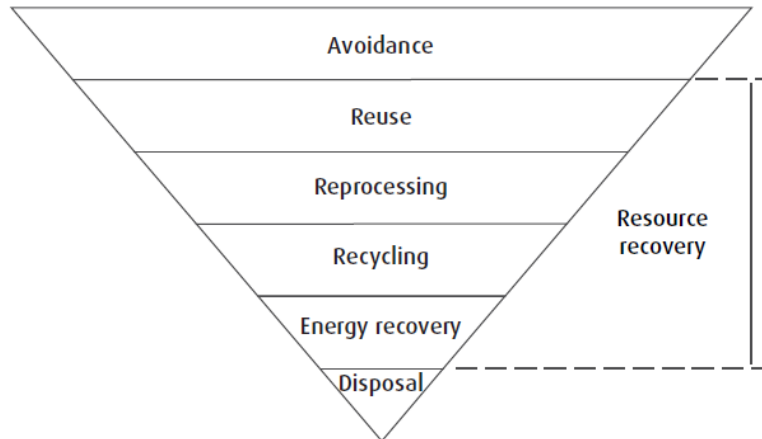
“Waste to energy is a recognised recovery option in the waste hierarchy and is likely to play an important role alongside other waste management options in contributing to Western Australia’s resource recovery targets.” Paul Vogel, EPA Chairman, Report 1468, April 2013

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The waste hierarchy is set out in the *Waste Avoidance and Resource Recovery Act 2007* (WARR Act) and is depicted in the Figure 16. As a higher order recovery option, waste to energy competes directly with landfill disposal,

but is complementary to recycling by targeting only the residual waste i.e. the waste remaining after householders have removed recyclable plastics, glass and metals from their household waste.

Figure 16 – An illustration of the waste hierarchy (Source: EPA Report 1468, April 2013)



After studying the recycling behaviour of more than 500 communities in 22 US states that rely on WtE for processing their waste, Berenyi (2009) found that those communities recycle at rates above the national average and “many of these areas have recycling rates at least three to five percentage points above the national average and in some cases are leading the country in recycling”. Berenyi (2009) concludes that “recycling and waste-to-energy are compatible waste management strategies, which are part of an integrated waste management approach in many communities across the United States.”

The proposal is consistent with the Western Australian state government’s waste strategy, *Creating the Right Environment*, which in turn supports the management of waste in a manner consistent with the waste hierarchy. This is evident since the proposal aims to eliminate the requirement for putrescible landfill disposal and minimise its environmental impact.

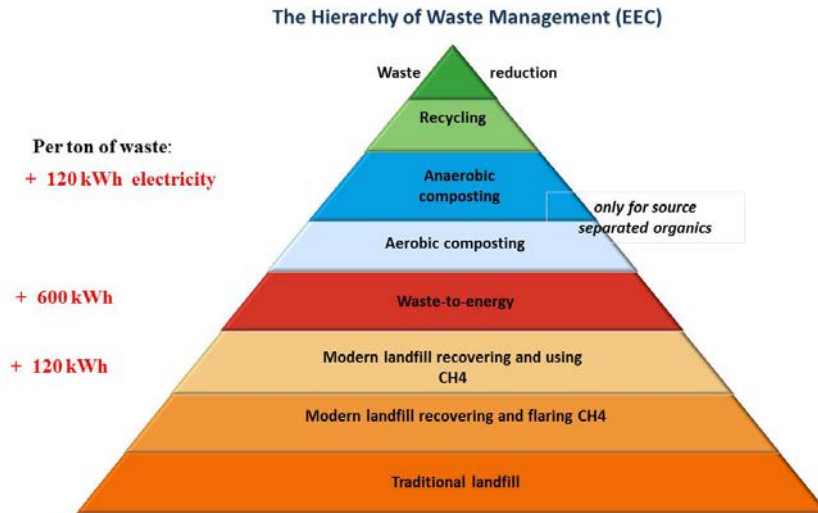
While the proposal will ultimately help to increase waste avoidance through participation in the ongoing education of the community with respect to options to reduce waste generation at its source, its biggest impacts will be immediately evident in the areas of:

- Landfill avoidance - zero waste to landfill
- Energy recovery - in the form of clean renewable electricity generation,
- Recycling - through the recovery of metals from the ash by-product i.e. the capture of metals which are not recovered by kerbside recyclable collection services, and
- Reprocessing and reuse - through the proposed conversion of the solid ash by-product of combustion into bricks and pavers and/or use as construction aggregate.

Given that the proposal will send zero residual waste to landfill and given the scale of the proposal, the proposal will significantly assist the state in achieving its target municipal solid waste recovery rate of 65% of material presented for collection in the Perth metropolitan region by 2020 (Western Australian Waste Strategy, March 2012). Because energy is recovered immediately rather than by slower and less flexible biological processes, the energy generation potential of WtE is 5-6 times that of landfill gas to electricity, as seen in Figure 17.



Figure 17 – The hierarchy of Waste Management (EEC), Themelis (2010)

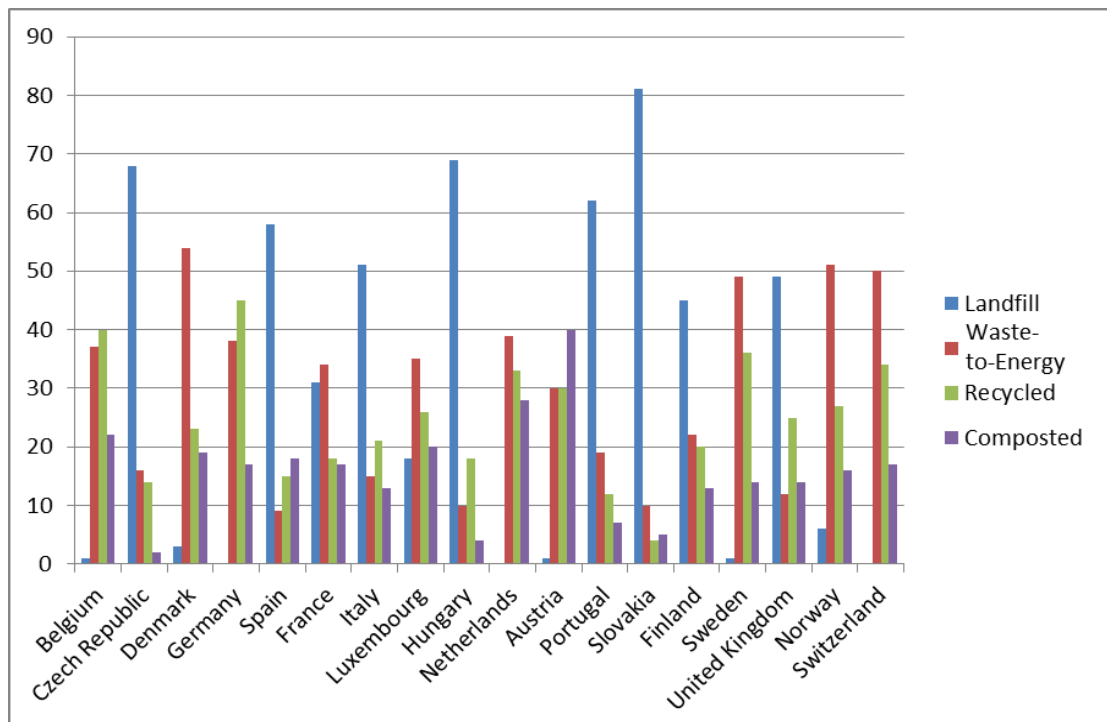


“Waste to energy technologies should not replace management options higher up the waste hierarchy. However, where no viable alternatives exist, waste to energy could play an important role in diverting residual waste from landfill and contribute to policy objectives and strategy targets.” (EPA Report 1468, April 2013)

The Kwinana WtE proposal is targeting residual MSW waste bin from a typical 2 or 3

bin collection system, which includes a separate dry recyclables collection bin and a green waste collection bin (for a 3 bin system). This is consistent with EPA recommendation #5 “The waste hierarchy should be applied and only waste that does not have a viable recycling or reuse alternative should be used as feedstock.”(EPA Report 1468, April 2013).

Figure 18 – Pathways for Municipal Solid Waste in European Countries that Combusted at Least 9% of their MSW (2010) (% by application) (Source: Eurostat Commission, derived from data from [http://europa.eu/rapid/press-release\\_STAT-12-48\\_en.htm](http://europa.eu/rapid/press-release_STAT-12-48_en.htm). Accessed September 2013,



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This recommendation is consistent with international experience, which demonstrates that waste to energy and recycling can successfully coexist and are both currently essential elements of a waste management system which aims to maximise resource recovery and minimise (if not eliminate) reliance on landfill disposal. The chart in Figure 18, which is based on Eurostat 2010 data, depicts the proportions of municipal waste by management outcome. Those with the least reliance on landfill disposal also have the highest install base of waste to energy and also the highest proportion of waste being recycled.

**10.1.1.6.2 Compare the environmental risks and benefits of the existing disposal method (landfill) with the proposed technology on a lifecycle basis**

It should be recognised that there are more than 1000 operating WtE plants worldwide (Whiting et al, 2013), many of which have been operating for many years and the

majority of which are now required to meet the most stringent environmental limits and regulations of any form of energy/electricity generation.

In their report entitled *Waste and Recycling in Australia 2011*, Smith et al (2012) note that the increased removal of recyclables from MSW has resulted in an increase in the organic content of the residual MSW stream. It is the organic portion of the waste which decomposes over time in the landfill to produce emissions such as: landfill gas (primarily consisting of methane and carbon dioxide), liquid (known as leachate), odours and litter. Typical operation and licensing arrangements, which include monitoring and reporting, often extend for up to 30 years after closure (Smith et al, 2012). Waste to Energy avoids this decomposition process by converting the organic material immediately into clean renewable energy. Table 13 provides a summary of the qualitative lifecycle environmental risk assessment of landfill disposal compared to waste to energy.

Table 13 – Lifecycle Environmental Risk Assessment of Landfill Compared to WtE

Landfill		WTE	
Direct Risks	Indirect Risks	Direct Risks	Indirect Risks
<p>The volume of landfill airspace required to receive the same volume of waste over the lifetime of operation of a modern WtE plant would, depending on the depth of the cells, require the use of a considerably larger footprint than the equivalent capacity WtE plant.</p>	<p>Loss of valuable land until after the landfill site is capped closed and rehabilitated. Even after rehabilitation, various management measures are required.</p> <p>The loss of embodied energy in the buried waste.</p> <p>The loss of recyclable metals in the buried waste.</p>	<p><b>Gaseous emissions:</b> These are typical of any combustion process. Nonetheless, the EPA has concluded that “It has been demonstrated internationally that modern waste to energy plants can operate within strict emissions standards with acceptable environmental and health impacts to the community when a plant is</p>	<p><b>Dust:</b> Dust generated during construction will be managed in accordance with the construction management plan to be prepared by the EPC contractor, John Holland.</p>
<p><b>Gaseous emissions:</b> As described by Smith et al (2012), when organic waste decomposes, it releases gaseous emissions of primarily carbon dioxide and methane, along with trace concentrations of various other gases such as hydrogen sulphide (rotten egg gas) and Volatile Organic Compounds (VOCs). These gases are</p>			

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Landfill		WTE	
Direct Risks	Indirect Risks	Direct Risks	Indirect Risks
<p>produced at ground level throughout the operating life of the landfill and for decades after it is capped and closed.</p> <p>Moy (2005) also presents a summary of pollutants which may be present in landfill gas emissions, though studies of potential health and environmental impacts tend to be fairly academic. Smith et al (2012) note that management of landfill gas is important as accumulations of gas will give rise to the risk of explosions; landfill gas is associated with odours, and the methane in landfill gas is a strong greenhouse gas.</p> <p>Other airborne emissions include dust generated by the operation of machinery on and around the landfill and the movement of trucks into and out of the landfill</p>		<p>well designed and operated using best practice technologies and processes.” (EPA Report 1468, 2013) The PER process, the Works Approval and Licensing processes are being fully implemented by the EPA for this proposal.</p> <p>Furthermore, the cleaned flue gases are emitted at elevation by an appropriately sized multi-flue stack with twin flues, to ensure adequate dispersion before emissions reach any sensitive ground level receptors.</p>	
<p><b>Aqueous emissions:</b> Leachate from waste decomposition may contain: dissolved organic matter; inorganic macro components such: as calcium, magnesium, chlorides, sulphates and hydrogen carbonate; heavy metals and xenobiotic organic compounds such as aromatic hydrocarbons (Smith et al, 2012). The potential for contamination of groundwater and surrounding soil depends on site specific factors such as the height of the water table, soil type, waste profile and concentration of contaminants in the leachate (Smith et al, 2012). Importantly, Smith et al (2012) also note that “it is also broadly recognised that all landfills will emit some leachate and that the lining systems are in place to slow and enable control of leachate migration.”(pg.106)</p>		<p><b>Aqueous emissions:</b> The proposal will be designed for zero process wastewater discharge.</p> <p>Stormwater will be collected for reuse, with rainwater in excess of process requirements being managed in accordance with City of Kwinana standards for the KIA. Aqueous emissions from within the process, such as boiler blowdown will be reused. Any leachate collected in the waste bunker will be managed within the waste bunker area.</p> <p>The proposal does not include an open cooling water system i.e. there will not be any cooling tower blowdown.</p>	

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Landfill		WTE	
Direct Risks	Indirect Risks	Direct Risks	Indirect Risks
		<p><b>Safety:</b> Modern WtE plants are highly automated, thus reducing the opportunity for human error and injury. Safety of the employees, contractors and the community is the highest priority during construction, operation and maintenance. Safety is managed in accordance with the Site Safety Management Plan to be developed by John Holland and by the Operator, Covanta.</p>	
<p><b>Fire:</b> When handling a mixed waste feed stream there is a small possibility of fire due to handling of the waste and/or incompatible materials in the waste. The danger with landfill fires is that they are in the open air and might not be easily contained.</p>	<p>Furthermore, contaminated water from fire-fighting efforts may increase the leachate level.</p>	<p><b>Fire:</b> When handling a mixed waste feed stream there is a small possibility of fire. The plant will be equipped with fire suppression equipment and will be constructed, operated and maintained by companies who are experienced in the construction, operation and maintenance of such facilities. Waste will be contained within a concrete lined waste bunker in an enclosed area.</p>	
<p><b>Odour:</b> Odour is a constant challenge for landfill because landfill sites are open to the atmosphere while operating and continue to produce emissions after capping and closure.</p> <p>In addition, landfills are at ground level, so any odours emitted are dispersed at ground level by prevailing winds.</p>		<p><b>Odour:</b> Odour is not a significant risk factor for a modern WtE plant because the waste storage bunker is contained within a fully enclosed building equipped with fast acting roller doors at the entrance and exit and automatic doors for each tipping bay. Furthermore, as combustion air for the process is drawn from the waste bunker area through the combustion chamber, odours are destroyed before the flue gas is released at elevation from the stack. Consequently the tipping area and waste bunker are maintained under slightly negative air pressure while the facility is receiving and processing waste.</p>	
<p><b>Noise:</b> Noise is another typical risk for landfill sites because they are open air</p>		<p><b>Noise:</b> Noise is not a risk factor for modern WtE plants because most noisy</p>	

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Landfill		WTE	
Direct Risks	Indirect Risks	Direct Risks	Indirect Risks
operations involving trucks (reversing beepers) and heavy machinery		operations and machinery are housed within buildings or suitable enclosures. The tipping hall is also enclosed so truck reversing beepers are also contained	
<p><b>Human Health:</b></p> <p>Health risks are less quantifiable than for WTE facilities due to uncertainties in the level of air emissions and leachate (Moy, 2005)</p>		<p><b>Human Health:</b></p> <p>Studies by the UK Health Protection Agency (now part of Public Health England) of the Impact on Health of Emissions to Air from Municipal Waste Incinerators (Feb, 2010) and for the Montgomery County Waste Resource Recovery facility in Maryland, USA (ENSR 2006) support the conclusions of the Preliminary Public Health Risk Assessment undertaken as part of this PER, that gaseous emissions from the proposal will not put human health at risk (please refer to section 10.2.1.6.2.2 Preliminary Public Health Risk Assessment, page 147).</p>	

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Table 14 provides a summary of a qualitative lifecycle environmental benefits assessment comparing landfill disposal to waste to energy.

**Table 14 - Lifecycle Environmental Benefits Assessment comparing Landfill disposal to WtE**

Landfill		WTE	
Direct Benefits	Indirect Benefits	Direct Benefits	Indirect Benefits
A final disposal option for inert and appropriately treated prescribed waste, for which there is no appropriate or feasible recovery or reuse option. Landfill airspace is a valuable resource, which should not be wasted by landfilling putrescible and other wastes for which a higher order waste management option exists.	If appropriately managed, landfills allow for the removal and management of waste outside of populated residential and commercial areas.	While thermal WtE facilities can typically reduce the volume of waste to ~10% of the incoming waste volume after processing, the proposal objective is to send zero residual waste to landfill, thus saving even more valuable landfill airspace for future needs and preferably for inert wastes, which do not decompose	Eliminates future landfill gas emissions, of which ~50% is methane (a strong greenhouse gas, GHG)
Landfill gas, generated from the anaerobic decomposition of legacy organic waste materials, is combustible (due to its methane content) and therefore, can be used to generate small amounts of renewable electricity at around 20-25% of the rate of electricity generation by WtE i.e. 120+ kWh/t for landfill gas to electricity versus 600+ kWh/t (Themelis, 2010)	Each MegaWatt (MW <sub>e</sub> ) of electricity generated from waste is one MW <sub>e</sub> less to be generated from fossil fuel sources.	Energy will be recovered in the form of base load electricity – a portion of which is deemed to be renewable under the Australian Renewable Energy Act 2000. The facility will continuously produce renewable electricity, unlike intermittent renewable electricity generators such as wind and solar, with a plant availability of ~90% (Whiting et al, 2013).	Each MW <sub>e</sub> of electricity generated from waste is one MW <sub>e</sub> less to be generated from fossil fuel sources.  The fossil fuels avoided will consequently mean that the production of those fossil fuels will be avoided, as will the emissions from combustion of those fuels.  Furthermore, because of the stringent emission control limits for WtE plants (e.g. the European WID/IED), environmental emissions from WtE facilities are less than those for coal fired power stations and similar to those from oil or gas fired electricity generation. Please see Table 15 below from RenoSam & Ramboll (2006) sourced from the Danish Energy Agency.
		The production of useful products such as bricks and pavers, and/or construction aggregate from the ash by-product of combustion	The proposed brick making process uses less energy than conventional brick making (hence fewer GHG emissions) and is made from a renewable source (waste), rather than virgin materials
		The recovery of metals from the ash by-product of combustion	Every tonne of metal recovered and recycled, means one less tonne to be produced from virgin materials

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Landfill		WTE	
Direct Benefits	Indirect Benefits	Direct Benefits	Indirect Benefits
		Experiences in Europe, the east coast of the US, Japan, Singapore and more recently, China, demonstrate that WtE is an important component of an integrated waste management system. Operating along side recycling, composting of green waste and landfill, for inert and/or prescribed wastes	Being a safe and controllable process and operating environment, WTE plants host regular tours and open days for school groups and the local community. In some cases, local universities can benefit from the advanced emissions monitoring and measurement facilities. It is now standard practice for modern WTE plants to display the Continuous Emissions Monitoring System (CEMS) results online to keep the community and the EPA fully informed. All in all, WtE plants are one aspect of the process of educating the community about the 4Rs of waste management: Reduce, Reuse, Recycle and Recovery (of energy)

Table 15 –Emission factors of different fuels (RenoSam & Ramboll, 2006)

Fuel	Coal	Gas oil	Natural gas	Waste
CO <sub>2</sub> (kg/GJ)	95	74	57	18 (Note 1)
CH <sub>4</sub> (g/GJ)	1,5	1,5	15	0,6
N <sub>2</sub> O (g/GJ)	3	2	1	1,5
SO <sub>2</sub> (g/GJ)	45	23	0	23,9
NO <sub>x</sub> (g/GJ)	130	52	50	124

Source: Danish Energy Agency

Note 1: The tabulated carbon dioxide (CO<sub>2</sub>) emission rate has been adjusted by the Danish Energy Agency to exclude the CO<sub>2</sub> emissions associated with the biomass fraction of the waste. Also note that each GJ of energy generated from waste eliminates the need to generate that GJ from a fossil fuel source, which is why WtE is typically presented as being a GHG sink, rather than a source.

A comparative analysis undertaken as part of the Durham/York Residual Waste Study, entitled ‘Summary: Comparative Analysis of the Environmental Impacts of Thermal Treatment and Remote Landfill Disposal on a Lifecycle Basis’ (no date given), summarises the environmental impacts of thermal treatment and remote landfill disposal on a lifecycle basis for a new WtE proposal, which

is currently under construction in Ontario, Canada. The project, which will utilise two Martin grate lines operating in parallel, is known as the Durham York Energy Centre. The lifecycle analysis compared the net environmental effects of the two strategies, both of which included electricity generation, over the longer term and was undertaken using a US EPA lifecycle modelling tool. The

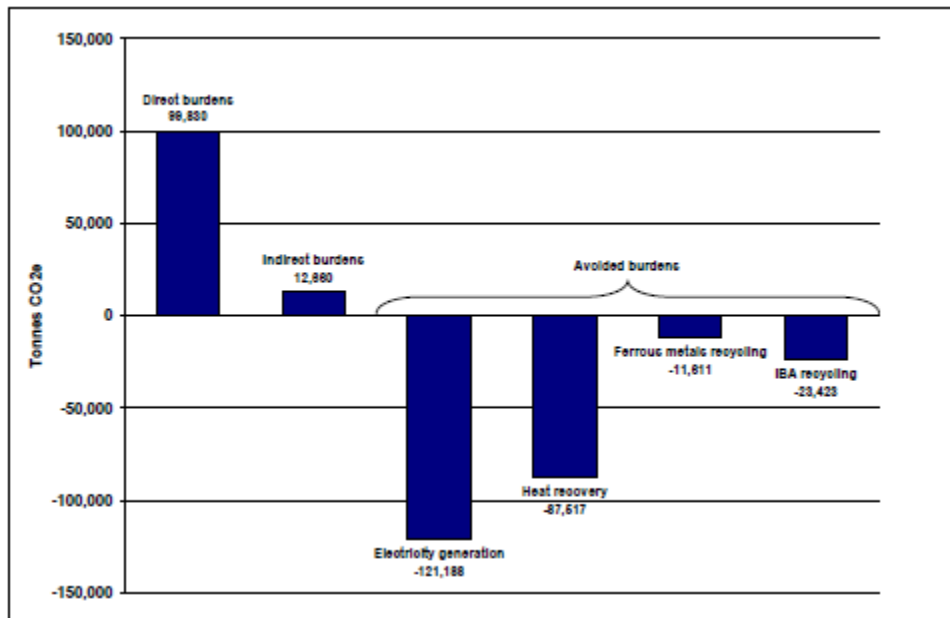
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study results show that residual waste managed by thermal treatment is better than remote landfill disposal with respect to energy consumption/generation, emissions to air of greenhouse gases, acid gases, pollutants that cause smog and emissions to water. Key differentiators noted in the study were the considerably higher energy recovery by thermal treatment, along with the recovery of recyclable metals. These offsetting factors, along with modern control of gaseous emissions, means that thermal treatment typically has a lesser impact on the environment than landfill disposal. RTI International (2008) came to similar conclusions in Life Cycle modelling assessment comparing WtE to both local and inter-state landfill disposal options for Frederick County in Maryland, US. RTI (2008) concluded that while on a cost basis, it appeared that the local landfill and WtE alternatives were comparable, on an

environmental basis, the higher materials and energy recovery associated with WtE creates significant environmental benefits over landfill.

In another case study from the UK, SLR (2010) used WRATE (Waste and Resources Assessment Tool for the Environment), a software tool, to evaluate the carbon foot print of the then proposed Trident Park Energy from Waste facility against the baseline of waste disposal to landfill. The Trident Park EfW facility in the UK is due to be commissioned this year and will have a capacity to process up to ~420,000t/yr of residual MSW and C&I waste. The results of this case study using the WRATE lifecycle assessment tool are presented in Figure 19, showing the detailed breakdown of the direct and indirect greenhouse gas emission burdens and the avoided burdens (or offsets). Once again, it is predicted that WtE will deliver a net reduction in greenhouse gas emissions on a lifecycle assessment basis.

Figure 19 – WtE carbon footprint showing a detailed breakdown of the make-up of the avoided burden (Note: IBA stands for Incinerator Bottom Ash)



In relation to the Kwinana WtE proposal when operating at its full capacity processing 400,000t/yr of MSW, net greenhouse gas emissions are estimated to be up to – 584,350t CO<sub>2</sub>-e/yr (i.e. a net reduction), once all offsets are taken into consideration and in

the absence of any landfill gas capture for either flaring or electricity generation.

Total direct (Scope 1) emissions associated with combustion of MSW only at full capacity are estimated to be 119,600t CO<sub>2</sub>-e per year based on expected feedstock rates



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(Combustion of biomass (~276,000 t/yr) and non-biomass (~124,000 t/yr)) and using energy content and emission factors from the National Greenhouse Accounts (NGA) Factors July 2012 (Department of Climate Change and Energy Efficiency, 2012).

In addition, there will be a small emission rate of ~1,750t CO<sub>2</sub>-e per year associated with auxiliary natural gas fuel (Natural gas is typically only required during start-up for warm-up and establishing self-sustaining combustion conditions. An emission factor of 51.2 kgCO<sub>2</sub>-e/GJ is used (Ref.: NGA Factors (July 2012) for pipeline natural gas)).

There are virtually no indirect (Scope 2) emissions, since the facility will generate electricity in excess of the plant parasitic load requirements.

The facility will be a net CO<sub>2</sub>-e sink due to the following abatements:

a) The facility is expected to export electricity generated in excess of parasitic load requirements. This electricity will offset the equivalent amount of baseload fossil fuel generated electricity. Using the NGA Factors July 2012, State based emission factor of 0.82 kt CO<sub>2</sub>-e/kWh for consumption of electricity from the Grid in WA, the estimated abatement is 208,000t CO<sub>2</sub>-e per year.

b) The facility will divert large quantities of waste material (a large portion of which is considered to be biomass) away from landfill. This will prevent the legacy fugitive emissions associated with the degradable organic carbon (DOC) fraction of the waste material. Using current National Greenhouse Account guidelines of 1.2t CO<sub>2</sub>-e per tonne of MSW, it is estimated that the facility will abate an estimated 480,000t CO<sub>2</sub>-e per year associated with the diversion of waste away from landfills.

c) If the facility produces bricks, the brick making process is considerably less energy intensive than conventional brick making. The abatement of emissions avoided as a result of the reduction in the demand for conventional brick making is estimated to be 17,700t CO<sub>2</sub>-e per year.

d) The facility will recover an estimated 8000 t/yr of recyclable metals which would

otherwise be buried in landfill. The CO<sub>2</sub>-e emissions associated with the production of the equivalent amount of virgin metals has not been quantified, but is expected to be significant. However, even without quantifying this abatement, the facility is a net GHG sink.

In conclusion, it can be demonstrated that EfW yields a negative carbon footprint, that is, an overall reduction in global CO<sub>2</sub>-e emissions.

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#### 10.1.1.6.3 Provide detail on the composition of the proposed feedstock(s) identified by the proponent and any other potentially suitable feedstocks using previously released waste studies

The proposal is targeting the municipal residual waste Mobile Garbage Bin (MGB) or general waste bin in a 2 or 3 bin collection system currently provided by local municipalities. "The waste sourced as input must target genuine residual waste that cannot feasibly be reused or recycled." (EPA report 1468, 2013)

Source separation of waste at the point of generation by the householder is the most efficient and cost effective means of keeping recyclables, garden waste (where such a collection service exists) and undesirable materials out of the residual waste bin. The effectiveness of source separation is enhanced by effective community education programs as well as the provision of drop-off services to keep specific undesirable materials, such as batteries, asbestos, and certain household chemicals and solvents out of the residual waste stream.

The dry recyclables MGB will continue to be sent to a Materials Recovery Facility (MRF) for processing, and, if a separate green waste or garden waste collection service is provided, the green waste will continue to be sent to a composting or organics processing facility. In a MRF plant where dry recyclable materials are overly contaminated or when markets do not exist for the recovered materials, those materials are currently sent to landfill disposal. However, those materials (typically 10-30% of the dry recyclable waste stream after processing in the MRF, according to Cullen et al 2008) would also be suitable for processing by the Proposal, since that waste still meets the definition of residual MSW.

Residual MSW composition data from representative household domestic waste

audits has been used to illustrate the possible composition of the residual MSW feedstock for the proposal. However, it is expected that some categories such as garden waste (green waste) and recyclables will change with time as councils standardise their waste collection services and households become more accustomed to separating recyclables from their general waste. The stoker grate technology has been demonstrated to be the most flexible of all of the available options for management of a change of composition of the feedstock, as evidenced by the successful application of the technology to mixed waste streams in numerous countries over the past four decades (see **Appendix D**).

In late 2011, APC Environmental Management undertook an audit of the general domestic waste for the member councils of the Rivers Regional Council (RRC), which comprises the WA councils of Armadale, Gosnells, Mandurah, Murray, Serpentine and Jarrahdale, South Perth and Waroona councils. These seven councils are located in the likely waste catchment area for the proposal. APC noted that the majority of councils have a standard 240lt MGB collection service and that all councils offer a fortnightly 240lt MGB dry recyclables collection service. Councils offer both a bulky garden waste and hard waste collection service once or twice annually, but none currently provide a 3<sup>rd</sup> MGB garden waste collection service.

Figure 20 illustrates the consolidated composition (by weight%) per waste category, averaged across all member councils of the Rivers Regional Council. The proposed WtE plant would recover useful energy from the mixed organics, and generally contaminated plastics, paper, cardboard, and textiles, while recovering the recyclable metals and converting soil, ceramics, bricks and glass into environmentally friendly bricks and pavers for sale in the on-site Brick Plant.

Figure 20 – West Australian Rivers Regional Council Domestic Waste Audit: All councils consolidated composition of general waste (Source: APC 2011)

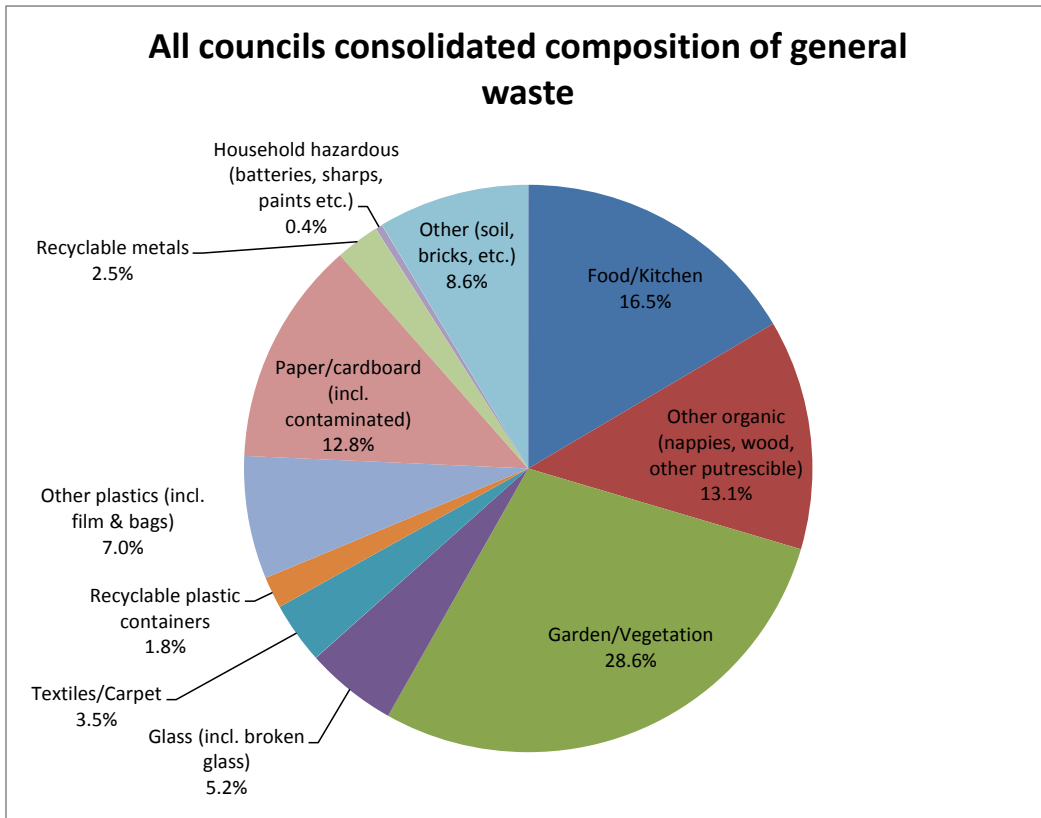
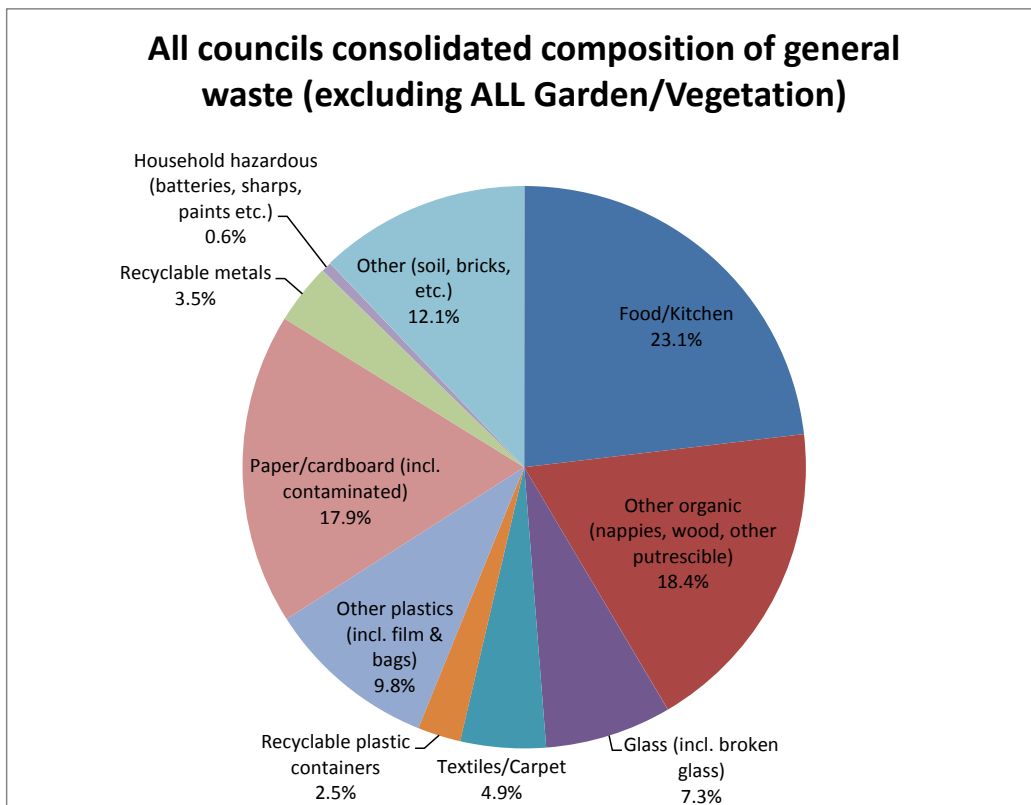


Figure 21 – Hypothetical WA Rivers Regional Council Domestic Waste Audit: All councils consolidated composition of general waste excluding ALL garden/vegetation waste (Base data source: APC 2011)



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Due to the relatively high proportion of garden waste in conjunction with food, nappies and other putrescible wastes, the average moisture content estimated by APC (2011) at a little over 50% by weight, is currently quite high. However, this will not present an operational issue due to the flexibility of the proposed grate type WtE technology.

If, in the future, all councils introduced a 3<sup>rd</sup> bin dedicated to garden and vegetation waste, and continued to provide verge collection of bulk green waste, and assuming 100% presentation and 100% participation and source separation by the householder, the hypothetical composition of the general waste stream is illustrated in Figure 21. Note that even under this hypothetical scenario, that portion of the waste stream designated as recyclable plastic containers (of which some would likely be contaminated) would only account for 2.5% of the total waste stream.

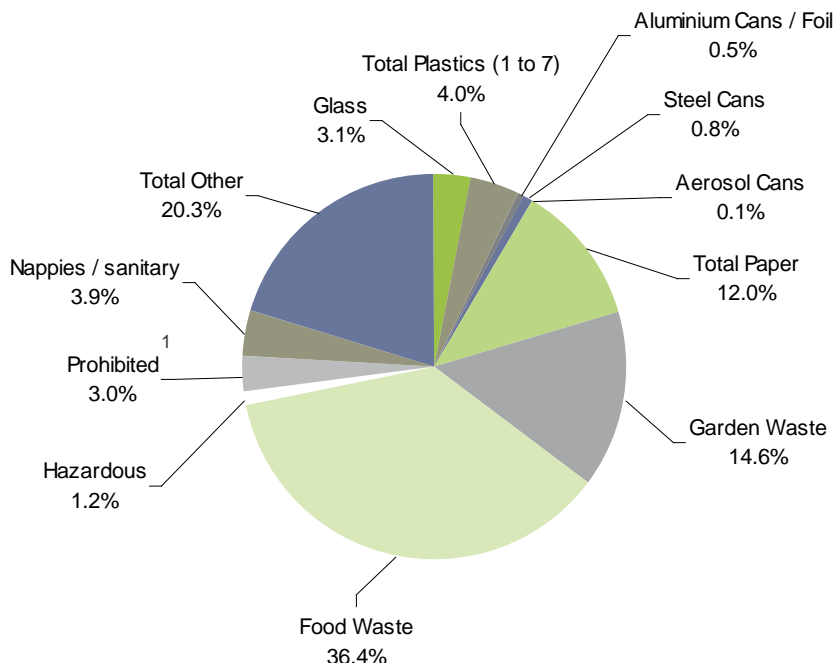
There is currently only limited representative WA waste audit data for a regular 3 Bin waste collection service. In 2008, the City of Nedlands undertook a Performance Review of a 3 Bin Municipal Waste Collection System,

after introducing a 3<sup>rd</sup> bin for the fortnightly collection of garden organic waste and reducing the capacity of the residual waste MGB from 240L to 120L in November, 2006 (Bowman and Associates, 2008). The performance review indicated that the proportion of green waste in the residual waste bin fell from 41% in 2004 to 4.7% in 2007, resulting in a >90% reduction in green waste disposal to landfill.

Given the limited availability of representative Perth metro, non-metro or regional WA waste audit data for a 3 Bin waste collection service, Figure 22 and Figure 23 present actual Victorian waste composition data from Sustainability Victoria's 2008 *Kerbside garbage composition: recent findings* document, to further demonstrate the potential impact of a third bin dedicated to garden/green waste, on the overall residual bin composition. This data, which is also based on a regular (typically) fortnightly collection service, is consistent with the results of the City of Nedlands performance review of its 3 bin municipal waste system, and is presented for illustration purposes only.

Figure 22 – Example garbage bin composition from a Melbourne metropolitan local government with a two bin system (Source: Sustainability Victoria)

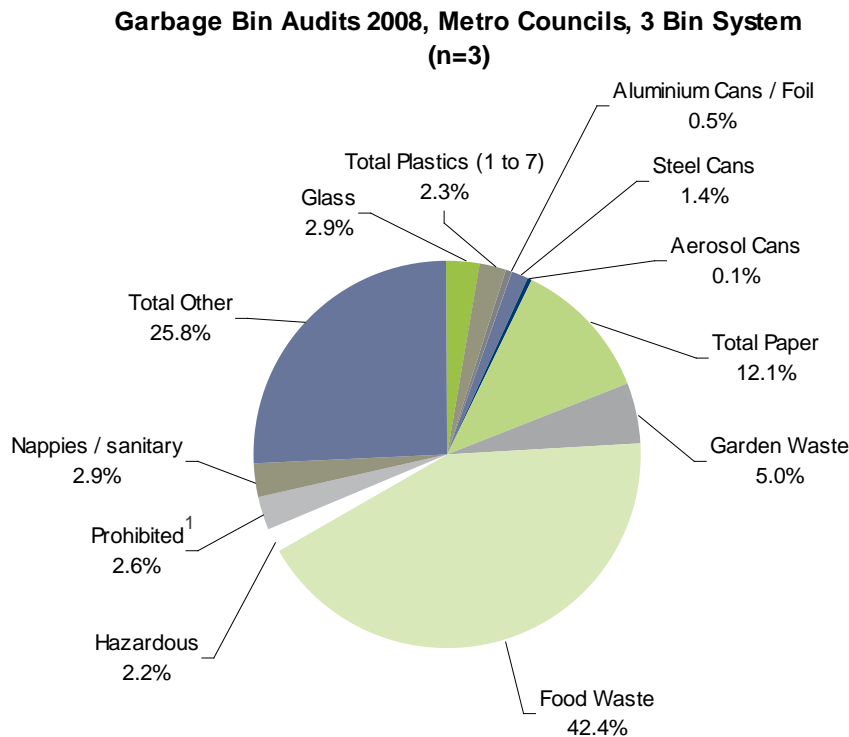
Garbage Bin Audits 2008, Metro Councils, 2 Bin System (n=1)



Notes:

1. 'Prohibited' waste refers to inert waste (i.e. bricks and cement) and building materials (including timber), which are not to be placed in the general waste bin, according to local council regulations.

Figure 23 – Example garbage bin composition from a Melbourne metropolitan local government with a three bin system (Source: Sustainability Victoria)



**Notes:**

1. 'Prohibited' waste refers to inert waste (i.e. bricks and cement) and building materials (including timber), which are not to be placed in the general waste bin, according to local council regulations.

Figure 23 shows that, like the City of Nedlands experience, garden waste is reduced from 14.6% (2 Bin) to only 5%, though not to zero, for councils with a 3 bin collection system. As such, a reduction in the green waste content to this level can be expected with the introduction of a green or garden organics bin, along with the provision of education to the community on how to utilise the new collection service.

**10.1.1.6.3.1 Other Potentially Suitable Feedstocks**

While this proposal is specifically to process residual MSW (including MRF residues otherwise destined for landfill disposal) to recovery energy and other resources, the WtE technology selected for this proposal, the Martin GmbH moving grate furnace system has the largest install base of any WtE technology because of its demonstrated flexibility to handle variable heterogeneous

feedstocks i.e. feedstocks with varying compositions (including moisture content) and mixtures of primarily non-hazardous solid wastes. Globally there are reference sites for Martin grate WtE plants, which are processing MSW (including bulky household waste), Commercial & Industrial (C&I) wastes, combustible Construction & Demolition (C&D) wastes, dewatered biosolids/sewage sludge and biomass, such as the Martin Brescia, Italy reference site (Figure 24). In Denmark, of the 3.3 million tonnes of waste sent to a waste to energy plant for processing, "General household waste accounted for a little less than 1.5 million tonnes, while waste from the service sector amounted to 800,000 tonnes. Bulky waste, industrial waste and waste from wastewater treatment plants amounted to approx. 300,000 tonnes each, while construction and demolition waste represented 100,000 tonnes" (p5, RenoSam & Ramboll, 2006).

Figure 24 – The Martin GmbH Brescia, Italy reference facility, which processes both MSW and biomass



#### 10.1.1.6.4 Describe the acceptance criteria and quality control for waste accepted at the site

The proposal will accept residual MSW delivered directly to the waste bunker by standard side-loading municipal waste collection vehicles and residual MSW transfer trucks (from waste transfer stations) owned and operated by others.

Figure 20 in the previous section illustrates the typical composition of residual MSW in the Perth metro area. Certain wastes are prohibited from the waste collection system and most municipalities also provide a drop off service to keep undesirable and household hazardous materials out of the residual waste bin. Such materials may include batteries (including car batteries), dangerous goods, biomedical waste, pharmaceutical waste, poisons, quarantine waste, radioactive waste, significantly contaminated soils and asbestos waste. Other wastes such as controlled clinical or medical waste and household bulky waste e.g. white goods, mattresses, vehicle

components, LPG cylinders, tyres etc. are collected and treated/recovered separately from residual MSW, and are therefore not included in this proposal.

Source separation by the householder is the most efficient and cost effective means of ensuring that inappropriate wastes are kept out of the residual MSW stream. The various at source diversion programs applicable to Kwinana WtE include:

- Dry recyclables collection service (2/3 bin collection service)
- Green waste collection service (3 bin collection, verge collection or drop-off)
- Operations of depots/transfer stations for the collection/drop-off of Municipal Hazardous waste e.g. household chemicals, paints and solvents
- Depots for collection/drop-off of electronic waste (including verge collection of hard waste) and batteries (including collection points in shopping centres and at other public locations)

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- Hard waste and bulky waste verge or drop-off collection services

While most of the community will make use of the various collection and drop off services available to them, it is inevitable that small quantities of undesirable waste materials will continue to enter the MSW collection system. However, it is important to recognise that the quantity of undesirable materials, in particular household hazardous waste, is typically only a very small fraction of the total residual waste stream (see Figure 20, Figure 21, Figure 22 and Figure 23 from the previous section) and WtE plants are both designed and operated to handle this contingency by:

- (a) constantly premixing the waste in the waste bunker, to reduce the likelihood of significant quantities of inappropriate waste being fed to the grate,
- (b) safely treating the waste feedstock at high temperatures,
- (c) cleaning the flue gas (predominantly nitrogen, carbon dioxide and water vapour) leaving the combustion chamber in the Air Pollution Control system, and
- (d) continuously monitor the concentrations of key pollutants in the flue gas stack.

The flue gas cleaning Air Pollution Control system will be designed to meet the licensed emission limits, which will be set for the proposal by the Department of Environment Regulation (DER) works approval (for construction) and licence (for operation of a prescribed facility), under Part V Division 3 of the *Environmental Protection Act 1986* (DER, 2013). Details of the flue gas cleaning system can be found in section 10.2.1.6 Proposed Management and Mitigation Measures from page 142 onwards, while details of the Continuous Emissions Monitoring System (CEMS) and intermittent sampling procedures are presented in section 10.2.1.6.4 Describe the proposed management, monitoring and validation of predictions for all air emissions., on page 157.

During planned future plant tours and open days, the importance of removing undesirable materials from household waste and utilising the available drop-off services will be highlighted as part of the ongoing process of

educating the community and enhancing source separation at the point of waste generation.

The waste bunker design will incorporate a back loading facility to enable the contents to be emptied into vehicles for removal from site in the event of prolonged shutdowns. This will typically comprise a feed chute to be loaded by one of the waste feed cranes and discharged into an articulated vehicle. Standard Operating Procedures (SOPs) will be developed to ensure that the facility waste acceptance criteria and quality control are adhered to at all times. The example SOP presented below has been adapted from those presented in the Application for a Certificate of Approval - Design and Operations documentation (Golder Associates Report No. 10-1151-0343 (5000), 2011) for a Covanta owned and operated facility currently under construction in Ontario, Canada.

#### 10.1.1.6.4.1 Standard Operating Procedure (SOP) for Handling of Radioactive Wastes

Any truck detected to contain radioactive material will be isolated on site for proper investigation by Facility personnel. If a truck contains radioactive material, the entire load will be rejected. The majority of loads will be returned to the generator or hauler. However, for approved circumstances, a truck may be allowed to be isolated in the tipping area to allow for natural decay of the radioactive isotope. All instances of radiation alarms will be documented and reported.

#### 10.1.1.6.5 Describe the acceptance criteria for feed to the combustion unit and describe the monitoring of feedstock for the combustion unit to ensure suitable quality for combustion

Due to the flexibility of the Martin grate WtE technology, which has been selected for the proposal, there is very little requirement for preparation of the feedstock prior to its introduction to the grate via the feed chute. It is not necessary to shred the waste, adjust its moisture content or remove components from the waste. As new loads of waste are dumped into the waste bunker, the grab

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cranes (see Figure 25) automatically work to keep the bunker constantly mixed. This helps to maintain a more consistent mixture of waste in terms of heat value, structure,

composition (IPPC BREF for Waste Incineration, 2006) and moisture content for presentation to the grate.

Figure 25 – Photo of a grab crane in action in a waste bunker (Kamuk, 2013)



Typically, the entire tipping floor is graded slightly towards the waste bunker. Wet and dry cleaning methods are employed for the tipping floor area, either using a broom sweeper or a wash down with hoses. Any water will drain into the sealed, cement lined waste bunker.

Best management practices, whereby the overhead grab crane continuously mixes the waste in the bunker and brings waste from the bottom of the bunker to the top and loads this waste into the feed hopper, will be employed to ensure that moisture does not accumulate in the bottom of the waste bunker. The small amount of water that enters the bunker either with the incoming waste or as a result of tipping floor wash-down will not adversely impact waste characteristics and the mixing of waste in the pit will avoid the accumulation of water in the bottom of the pit and prevent any possible negative impact on the Facility.

**10.1.1.6.6 Describe the design measures to prevent the potential for on-site contamination**

Modern WtE plants have a number of design measures to prevent the potential for on-site contamination of stormwater, waste, ash, groundwater and soil. The main design measures are described below:

**Waste (buffer storage) Bunker** – waste loads are deposited directly into a waste (buffer storage) bunker on arrival at the WtE plant. The waste bunker is a reinforced concrete bunker, which will be constructed to ensure that there is no potential for leakage of leachate into the surrounding soils or groundwater. The base of the waste bunker slopes toward a leachate collection pit, from which leachate can be pumped back to the top of the waste bunker to be reabsorbed into the solid waste, as the waste is mixed by the grab crane. The project partners are experienced with waste bunker design, construction and operation. Furthermore, the waste bunker is fully contained within a building.

**Bottom ash bunker** – the solid residue remaining after combustion of the waste is known as bottom ash. This ash leaves the end of the grate and is cooled in the ash discharger before being mechanically moved



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into the bottom ash bunker. The bottom ash bunker is lined with reinforced concrete and is contained within a building. The bunker provides temporary storage for the bottom ash before it is conveyed to the brick plant, via the metals recovery area.

**Fly ash bunker** – solid particulate matter collected from the boiler and particulate matter removed from the flue gas, along with solid Air Pollution Control system reaction products, are temporarily stored in the Fly Ash bunker. The fly ash bunker is lined with reinforced concrete and is contained within a building. The bunker provides temporary storage for the fly ash before it is conveyed to the brick plant.

**Stormwater** – as the facility is expected to be a net consumer of water, the process design will consider options to reuse stormwater harvested on-site as make-up to the process water system, to service process water consumers. Excess stormwater is to be handled separately from process water in a purpose built infiltration (soakage) basin sized to receive stormwater harvested from roofs and sealed surfaces, in accordance with local government regulations. The City of Kwinana has advised that excess stormwater i.e. up to a one in twenty (1 in 20) year 24-hour rain event, is to be managed on-site using an infiltration basin designed to City of Kwinana standards applicable to the KIA. This approach is consistent with the Department of Water's DoW's *Stormwater management manual for Western Australia* (DoW, 2004-2007) and *Water quality protection note 52; Stormwater management at industrial sites* (DoW, 2010).

**Process Water** - water is used for a number of processes (e.g. to maintain a water seal in the ash discharger, boiler feed water system make-up, quench water for the flue gas cleaning Air Pollution Control system and the brick plant) and cleaning activities. The process water will be stored and handled separately from stormwater, to eliminate the potential for contamination of stormwater.

#### 10.1.1.6.7 Describe the management of waste on site, Including: procedures for the identification, segregation and disposal of all hazardous materials; and procedures for waste material not accepted for combustion being moved off site for disposal

Educating the wider community is a key to preventing material which is not suitable for combustion from entering the residual waste stream in the first instance. Through the use of plant open days, guided tours for school groups and potential access to the laboratory for Universities, the proposal intends to play a proactive role in educating the wider community regarding appropriate source separation of wastes and appropriate disposal of those wastes which are either prohibited or undesirable, from entering the residual waste stream.

However there will be instances whereby small quantities of household hazardous material will be deposited by residents into their MGB. The typical plant combustion and air pollution control areas are designed to take into account such occurrences and with continuous emissions measurement and management, the operators are able to take action before any resultant pollutants are discharged, should pollutant concentrations approach the design or permit conditions.

The operator response will vary according to the type of potential excursion, but will range from increasing firing temperature to a reduction in firing rate. Recorded video feed of the bunker contents will also be examined to assist with identification of any influencing contaminants. As described in section 10.1.1.6.4.1 on page 79, loads contaminated by radioactive wastes are identified and diverted away from the waste bunker.

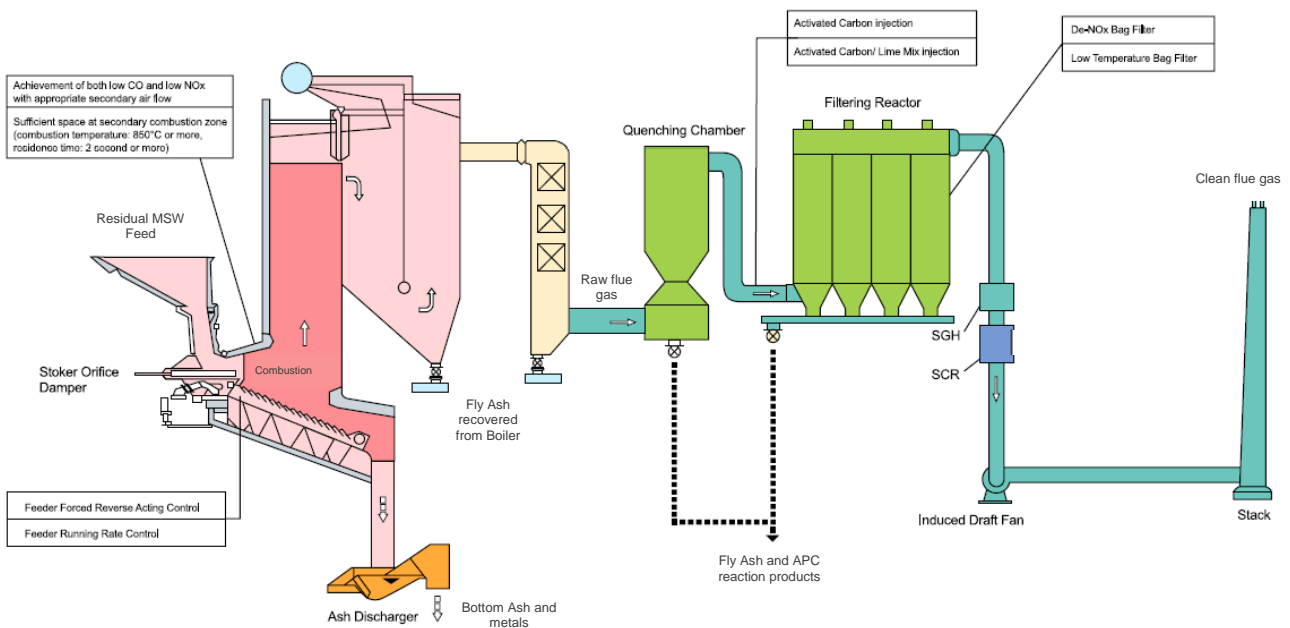
The Facility is completely fenced, providing a single entry and exit point for vehicles delivering waste to the Facility. The facility will only accept waste from contracted councils, in accordance with their collection scheduled and by approved and registered collection vehicles. After hours, the entry/exit gate is closed and entry is controlled by the Shift Supervisor.

**10.1.1.6.8 Describe how solid and liquid wastes generated by the proposal will be managed, tested and appropriately disposed of, including leaching tests of process ashes**

**10.1.1.6.8.1 Proposed measures for the management and mitigation of solid wastes**

The following Figure 26 identifies the key material flows associated with a typical MHIEC moving grate combustion process. Material flows are either gaseous (air or flue gas) or solid (MSW, ash, recovered recyclable metals and Air Pollution Control system reaction products associated with flue gas cleaning.

Figure 26 – Illustration of the material flows associated with the WtE process (Source: MHIEC)



The proposal will be designed to send zero feedstock waste to landfill by integrating a brick and paver making technology to convert the bottom ash, fly ash and solid Air Pollution Control (APC) reaction products into inert bricks and pavers, in compliance with Australian standards and EPA requirements with regard to leach testing. Alternatively, or in addition to brick making, the bottom ash may be marketed as a construction aggregate.

In Japan and Europe it is quite common for the bottom ash to be used beneficially as an alternative construction material. The Danish Ministry of Environment and Energy Statutory Order No. 655, 2000 defines a number of possible applications for untreated (Category 3) and partially treated (Category 2) bottom ash, as shown in Table 16.

Table 16 – Possible applications of bottom ash in category 2 and 3 (Source: Danish EPA, Statutory Order No. 655, 2000)

Construction Application for Bottom Ash	Category 2	Category 3
Roads	YES	YES
Paths	YES	YES

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Construction Application for Bottom Ash	Category 2	Category 3
Open spaces	YES	NO
Conduits	YES	YES
Exit ramps	YES	NO
Noise barriers	YES	NO
Foundations and floors	YES	YES

A recent example of the beneficial reuse of bottom ash as a construction aggregate in the UK (see Figure 27) was reported by DEFRA (2013): “Ballast Phoenix worked with Skanska / Balfour Beatty Joint Venture to provide Incinerator Bottom Ash Aggregate

(IBAA) product for use in the project to widen junctions 29 – 30 of the M25. IBAA was applied as a backfill material to a retaining wall in 250mm layers, using 40,000 tonnes of IBAA graded to <10mm and complying with a variety of specifications.”

Figure 27 – The use of bottom ash (left) as road base for road construction e.g. the M25 in the UK (right)



**10.1.1.6.8.2 Onsite residue storage and metals recovery**

**Bottom Ash Bunker** - bottom ash is deposited in a reinforced concrete lined bottom ash bunker where it can be temporarily stored while awaiting transfer to the metals recovery area and then to the on-site brick making plant. A grab crane will be used to load bottom ash onto an enclosed conveyor system, which moves the ash to the brick plant via the metals recovery area.

**Fly Ash Bunker** – fly ash is the name given to the particulate matter which is recovered from the flue gas as it passes through the boiler and any dedicated particulate matter recovery unit operation associated with the flue gas cleaning Air Pollution Control system. Fly ash, which may also contain solid APC

reaction products, is deposited in an enclosed, cement lined bunker. Fly ash is segregated from the bottom ash to maximise reuse opportunities for both materials. The fly ash bunker is also equipped with a grab crane, which feeds the fly ash onto an enclosed conveyor connected to the brick plant.

**10.1.1.6.8.3 Ferrous and non-ferrous Metals Bay**

Ferrous and non-ferrous metals recovered from the bottom ash are stored in a designated recovered metals storage area for regular collection by a contracted scrap metal merchant. The storage area is nominally sized for 7 days at normal throughput rates.

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**10.1.1.6.8.4 Ferrous metal recovery**

The ferrous metal recovery system is typically designed to recover a minimum of 80% of ferrous metals. The system will likely consist of the following equipment items:

- Rotary drum magnet located above the bottom ash conveyor
- Vibrating screen to agitate and remove loose dirt and scale
- Materials handling equipment (to transfer the recovered metals to the Ferrous Metal Storage Bay

**10.1.1.6.8.5 Non-ferrous metal recovery**

The non-ferrous metal recovery system is typically designed to recover a minimum of 60% of the non-ferrous metals that are in the bottom ash stream. The system will likely consist of the following equipment items:

- Vibrating screen to separate residue into two streams
- A vibratory feeder to ensure an even and uniform flow of residue onto the eddy current separator;
- An eddy current separator; and
- Materials handling equipment (to transfer the recovered metals to the Non-Ferrous Metal Storage Bay

**10.1.1.6.8.6 Characterisation and Leach testing of solid residues and by-products**

All process residues (bottom ash, fly ash and APC reaction products) will be subjected to periodic characterisation as required by the brick plant technology provider (**Appendix J**), to ensure the integrity of the process; to confirm the appropriate blend of additives and to ensure the quality of the products.

All solid by-products such as bricks, pavers and construction aggregate leaving the site will be subject to a testing regime in accordance with Standard Operating Procedures and will be managed as follows:

- Products will be tested in accordance with Australian Standards prior to their sale for end-use activities
- Products will be subjected to periodic leach testing in accordance with and appropriate leach test method such as the US EPA Solid Waste Test Method 1311 Toxicity Characteristic Leaching Procedure (TCLP). It is proposed that testing will occur once steady state operation of the WtE and brick plants has been established. Once the leach testing confirms that the product is suitable for its proposed end-use, it is proposed that further leach testing will be carried out periodically in accordance with standard operating procedures.

**10.1.1.6.8.7 Contingency plan for the characterisation, leach testing and disposal of solid residues in the event of a market failure**

As the saleable solid by-products from the proposed WtE facility will be marketed to both the public (participating councils) and private sectors, Phoenix Energy is confident that there will be a demand for the competitively priced, alternative construction products noted in this proposal. However, in the event of a market failure, such that some or all of the alternative construction products cannot be sold or fail to meet appropriate building or regulatory standards, any solid residue requiring disposal will be handled as follows:

- (1) The material will be characterised to determine its composition. Note that for illustration purposes, the bottom ash and fly ash characteristics from a Martin reference site in Austria are provided for information only in Table 17.
- (2) The material will be subjected to an appropriate leach test, to confirm if the material may pose a threat to ground or surface water, and subject to the results of steps (1) and (2),
- (3) The material will be handled appropriately and transported in covered vehicles to an appropriately classed landfill site for disposal.

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Table 17– Example characteristics of bottom ash and fly ash from the Martin reference plant in Flötzersteig, Austria, from 196,605 tonnes of domestic waste processed (Source: IPPC BREF for Waste Incineration, 2006)

Parameter	Measured value	
	Bottom Ash	Fly ash
Bulk density (kg/m <sup>3</sup> )	800 - 2300	500 - 800
TOC (%) (air dried basis = ad)	1.5 - 2.5	1.5 - 2.0
Σ(SO <sub>4</sub> +SO <sub>3</sub> ) (%) (ad)	1.5 - 8.0	4.5 - 17.0
Cl (%) (ad)	0.2 - 0.5	7.5 - 11.5
F (%) (ad)	0.01 - 0.1	0.1 - 0.3
CO <sub>3</sub> (%) (ad)	3.0 - 15.0	2.5 - 15.0
SO <sub>4</sub> (%) (ad)	1.5 - 5.0	4.5 - 12.5
Total moisture (%) (ad)	15.0 - 40.0	0.1 - 0.5
Loss on ignition (%) (ad)	1.5 - 4.5	0.5 - 3.0
<b>Main components (g/kg) (dry basis)</b>		
Si	130 – 220	65 - 130
Al	40 - 110	40 - 70
Mg	10 – 25	10 - 25
Fe	20 – 40	10 - 20
Ca	120 – 160	150 - 210
Na	15 – 30	30 - 50
K	10 – 25	45 - 120
<b>Heavy metals (g/kg) (dry basis)</b>		
Zn	1.5 - 5	12 - 25
Pb	1 - 3.5	3 - 7
Mn	0.4 - 1	0.4 - 0.9
Cr	0.2 - 0.5	0.4 - 0.9
Cd	0.005 - 0.015	0.2 - 0.8
As	0.003 - 0.015	0.003 - 0.03
Hg	0.0003 - 0.003	0.005 - 0.04
Ni	0.05 - 0.7	0.1 - 0.7
<b>Organic compounds (µg/kg)</b>		
Total PCDF (Furans)	0.05 - 0.2	2 - 20

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Parameter	Measured value	
	Bottom Ash	Fly ash
Total PCDD (Dioxins)	0.02 - 0.2	5 - 80
TEQ	0.001 - 0.008	1.0 - 2.0
Total PCB	<600	<600
Total PAH	<50	<50

**10.1.1.6.8.8 Proposed measures for the management and mitigation of liquid wastes**

*10.1.1.6.8.8.1 Protection of Surface Water and Groundwater Quality during Construction*

- The majority of the site has been cleared, levelled and compacted due to past industrial activities, thus minimising the likelihood of erosion during construction.
- During construction, when staffing numbers increase, all sewage effluent and waste water will be temporarily held in dedicated tanks for off-site disposal by a licensed contractor.

*10.1.1.6.8.8.2 Protection of Surface Water and Groundwater Quality during Operation*

- The feedstock (residual MSW) receiving will be conducted within a building on an impermeable floor sloped towards the waste storage bunker
- The waste storage bunker will be a sealed, cement lined bunker within the main building. The bunker will be fitted with a leachate collection (sump pump) system, to recover leachate and return it to the top of the bunker for re-absorption by the incoming fresh waste
- All combustion residues (bottom ash and fly ash) will be stored in sealed, cement lined bunkers within the main building
- All chemical consumables will be stored in accordance with manufacturer material safety data sheet requirements within buildings with impermeable floors and

appropriate bunding. Operations staff will be trained to report and attend to any spillages which may occur on site due to the transportation or handling. Procedures for containment, collection and disposal of spilt material, and the training of operations personnel will be included in the Environmental Management System and in the Site Safety Management Plan, in relation to hazardous materials handling

- Spills of contaminated liquids (such as process water) and/or chemicals, which occur outside of bunded areas will be cleaned up immediately. The site Environmental Management System will draw upon the recommended contingency plans described in the DoW's *Water quality protection note 52; Stormwater management at industrial sites* (DoW, 2010), relating to staff and contractor training in practices designed to minimise containment loss to the stormwater system and recommended approaches to handling spillages.

Waste water from water treatment and boiler blowdown will be recovered in a waste water holding tank and reused. While it is intended that scheme water will be used for potable water requirements and for some process and firewater make-up water requirements, there are numerous opportunities for water re-use on site including: quench water for the bottom ash discharger, flue gas conditioning, feed hopper and transition piece cooling, brick making and service water for washdown and maintenance purposes. Consequently, modern WtE plants typically operate with zero process waste water discharge, except for a sanitary sewer connection to the staff amenities areas. However, as such a sewer

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connection does not exist in the Kwinana Industrial Area, the project will replace the existing on-site septic system with a new nutrient retentive system (i.e. aerobic treatment units) to reduce nutrients and contaminants entering into the surrounding groundwater. This new system will be designed to operate in accordance with City of Kwinana design specifications for the Kwinana Industrial Area.

The other significant liquid discharge from the facility will be excess stormwater harvested on the site.

Stormwater in excess of potential process make-up water requirements will be managed in a dedicated stormwater management system, consisting of oil/water separation and an infiltration basin designed to City of Kwinana standards for the Kwinana Industrial Area as described in section 10.1.1.6.6 on page 80. For rain or storm events in excess of a one in twenty (1 in 20) year, 24-hour rain event, the excess stormwater will be allowed to flow off-site via crossovers to the surrounding roadways. The roadways and associated off-site stormwater management infrastructure in the KIA is owned and managed by the City of Kwinana. The existing off-site infrastructure is designed to handle a one in one hundred (1 in 100) year 24-hour event, with roads and pipes directing the excess stormwater along the designated 100 year flood paths. This approach is consistent with the Department of Water's *Stormwater management manual for Western Australia* (DoW, 2004-2007) and *Water quality protection note 52; Stormwater management at industrial sites* (DoW, 2010).

#### **10.1.1.6.9 Identify in the key proposal characteristics waste types accepted for processing and excluded wastes.**

Please refer to section 6 Key Characteristics of the Proposal, on page 52 of the document. The proposal is to process post-source separated (residual) MSW.

#### **10.1.1.6.10 Describe how the proposal is consistent with the EPA Advice to the Minister for Environment on the Environmental and Health Performance of Waste to Energy Technologies.**

Please refer to the **Executive Summary** section 2.3 Demonstrate compliance with Advice and Recommendations, beginning on page 18, for responses to each of the 21 recommendations contained in the EPA Advice to the Minister of Environment (EPA Report 1468, April 2013).

#### **10.1.1.7 Predicted Environmental Outcomes**

The EPA objectives in relation to protecting the quality of soil, surface water and ground water will be achieved by: processing appropriate wastes, appropriate handling of waste feedstock and management and mitigation of both solid and liquid wastes during both construction and operation, through re-use and/or on-site processing into value added by-products. Given the management measures proposed and the vast amount of operating experience associated with the use of the proposed tried and proven technologies, it is considered unlikely that there will be any unacceptable level of impact on soil quality, ground water quality or surface water quality by the construction and operation of the proposed facility.

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### 10.1.2 Amenity - Odour

For the WtE plant Storage and Handling Facilities, the focus of this environmental factor is on how the feedstock is handled such that the local amenity is managed with respect to potential fugitive odour emissions.

#### 10.1.2.1 EPA Objective:

- To ensure that impacts to amenity are reduced as low as reasonably practicable.

#### 10.1.2.2 Applicable Standards, Guidelines or Procedures:

- Odour Methodology Guideline, Department of Environmental Protection, Perth, Western Australia March 2002

#### 10.1.2.3 Existing Environment

The site is situated in the heart of the Kwinana Industrial Area with substantial existing buffer zones to sensitive receptors.

#### 10.1.2.4 Potential Sources of Impact

Putrescible waste will be stored and handled on site as buffer capacity to enable continuous operation (24 hours a day, 7 days a week and 365 days a year). The storage and handling of putrescible waste can result in undesirable odour emissions, which have the potential to impact on the local amenity.

#### 10.1.2.5 Assessment of potential odour impacts

The primary source of potential fugitive odour emissions associated with a WtE facility is the waste itself. As such, the storage and handling of the waste is crucial to the mitigation and management of potential odour impacts. Unlike biological processes, such as composting, aerobic and anaerobic digestion, used for recovering resources from waste (with any energy recovery usually a by-product of the process), the proposal will not require biofilters for the management of odour emissions. This is because combustion air is drawn from both the tipping hall and the waste bunker area, through the combustion process itself and then through the Air Pollution Control system. Odours are destroyed in the combustion chamber before the cleaned flue gases are emitted at elevation for dispersion, after exiting the stack.

Drawing combustion air from those areas of the building where putrescible waste is stored and handled both eliminates the requirement for biofiltration of ventilation air, while also maintaining the waste receiving and storage areas under negative air pressure, such that air will preferentially be drawn into the building, rather than being emitted with odours. With two lines operating in parallel to maintain continuous operation 24 hours a day, 365 days per year, the waste receiving and storage areas will constantly be held under negative air pressure.

Furthermore, since the selected WtE technology is a combustion process, the process will have a greater requirement for combustion air than partial combustion processes such as gasification. Therefore, odour management using the aforementioned approach to managing combustion air can be expected to be more effective than for gasification technologies.

While international experience with the hundreds of WtE facilities similar to the Kwinana WtE facility indicates that a well operated combustion type WtE facility will not emit odour, the air quality consultant, ENVIRON, undertook a screening assessment for a hypothetical fugitive odour emission scenario as part of the air quality assessment undertaken for the proposal. A copy of the consultant's Air Quality and Odour Impact Assessment report is provided in **Appendix F**, while the basis for and the results from the hypothetical fugitive odour emission assessment are described in the following section.

#### 10.1.2.6 Hypothetical Fugitive Odour Emission Calculation

The following assumptions were made in relation to determining a hypothetical odour emission rate for the air dispersion modelling:

- The Facility is operating at full capacity i.e. at 400,000 t/yr of MSW
- The truck delivery rate is estimated to be 90 fully covered trucks per two-hour shift, per weekday, based on standard size garbage trucks



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- Entry and Exit roller doors are expected to be open for 60s per truck (i.e. 30s entry and 30s exit) (Cardno, 2012)
- Odour flux was assumed to be 0.97 OU.m<sup>3</sup>/m<sup>2</sup>/s as measured for Fresh Uncovered Waste (Cardno, 2012)
- The length and width of the waste bunker (or refuse pit) was estimated to be 47m x 16m, scaled from the design drawing for a 350,000 t/yr Martin grate facility to be located in Trident Park, Cardiff (note that the bunker dimensions are site specific and also dependent on the allowable depth of the bunker)
- The calculation assumes that odour is emitted evenly from the total surface of the bunker i.e. assuming that the bunker is full and waste is fairly evenly distributed across the bunker
- The calculation also assumes that normal odour abatement as described earlier is ineffective and odours are escaping through the tipping bay doors and are evenly distributed throughout the Tipping Hall itself (which is also normally operating under negative pressure)
- The odour emission rate for fugitive odour emissions from the entry and exit roller doors, are averaged over a typical 2 hour receiving 'shift' using the estimated door opening time per shift divided by the shift duration i.e. a time averaging factor of (90/120 or 0.75). This is consistent with the EMRC's approach (Cardno, 2012)
- For the purposes of establishing a volume source for air dispersion modelling purposes, entrance and exit door dimensions of 6.25m height by 6.20m width were used, based on a typical Covanta WtE plant tipping hall in the US. Note that refuse trucks tend to be smaller in Tokyo, Japan, so a US facility door size was used to ensure conservatism

Therefore, based on an estimated total waste surface area of 750m<sup>2</sup>, a time averaging factor of 0.75 and an odour flux of 0.97 OU.m<sup>3</sup>/m<sup>2</sup>/s, the hypothetical fugitive odour emission rate through fully open entry

and exit doors was calculated to be 545 OU.m<sup>3</sup>/s.

**10.1.2.7 Air Dispersion Modelling and Methodology**

The American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (Version 12060), the USEPA's preferred model for most local scale regulatory applications. was used for the odour assessment for the proposed WtE facility in isolation.

**10.1.2.7.1 Meteorological Data**

AERMET, the meteorological pre-processor for AERMOD, was used to process measured meteorological data from the Alcoa mudlakes meteorological monitoring station, located approximately 3 km east of the proposed WtE facility. Measured 10-minute averages of the following parameters were provided by the KIC for the 2011 calendar year:

- wind speed;
- wind direction;
- standard deviation of wind direction;
- temperature;
- temperature difference (between 2 m and 10 m);
- atmospheric pressure;
- net solar radiation; and
- precipitation

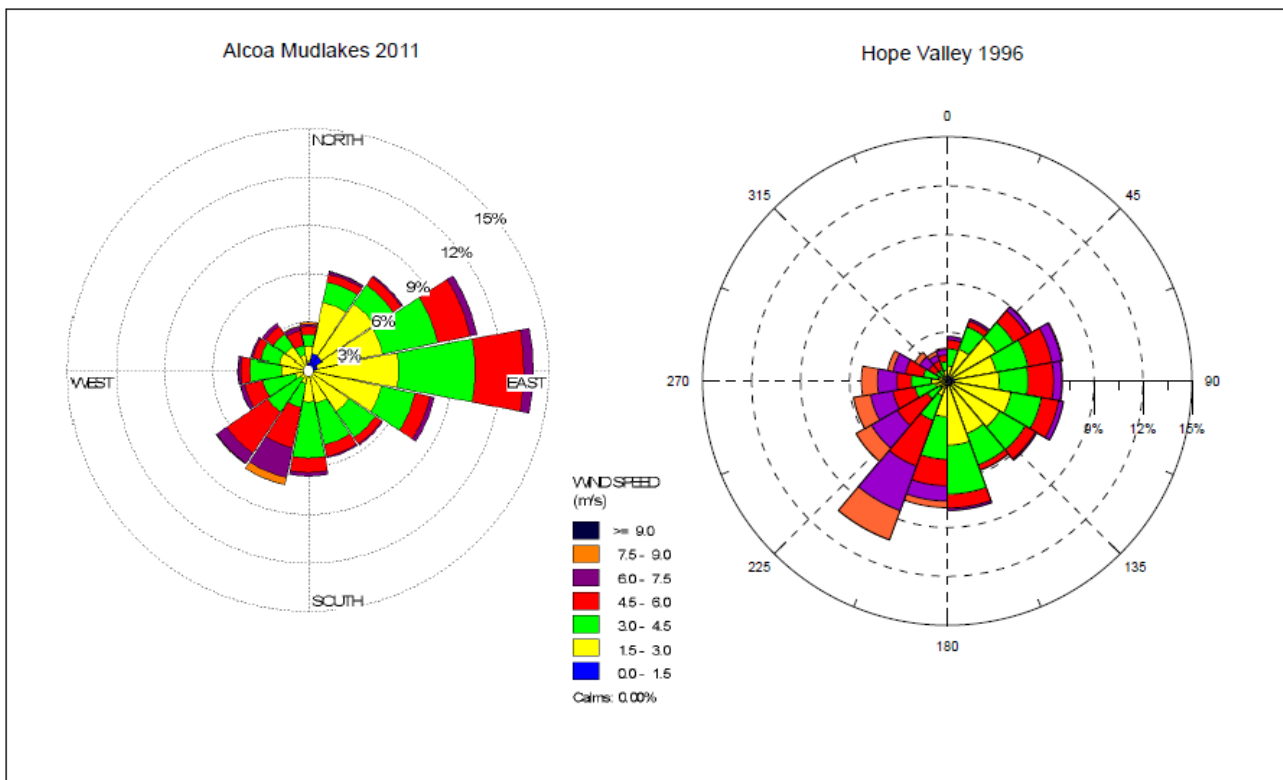
Where single 10-minute records of wind speed, wind direction and temperature were missing, these were substituted with the average of the records before and after the missing data. Where more than one consecutive 10-minute record was missing, the whole hour(s) in which the record fell was entered as missing data. The average data recovery for each parameter following this treatment was 99% over the year.

The Upper Air Estimator tool within AERMET was used to estimate upper air data. This is a non-US EPA AERMET option, which allows the pre-processing of meteorological data in AERMET without the use of actual upper air data. The Upper Air Estimator tool was developed by Lakes Environmental and is designed to allow the US EPA AERMET

program to run for sites without upper air data. This option estimates upper air data from the hourly surface data. Mixing height is not considered to be a significant factor for low level fugitive emission sources, such as the tipping hall doors, and the use of the Upper Air Estimator tool was considered appropriate for this application. The non-default BETA option to adjust surface friction velocity for low wind speed stable conditions was selected within AERMET, following discussions with the DER. Samples of the AERMET input files are presented in Appendix F. The albedo and Bowen ratio values were based on AERMET guidance for the land-use type corresponding to the surrounds of the meteorological monitoring station.

The annual wind rose derived from wind speed and direction measurements at the Alcoa mudlakes site for the 2011 calendar year was compared to the annual wind roses derived from the meteorological data collected by the DER at the Hope Valley monitoring site during the 1996 calendar year. Moderate easterlies and stronger south-westerlies dominate the winds at the Alcoa mudlakes sites, which is consistent with the wind rose for the Hope Valley site (Figure 28). However, the Hope Valley data does exhibit stronger south-westerly and lower easterly components than the Alcoa mudlakes data, which may be attributable to the different monitoring locations or differences in the general meteorology associated with the monitoring years.

Figure 28 – Annual Wind Roses – Alcoa Mudlakes 2011 and Hope Valley 1996



**10.1.2.8 Commentary on the results of the Odour Assessment**

The hypothetical fugitive odour emission rate was modelled by ENVIRON as a volume source of fugitive emissions, from the tipping hall and waste bunker (Table 18), in

AERMOD. The modelling considered the possible locations of the Tipping Hall entry and exit doors at the Kwinana WtE project site in the Kwinana Industrial Area, and also considered worst case meteorological conditions over a representative one year period.

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Table 18 – Summary of Odour Emission Estimate and Modelling Parameters

Parameter	Unit	Tipping Hall and Waste Bunker
Building dimensions for odour assessment (L x W x H)	m	56.1 x 56.1 x 7.5
Initial Lateral Dimension	m	14.26
Initial Vertical Dimension	m	3.63
Odour <sup>[1]</sup>	OU/s	545

Notes:

1. Based on hypothetical fugitive odour estimate assumptions described earlier.

Since the hypothetical fugitive odour emissions are assumed to be emitted close to ground level, ENVIRON utilised the applicable guideline for ground-level sources and down-washed plumes from short stacks in undertaking its assessment of the worst case predicted 1-hour averaged Odour Units for the 2011 modelled year. The assessment considers the highest predicted odour concentration at ground level from 99.5% (i.e. the 99.5<sup>th</sup> percentile) of all predicted concentrations, for the 2011 modelled year.

The results of the air dispersion modelling can be found in Table 19, which follows, taken from **Appendix F**. The results show that the highest 99.5<sup>th</sup> 1-hour average hypothetical odour unit concentration predicted for the 2011 modelled year represents 7.2% of the applicable guideline, and that the predicted odour concentrations comfortably comply with the applicable 1-hour average odour guideline of 2.5 OU at all times. Contours of the predicted 99.5<sup>th</sup> 1-hour average odour unit indicate that peak concentrations are expected to occur within

close proximity of the proposed WtE facility (please refer to Figure 29). The maximum predicted 1-hour average concentration is also provided in Table 19, though there is no applicable guideline for comparison.

The predicted results are considered conservative as the modelling ignores the effects of maintaining the Tipping Hall under negative air pressure and assumes a continuous emission release, while the opening and closing of the tipping hall doors is likely to occur intermittently and for short periods at a time.

With hundreds of similar WtE plants operating effectively within heavily populated urban areas, this hypothetical assessment shows that even under a hypothetical fugitive odour emission scenario and under worst case meteorological conditions, the local amenity will be protected, with respect to odour, by both good building design and good operation of the Facility.

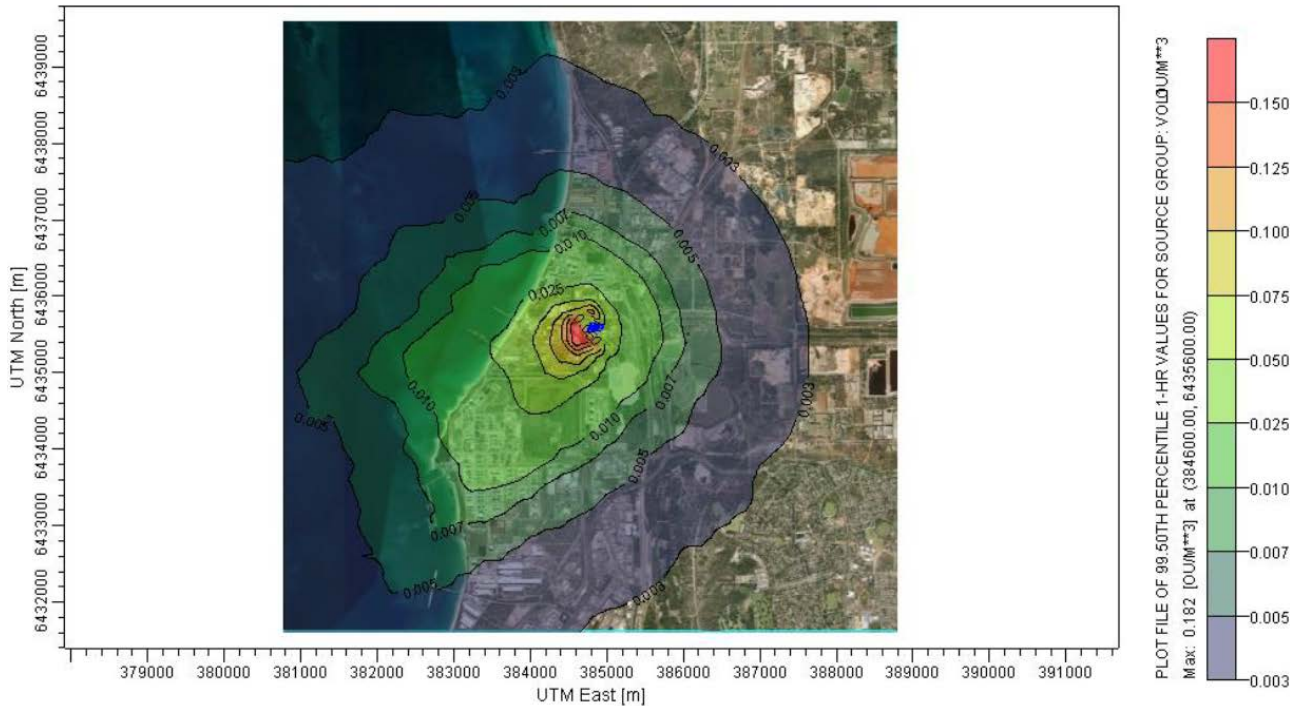
Table 19 – Summary of Maximum Predicted Odour Concentrations Across the Model Domain

Averaging Period	OU	Guideline (OU)	% Guideline Value
Maximum 1-hour	0.31	-	-
99.5 <sup>th</sup> percentile 1-hour	0.18	2.5 <sup>[1]</sup>	7.2%

Notes:

1. Applicable guideline for ground-level sources and down-washed plumes from short stacks.

Figure 29 - 99.5th Predicted 1-hour Average Odour Concentrations (OU) – Normal Operations (Maximum Emission Levels)



**10.1.2.9 Proposed Management and Mitigation Measures**

**10.1.2.9.1 Describe the design measures and management to manage odour as low as reasonably practicable**

All waste accepted into the WtE plant is managed in a fully enclosed building containing a tipping hall and waste bunker. The tipping hall has fast closing roller doors for the entrance and exit, while the waste bunker is equipped with doors on each unloading bay, which act to keep the bunker area sealed at all times. Combustion air for the grate is drawn through the tipping hall by inlet ducts above the waste bunker, thus maintaining a slight negative air pressure in the tipping building to help prevent the escape of dust and odour. Note that as the Kwinana WtE proposal involves the use of proven full combustion WtE technology rather than partial combustion technology, the odour suppression benefits described above are expected to be greater than for a similar sized partial combustion type facility.

Odours drawn into the grate furnace will be destroyed at high temperatures, with any excess air remaining after combustion,

passing through the air pollution control system. Further, locating the waste bunker close to the combustion air intake ducts and away from the entrance and exit doors allows for anticipated dynamic fluctuations in ambient air conditions outside of the enclosure e.g. a gust of wind. This configuration makes it difficult for odours to escape from the enclosure. When the fast acting roller doors are closed during non-delivery hours, combustion air will be admitted to the tipping area via manually operated louvers in the tipping hall and waste bunker building walls.

With two lines (each consisting of a grate-boiler system, APC, ID fan and flue) operating independently and in parallel, it is very unusual for both lines to be offline simultaneously for any significant period of time, except for a planned plant turnaround (e.g. to overhaul the steam turbine), which is typically expected to occur every ~5 years. If both lines are to be offline for a plant turnaround, then the typical operating procedure would be to run down the waste bunker prior to the outage, and temporarily divert waste to a suitable landfill under a contractual agreement. This would also allow the waste bunker to be inspected and

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maintained as part of the plant turnaround. After a full plant shutdown (e.g. for a plant turnaround), operating procedures would dictate that waste cannot be deposited into the waste bunker until after the auxiliary burners have been activated to initiate the grate warm up process.

An Odour Management and Mitigation Plan will be developed. The plan will include at a minimum:

- Standard operating and shutdown procedures;
- Maintenance schedules;

- Corrective action measures and other best management practices for ongoing odour control and for potential operational malfunction; and
- A section that specifically addresses odour control measures should operation of the Facility be disrupted or ceased.

Table 20 provides a summary of preventative control measures and management, to manage odour to as low a level as reasonably practicable.

Table 20 – Description of Odour preventative control measures and management

Emission Source	Description	Control Measures / Preventative Procedures
Waste Trucks	Trucks carrying residual MSW to the facility and returning after unloading	<ul style="list-style-type: none"> <li>▪ All trucks will be covered and suitable for hauling MSW.</li> </ul>
Waste Storage		<ul style="list-style-type: none"> <li>▪ Waste will only be stored in the waste bunker inside the tipping building, which will be equipped with fast closing roller doors.</li> </ul>
Tipping Building and Waste Bunker	Fugitive odours	<ul style="list-style-type: none"> <li>▪ The tipping building will be equipped with fast closing roller doors, to keep the building doors closed when no truck movements are occurring.</li> <li>▪ ID Fans will be running, drawing combustion air from the waste bunker and tipping hall into the furnaces where odours will be destroyed by high temperature combustion reactions.</li> <li>▪ The tipping building and waste bunker will be under negative pressure to minimize the potential for fugitive emissions.</li> <li>▪ Manually operated combustion air louvres can be closed, if the plant is not operating and it is necessary to seal the waste bunker area.</li> </ul>
Both lines are shutdown	Both lines are shut down and offline for an extended period. As there will be two lines operating in parallel, the most likely cause of such an outage would be a planned turnaround for major maintenance activities	<ul style="list-style-type: none"> <li>▪ Facility staff will communicate with waste suppliers to divert trucks to a contracted landfill for the duration of the shutdown. This will be planned well in advance.</li> <li>▪ In the lead up to the plant turnaround, the operations staff will empty the waste bunker – once empty, the natural gas fired auxiliary burners will be used to bring the plant to a controlled shutdown condition.</li> <li>▪ Entrance and exit doors will remain closed</li> <li>▪ On start-up, waste will not be loaded into the waste bunker until after at least one line has been warmed up using auxiliary burners, as per the normal start-up sequence.</li> </ul>

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**10.1.2.10 Predicted Environmental Outcome**

The EPA objective of protecting the local amenity from odour will be met at all times. International experience with the proposed approach to waste management demonstrates that such facilities can be successfully integrated into the urban environment.

## 10.2 Combustion Facilities

### 10.2.1 Air Quality – Stack Emissions

For the WtE plant Combustion Facilities, the focus of this environmental factor is on the potential impact of the stack emissions on local and regional air quality, with due consideration of the cumulative impact of the proposal on emissions from existing and approved future operating facilities, and how the emissions are measured, monitored and controlled to international best practice standards using best available techniques.

#### 10.2.1.1 EPA Objective:

To maintain air quality for the protection of the environment and human health and amenity.

#### 10.2.1.2 Applicable Standards, Guidelines or Procedures:

- Advice to the Minister for Environment on the Environmental and Health Performance of Waste to Energy Technologies
- Air Quality Modelling Guidance Notes, Department of Environment, March 2006
- EPA Guidance Statement No. 55 Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process, December 2003
- European Directives 2000/76/EC on the incineration of waste (WID) recast as Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control)
- National Environment Protection Measure standards and goals
- World Health Organisation Air Quality and Health guidelines
- A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities, Department of Environment and Conservation, March 2011
- Department of Health and DER, Relevant policy and air quality guidelines

- *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999 (EPP)*
- *Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992*

#### 10.2.1.3 Existing Environment

- The site is situated in the heart of the Kwinana Industrial Area and within the Kwinana Industrial Area (KIA) air shed.
- Numerous other existing industrial sites are located within 5km of the site.
- The main contaminants of concern in the Kwinana airshed are:
  - Sulphur dioxide (SO<sub>2</sub>);
  - Oxides of nitrogen (NO<sub>x</sub>);
  - Particulate matter, heavy metals and volatile and semi-volatile organics;
  - Dioxins and furans;
  - Carbon Monoxide (CO);
  - Formaldehyde and other complex organic compounds;
  - Hydrogen chloride (HCl) and Hydrogen Fluoride (HF); and
  - Odour.

#### 10.2.1.4 Potential Impacts

Potential impacts include:

- The facility will employ technology purpose built to recover energy and other resources from a mixed waste feedstock, such as source separated residual Municipal Solid Waste, which contains a mixture of materials. As such, and if uncontrolled, the process has the potential to emit into the atmosphere a range of contaminants including heavy metals, particulate matter, dioxins, other toxic organic compounds and acid gases including sulphur dioxide, oxides of nitrogen, hydrogen chloride and hydrogen fluoride, via the flue gas stack, which may impact residential areas and neighbouring premises.
- The plant is designed to handle and process putrescible material, which if not handled or managed appropriately, may result in fugitive odour emissions.

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- Dust from construction activities.

**10.2.1.5 Air Quality and Odour Impact Assessment**

ENVIRON Australia Pty Ltd was commissioned to undertake a detailed preliminary Air Quality and Odour Impact Assessment for the proposal. A copy of the consultant’s Air and Odour Assessment report is provided in **Appendix F**.

**10.2.1.5.1 Identify all atmospheric emissions from all potential points of discharge from the proposal**

Table 21 provides a summary of emissions sources and the types of contaminants, which are typical of this type of WtE facility.

**Table 21 – Preliminary Atmospheric Emission Sources and Contaminants Identification Table**

Source Description	General Location	Expected Contaminants	Considered for modelling? (Yes or No)	Comment
Multi-Flue Stack	Adjacent to Main Plant and Brick Plant	Products of combustion, trace particulate matter and metals	Yes	The Stack will incorporate two flues, one for each grate line operating in parallel. This is the primary source of atmospheric emissions for the proposal
Silo Filling	Main Plant Area	Particulate Matter	No	Intermittent and deemed to be negligible relative to the multi-flue stack
Brick Plant Baghouse	Brick Plant Area	Particulate Matter	No	Appropriate sizing and operation of the baghouse will ensure that any emissions are negligible
Stand-by diesel generator	Main Plant Area	Products of combustion	No	Intermittent. Primarily for emergency use, hence usually only operated for routine testing.
Building exhaust fans	Main Plant Area	Particulate matter	No	Due to the measures to prevent dust movement within the buildings, these emissions are deemed to be negligible
HVAC	Main Plant Area	Products of combustion	No	Possible use of natural gas for HVAC heating purposes, but negligible relative to multi-flue Stack emissions
Emergency Fire Water Pumps (see also Stand-by diesel generator)	Main Plant Area	Products of combustion	No	Intermittent. The use of the emergency fire water pumps will be limited to emergencies and scheduled maintenance testing

**10.2.1.5.2 Investigate the impact of odour on residential and neighbouring premises**

A preliminary odour impact assessment has been carried out for the proposal by ENVIRON Australia Pty Ltd. Please refer to section 10.1.2 Amenity - Odour, from page 88 onwards, for details of the modelling and the outcomes of the assessment. ENVIRON

concluded that “Comparison of the predicted odour concentrations against the nominated guidelines indicates that no exceedances of the odour guidelines are predicted to occur.”



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**10.2.1.5.3 Details of the brick making plant shall be provided along with an assessment of the emissions from that process**

Pittsburgh Mineral & Environmental Technology, Inc. (PMET) has developed and patented a process (U.S. Patent # 6,068,803) for making green building products (Brixx™) from industrial wastes. The following details have been obtained from PMET documentation, including A White Paper on the Technology Development Life Cycle, Sawayda (2005) and Claridge et al (2008).

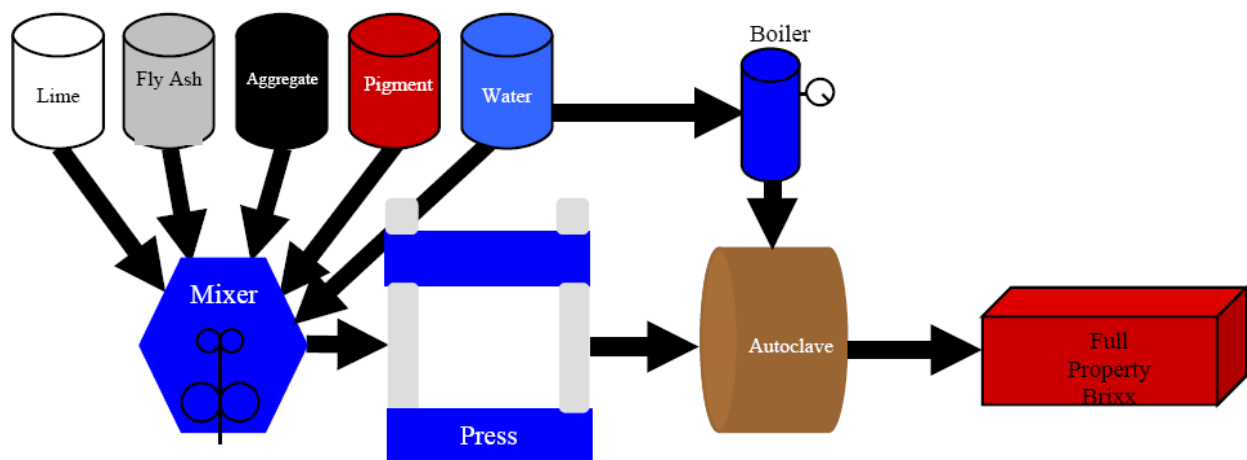
**10.2.1.5.3.1 The Brixx™ Process**

Bottom ash and fly ash will be characterised and tested periodically to confirm the desired blend ratio and additive rates. PMET (2014) has advised that testing should occur monthly during the first year of operation to check for any seasonal variation. If the monthly testing shows reasonable constancy in the materials, then the frequency of testing can be reduced. Naturally, if the test samples of the “standard” mix fail to produce acceptable strength and water absorption, the mix will need to be modified until the correct properties are achieved. In PMET’s experience with MSW ash in the US, it has not been necessary to change mixes over calendar time. A letter from PMET describing its recommended

testing regime can be found in **Appendix J**. With reference to Figure 30, the ash (bottom ash (aggregate) and fly ash) is mixed with quick lime, hydrated lime or lime kiln dust (10-12%) and water, and blended in a high intensity mixer. The raw material mix is inserted into a metal die and pressed using a hydraulic or mechanical press. Adding pigments before pressing or applying coatings to the finished pieces produces coloured products. The raw material is then removed, stacked on a pallet, and cured in an autoclave for six hours, using indirect steam heating. This curing process forms tobermorite mineral (calcium silicate hydroxide hydrate) crystals, which tightly bond with the ash to create a strong, weather resistant building product. After cooling, the finished Brixx™ are removed from the autoclave and inspected for defects. All defective Brixx™ can be crushed and completely recycled, resulting in no production waste.

PMET has demonstrated that its Brixx™ exceed the compressive strength requirements of ASTM standard C902 and also exceed the Severe Weather Requirements of ASTM standard C73, regarding compressive strength and water absorption.

Figure 30– A simplified process schematic of the patented PMET Brixx™ process



**10.2.1.5.3.2 Environmentally friendly building products**

It is intended to utilise steam from the WtE plant (i.e. low pressure pass-out steam from the steam turbine) as the heat sources for the

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autoclave, as such the only atmospheric emissions will be ventilation air, which is expected to pass through a baghouse prior to emission. Due to the nature of the process, all rejects and residues can be crushed and recycled to the mixer to make new brick/paver products. There are no aqueous or liquid emissions to the environment as the process is a net water consumer, with all water condensate recovered from the autoclave being recycled to the mixer. With an estimated energy consumption rate of 123 kWh per ton of Brixx™ produced, a commercial scale Brixx™ plant will use only 10-30% of the energy required by a conventional clay fired brick kiln process. With the expected reduction in energy consumption relative to conventional brick making along with the use of steam derived from the WtE plant, the brick plant is expected to result in a net reduction in greenhouse gas emissions.

Claridge et al (2008) report that bricks produced from the PMET Brixx™ process not only meet ASTM standards for strength and water absorption, but are also non-leaching. Samples of bricks created from copper mine tailings were crushed and submitted to an

independent laboratory for leach testing in accordance with the US EPA Toxicity Characteristic Leaching Procedure (TCLP). None of the 8 typical TCLP metals exceeded even the detection limits of the instruments used.

**10.2.1.5.4 For the purpose of establishing background pollutant levels to be used in cumulative modelling, both existing and future sources that have been approved by the EPA or DEC should be taken into account, where practicable. Where reliance is placed on historical data, modelling should contain a higher degree of conservatism and interannual variation of historical data should be taken into account**

**Sulphur Dioxide (SO<sub>2</sub>)**

The key gaseous pollutant of interest from a cumulative modelling perspective is sulphur dioxide (SO<sub>2</sub>). The results of ambient air quality monitoring within the Kwinana region for SO<sub>2</sub> at Rockingham and Wattleup are summarised in Table 22.

Table 22 – Summary of Ambient SO<sub>2</sub> Monitoring in Kwinana

Location	Daily Peak Concentration of SO <sub>2</sub> (µg/m <sup>3</sup> ) <sup>[1]</sup>			
	Rockingham		Wattleup	
Year	1-hour	24-hour	1-hour	24-hour
Standard <sup>[3]</sup>	350	125	500	150
Limit <sup>[4]</sup>	500	200	1,000	200
2002	100	17	231	23
2003	74	14	177	17
2004	111	17	217	26
2005	117	26	343 <sup>[2]</sup>	40 <sup>[2]</sup>
2006	114	20	177	26
2007	117	34 <sup>[2]</sup>	171	29
2008	226 <sup>[2]</sup>	20	220	31
2009	91	23	169	23
2010	106	20	163	29
2011	114	23	191	23

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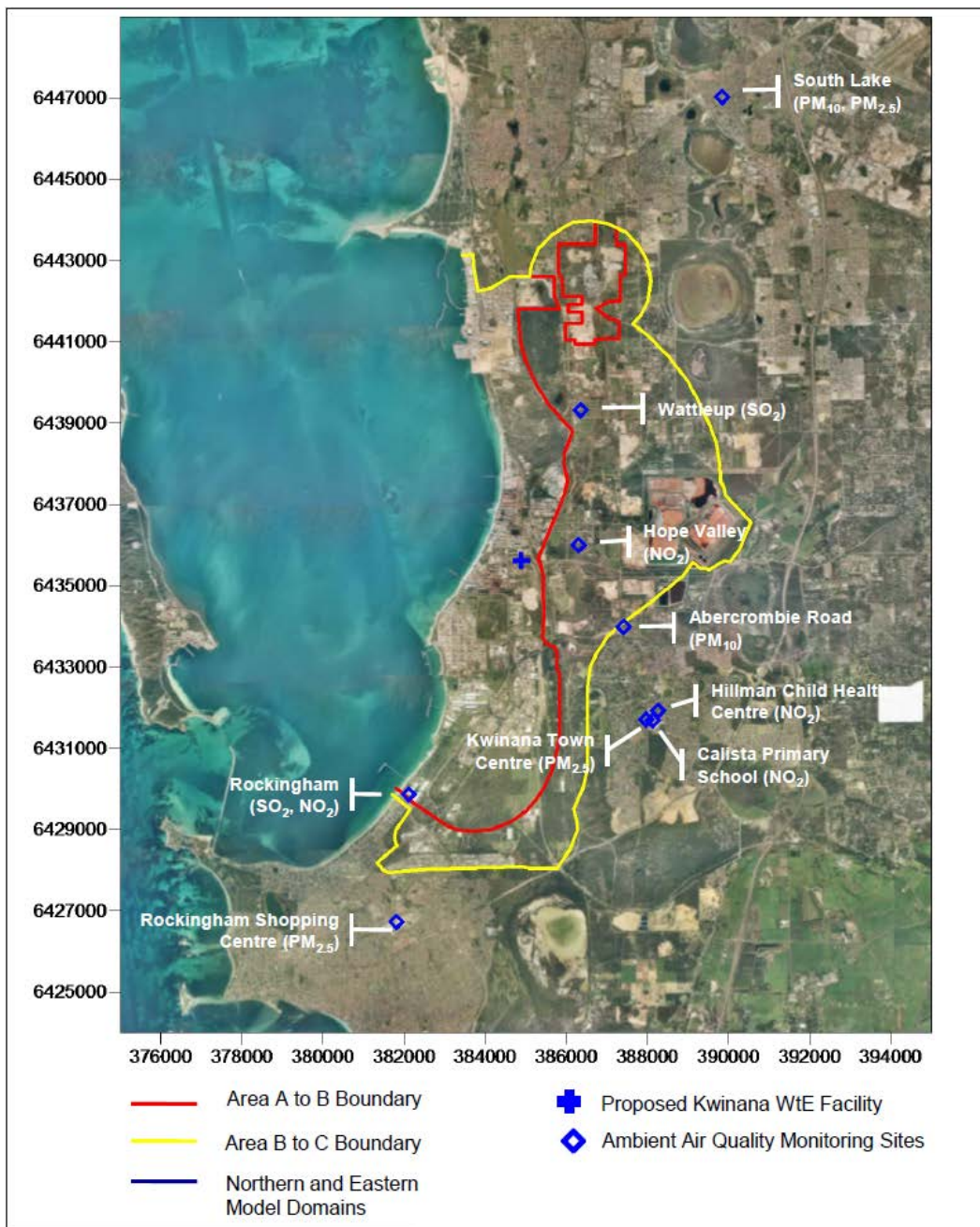
Notes to Table 22:

1. Data sourced from DER (2012).
2. The highest concentration of SO<sub>2</sub> measured at each location over the past decade is shown in **bold**.
3. Kwinana EPP Area C Standards applies at the Rockingham monitoring station, and the Area B Standards applied at the Wattleup monitoring station.
4. Kwinana EPP Area C Limits applies at the Rockingham monitoring station, and the Area B Limits applied at the Wattleup monitoring station.

The Rockingham monitoring station is located within the residential Area C (as defined in the Kwinana Environmental Protection Policy (EPP)), and the Wattleup monitoring station is

located within the buffer zone Area B (as defined in the Kwinana EPP). Please refer to Figure 31.

Figure 31 - Kwinana Environment Protection Policy Area Boundaries and Sulphur Dioxide Modelling Domains



The ambient air quality monitoring results within the Kwinana region for SO<sub>2</sub> indicate that the Kwinana EPP Standards and Limits have not been exceeded over the last ten years. The highest daily peak 1-hour concentration of SO<sub>2</sub> was measured at the Wattleup monitoring station during 2005 (343 µg/m<sup>3</sup>), and comfortably complies (34%) with the relevant Kwinana EPP Limit. The highest daily peak 24-hour concentration of SO<sub>2</sub> was also measured at the Wattleup monitoring station during 2005 (40 µg/m<sup>3</sup>), and comfortably complies (20%) with the relevant Kwinana EPP Limit. The Wattleup monitoring station is located closest to the proposed WtE facility, within approximately 3.5 km (Figure 31).

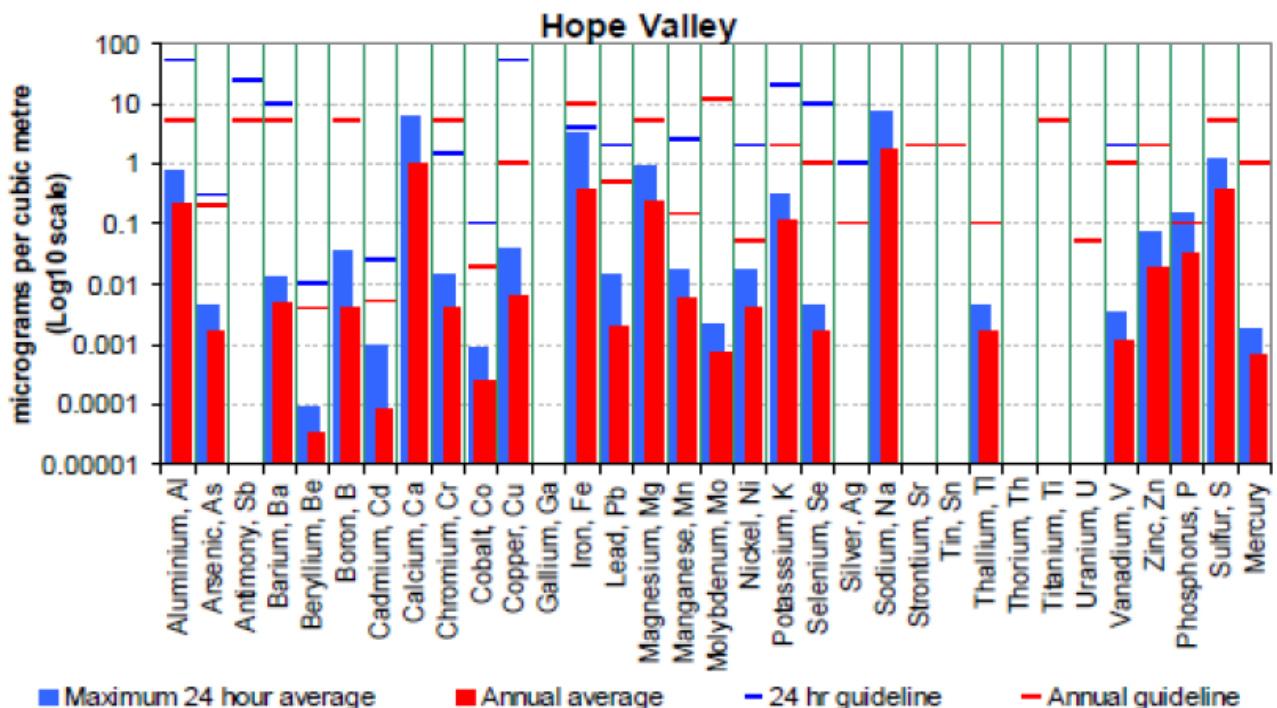
The 2011 Western Australia Air Monitoring Report (DER, 2012) does not report the 9<sup>th</sup> highest (or 99.9<sup>th</sup> percentile) statistic, required for comparison to the Kwinana EPP 1-hour Standards. Notwithstanding, the ambient air quality monitoring results within the Kwinana region for SO<sub>2</sub> indicate that the highest peak 1-hour and 24-hour concentrations of SO<sub>2</sub> measured at the Wattleup and Rockingham monitoring stations comply with the Kwinana EPP Standards.

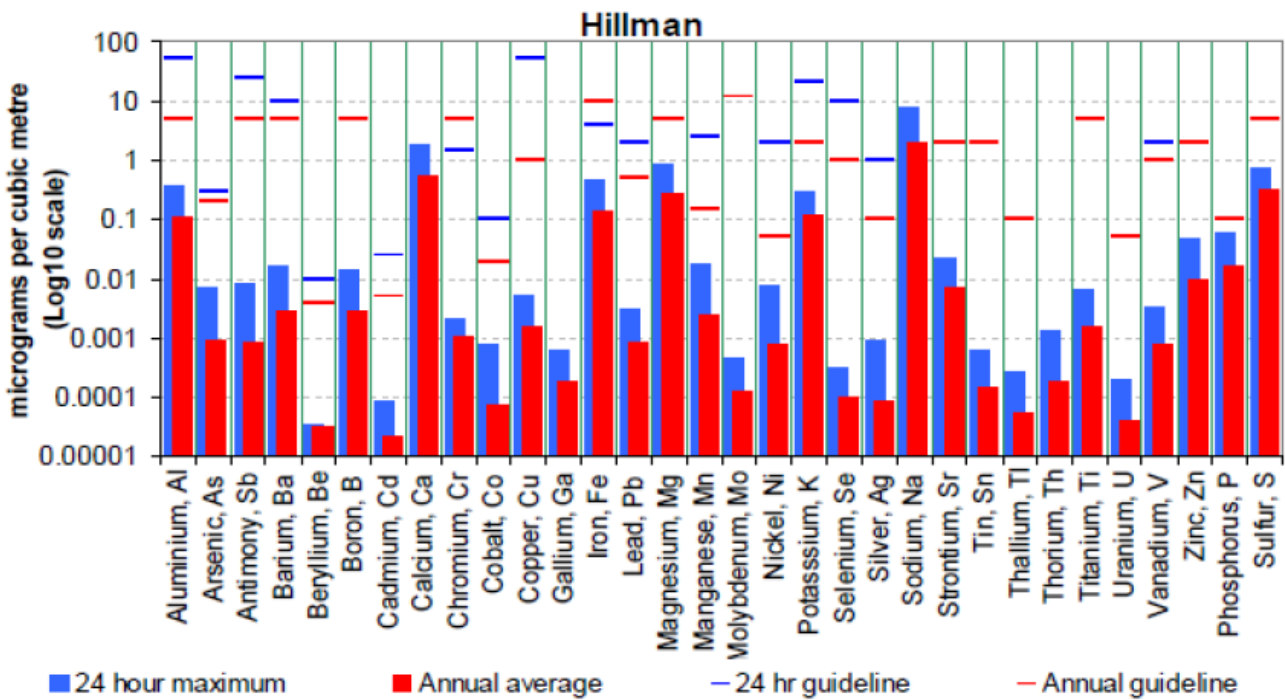
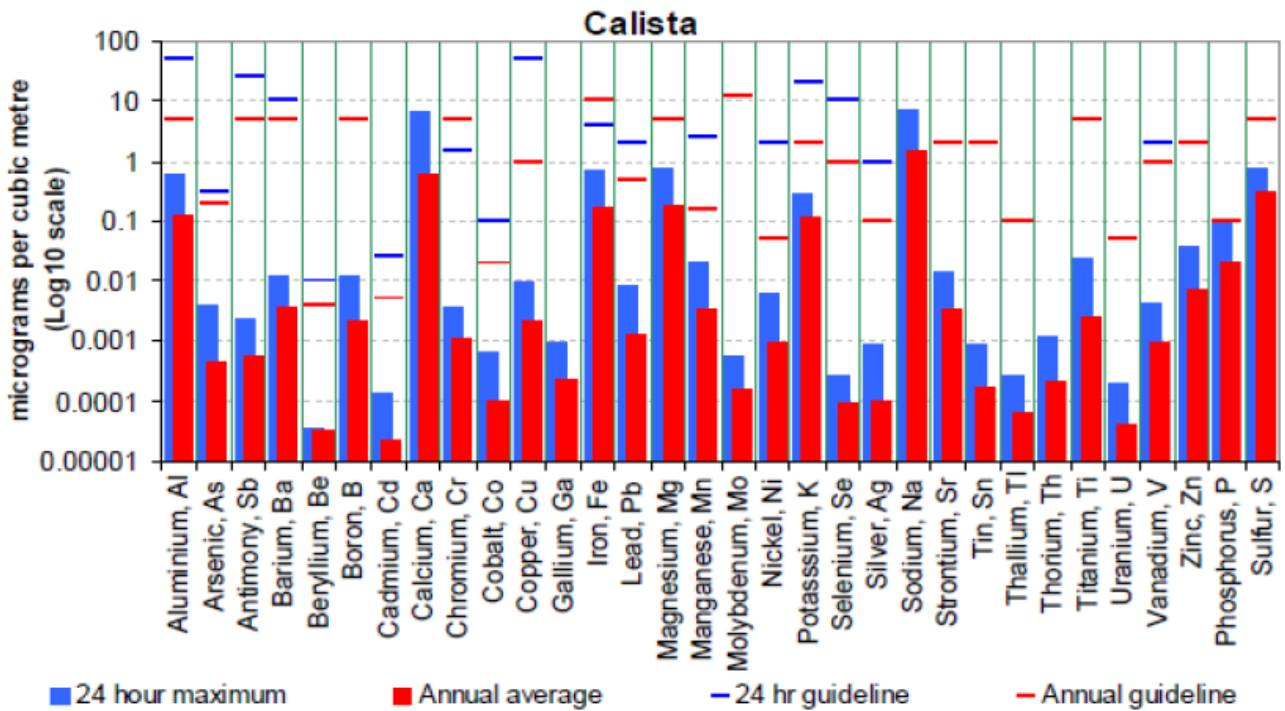
### Heavy Metals

Sampling for heavy metals was conducted by the DER as part of the Kwinana Background Air Quality Study (BAQS) at the Hope Valley monitoring site between February 2005 and February 2006 and at the Calista and Hillman monitoring sites between June 2009 and June 2010. Samples were collected using TSP High Volume (HiVol) Samplers which were run for 24-hours on a six-day rotational cycle (DER, 2011a). The filter papers were analysed for TSP and a suite of heavy metals including arsenic, antimony, cadmium, chromium, copper, lead, manganese, mercury and nickel (as relevant to this assessment).

A summary of the results of each monitoring campaign (as presented by the DER) are presented in Figure 32. The maximum 24-hour average for each of the measured elements remains well below the recommended guideline values adopted for the BAQS by the DER at each of the monitoring sites. Of those compounds relevant to this assessment, the maximum 24-hour and annual average measured concentrations represent less than 10% of the corresponding guideline value.

Figure 32 – Summary of Results of Ambient Heavy Metal Monitoring – Kwinana 2005 to 2010 (DER, 2011a)





### Oxides of Nitrogen and Particulate Matter

The establishment of background concentrations for particulate matter and oxides of nitrogen is discussed in the following sections of this document.

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### 10.2.1.5.5 Establish the background levels for particulates (PM<sub>10</sub> & PM<sub>2.5</sub>) and predict the levels of PM<sub>10</sub> and PM<sub>2.5</sub> at residential areas and neighbouring industrial premises, including the impacts of existing and proposed facilities

Monitoring of ambient PM<sub>10</sub> and PM<sub>2.5</sub> concentrations within the Kwinana region is carried out by the DER at the South Lake monitoring station, located some 12 km north-northeast of the proposed WtE facility. Monitoring of PM<sub>10</sub> began in 2000 and monitoring of PM<sub>2.5</sub> began in 2004, with both ongoing. However, as South Lake is located outside the modelled domain, historical PM<sub>10</sub> monitoring data were sourced from the Kwinana Industries Council (KIC) operated air quality monitoring station at Abercrombie Road, located approximately 2.8 km east-southeast of the proposed WtE facility (see Figure 31).

Ambient PM<sub>10</sub> concentrations were measured at the Abercrombie site between January

1997 and March 1998. The DER has indicated that monitoring data collected over the last 10 years shows a general decrease in PM<sub>10</sub> concentrations in the region, and that the monitoring data available from Abercrombie Road is appropriate to determine background PM<sub>10</sub> concentrations for the region (ENVIRON, 2011).

In addition to the South Lake monitoring site, PM<sub>2.5</sub> monitoring has also been undertaken at the Kwinana Town Centre, 4.8 km southeast of the proposed WtE facility; and the Rockingham Shopping Centre, 9 km south of the proposed WtE facility (Figure 31). This monitoring was carried out between September 2005 and September 2006 as part of the DER's Background Air Quality Study (BAQS). Further PM<sub>2.5</sub> monitoring was also undertaken as part of the BAQS at the Calista and Hillman monitoring stations between May 2009 and June 2010.

A summary of the maximum ambient PM<sub>10</sub> and PM<sub>2.5</sub> concentrations measured within the Kwinana region is presented in Table 23.

**Table 23 – Summary of Maximum Monitored PM<sub>10</sub> and PM<sub>2.5</sub> Concentrations within Kwinana**

Monitoring Site	PM <sub>10</sub> (µg/m <sup>3</sup> )		PM <sub>2.5</sub> (µg/m <sup>3</sup> )			
	24-hour Average	% of NEPM	24-hour Average	% of NEPM	Annual Average	% of NEPM
<b>NEPM Standard</b>	<b>50</b>		<b>25</b>			<b>8</b>
South Lake	66 <sup>[1]</sup>	132%	48 <sup>[1]</sup>	192%	8.7 <sup>[2]</sup>	109%
Abercrombie <sup>[3]</sup>	63 <sup>[4]</sup>	126%	No data	No data	No data	No data
Kwinana <sup>[5]</sup>	No data	No data	32 <sup>[6]</sup>	128%	7.5	94%
Rockingham <sup>[5]</sup>	No data	No data	30 <sup>[6]</sup>	120%	7.5	94%
Calista <sup>[7]</sup>	No data	No data	57 <sup>[8]</sup>	228%	8.7	109%
Hillman <sup>[7]</sup>	No data	No data	61 <sup>[8]</sup>	244%	9.0	113%

**Notes:**

1. Recorded in November 2011. **Attributed to smoke haze.**
2. Recorded in 2006 and 2010.
3. Operational between January 1997 and March 1998.
4. Recorded in December 1997. NEPM goal of no more than 5 exceedances per year was met.
5. Operational between September 2005 and September 2006.
6. Recorded in June 2006. **Attributed to smoke haze.**
7. Operational between May 2009 and June 2010.
8. Recorded in May 2010. **Attributed to smoke haze.**

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The maximum 24-hour average  $PM_{10}$  concentration measured by the DER at the South Lake monitoring site between 2000 and 2011 was  $66 \mu\text{g}/\text{m}^3$ , as recorded in November 2011 (**Appendix F**). Four similar exceedances were also reported in 2010 (**Appendix F**) and three in 2005 (**Appendix F**). Single exceedances of the  $PM_{10}$  NEPM standard were recorded in 2001, 2002, 2004, 2007 and 2008. The NEPM goal of no more than 5 exceedances was met during each of these years. **Smoke haze has been identified as the contributing factor to the majority of the exceedance events at South Lake.**

Similar trends were evident from the historical data collected at the Abercrombie Rd site. Two exceedances of the  $PM_{10}$  NEPM standard were recorded during 1997. A 24-hour average  $PM_{10}$  concentration of  $50.3 \mu\text{g}/\text{m}^3$  was measured on 9 December and a 24-hour average  $PM_{10}$  concentration of  $63 \mu\text{g}/\text{m}^3$  measured on the 30 December. However, the NEPM goal of no more than 5 exceedances per year was met for that year. A total of four exceedances of the  $PM_{10}$  NEPM standard were recorded between January and April 1998.

The 24-hour average  $PM_{10}$  concentration measured at Abercrombie Rd on 27 January was  $51 \mu\text{g}/\text{m}^3$  and on 28 January was  $54 \mu\text{g}/\text{m}^3$ . Consecutive exceedances of  $52 \mu\text{g}/\text{m}^3$  and  $67 \mu\text{g}/\text{m}^3$  were also measured on the 6 and 7 of March 1998.

The maximum 24-hour average  $PM_{2.5}$  concentration measured at the South Lake monitoring site between 2004 and 2011 was  $48 \mu\text{g}/\text{m}^3$ , recorded concurrently with the maximum  $PM_{10}$  concentration in November 2011 (**Appendix F**). Two exceedances of the 24-hour average advisory reporting standard for  $PM_{2.5}$  were also recorded in 2010 and three were recorded in 2009. A single exceedance was recorded in 2008 and 2006. **Smoke haze was identified as the contributing factor to each of the recorded exceedances at the South Lake site.**

The maximum 24-hour average  $PM_{2.5}$  concentrations recorded at the Kwinana Town Centre and Rockingham Shopping Centre between September 2005 and

September 2006 were  $32 \mu\text{g}/\text{m}^3$  and  $30 \mu\text{g}/\text{m}^3$  respectively. The maximum 24-hour average  $PM_{2.5}$  concentrations recorded between May 2009 and June 2010 at the Calista and Hillman monitoring sites were  $57 \mu\text{g}/\text{m}^3$  and  $61 \mu\text{g}/\text{m}^3$  respectively. **Each of these exceedances was attributed to smoke haze (Appendix F).**

The highest annual average  $PM_{2.5}$  concentration recorded between 2004 and 2011 at the South Lake site was  $8.7 \mu\text{g}/\text{m}^3$  (as recorded for 2006 and 2008). An annual average  $PM_{2.5}$  concentration of  $7.5 \text{mg}/\text{m}^3$  was recorded at both the Kwinana Town Centre and Rockingham Shopping Centre sites over the 2005 to 2006 monitoring campaign. The annual averages recorded at the Calista and Hillman sites over the 2009 to 2010 monitoring campaign were  $8.7 \mu\text{g}/\text{m}^3$  and  $9.0 \mu\text{g}/\text{m}^3$  respectively, exceeding the long-term advisory reporting standard.

The air dispersion model predicted results for PM emissions are discussed in section 10.2.1.5.11 from page 119 onwards.

#### 10.2.1.5.6 Review published literature on nano-particles and discuss the findings in relation to this project

Whiting et al (2013) have provided a helpful summary categorising particulate matter, which arises from a variety of sources including traffic emissions, agriculture, domestic and industrial processes:

“It [Particulate Matter] is commonly categorised by size i.e. average diameter of particles as follows:

- $PM_{10}$  - airborne particulate matter passing a sampling inlet with a 50 per cent efficiency cut-off at  $10 \mu\text{m}$  aerodynamic diameter and which transmits particles below this size.
- $PM_{2.5}$  - airborne particulate matter passing a sampling inlet with a 50 per cent efficiency cut-off at  $2.5 \mu\text{m}$  aerodynamic diameter and which transmits particles below this size; and
- $PM_{0.1}$  - particles smaller than  $100 \text{nm}$  in diameter (often referred to as ultrafine particles).” (p35, Summary Report –

Waste to Energy), while Figure 34, which follows, indicates that nano-particles are those ultrafine particles with an average diameter of less than 50 nm.

Stanmore (2011, unpublished) undertook a literature review in relation to nano or ultrafine particles. He notes that due to the relatively new developments in understanding and particulate measurement technologies in the field of nanotechnology, misconceptions about this area of science and technology have also heightened community concerns about emissions of ultrafine particles from various sources, and their potential health impacts. In summary, Stanmore (2011) found that: "Nanoparticles stay in suspension for long periods, and are transported over intercontinental distances. Organic compounds and metals are found to some extent in all samples of ambient air. The species which are responsible for health

impacts are present in material from all sources. Motor vehicles produce most fine particles and dominate the generation of urban pollution. Uncontrolled emissions from bushfires, backyard burning and other internal combustion engines are also a significant contributor to poor air quality." (p1)

In its assessment Emissions from Waste Management Facilities, the UK's DEFRA (2011) presents the following Figure 33, which illustrates how small (nano-size) airborne particles grow from a nuclei whose origin is overwhelmingly from combustion processes (Stanmore, 2011), by what Stanmore (2011) describes as a dynamic process of accretion, mostly by inorganic salts such as nitrates. DEFRA (2011) notes that due to the wide range of potential sources and the various mechanisms of formation, particulate matter is a complex substance.

Figure 33 – Primary Particle Generation Pathways in Combustion Processes (Defra, 2011, adapted from Lighty, Varanth and Sarofim (2000))

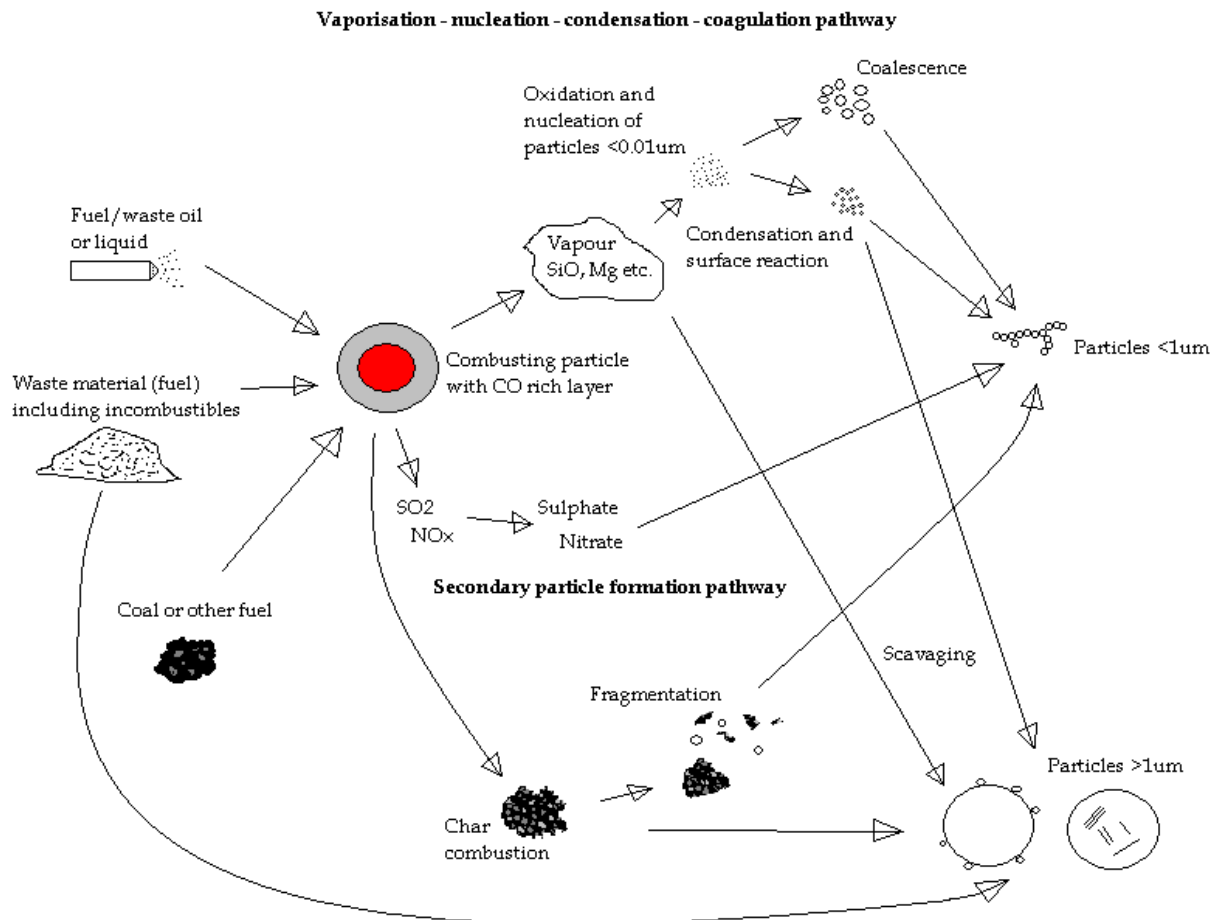
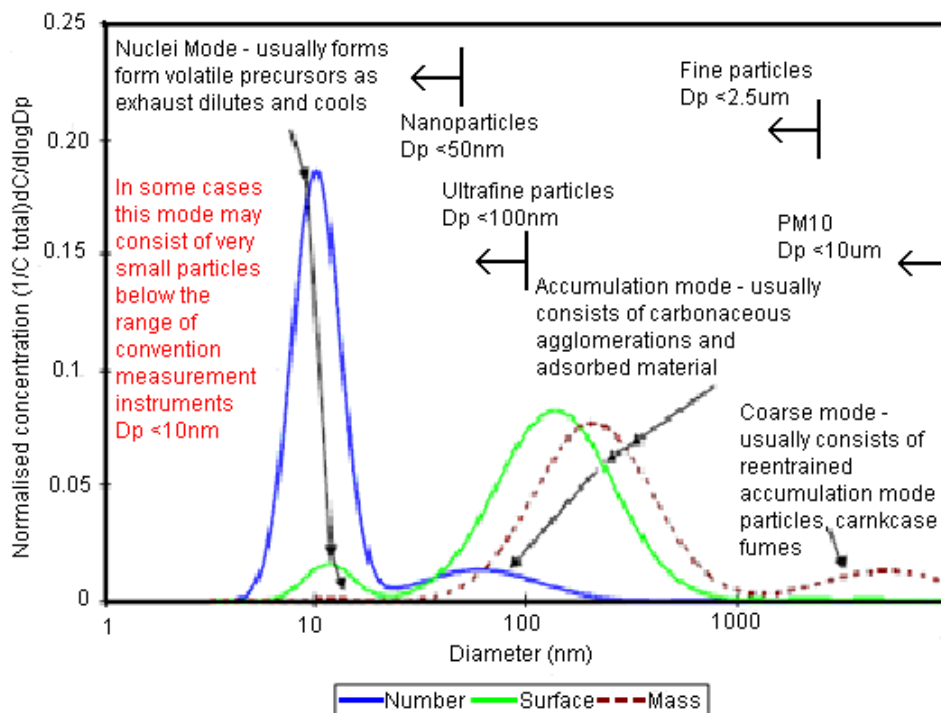




Figure 34 – Distribution of Particles in Terms of Mass, Size and Surface Area



In concluding his review of the literature, Stanmore (2011) draws two primary conclusions in relation to WtE plant particulate emissions:

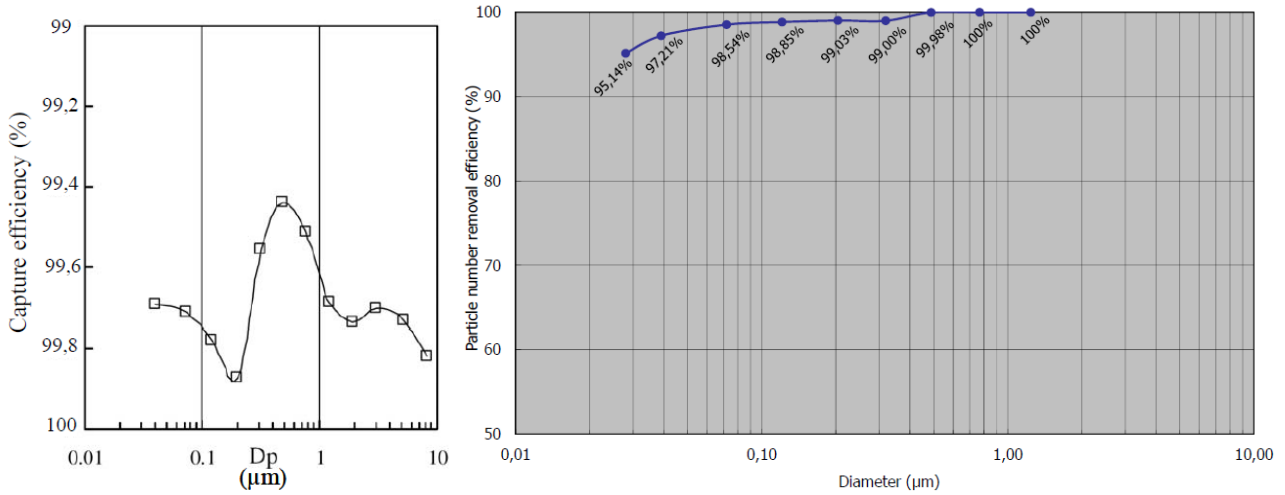
1. Most of the mass of aerosols is not due to the primary source, but has accumulated during transport in the atmosphere. As a result their toxicity will primarily be the result of accreted material.
2. The emissions of particulate matter from a modern WtE plant are inherently low and are insignificant against the background of particulates in an urban airshed. Thus the particulate concentrations emerging from these stacks would be indistinguishable from ambient air sampled at a central city site, and only 5 to 20 times higher than in the relatively clean air of a coastal suburb. In a very short time after discharge they would have been diluted to ambient levels.

DEFRA (2011) notes that one of the main concerns when assessing potential health impacts and devising suitable health based air quality standards has been deriving a suitable metric for measurement. At the present time mass based metrics are used in the UK for measuring ambient concentrations

of particulate matter, however, in the light of the distribution of particles in terms of mass, size and surface area (see **Figure X**), there is evidence to suggest that this is not necessarily the most appropriate metric for the protection of human health. As such particle size and particle composition may be more important factors in how PM affects health (Lighty, Varanth and Sarofim 2000). DEFRA (2011) concludes that setting air quality standards around these metrics that can be practically applied is extremely difficult and therefore metrics are set on a total mass basis.

A recent paper by Cernuschi et al (2010) reported on the results of a wide ranging study undertaken on Ultrafine Particles (UP) from combustion processes. They found that current Best Available air pollution control technologies such as fabric filters (baghouses) and electrostatic precipitators are effective in removing fine and ultrafine particulate matter with capture levels for units, which are correctly sized and well maintained, of between 97% and 99% of the total number of particles (see Figure 35).

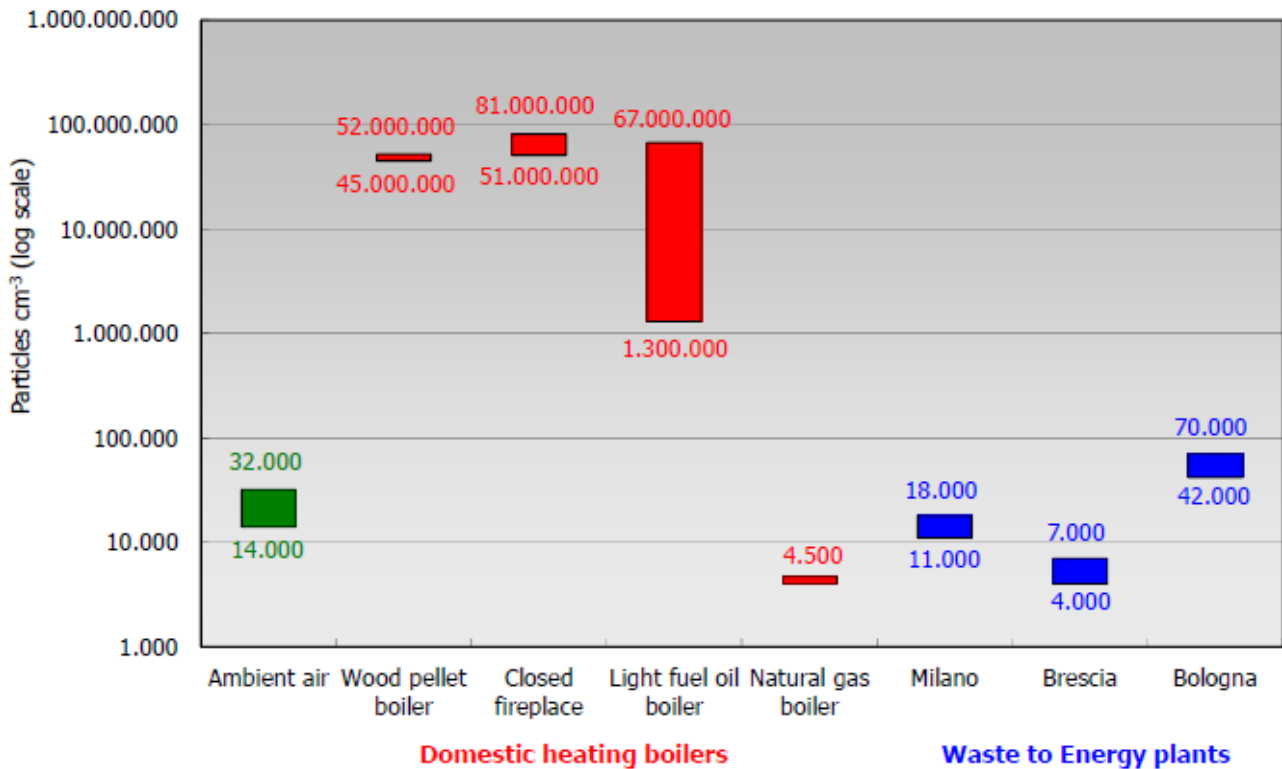
Figure 35 – (Left) Example particle size removal efficiency by number measured for a fabric filter (baghouse) (Source: Yi H. et al., Fuel (2008)) and (Right) Size-fractionated potential removal efficiency of fabric filter as measured during the investigation by Cernuschi et al (2010)



The following figure (Figure 36) compares particulate emissions from three Italian WTE plants with that from other combustion sources and demonstrates that particulate

emission rates from WTE plants are similar if not less than particulate concentrations in the ambient air.

Figure 36 – Summary of the results obtained in the study (Cernuschi et al (2010), p30



Cernuschi et al (2010) drew a number of important conclusions:

- “concentrations of UP measured at emission from WTE plants are generally

at the same levels, when not lower, than those in the ambient air of plant site. The only exception is found for a plant equipped with a wet flue gas treatment unit, where the slight increase seems to

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be attributable to the corresponding small increase in the humidity content of the gas flow. For all plants studied, the concentrations measured are consistently lower by at least two orders of magnitude compared with those found for wood and oil combustion in domestic boilers, and only slightly higher than those produced by natural gas boilers;" (p30), and,

- "fabric filter confirms its recognized excellent potential for particle capture even in the ultrafine size range, with capacities for control [of] both primary particles already present in the gas flow [and] those of condensable origin, arising from nucleation, condensation and coagulation process due to cooling and dilution of flue gases immediately after their stack emission into the atmosphere;" (p31, also see Figure 35 earlier)

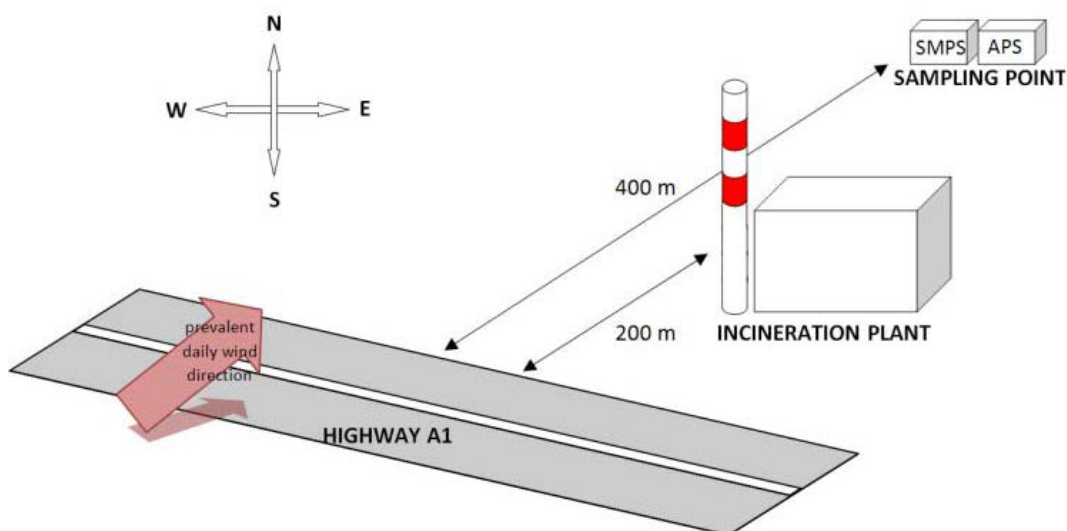
"Regarding exposure and health risks, while due attention to the environmental role of ultrafine particulate and its components is necessary, analysis of Epidemiological and toxicological implications in studies in this field yields no indications of particular risk attributable to UP deriving from waste

combustion, provided plant is equipped and operated in accordance with the best technologies available in the field." (p31)

Buonanno et al (2009) found that emissions from a modern WTE plant to be in the same order as that of ambient inner-city air, and overall annual particulate emissions were equivalent to that from 70 motor vehicles including 5 trucks, travelling constantly along a 1 km section of highway.

In a second study Buonanno et al (2010) considered the relative contributions to atmospheric particulate matter concentrations (in terms of mass of particles and number of particles) over the PM<sub>10</sub> and below particle size range being emitted simultaneously from a major highway and a nearby waste to energy plant, as illustrated in Figure 37. One difference between the WtE plant in the study and the Proposal is that the WtE plant in the study utilised a Refuse Derived Fuel (RDF) or sorted from MSW with the non-combustible fraction removed. The WtE plant, which was designed to meet WID requirements, consisted of a moving grate, a semi-dry APC system and a condensing steam turbine coupled to a generator, for electricity generation.

Figure 37 – Location of the sampling site in the San Vittore del Lazio area



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Buonanno et al (2010) note that “In the plant analyzed, the presence of the fabric filter in a semi - dry flue gas treatment allows an optimum performance in reducing not only the total particle mass, but also the total particle number emission. For this purpose, the particle number distribution and concentration were also measured before the fabric filter, showing an efficiency of 99.995% in terms of total particle number concentration.”

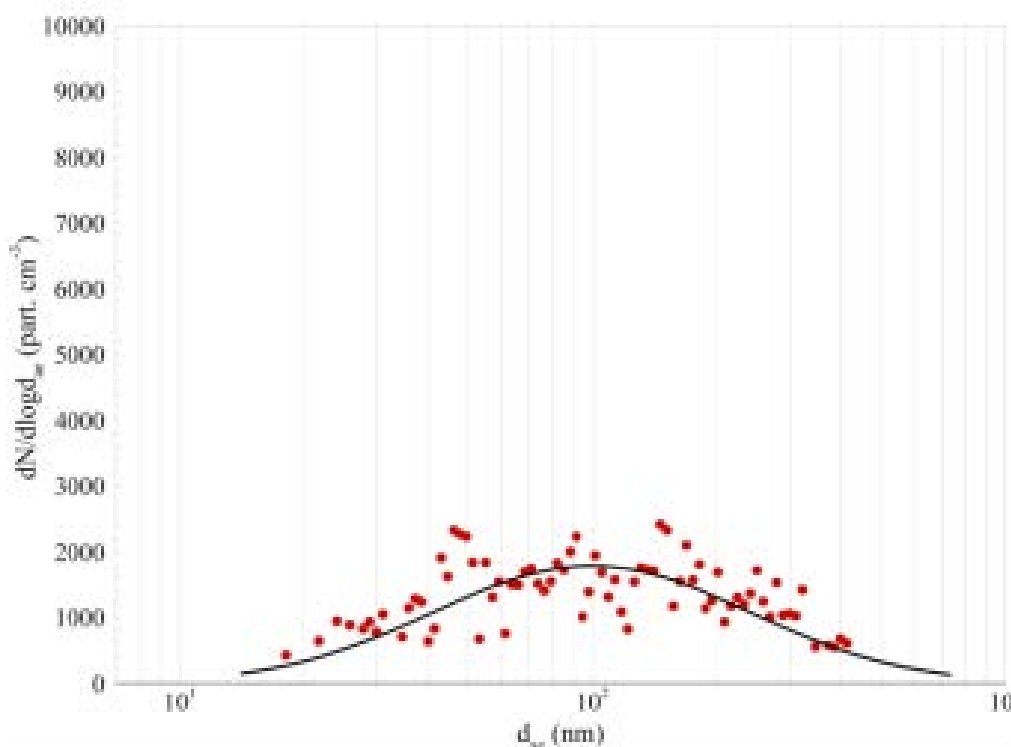
In practice, almost all of the PM emitted will be in the size fraction 2.5 μm and less, because the fabric filter used will remove almost all of the particles with a larger

diameter, whilst being least efficient at around 0.2 – 0.5 μm as indicated in Figure 35.

, which presents typical fabric filter collection efficiencies. Particles of size 0.1 μm and less will be very efficiently removed by the filter through a process of diffusion.

Figure 38 presents the particle number distribution at the stack of the WtE plant under observation by Buonanno et al (2010). The average particle size is approximately 100 nm, with the majority of particles being less than 1 μm, or PM<sub>2.5</sub>.

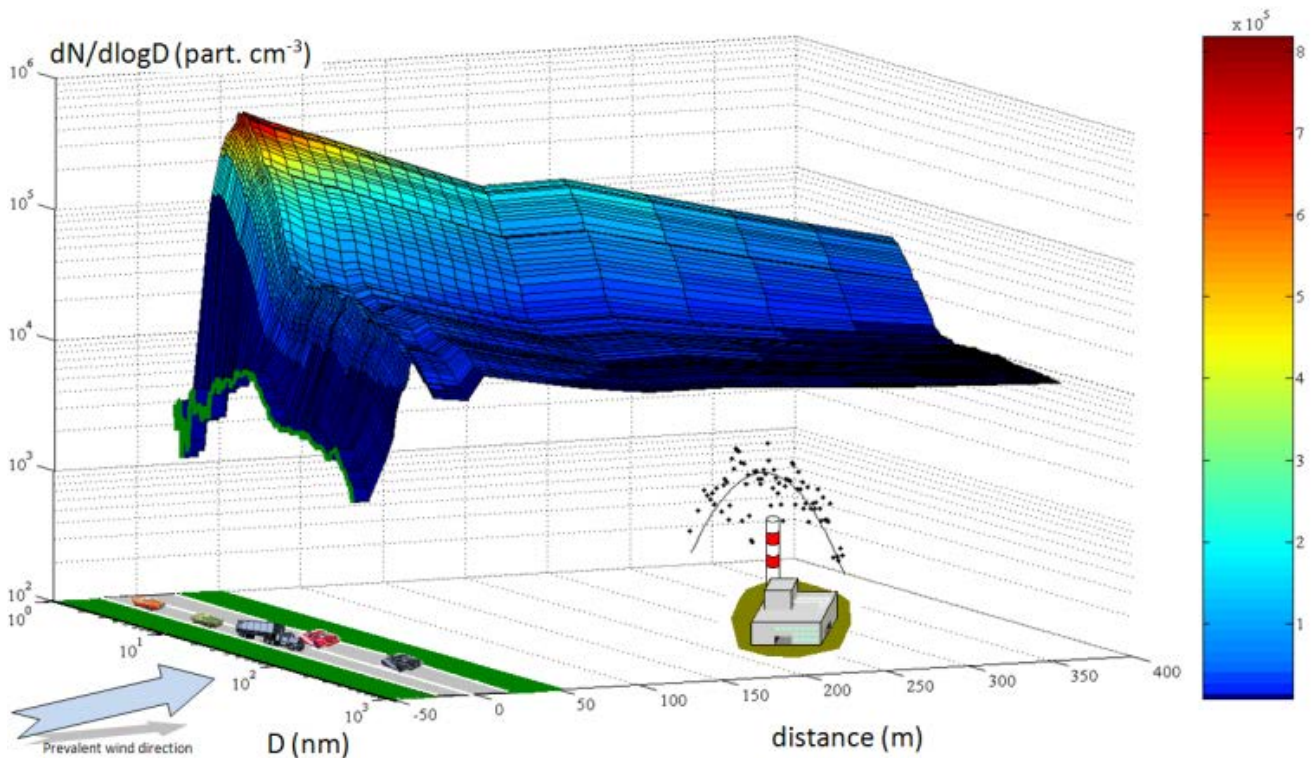
Figure 38 – Particle number distribution at the stack of the WtE plant (Buonanno et al, 2010)



In Figure 39 the particle number size distribution emitted by the WtE Plant (point source) has been superimposed on the contribution from the linear source, being the A1 “Autostrada del Sole” highway in the San Vittore del Lazio area of Italy. It is evident that the contribution of particulate matter emissions by the WtE plant are negligible in

comparison to the highway and are below the background particle number distribution as indicated by the green line at the upwind position in respect to the highway. This is consistent with the findings and conclusions of the literature search and assessment by Stanmore (2011).

Figure 39 – Particle number distribution in the San Vittore del Lazio area. The green line at upwind position in respect to the highway represents the background particle number distribution (Buonanno et al, 2010)



The published literature supports the conclusion that particulate emissions from a well-designed WtE plant, before release into the atmosphere, are of the same order as in the ambient air above a modern city site, and as such they will have a negligible addition to the overall sum of particulates in an urban environment.

The Kwinana WTE plant will be designed to incorporate Best Available air pollution control technologies that are equal to or exceed the requirements of the European WID/IED.

**10.2.1.5.7 Detail the expected emissions of metals, acid gases, organic compounds, dioxins and furans under normal operation, worst case conditions and during commissioning. Describe how the expected emissions were predicted. Substantiate the predictions with reference to data from a similar plant with similar scrubbing system and accepting comparable waste streams**

The starting point for the air quality assessment for the proposal was to take the extremely conservative approach of assuming that the facility is operating at full

capacity and that all pollutants of interest are being emitted at a concentration equal to their respective WID/IED limit values from **both** grate lines (consisting of a grate, boiler, Air Pollution Control (APC) system, CEMs, ID fan and a separate flue), which in reality will operate independently and in parallel. While the WID/IED is widely acknowledged as the international benchmark for establishing emission limits for WtE facilities processing MSW and that those limits have been set so as 'to prevent or limit as far as practicable negative effects on the environment and the resulting risks to human health', it is also understood that the limit values are set to accommodate a range of WtE technologies, which employ Best Available Techniques (BAT) for both thermal conversion and Air Pollution Control. Furthermore, by assuming that all pollutants in the flue gas are being simultaneously emitted at their WID/IED limit values also assumes that the APC system is designed to exactly achieve the WID/IED limit value for each pollutant, whereas in reality, the APC system performance is typically well within the WID/IED limit values, please refer to section 10.2.1.6.1.5 Typical Best Available Technique (BAT) Operational Emissions Levels on page 145),

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Individual WtE technologies and APC technologies have their own unique responses to abnormal operation, hence the special allowances in the WID/IED to accommodate excursions in Total Dust (i.e. Particulate Matter) and the allowances for higher half-hourly average limit values, to accommodate short term operating conditions. The WID/IED also requires that any abnormal operation must be addressed quickly and expediently. However, each proposal must be assessed in the context of the proposed plant configuration (i.e. the number of operating lines), the proposed APC system configuration, as well as the local and regional environment in which it is to be located, with due consideration given to topography, meteorological conditions (and effects associated with a coastal location), and proximity to sensitive receptors.

As such, ENVIRON Australia (ENVIRON, the air quality consultant employed by Phoenix Energy to undertake the air quality and odour assessment for the proposal) undertook a two stage approach to its assessment of air quality impacts:

**Stage 1** – Consider all pollutants in the flue gas as being simultaneously at their WID/IED limit values (by definition this assumes that the APC system is designed to exactly achieve the WID/IED limit value for each pollutant, whereas in reality, the APC system performance is typically well within the WID/IED limit values, please refer to section 10.2.1.6.1.5 Typical Best Available Technique (BAT) Operational Emissions Levels on page 145), while the proposal is assumed to be operating at full capacity, and compare worst case predicted ground level concentrations (GLCs) against the relevant standards and guidelines.

**Stage 2** – For those pollutants whose worst case GLCs predicted in Stage 1 were found to hypothetically approach or exceed a relevant standard or guideline, actual independent stack test results from Martin grate reference facilities with similar size lines and Air Pollution Control systems designed using BAT or US EPA approved MACT (Maximum Achievable Control Technology) were applied to the assessment, in order to demonstrate compliance with relevant

standards and guidelines applicable to a new proposal located in the Kwinana Industrial Area and operating under worst case local meteorological conditions.

While the Environmental Scoping Document calls for consideration of a range of operating scenarios including start-up, worst case and commissioning, the air quality assessment focused on the worst case operating condition, i.e. operation at full capacity under worst case meteorological conditions and applicable background ground level concentrations of those pollutants of interest to the assessment. The reason for focussing on operation at full capacity as the ‘worst case’ scenario is due to the following observations, some of which are unique to Martin grate or similar stoker grate WtE technologies:

- 1.) In a WtE facility, the majority of pollutants are due to the nature and composition of the fuel itself i.e. MSW. Therefore, in the event of a system upset, likely flagged by an ‘approach to limit’ alarm linked to the Continuous Emissions Monitoring System (CEMS), standard operating procedure is to stop MSW feed to the grate until the system upset has been diagnosed and rectified, or failing that to shut down the line and undertake repairs.
- 2.) Natural gas fuelled auxiliary burners: All grate type WtE plants are equipped with auxiliary burners, which act automatically to maintain combustion temperatures in the furnace at or above the minimum allowable combustion temperature (i.e. 850°C) whenever there is MSW on the grate. This helps to destroy the majority of organic compounds remaining in the flue gas (including dioxins and furans) and also to ensure that the majority of carbon monoxide is converted to carbon dioxide.
- 3.) An automated combustion control system: Today’s modern grate type WtE plants have fully automated combustion control systems, which constantly monitor the conditions on and above the grate, making adjustments to primary and secondary combustion air, calling on the auxiliary burners if necessary, and monitoring the steam generation rate in

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the boiler, in order to ensure that there is sufficient fuel on the grate. The control system is critical to ensuring maximum carbon burnout, which leads to the maximum possible energy recovery from the carbon in the feedstock, while also ensuring that pollutants associated with incomplete combustion (e.g. carbon monoxide) are minimised at all times.

- 4.) A Continuous Emissions Monitoring System (CEMS). The majority of pollutants of interest in terms of their potential to impact on either the environment or human health (if uncontrolled), are continuously monitored online by the CEMS. The CEMS is integrated with the plant control system, which allows for automatic adjustments to reagent injection rates or operating temperatures, to ensure that the Air Pollution Control equipment is operating effectively at all times.
- 5.) Most modern APC systems designed using BAT include a fabric filter or baghouse. As illustrated in Figure 35 in section 10.2.1.5.6 relating to nanoparticles, fabric filters are highly effective in capturing large, small and ultrafine particulate matter. Furthermore, the baghouse will typically have multiple sections, each of which can be taken out of service to allow online bag replacement. The fabric filter in conjunction with the Martin grate type combustion system will ensure that emissions of Particulate Matter are effectively controlled at all times and under all operating conditions.
- 6.) Built-in redundancy of key plant and equipment: two parallel grate lines (including APC equipment, ID fan, CEMS and flue) operating independently means that the plant can continue to accept and process MSW even one line is shut down for maintenance. Furthermore, critical items of equipment such as the combustion air fans, firewater pumps, boiler feed water pumps and CEMS are duplicated for duty/stand-by configuration.
- 7.) A stand-by diesel generator is typically available to maintain emergency power to key control systems and critical

process systems, to allow for a controlled plant shutdown in the event of an emergency or in the unusual even of a blackout. A total loss of electricity is indeed highly unusual in that the plant will provide its own power during normal operation.

- 8.) Experienced Operations & Maintenance service provision: It is not sufficient to have included BAT or MACT throughout, if the plant is not operated in accordance with the technology providers operating instructions and/or if maintenance regimes are not effectively enforced. As a dedicated WtE plant owner and/or operator of 44 similar large scale WtE facilities (22 of which are Martin grate reference sites) worldwide, Covanta Energy Corporation (the preferred facility manager and plant operations and maintenance service provider) is well placed to ensure the facility is operated safely and efficiently. Covanta is also implementing its Clean World Initiative, which provides a corporate led focus on sustainability, covering all aspects of facility operation as well as community outreach programs that create a direct connection between the facility, the local community and the municipalities it serves.

With ~1000 grate type WtE plants (~400 of which use the Martin grate technology) operating worldwide, many of which are located within heavily populated urban environments, and operating successfully under their environmental permit or license conditions, it is quite evident that these facilities can and do fulfil a critical role in creating both sustainable waste management outcomes and generating clean renewable energy for the communities they serve, alongside composting of source separated organics and recyclable recovery services.

Table 24 provides a summary of the WID/IED limit values for each pollutant identified in the WID/IED and compares this to actual operating plant data. The table also identifies where actual operating plant data has been used in the second stage of the air dispersion modelling assessment, since the use of WID/IED emission limit values would give the

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false impression that expected emissions could approach ground level concentration guidelines under certain worst case meteorological conditions. Where WID/IED limits are utilised, the highest limit value (typically corresponding to the shortest averaging period) was used for conservatism.

Actual independent emissions test data undertaken for reporting by the Clean Association of TOKYO23 (2012) to the Japanese Ministry of the Environment is provided for the Kita, Tokyo MHIEC reference plant (or North Incineration Plant), a facility located in the north of the greater Tokyo area with a single 600 tpd MHIEC-Martin stoker grate line with an APC system consisting of a flue gas quench followed by a baghouse, a wet scrubber and a selective catalytic reduction reactor. Of the 10 potential reference facilities with one or more 600 tpd (or similar size) lines, and operating for more than 12 months, the single line, 600 tpd MHIEC-Martin Tokyo-Kita reference plant has been selected as the primary reference facility for benchmarking the proposal. The reasons for selecting this particular facility are as follows:

- While the extensive Martin reference list (see **Appendix D**) demonstrates that the proposed scale, with respect to overall plant throughput, does not present an issue for the proposal, the line size is a more appropriate measure for benchmarking the Air Pollution Control system performance

- The Tokyo-Kita plant has a similar APC system to that proposed for the Kwinana WtE plant, and the same underlying combustion system – the Martin reverse acting grate system
- The Tokyo-Kita plant has a proven track record (with an operational start date of 1998)
- The plant was built by technology provider MHIEC, and
- Air emissions data is readily available in the public domain (please refer to <http://www.union.tokyo23-seisou.lg.jp.e.de.hp.transer.com/gijutsu/kankyo/toke/chosa/sokute/h24kekka.html>)

As the Kita plant data indicates that the measured value for each of the heavy metals tested for was below the lowest concentration that can be accurately quantified in the analysis method used for stack test measurement and reporting, it was decided to use the publically available independent stack testing results for inorganic components obtained from Montgomery County, a 3 x 544 tpd Martin grate reference site (with a similar line size and a similar APC system configuration with respect to heavy metals abatement, but designed to US EPA standards, which are generally slightly lower than the equivalent EU or Japanese standards, and therefore a more conservative choice for modelling purposes) operated by Covanta on behalf of the State of Maryland.

Table 24 – Summary of Limit Values, Operating Plant Data and Air Dispersion Model Inputs (all concentration units are expressed in mg/Nm<sup>3</sup> dry, @ 11% Oxygen, unless otherwise indicated)

Compound	Averaging Period	WID/IED Emission Rate Limit Value	WID/IED Emission Limit Value Averaging Period	Source of Emission Concentration used for Air Dispersion Modelling	Emission Concentration used for Air Dispersion Modelling	Actual Plant Exhaust Gas Measurement Data as reported for Kita, Tokyo	Comment
NOx	1-hour	400	Half-hourly Ave. 100th Percentile	Tokyo-Kita	87	68-87 as NOx (expressed as NO <sub>2</sub> [9])	Tokyo-Kita plant 2012 emissions report
	Annual	200	Daily ave. & 30-min. mean 97th percentile	Tokyo-Kita	87	68-87 as NOx (expressed as NO <sub>2</sub> [9])	Tokyo-Kita plant 2012 emissions report
CO	8-hour	100	Half-hourly Ave. 100th Percentile	WID	100	5.5-22	Tokyo-Kita plant 2012 emissions report



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Compound	Averaging Period	WID/IED Emission Rate Limit Value	WID/IED Emission Limit Value Averaging Period	Source of Emission Concentration used for Air Dispersion Modelling	Emission Concentration used for Air Dispersion Modelling	Actual Plant Exhaust Gas Measurement Data as reported for Kita, Tokyo	Comment
SO <sub>2</sub>	1-hour	200	Half-hourly Ave. 100th Percentile	WID	200	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
	24-hour & Annual	200	Half-hourly Ave. 100th Percentile	WID	200	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
PM <sub>2.5</sub>	Annual	30	Half-hourly Ave. 100th Percentile	WID	30	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
PM <sub>10</sub> [2]	24-hour	30	Half-hourly Ave. 100th Percentile	WID	30	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
TSP[2]	1-hour	30	Half-hourly Ave. 100th Percentile	WID	30	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
	24-hour	30	Half-hourly Ave. 100th Percentile	WID	30	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
HF	1-hour	4	Half-hourly Ave. 100th Percentile	WID	4	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
HCl	1-hour	60	Half-hourly Ave. 100th Percentile	WID	60	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
	Annual	60	Half-hourly Ave. 100th Percentile	WID	60	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
Total Organic Carbon	1-hour	20	Half-hourly Ave. 100th Percentile	N/A	Note 7	3.0 ppm Total Hydrocarbons	Tokyo-Kita plant 2012 emissions report
	Annual	10	Daily average	N/A	Note 7		Tokyo-Kita plant 2012 emissions report
Lead <sup>6</sup>	Annual	0.055 [3]	11% of Limit Value	Montgomery [10]	2.68E-03	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
Cadmium <sup>4</sup>	Annual	0.05	Limit Value	Montgomery [10]	4.59E-04	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
	1-hour	0.05	Limit Value	Montgomery [10]	4.59E-04	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
	24-hour	0.05	Limit Value	Montgomery [10]	4.59E-04	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
Mercury <sup>5</sup>	Annual	0.05	Limit Value	Montgomery [10]	1.61E-02	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
Antimony <sup>6</sup>	1-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	7.01E-04	Not measured	Note 10
Arsenic <sup>6</sup>	Annual	0.055 [3]	11% of Limit Value	Montgomery [10]	6.97E-04	Not Detected [8]	Tokyo-Kita plant 2012 emissions report

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Compound	Averaging Period	WID/IED Emission Rate Limit Value	WID/IED Emission Limit Value Averaging Period	Source of Emission Concentration used for Air Dispersion Modelling	Emission Concentration used for Air Dispersion Modelling	Actual Plant Exhaust Gas Measurement Data as reported for Kita, Tokyo	Comment
	1-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	6.97E-04	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
	24-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	6.97E-04	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
Copper <sup>6</sup>	1-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	1.21E-03	Not Detected [8]	Note 10
	24-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	1.21E-03	Not Detected [8]	Note 10
Chromium VI <sup>6</sup>	1-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	1.04E-03 (assumes Total Cr = CrVI)	Not Detected [8]	Note 10
	Annual	0.055 [3]	11% of Limit Value	Montgomery [10]	1.04E-03 (assumes Total Cr = CrVI)	Not Detected [8]	Note 10
Manganese <sup>6</sup>	1-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	1.79E-03	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
	24-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	1.79E-03	Not Detected [8]	Tokyo-Kita plant 2012 emissions report
Nickel <sup>6</sup>	1-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	1.93E-03	Not measured	Note 10
	24-hour	0.055 [3]	11% of Limit Value	Montgomery [10]	1.93E-03	Not measured	Note 10
	Annual	0.055 [3]	11% of Limit Value	Montgomery [10]	1.93E-03	Not measured	Note 10
Dioxins and Furans (ng.ITEQ/ Nm <sup>3</sup> )	1-hour	0.1	Limit Value (ave. for sampling period)	WID	0.1	0.000052	2013 Clean Energy Association Report (Kita)
	Annual (Incremental Carcinogenic Risk)	0.1	Limit Value (ave. for sampling period)	WID	0.1	0.000052	2013 Clean Energy Association Report (Kita)

Notes:

1. Clean Association of TOKYO23, Kita, Tokyo (North incineration plant) 2012 Environment Measurements downloaded from <http://www.union.tokyo23-seisou.lg.jp/gijutsu/kankyo/toke/chosa/sokute/documents/24kita.pdf> (accessed November 2013)
2. The maximum predicted PM2.5 Ground Level Concentrations (GLCs) have been assessed as representative of TSP and PM10.
3. UK Environment Agency "Guidance to applicants on impact assessment for group 3 metals stack releases", Step 2 recommends equal weighting of Group III metals for screening purposes. i.e. 11% of Limit Value (averaged over the sampling period)
4. Group I metal.
5. Group II metal.
6. Group III metals.
7. No speciation provided for TOC in reference plant stack test results. These results are reported in Japan and the US as Total Hydrocarbons, including methane and ethane (for which no specific air quality guidelines for Ground Level Concentrations exist).

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8. Not detected means that the measured value is below the lowest concentration that can be accurately quantified in the analysis method used for stack test measurement and reporting.

9. Measurement data indicates total NO<sub>x</sub> is 30-38 ppmvd @12% O<sub>2</sub>, of which 1.7 ppmvd @12% O<sub>2</sub> is NO<sub>2</sub> i.e. ~5% or less of NO<sub>x</sub> is actually NO<sub>2</sub>.

10. Refer to Montgomery County ERC HRA 2006 Table 4-1, represented as Table 25, which follows.

**Table 25 – Montgomery County RRF Compounds of Potential Concern and Emission Rates for Maximum Operating Conditions for the Health Risk Assessment Update (with estimated emission rates and associated emission concentrations applicable to the Kwinana WtE proposal**

Compound of Potential Concern	Emission Rate (lb/hr) (1)	Emission Rate (g/sec) (1)	Estimated emission rate (g/s) for Kwinana WtE Capacity (both lines)	Estimated emission conc. For Kwinana (mg/Nm <sup>3</sup> dry @11% O <sub>2</sub> )
<b>Inorganics/Metals</b>				
Antimony	7.23E-04	9.12E-05	6.78E-05	7.01E-04
Arsenic	7.20E-04	9.06E-05	6.72E-05	6.97E-04
Beryllium	1.21E-04	1.53E-05	1.14E-05	1.18E-04
Cadmium	4.74E-04	5.97E-05	4.44E-05	4.59E-04
Chromium (Total)	1.07E-03	1.35E-04	1.00E-04	1.04E-03
Chromium (VI)	5.19E-04	6.51E-05	4.84E-05	5.01E-04
Cobalt	5.13E-04	6.45E-05	4.80E-05	4.96E-04
Copper	1.25E-03	1.58E-04	1.17E-04	1.21E-03
Lead	2.75E-03	3.48E-04	2.58E-04	2.68E-03
Manganese	1.85E-03	2.33E-04	1.73E-04	1.79E-03
Mercury	1.66E-02	2.09E-03	1.55E-03	1.61E-02
Nickel	1.99E-03	2.51E-04	1.86E-04	1.93E-03
Selenium	8.70E-04	1.10E-04	8.16E-05	8.46E-04
Zinc	1.32E-02	1.66E-03	1.23E-03	1.28E-02

**Notes:**

(1) Emission rate from the RRF with all 3 Martin grate lines operating at maximum load i.e. 1632 tpd, compared to 1212 tpd for Kwinana WtE (2 x 606 tpd lines).

A summary of the stack parameters and emissions rates are provided in Table 26. The air dispersion modelling assessment has considered odour emissions from the tipping hall entry and exit doors, while all other modelled compounds are associated with emissions from the multi-flue stack. The multi-flue stack has been modelled as a

single stack source using exhaust parameters provided by Phoenix Energy. An effective stack diameter was calculated based on the exit velocity and combined volumetric flow rate for each flue. Note that only those components for which an air quality guideline exists have been included in the air dispersion modelling.

**Table 26 - Summary of Emission Estimates and Stack Parameters**

Parameter	Unit	Multi-flue Stack
Release Height	m	87.5
Stack Diameter <sup>[3]</sup>	m	3.0
Exit Velocity	m/s	18.3
Exit Temperature	K	405
<b>Modelled Compounds</b>		
SO <sub>2</sub> <sup>[1]</sup>	g/s	19

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Parameter	Unit	Multi-flue Stack
NO <sub>x</sub> <sup>[2]</sup>	g/s	8.4
Particulate Matter <sup>[1]</sup>	g/s	2.9
CO <sup>[1]</sup>	g/s	9.7
HF <sup>[1]</sup>	g/s	0.4
HCl <sup>[1]</sup>	g/s	5.8
Dioxins and Furans <sup>[1]</sup>	g/s	9.7E-09
Antimony <sup>[2]</sup>	g/s	6.8E-05
Arsenic <sup>[2]</sup>	g/s	6.7E-05
Cadmium <sup>[2]</sup>	g/s	4.4E-05
Chromium VI <sup>[2]</sup>	g/s	4.8E-05
Copper <sup>[2]</sup>	g/s	1.2E-04
Lead <sup>[2]</sup>	g/s	2.6E-04
Manganese <sup>[2]</sup>	g/s	1.7E-04
Mercury <sup>[2]</sup>	g/s	1.6E-03
Nickel <sup>[2]</sup>	g/s	1.9E-04

**Notes:**

1. Emission estimate based on WID Emission Limits.
2. Emission estimate based on reference plant stack testing data.
3. Effective stack diameter calculated based on the exit velocity and combined volumetric flow rate for each flue.

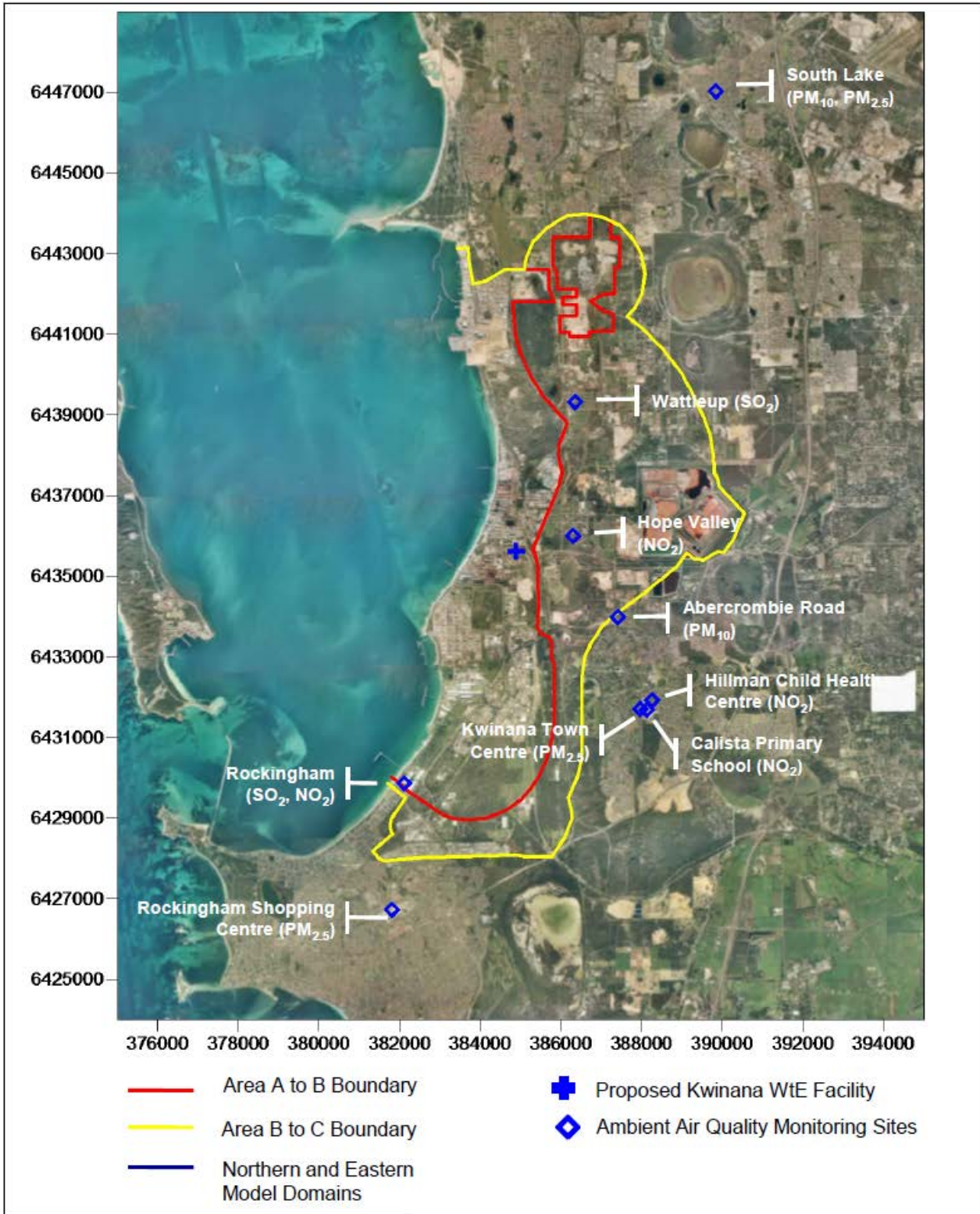
**10.2.1.5.8 Establish the background levels of oxides of nitrogen and model the expected ground level concentrations under normal operation, worst case conditions and during commissioning from the proposal in isolation and cumulatively with other sources in the airshed**

Monitoring of ambient nitric oxide (NO) and NO<sub>2</sub> concentrations within the Kwinana region has been carried out by the DER for a number of years. Long-term monitoring stations established in the mid-1990's as part of the Perth Photochemical Smog Study and the Perth Haze Study were located at Hope Valley and North Rockingham (Figure 40). Monitoring at the Hope Valley site, located within approximately 1.2 km of the proposed

WtE facility, began in 1994 and continued until 2009 when the station was decommissioned. Monitoring at the Rockingham site, located within approximately 6 km of the proposed WtE facility, began in 1995 and is currently ongoing.

Two additional NO<sub>2</sub> monitoring sites were established in the Kwinana region in 2009 as part of the DER's Background Air Quality Study (BAQS). These were located at the Calista Primary School, 4.8 km southeast of the proposed WtE facility; and the Hillman Child Health Centre, 4.9 km southeast of the proposed WtE facility (Figure 40). Continuous monitoring was carried out at these two sites for a 12-month period between May 2009 and June 2010.

Figure 40 - Kwinana Environment Protection Policy Area boundaries and monitoring sites



A summary of the maximum 1-hour and annual average NO<sub>2</sub> concentrations recorded at the Hope Valley, North Rockingham, Calista and Hillman monitoring stations is presented in Table 27. This data shows that

no exceedances of the NEPM NO<sub>2</sub> 1-hour standard of 0.12 ppm or annual standard of 0.03 ppm have been recorded at any of the monitoring sites.

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Table 27 – Summary of Maximum Monitored NO<sub>2</sub> Concentrations within the Kwinana Area

Monitoring Site	1-hour Average			Annual Average		
	ppm	µg/m <sup>3</sup> [1]	% of NEPM	ppm	µg/m <sup>3</sup> [1]	% of NEPM
Standard	0.12	226		0.03	56	
Hope Valley	0.084 <sup>[2]</sup>	158	70%	0.005 <sup>[3]</sup>	9.4	17%
North Rockingham	0.055 <sup>[4]</sup>	103	46%	0.008 <sup>[5]</sup>	15	27%
Calista	0.049 <sup>[6]</sup>	92	41%	0.005 <sup>[6]</sup>	9.4	17%
Hillman	0.043 <sup>[6]</sup>	81	36%	0.006 <sup>[6]</sup>	11	20%

**Notes**

1. Referenced to 25°C, and 101.325kPa.
2. Recorded in 2007.
3. Recorded in 1999, 2000, 2001, 2002, 2003 and 2004.
4. Recorded in 2004.
5. Recorded in 2000.
6. Recorded between May 2009 and June 2010.

The highest maximum 1-hour NO<sub>2</sub> concentration monitored at any of the Kwinana monitoring stations is 0.084 ppm (70% of the NO<sub>2</sub> NEPM) and was recorded in 2007 at the Hope Valley site. The highest maximum 1-hour NO<sub>2</sub> concentration monitored at the North Rockingham site is 0.055 ppm (46% of the NO<sub>2</sub> NEPM) and was recorded in 2004.

The highest maximum 1-hour NO<sub>2</sub> concentrations recorded at the Calista and Hillman monitoring stations between May 2009 and June 2010 were 0.049 ppm and 0.043 ppm respectively, representing no more than 41% of the NO<sub>2</sub> NEPM standard. Assessment of pollution roses for the Calista and Hillman monitoring sites does not indicate any particular direction as a dominant source of NO<sub>2</sub> (**Appendix F**). The DER found this result was not unexpected as the major contributor to NO<sub>2</sub> levels in populated regions is vehicle exhaust (**Appendix F**).

The annual average NO<sub>2</sub> concentrations measured at the Hope Valley, North Rockingham, Calista and Hillman monitoring stations also remain well below the annual NEPM standard of 0.03 ppm, the highest

annual mean recorded at any site being 0.008 ppm (27% of the annual NO<sub>2</sub> NEPM).

The air dispersion model predicted results for oxides of nitrogen emissions are presented and discussed in section 10.2.1.5.11.5 Normal Operations – Other Pollutants, for the facility in isolation, beginning on page 126 and section 10.2.1.5.11.6 Cumulative Impact Assessment for NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and Heavy Metals, cumulatively with other sources, beginning on page 137.

#### 10.2.1.5.9 Consider the implications of the project in relation to ambient ozone concentrations within the regional airshed

Photochemical smog is an air pollution problem common in large cities. It is characterised by high ozone concentrations at ground level, and can be generated through the interaction of NO<sub>x</sub> and reactive organic compounds (ROC) in the environment. Potential sources of NO<sub>x</sub> and ROC include industrial processes, vehicle exhausts and bushfires.

2011/2012 National Pollution Inventory (NPI) data indicates that within the Perth airshed approximately 25,560 tonnes (out of the total of 26,378 tonnes) of NO<sub>x</sub> emissions are from

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diffuse (i.e. non industrial) sources including motor vehicles (21,683 tonnes) and biogenic sources (2,606 tonnes) and that these diffuse emission estimates are based on data from 1999.

The proposed Phoenix Energy WtE Facility is conservatively estimated to add approximately 132 tonnes per year or a 2% increase in the 6,600 tonnes per year of NO<sub>x</sub> emitted to the Kwinana Airshed (NPI, 2011/12 reporting year) or a further 0.5% to the total Perth airshed NO<sub>x</sub> emissions). Due to the complexity of photochemistry in the Perth airshed, it is difficult to reliably quantify the impact of such a small increase in the overall NO<sub>x</sub> emissions as the change in the total airshed emission rate is very small and would be no more than “noise” in any numerical modelling assessment.

ENVIRON concluded that its analysis of emissions of NO<sub>x</sub> from the proposed WtE Plant indicates that it is unlikely to make a noticeable contribution to ozone formation within the Perth airshed.

#### **10.2.1.5.10 Estimate the background levels of carbon monoxide and model the expected ground level concentrations from the proposal in isolation and cumulatively with other sources in the airshed if it appears that the NEPM standard may be exceeded**

Carbon monoxide was included in the air quality assessment as it is one of the criteria components included in the WID/IED.

The results of the assessment of ground level concentrations for carbon monoxide for normal operations (at maximum emission rates) under worst case meteorological conditions and worst case background ground level concentrations is presented in the following section. However, it is clear that the proposal will have a negligible impact on ground level concentrations either in isolation or cumulatively, and using the highly conservative WID/IED limit value as the basis for the emission rate, the ground level concentration is predicted to be less than 1% of the guideline value.

#### **10.2.1.5.11 Model ground level concentrations of particulates, metals, acid gases, organic compounds, dioxins and furans formaldehyde and acetaldehyde from the proposal and cumulatively with other existing and proposed sources in the area at residential and neighbouring premises under normal operation, worst case conditions and during commissioning, as necessary. Compare predicted emissions and ground level concentrations with appropriate standards**

##### **10.2.1.5.11.1 Air Dispersion Modelling and Methodology**

The Gaussian dispersion models DISPMOD (Versions 1997 and 2005) and the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (Version 12060) were both used in this study to predict the air quality impacts from the proposed WtE facility, though AERMOD was only used for the fugitive odour assessment as described in section 10.1.2.7 on page 89. The use of DISPMOD is required by the DER for assessing compliance with the Kwinana EPP Limits and Standards for SO<sub>2</sub>. Further details regarding the two models are presented in Sections 5.1.1 and 5.1.2 of **Appendix F**.

##### **10.2.1.5.11.2 Meteorological Data**

Meteorological datasets used in DISPMOD were developed by the DER for the 1980, 1995 and 1996 calendar years, consistent with the approach used for the most recent redetermination (DER, 2009). Previous studies conducted by the DER have determined that these years are considered representative of meteorology in the region.

##### **10.2.1.5.11.3 Impact Assessment for Sulphur Dioxide (SO<sub>2</sub>) for Kwinana WtE in Isolation**

Modelling of sulphur dioxide emissions associated with the proposal was undertaken by ENVIRON using DISPMOD, an air dispersion model developed by the

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Department of Environment Regulation (DER) specifically for the Kwinana area.

The results of DISPMOD modelling of SO<sub>2</sub> emissions from the proposed Phoenix Energy WtE facility in isolation are presented in Table 28. The results have been presented for the Full modelling domain using DISPMOD 2005 for the 1996 calendar year only, as this combination tends to be the most conservative (i.e. highest predicted GLCs).

The data presented in Table 28 indicates that the predicted SO<sub>2</sub> GLCs for the proposed Phoenix Energy WtE facility operating in

isolation are expected to remain well below the Kwinana EPP Limits and Standards. The maximum 1-hour average SO<sub>2</sub> GLCs predicted for Areas A, B and C represent no more than 3.5% of the applicable Limit value. The 99.9<sup>th</sup> percentile 1-hour average SO<sub>2</sub> GLCs predicted within each of the Policy areas are no greater than 4.2% of the applicable Standard value. The maximum predicted 24-hour average SO<sub>2</sub> GLCs are similarly no more than 4.3% of the corresponding Standard, while the annual average predicted SO<sub>2</sub> GLCs remain less than 1.6% of the applicable Standard.

Table 28 – Predicted SO<sub>2</sub> Concentrations for Phoenix Energy in Isolation – Full Domain

Model Domain	Area	EPP Guidelines		DISPMOD 2005	
		Standard	Limit	1996	%Guideline
24hr max. (µg/m <sup>3</sup> )	A	n/a	1400	36	2.6%
	B	n/a	1000	35	3.5%
	C	n/a	700	17	2.4%
1hr 99.9 <sup>th</sup> percentile (µg/m <sup>3</sup> )	A	700	n/a	21	3.0%
	B	500	n/a	21	4.2%
	C	350	n/a	10	2.9%
24hr max. (µg/m <sup>3</sup> )	A	200	365	7.0	3.5%
	B	150	200	6.4	4.3%
	C	125	200	1.9	1.5%
Annual average (µg/m <sup>3</sup> )	A	60	80	0.4	0.7%
	B	50	60	0.8	1.6%
	C	50	60	0.2	0.3%

Contours of the maximum 1-hour average and 99.9<sup>th</sup> percentile 1-hour average SO<sub>2</sub> GLCs indicate that peak concentrations are expected to occur approximately 1 km south west of the proposed WtE facility (Figure 41 and Figure 42). The peak 24-hour average

SO<sub>2</sub> GLCs are predicted to occur to the west of the proposed WtE facility (Figure 43), while peak annual average SO<sub>2</sub> GLCs are predicted to occur to the north east of the site (Figure 44). All predicted GLCs are at the assumed maximum emission limits.



Figure 41 – Maximum predicted 1-hr average SO<sub>2</sub> GLCs (µg/m<sup>3</sup>) – Kwinana WtE in Isolation

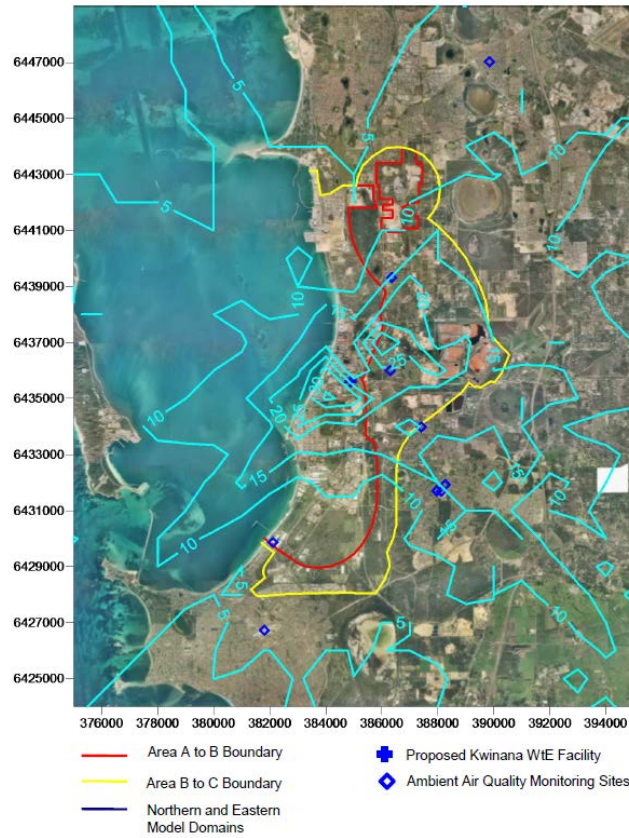


Figure 42 – 9<sup>th</sup> highest predicted 1-hr average SO<sub>2</sub> GLCs (µg/m<sup>3</sup>) – Kwinana WtE in Isolation

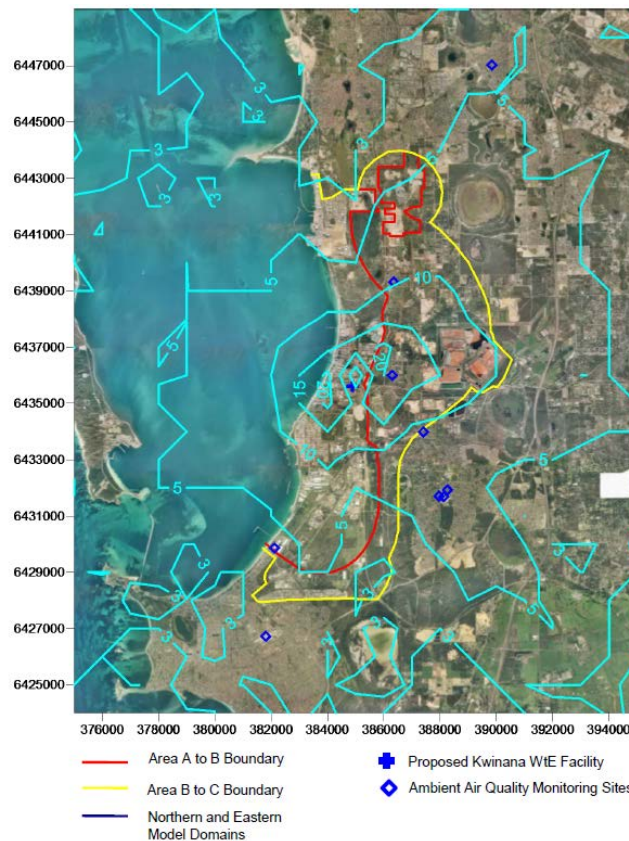


Figure 43 – Maximum predicted 24-hr average SO<sub>2</sub> GLCs (µg/m<sup>3</sup>) – Kwinana WtE in Isolation

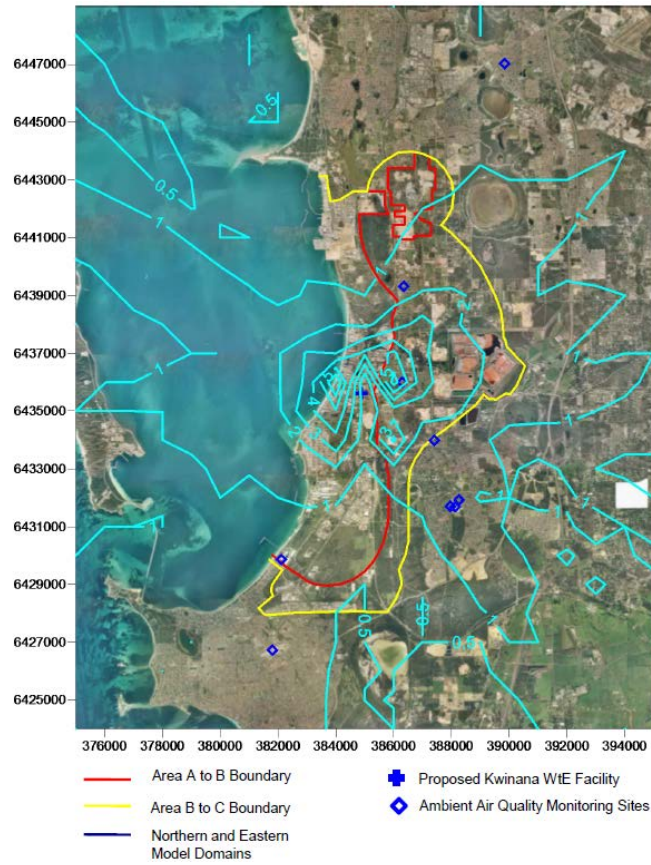
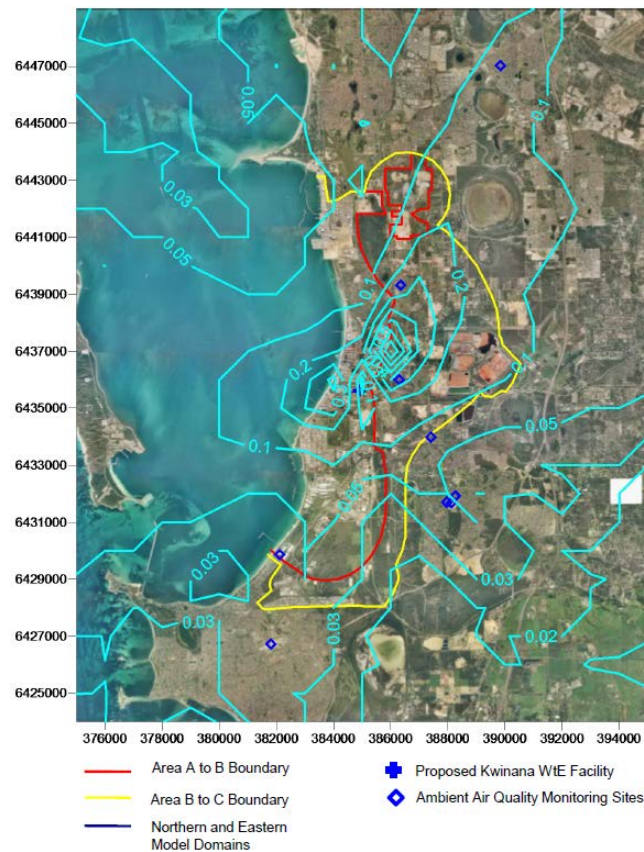


Figure 44 – Predicted annual average SO<sub>2</sub> GLCs (µg/m<sup>3</sup>) – Kwinana WtE in Isolation



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**10.2.1.5.11.4 Cumulative Assessment for Impact Sulphur Dioxide (SO<sub>2</sub>)**

The results of the DISPMOD modelling for SO<sub>2</sub> are summarised for the approved industry emissions and the cumulative impacts with the proposed WtE facility, as follows:

- Existing Kwinana industry emissions, using the Maximum Permissible Quantities (Tables 10 to 12, **Appendix F**);
- Existing Kwinana industry emissions with the proposed WtE facility (Tables 13 to 15, **Appendix F**); and
- Difference between the predicted concentration statistics with and without the proposed WtE facility (Tables 16 to 18, **Appendix F**).

The tabulated results are presented for the three modelling domains (Full, Eastern and Northern) respectively.

Contours of the predicted GLCs of SO<sub>2</sub> for the Existing Kwinana Industry emissions and for the Existing Kwinana Industry emissions with the proposed WtE facility are presented in the following Figures:

- Maximum predicted 1-hr average GLC of SO<sub>2</sub> (Figure 45);
- 9th highest predicted 1-hr average GLC of SO<sub>2</sub> (Figure 46);
- Maximum predicted 24-hr average GLC of SO<sub>2</sub> (Figure 47); and
- Predicted annual average GLC of SO<sub>2</sub> (Figure 48).

It should be noted that the predicted GLC contours are presented for the Full modelling domain using DISPMOD 2005 for the 1996 calendar year only, as this combination tends to be the most conservative (i.e. highest predicted GLCs).

Figure 45 – Maximum predicted 1-hr average GLC of SO<sub>2</sub>

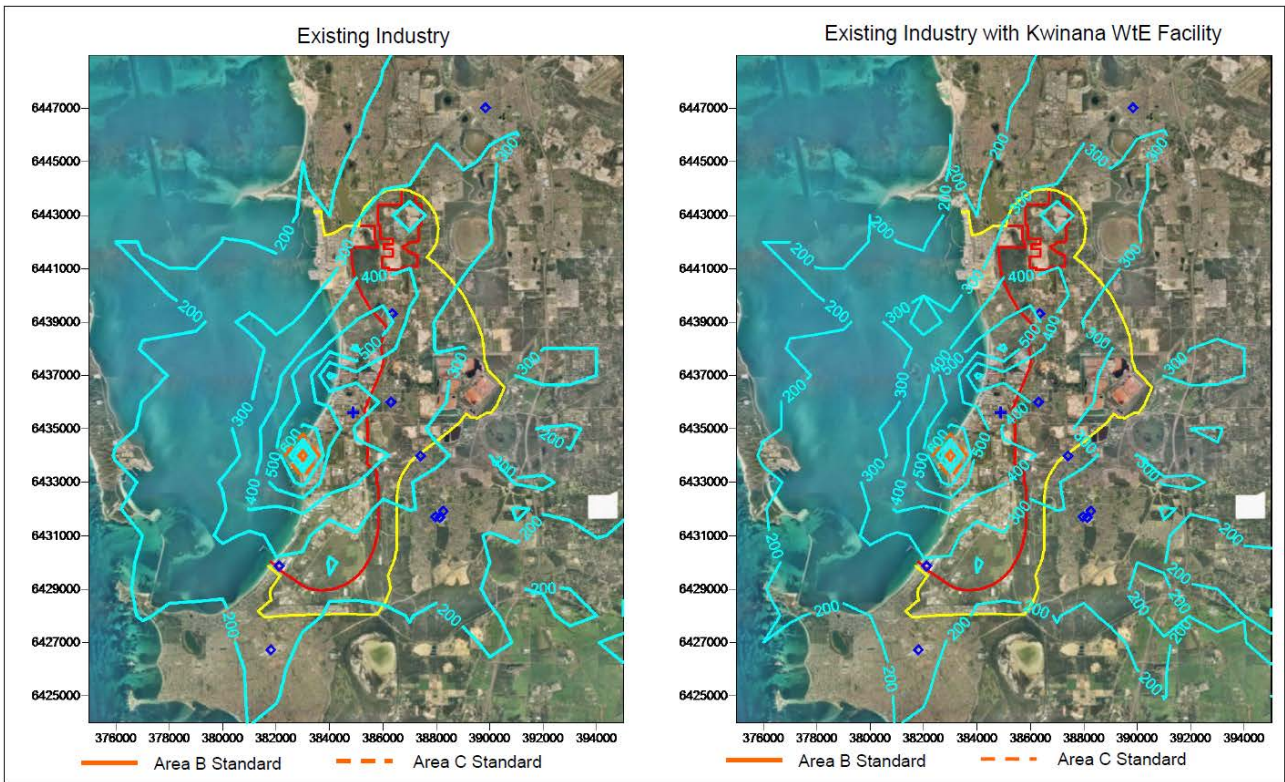


Figure 46 – 9<sup>th</sup> highest predicted 1-hr average GLC of SO<sub>2</sub>

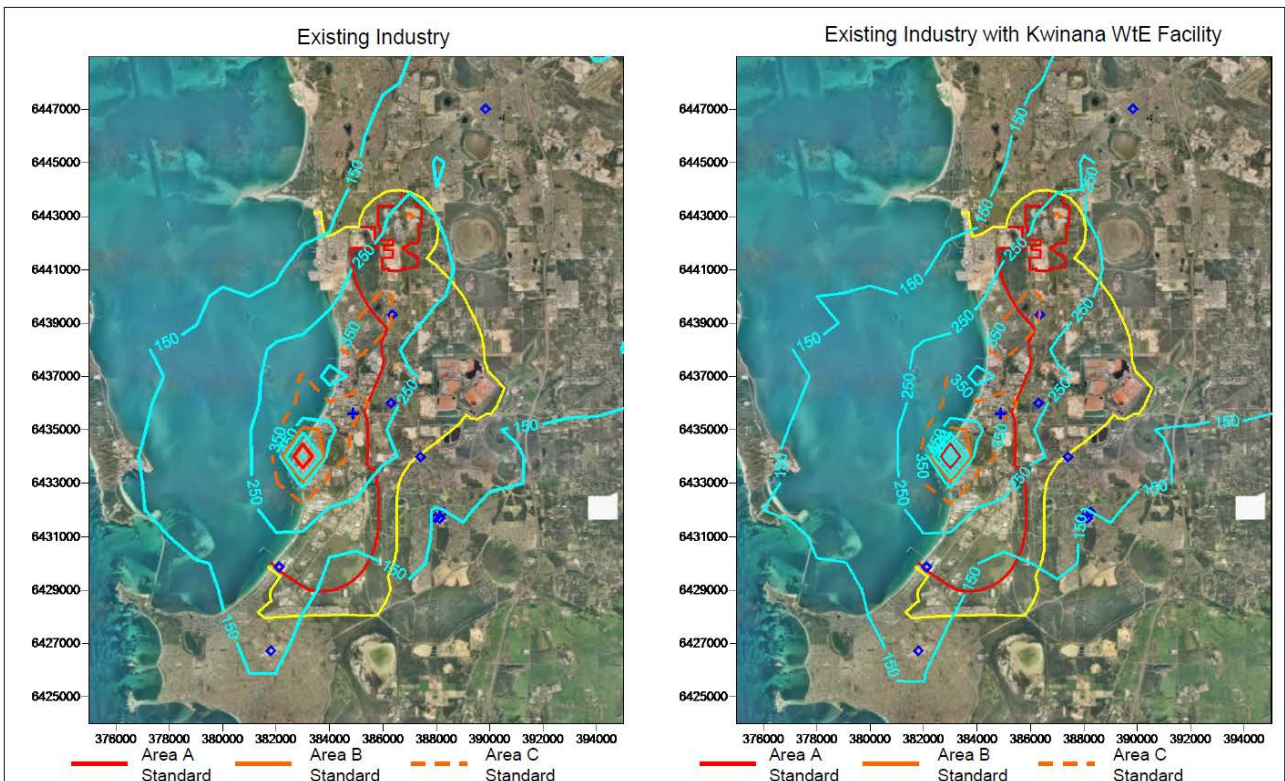


Figure 47 – Maximum predicted 24-hr average GLC of SO<sub>2</sub>

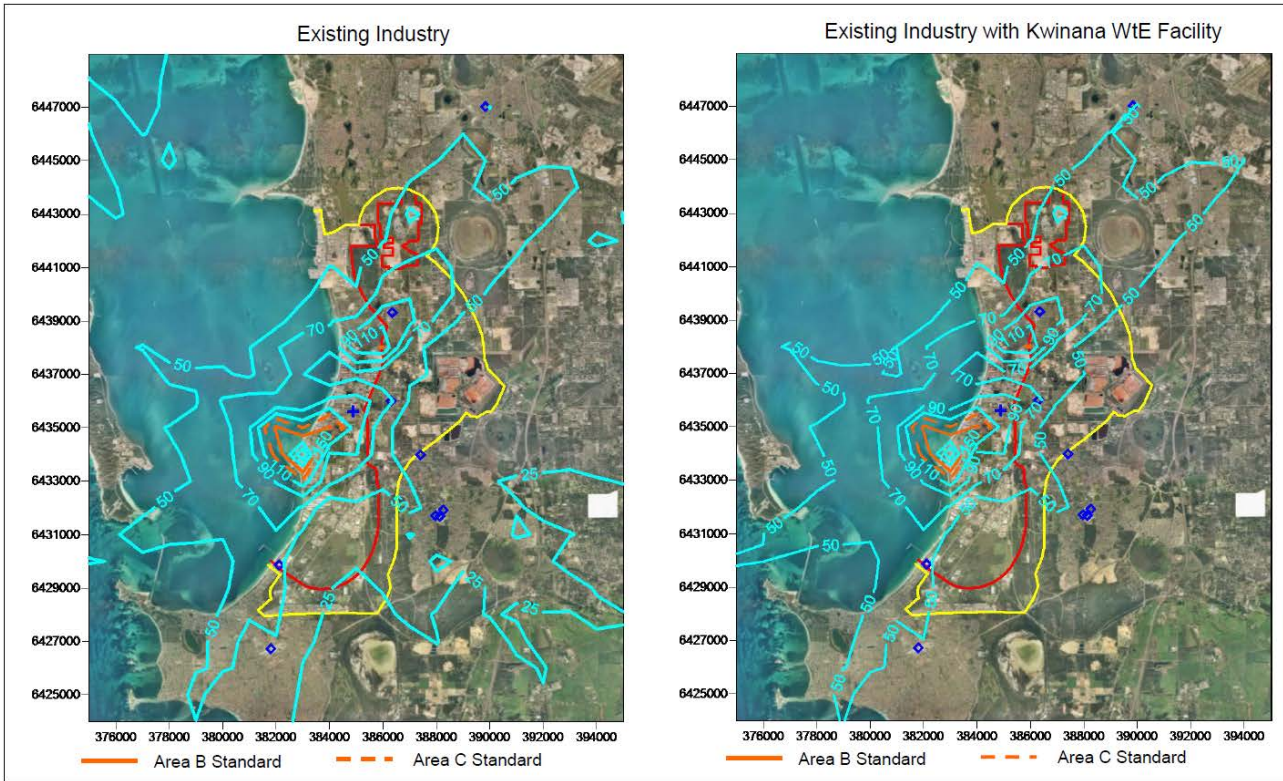
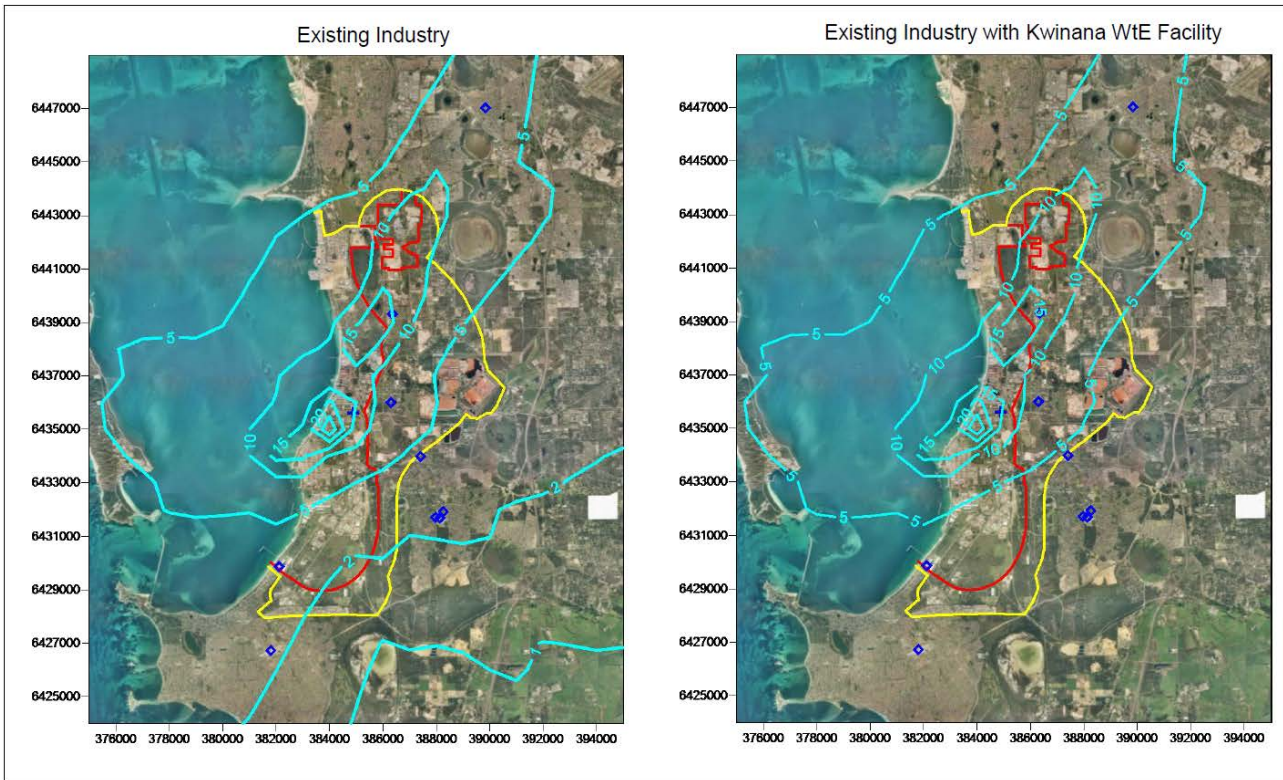


Figure 48 – Predicted annual average GLC of SO<sub>2</sub>



The DISPMOD modelling results indicate that the emissions from the proposed WtE facility will not result in a significant increase to the maximum predicted GLCs of SO<sub>2</sub> associated

with emissions from the existing industry located in Kwinana. This finding is based on a comparison of the modelling results for Existing Kwinana Industry emissions, with

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and without the proposed Kwinana WtE facility emissions, which indicates the following:

- Very little change to the existing maximum predicted GLCs of SO<sub>2</sub> within policy Area A;
- No significant change to the existing maximum predicted GLCs of SO<sub>2</sub> within policy Areas B and C;
- Up to a 23 µg/m<sup>3</sup> increase in the maximum predicted 1-hr average GLC of SO<sub>2</sub> is predicted to occur (within Area B), which represents an increase from 41% (Existing Industry) to 44% (Existing Industry with the Kwinana WtE facility) of the Area B Limit;
- Up to a 6 µg/m<sup>3</sup> increase in the 9<sup>th</sup> highest predicted 1-hr average GLC of SO<sub>2</sub> is predicted to occur (within Area A), which represents an increase from 84% (Existing Industry) to 85% (Existing Industry with the Kwinana WtE facility) of the Area A Standard;
- The largest increases in the GLCs are predicted to occur within Area B (Full modelling domain), located immediately east of the proposed location for the proposed Kwinana WtE facility.

The DISPMOD modelling results also indicate broad compliance with the Kwinana EPP Limits and Standards, except for a number of exceedances that are predicted to also occur for **Existing Kwinana Industry** emissions, without the proposed Kwinana WtE facility.

The predicted exceedances occur within Area A, in the immediate vicinity of the BP Refinery and Alcoa Alumina Refinery, and were identified as part of the redetermination (**Appendix F**) to represent an over-prediction. ***The proposed Kwinana WtE facility does not affect or add to these predicted exceedances.***

***As such, ENVIRON concluded that the emissions from the proposed Kwinana WtE facility are not expected to significantly increase the maximum predicted GLCs of SO<sub>2</sub> within the Kwinana area, and will not result in any change to compliance with the Standards and Limits of the Kwinana EPP.***

#### 10.2.1.5.11.5 Normal Operations – Other Pollutants

A summary of the maximum GLCs predicted for each of the modelled compounds using DISPMOD and the maximum emissions rates for the proposed WtE facility operating in isolation of other emission sources and at full capacity under 'normal conditions' is presented in Table 29. The relevant ambient air quality criteria are provided for comparison.

The maximum predicted PM<sub>2.5</sub> GLCs have been assessed as representative of Total Suspended Particulates (TSP) and PM<sub>10</sub>. However, as noted in the earlier discussion on nanoparticles, it is expected that particulate matter from the flue gas stack will be comprised primarily of particles less than 0.1 micron in diameter.

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Table 29 – Summary of Predicted Ground Level Concentrations for Normal Operations (Maximum Emission Rates) (corresponding to Table 20, Appendix F)

Compound	Averaging Period	DISPMOD 2005			Guideline (µg/m <sup>3</sup> ) <sup>1</sup>	% Guideline Value <sup>2</sup>
		1980	1995	1996		
NO <sub>2</sub>	1-hour	13	11	12	246	5.3%
	Annual	0.2	0.2	0.2	62	0.3%
CO	8-hour	8.2	7.7	9.3	11,254	0.08%
PM <sub>2.5</sub>	24-hour	1.0	1.0	1.0	25	4.0%
	Annual	0.1	0.1	0.1	8	1.3%
PM <sub>10</sub> [3]	24-hour	1.0	1.0	1.0	50	2.0%
TSP[3]	1-hour	7.7	6.2	7.1	758[4]	1.0%
	24-hour	1.0	1.0	1.0	90[5]	1.1%
HF	1-hour	1.0	0.8	1.0	262	0.4%
	24-hour	0.1	0.1	0.1	1.5[6]/2.9[7]	9.2%[6]/3.4%[7]
	7-days	0.06	0.07	0.06	0.8[6]/1.7[7]	8.9%[6]/4.1%[7]
	30-days	0.04	0.04	0.04	0.4[6]/0.84[7]	11%[6]/4.8%[7]
	90-days	0.03	0.03	0.04	0.25[6]/0.5[7]	14%[6]/8.0%[7]
HCl	1-hour	16	12	14	153	10%
	Annual	0.3	0.2	0.3	10	3.0%
Lead	Annual	0.00001	0.00001	0.00001	0.5	0.002%
Cadmium	1-hour	0.0001	0.0001	0.0001	0.0196	0.5%
	24-hour	0.00002	0.00002	0.00002	0.022	0.1%
	Annual	0.000002	0.000002	0.000002	0.011	0.02%
Mercury	1-hour	0.004	0.003	0.004	0.65	0.6%
	Annual	0.00007	0.00006	0.00007	0.22	0.03%
Antimony	1-hour	0.0002	0.0001	0.0002	0.98	0.02%
	Annual	0.000003	0.000003	0.000003	0.033	0.09%
Arsenic	1-hour	0.0002	0.0001	0.0002	0.098	0.2%
	24-hour	0.00002	0.00002	0.00002	0.033	0.06%
	Annual	0.000003	0.000003	0.000003	0.0033	0.09%
Copper	1-hour	0.0003	0.0002	0.0003	20	0.002%
	24-hour	0.00004	0.00004	0.00004	1.1	0.004%
Chromium VI	1-hour	0.0001	0.0001	0.0001	0.098	0.1%

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Compound	Averaging Period	DISPMOD 2005			Guideline ( $\mu\text{g}/\text{m}^3$ ) <sup>1</sup>	% Guideline Value <sup>2</sup>
		1980	1995	1996		
Chromium VI	24-hour	0.00002	0.00002	0.00002	0.33	0.006%
	Annual	0.000002	0.000002	0.000002	0.00022	1.0%
Manganese	1-hour	0.0005	0.0004	0.0004	20	0.003%
	24-hour	0.00006	0.00006	0.00006	0.16	0.04%
Nickel	1-hour	0.0005	0.0004	0.0005	0.19	0.3%
	24-hour	0.00007	0.00007	0.00007	0.15	0.05%
	Annual	0.000009	0.000007	0.000009	0.0033	0.3%
Dioxins and Furans	1-hour	3.0E-08	2.1E-08	2.4E-08	0.0000022	1.4%

**Notes:**

1. Referenced to 0°C, and 101.325 kPa.
2. Comparison of maximum predicted GLC for the three modelled years against the relevant guideline value.
3. The maximum predicted PM<sub>2.5</sub> GLCs have been assessed as representative of TSP and PM<sub>10</sub>.
4. Based on the Kwinana EPP 15-minute Area C Standard for TSP.
5. Kwinana EPP Area C Standard.
6. Specialised land use criteria, including all areas sensitive to fluoride.
7. General land use criteria, including residential.

The data presented in Table 29 indicates that the predicted GLCs are expected to comply with the applicable short-term and long-term ambient air quality guidelines for all of the modelled pollutants.

The maximum 90-day average HF GLC predicted for the 1996 modelled year most closely approaches the relevant guideline, representing 14% of the ANZECC guideline applicable for specialised land use (Table 29), though once again it is noted that the assessment is using the very conservative assumption that both Martin grate lines are operating simultaneously at the WID limit. However, the specialised land use criteria are not intended for application within industrial areas or buffer zones associated with fluoride emitting industries (ANZECC, 1990). The general land use criteria, which are applicable within residential areas and are designed to protect most of the sensitive species in the natural environment, are considered more appropriate for application within the KIA. As such, the maximum predicted 90-day average HF GLC, which is predicted to occur within

the boundaries of the KIA, represents 8.0% of the general land use guideline.

The maximum 30-day average HF GLC predicted for each of the modelled years is equal to 4.8% of the general land use criteria, while the maximum 7-day average predicted for the 1995 modelled year is equal to 4.1% of the general land use criteria (Table 29). The maximum predicted 24-hour average HF GLC also remains well below the general land use criteria, representing 3.4% of the guideline value. The maximum predicted 1-hour average HF GLC represents no more than 0.4% of the corresponding OEHHA guideline value (Table 29). Contours of the predicted 24-hour, 7-day, 30-day and 90-day average HF GLCs are presented in Figure 49, Figure 50, Figure 51 and Figure 52, and indicate that peak concentrations are expected to occur approximately 1 km north east of the proposed WtE facility.

The maximum 1-hour average HCl GLC predicted for the 1980 modelled year represents 10% of the NSW OEH guideline



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(Table 29) due to the highly conservative approach of using the WID/IED limit value concentration with the estimated maximum flue gas rate i.e. with both grate lines simultaneously at their maximum limit values for modelling purposes.

Contours of the 1-hour HCl GLCs indicate that peak concentrations are expected to occur approximately 500 m to the west of the proposed Kwinana WtE site (Figure 53). The predicted annual average HCl GLCs remain well below the corresponding criteria, representing no more than 3.0% of the annual Californian Office of Environmental Health Hazard Assessment (OEHHA) guideline. Contours of the annual HCl GLCs indicate that peak concentrations are expected to occur approximately 1 km to the north east of the proposed WtE facility (Figure 54).

The maximum 1-hour average NO<sub>2</sub> GLC predicted for the 1980 modelled year is 13 µg/m<sup>3</sup> (Table 29). This concentration represents 5.3% of the applicable NEPM Standard and is expected to occur to the west of the proposed WtE facility (Figure 55). The predicted annual average NO<sub>2</sub> GLCs remain well below the corresponding criteria, representing no more than 0.3% of the annual NEPM Standard. Contours of the annual NO<sub>2</sub> GLCs indicate that peak concentrations are expected to occur approximately 1 km north east of the proposed WtE facility (Figure 56).

Using the highly conservative WID/IED limit value for Total Dust (modelled as 100% PM<sub>2.5</sub>), the maximum 24-hour average PM<sub>2.5</sub> GLC predicted for each of the modelled years represents 4% of the 24-hour NEPM Advisory Reporting Standard (Table 29). Contours of the 24-hour PM<sub>2.5</sub> GLCs indicate the maximum concentrations are expected to

occur to the north east of the proposed WtE facility (Figure 57). The predicted annual average PM<sub>2.5</sub> GLCs remain well below the relevant guideline, representing no more than 1.3% of the annual NEPM Advisory Reporting Standard. Contours of the annual PM<sub>2.5</sub> GLCs indicate peak concentrations are expected to occur to the north east of the proposed WtE facility (Figure 58).

Compliance with the less stringent PM<sub>10</sub> and TSP criteria is also demonstrated by these results.

The maximum 1-hour average dioxins and furans GLC predicted for any of the modelled year is 3.0E-08 µg-ITEQ/m<sup>3</sup> and represents 1.4% of the applicable NSW Office of Environmental Heritage (OEH) guideline (Table 29).

Contours of the maximum 1-hour average dioxins and furans GLCs indicate peak concentrations are expected to occur to the west of the proposed Kwinana WtE site (Figure 59).

The predicted GLCs of CO and the heavy metals (i.e. lead, cadmium, mercury, antimony, arsenic, copper, manganese and nickel) associated with normal operations at maximum emission rates comfortably comply with the applicable air quality guidelines, being less than 1% of the corresponding short-term and long-term criteria.

Note while contours have only been presented for compounds where the maximum predicted GLC is >1% of the corresponding short-term air quality guideline, the 1-hour and annual average dispersion patterns for the remaining modelled compounds can be inferred from Figure 53 and Figure 54 and the predicted GLCs scaled accordingly (based on the emission rates presented in Table 26).

Figure 49 - Maximum Predicted 24-hour Average HF GLCs ( $\mu\text{g}/\text{m}^3$ ) – Normal Operations (Max. Emission Limits)

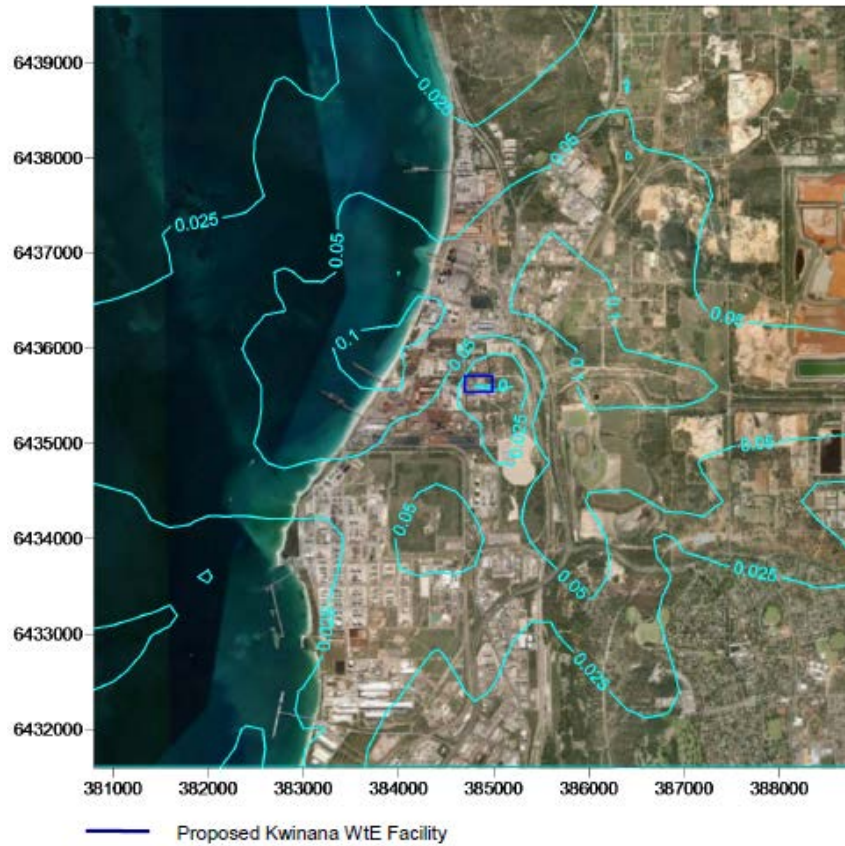


Figure 50 - Maximum Predicted 7-day Average HF GLCs ( $\mu\text{g}/\text{m}^3$ ) – Normal Operations (Max. Emission Limits)

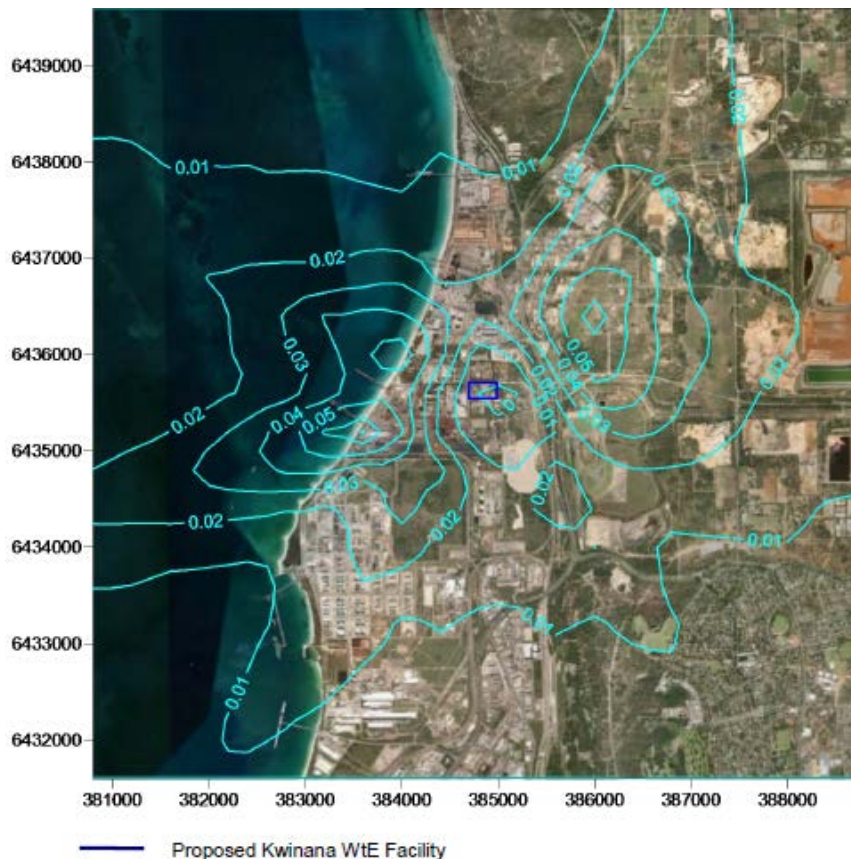


Figure 51 - Maximum Predicted 30-day Average HF GLCs ( $\mu\text{g}/\text{m}^3$ ) – Normal Operations (Max. Emission Limits)

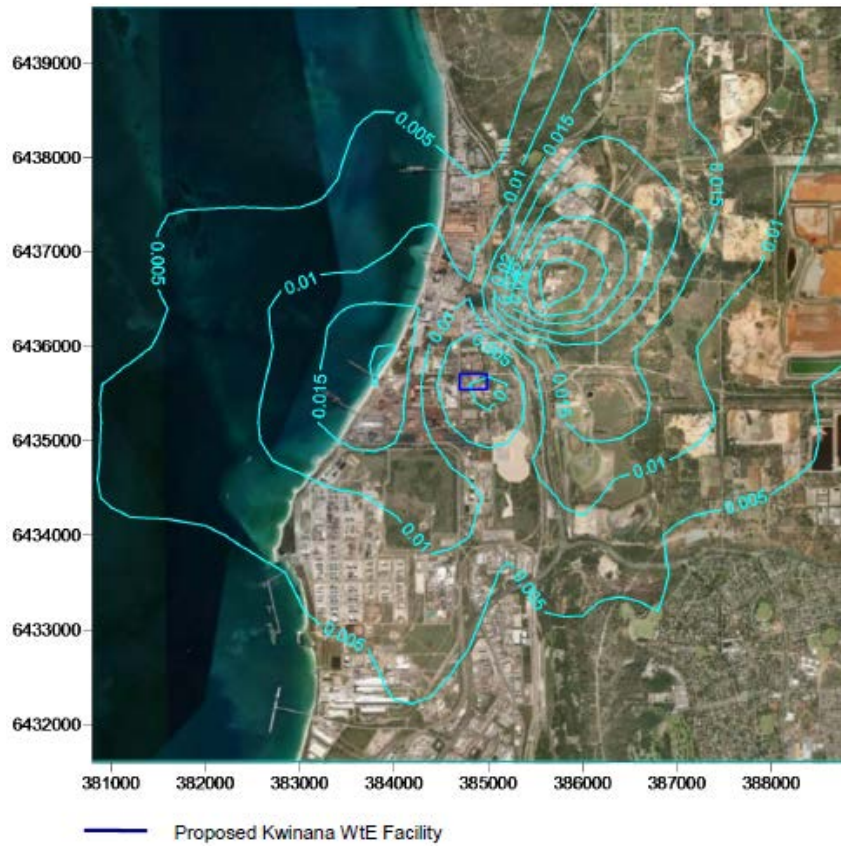


Figure 52 - Maximum Predicted 90-day Average HF GLCs ( $\mu\text{g}/\text{m}^3$ ) – Normal Operations (Max. Emission Limits)

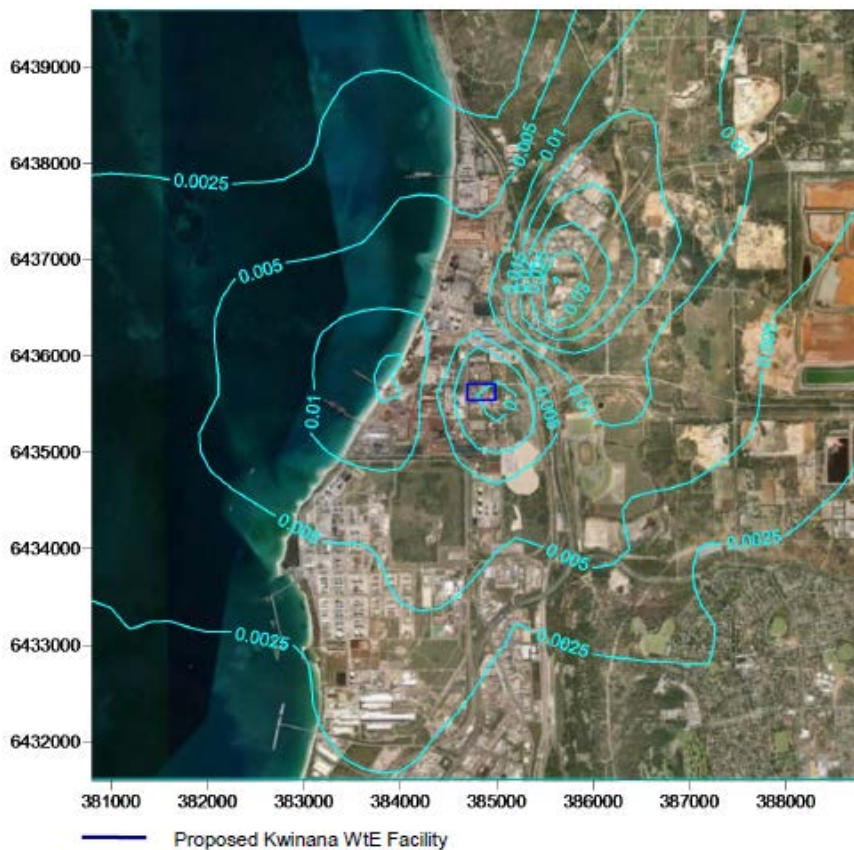


Figure 53 - Maximum Predicted 1-hour Average HCl GLCs ( $\mu\text{g}/\text{m}^3$ ) – Normal Operations (Max. Emission Limits)

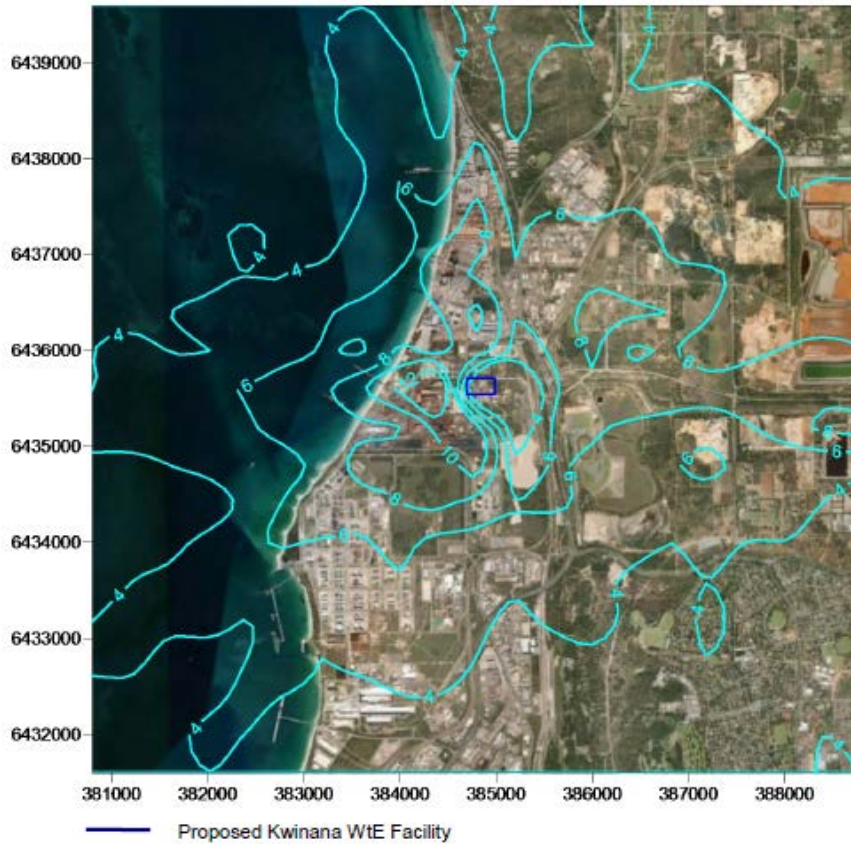


Figure 54 - Predicted Annual Average HCl GLCs ( $\mu\text{g}/\text{m}^3$ ) – Normal Operations (Maximum Emission Limits)

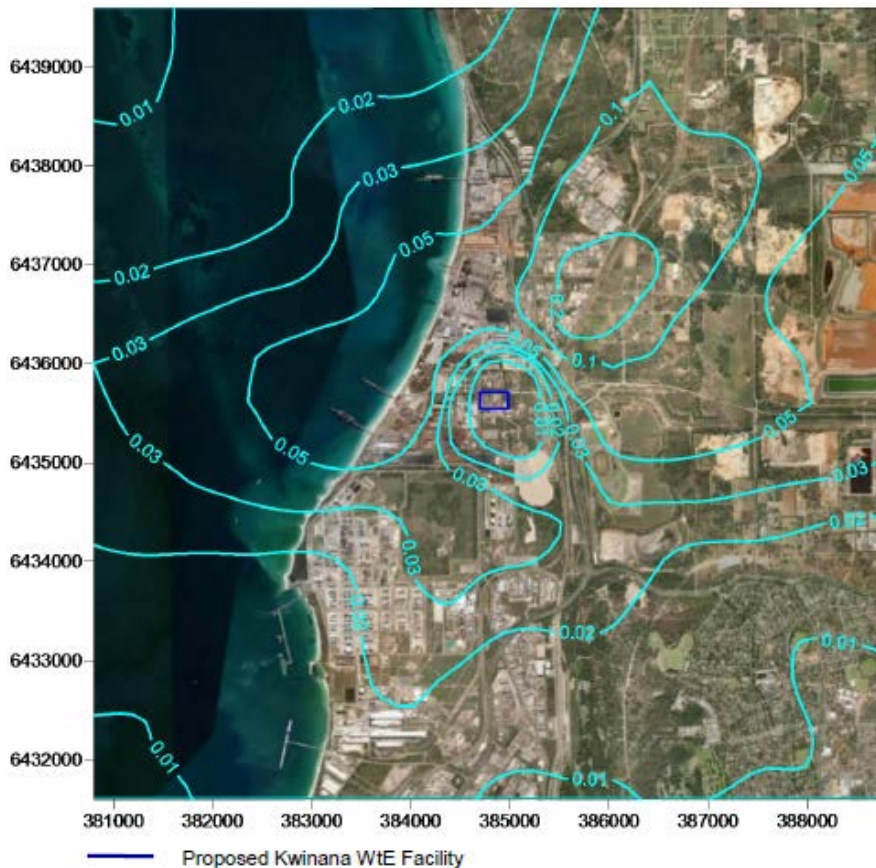


Figure 55 - Maximum Predicted 1-hour Average NO<sub>2</sub> GLCs (µg/m<sup>3</sup>) – Normal Operations (Max. Emission Limits)

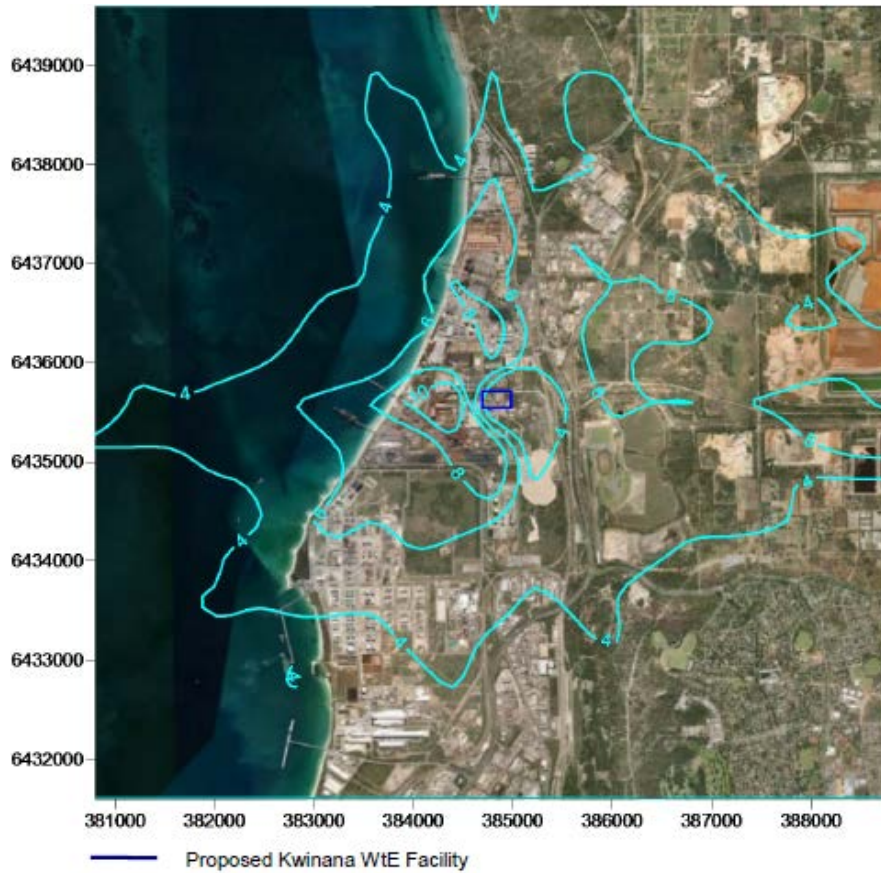


Figure 56 - Predicted Annual Average NO<sub>2</sub> GLCs (µg/m<sup>3</sup>) – Normal Operations (Maximum Emission Limits)

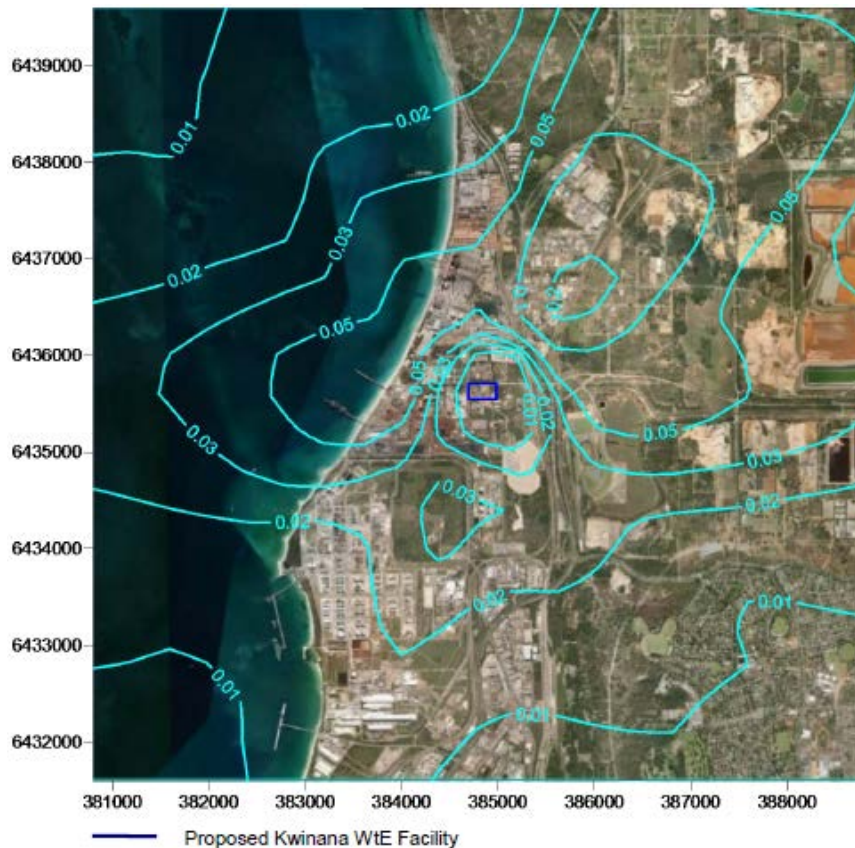


Figure 57 – Max. Predicted 24-hour Average PM<sub>2.5</sub> GLCs (µg/m<sup>3</sup>) – Normal Operations (Max. Emission Limits)

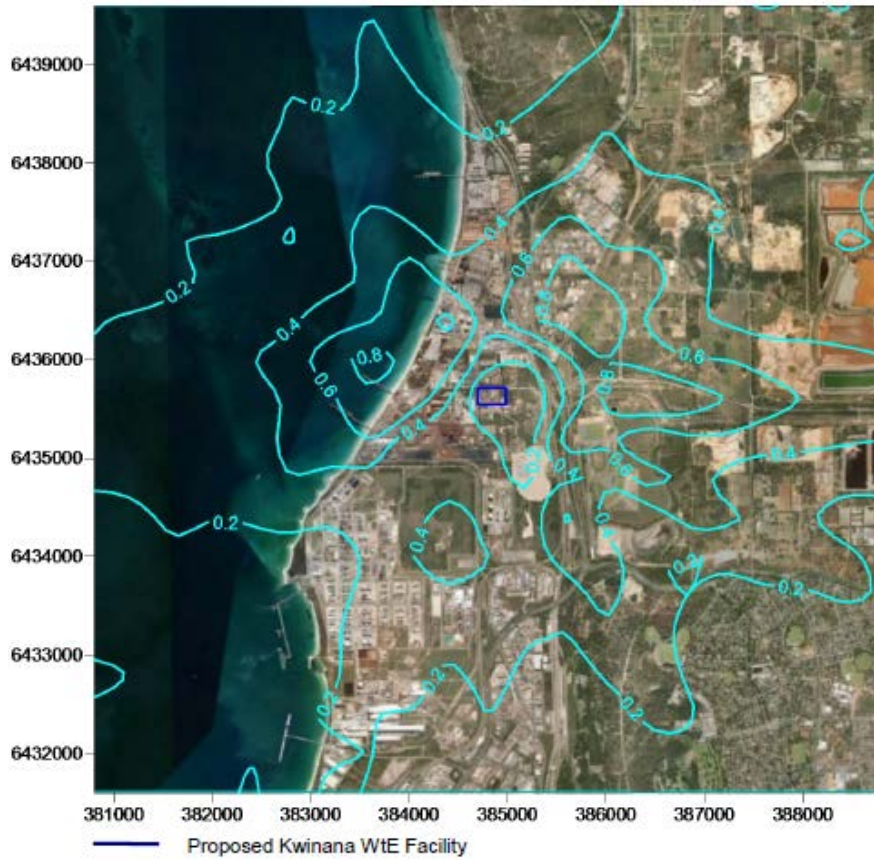


Figure 58 - Predicted Annual Average PM<sub>2.5</sub> GLCs (µg/m<sup>3</sup>) – Normal Operations (Maximum Emission Limits)

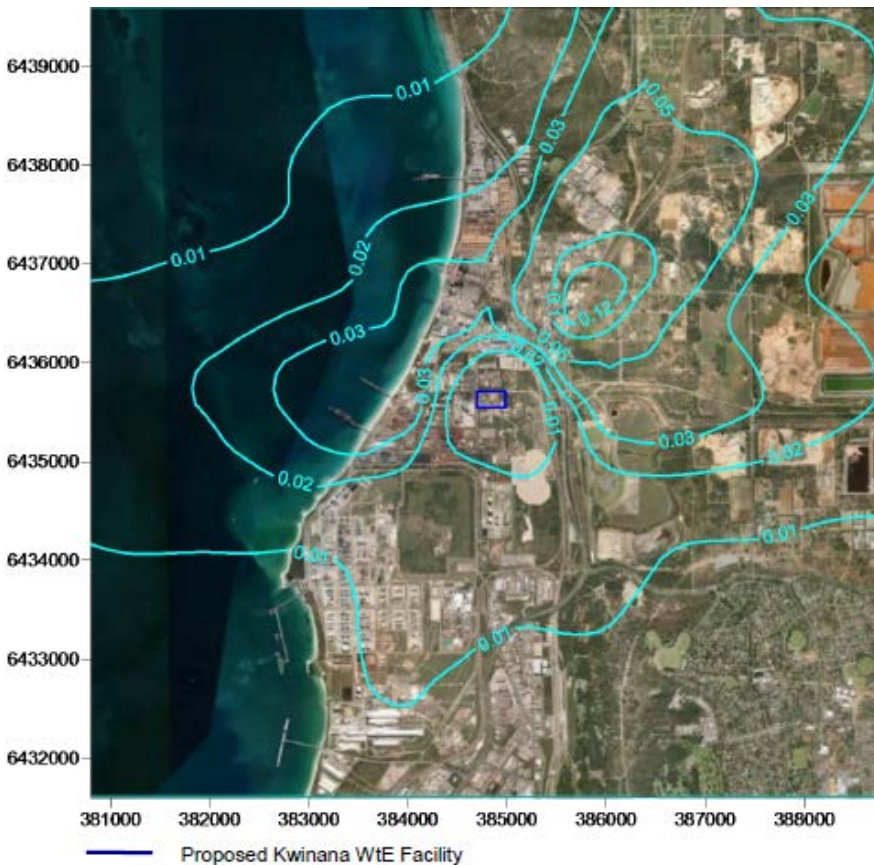
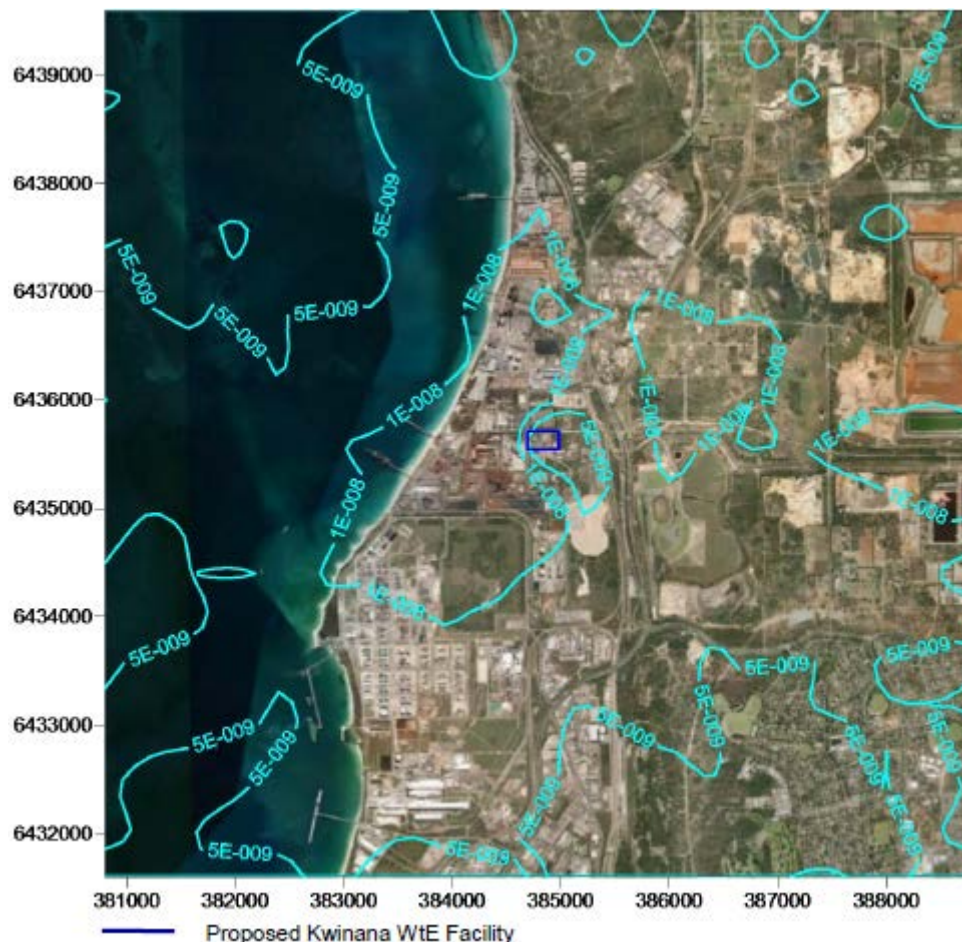


Figure 59 – Max. Predicted 1-hr Ave. Dioxins & Furans GLCs (pg-TEQ/m<sup>3</sup>) – Normal Op. (Max. Emission Limits)



As described in Section 10.2.1.5.7 from page 109 onwards, the multi-flue stack has been modelled as a single stack source using an effective stack diameter calculated based on the exit velocity and combined volumetric flow rate for each flue. However, as the

combination of multi-flue emissions can be dependent on wind direction, an additional model run was completed assuming no buoyancy enhancement between the two plumes. A summary of the source parameters adopted for this run are presented in Table 30.

Table 30 - Summary of Source Parameters for Independent Plume Assessment

Parameter	Unit	Stack
Easting	m	384,946
Northing	m	6,435,610
Release Height	m	87.5
Effective Stack Diameter <sup>1</sup>	m	2.12
Exit Velocity	m/s	18.3
Exit Temperature	K	405
Volumetric Flowrate	m <sup>3</sup> /s	64.7

**Notes:**

1. Effective stack diameter calculated based on the exit velocity and volumetric flow rate for a single flue.

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The emission rates applied in this assessment are as per those presented in Table 26. This approach is considered conservative as it assumes there is no mixing of the two plumes and therefore no enhancement in momentum buoyancy; however the emission rates applied are based on the total exhaust from the two flues.

A summary of the predicted maximum GLCs assuming no buoyancy enhancement and conservatively applying the combined mass emission rates for the two flues is presented in Table 31. The relevant ambient air quality criteria are provided for comparison.

Table 31 – Comparison of Predicted GLCs for Enhanced and Non-Enhanced Plume Buoyancy

Compound	Averaging Period	Guideline Value	Maximum Predicted GLCs <sup>[1]</sup>		% Guideline Value	
			( $\mu\text{g}/\text{m}^3$ ) <sup>[2]</sup>	Enhanced Plume Buoyancy	Non-Enhanced Plume Buoyancy	Enhanced Plume Buoyancy
NO <sub>2</sub>	1-hour	246	13	13	5.3%	5.3%
	Annual	62	0.2	0.3	0.3%	0.5%
CO	8-hour	11,254	9.3	12	0.08%	0.1%
TSP <sup>[3]</sup>	1-hour	758 <sup>[4]</sup>	7.7	7.5	1.0%	1.0%
PM <sub>2.5</sub>	24-hour	25	1	1.5	4.0%	6.0%
	Annual	8	0.1	0.1	1.3%	1.3%
HF	1-hour	262	1	1	0.4%	0.4%
	24-hour	2.9 <sup>[5]</sup>	0.1	0.2	3.4%	6.9%
HCl	1-hour	153	16	15	10.5%	9.8%
	Annual	10	0.3	0.3	3.0%	3.0%
Lead	Annual	0.5	0.00001	0.00001	0.002%	0.002%
Cadmium	1-hour	0.0196	0.0001	0.0001	0.5%	0.5%
	24-hour	0.022	0.00002	0.00002	0.1%	0.1%
	Annual	0.011	0.000002	0.000002	0.02%	0.02%
Mercury	1-hour	0.65	0.004	0.004	0.6%	0.6%
	Annual	0.22	0.00007	0.00008	0.03%	0.04%
Antimony	1-hour	0.98	0.0002	0.0002	0.02%	0.02%
	Annual	0.033	0.000003	0.000002	0.009%	0.006%
Arsenic	1-hour	0.098	0.0002	0.0002	0.2%	0.2%
	24-hour	0.033	0.00002	0.00004	0.06%	0.1%
	Annual	0.0033	0.000003	0.000003	0.09%	0.09%
Copper	1-hour	20	0.0003	0.0003	0.002%	0.002%
	24-hour	1.1	0.00004	0.00006	0.004%	0.005%
Chromium VI	1-hour	0.098	0.0001	0.0003	0.1%	0.3%



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	24-hour	0.33	0.00002	0.00003	0.006%	0.009%
	Annual	0.00022	0.000002	0.000002	1.0%	1.0%
Manganese	1-hour	20	0.0005	0.0005	0.003%	0.003%
	24-hour	0.16	0.00006	0.00009	0.04%	0.06%
Nickel	1-hour	0.19	0.0005	0.0005	0.3%	0.3%
	24-hour	0.15	0.00007	0.0001	0.05%	0.07%
	Annual	0.0033	0.000009	0.00001	0.3%	0.3%
Dioxins and Furans	1-hour	0.0000022	3.0E-08	2.5E-08	1.4%	1.1%

Notes

1. Maximum predicted GLC of the three modelled years.
2. Referenced to 0°C, and 101.325 kPa.
3. The maximum predicted PM<sub>2.5</sub> GLCs have been assessed as representative of TSP and PM<sub>10</sub>.
4. Based on the Kwinana EPP 15-minute Area C Standard for TSP.
5. General land use criteria, including residential.

The data presented in Table 31 indicates that the maximum GLCs predicted assuming there is no mixing of the two plumes and therefore no enhancement of plume buoyancy, do not significantly differ from the GLCs predicted assuming enhanced plume buoyancy.

The greatest increase in comparison to the applicable guideline is evident for HF; the maximum 24-hour average HF GLC predicted without enhanced plume buoyancy is equal to 6.9% of the ANZECC general land use criteria, while the maximum 24-hour average HF GLC predicted with enhanced plume buoyancy is equal to 3.4% of the general land use criteria (Table 31). The maximum 1-hour average HF GLC predicted with and without enhanced plume buoyancy remains unchanged (Table 31).

The maximum 24-hour average PM<sub>2.5</sub> GLC predicted without enhanced plume buoyancy represents 6.0% of the relevant guideline, slightly higher than the maximum 24-hour average PM<sub>2.5</sub> GLC predicted with enhanced plume buoyancy, which equals 4.0% of the guideline value. The maximum annual average PM<sub>2.5</sub> GLCs predicted with and without enhanced plume buoyancy, however, remains unchanged (Table 31).

Minor increases are also predicted for the maximum 1-hour average chromium VI GLC,

maximum 8-hour average CO GLC, maximum 24-hour average arsenic, copper, chromium VI, manganese and nickel GLCs and the annual average NO<sub>2</sub>, mercury and nickel GLCs although it is noted these are minor (i.e. less than 0.2 percentage points). The remaining GLCs predicted without enhanced plume buoyancy are either unchanged or slightly lower than those predicted with enhanced plume buoyancy (Table 31).

The results presented in Table 31 indicate that limited mixing of emissions from the multi-flue stack, with no enhancement of momentum buoyancy, is not expected to result in unacceptable air quality impacts.

**10.2.1.5.11.6 Cumulative Impact Assessment for NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and Heavy Metals**

A summary of the cumulative impacts of the maximum emissions scenario for NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub>, under 'normal operations' for the proposed WtE facility on ambient air quality at the available monitoring locations is presented in Table 32. The maximum ambient NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and heavy metals (i.e. lead, cadmium, mercury, antimony, arsenic, copper, chromium VI, manganese and nickel) concentrations measured

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throughout the Kwinana region (as presented earlier) have been used in the assessment.

The cumulative impact of the proposed Kwinana WtE facility has been determined by adding the maximum GLCs predicted for NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> at the nominated receptors to the maximum ambient concentrations measured at each site. The percentage change between the measured and cumulative GLCs predicted for the modelled scenario has also been presented.

***It should be noted that this assessment is extremely conservative for the short term (i.e. 1-hour and 24-hour) averaging times as it is assumed that the maximum predicted GLCs for the proposed WtE facility operations occur at the same time as the maximum ambient concentrations measured at the monitoring sites, which is not expected to occur in reality.***

The maximum cumulative 1-hour average NO<sub>2</sub> GLC concentration predicted at the Hope Valley monitoring site is 179 µg/m<sup>3</sup> and represents a 3.5% increase in the maximum measured 1-hour average NO<sub>2</sub> GLC (Table 32). ***However, it should be noted the predicted maximum cumulative NO<sub>2</sub> GLC is considered to be highly conservative as it assumes that the maximum predicted concentration of NO<sub>2</sub> occurs at the same time as the maximum recorded concentration, which is not expected to occur in reality.*** The cumulative 1-hour average NO<sub>2</sub> concentration predicted at the Hope Valley site using the predicted 99.9<sup>th</sup> highest 1-hour average NO<sub>2</sub> GLC is 178 µg/m<sup>3</sup> and represents an increase of 2.8% in the maximum 1-hour average NO<sub>2</sub> GLCs measured at the site (Table 32).

The maximum cumulative 1-hour average NO<sub>2</sub> GLCs predicted at the Calista Primary School and Hillman Child Care Centre monitoring sites are 105 µg/m<sup>3</sup> and 91 µg/m<sup>3</sup> respectively (Table 32). These concentrations represent respective increases of 3.4% and 3.8% in the maximum measured 1-hour average NO<sub>2</sub> GLC at each site. ***However, the cumulative 1-hour average NO<sub>2</sub> concentrations calculated using the predicted 99.9<sup>th</sup> highest 1-hour average NO<sub>2</sub> GLCs are 103 µg/m<sup>3</sup> at the Calista Primary School and 90 µg/m<sup>3</sup> at Hillman Child Care Centre. These***

concentrations represent respective increases of 1.9% and 2.2% in the maximum 1-hour average NO<sub>2</sub> GLCs measured at each site (Table 32).

The maximum increase in the cumulative PM<sub>10</sub> concentration predicted at the Abercrombie Road monitoring site is expected to be minimal, equal to 0.6% of the measured 24-hour concentration (Table 32). The maximum increase in the cumulative PM<sub>2.5</sub> concentrations is also small, equal to 0.9% at the Kwinana Shopping Centre site, 0.3% at the Hillman Child Care Centre and 0.5% at the Calista Primary School. ***However, the predicted maximum cumulative PM<sub>10</sub> and PM<sub>2.5</sub> GLCs are also considered to be highly conservative as they assume that the maximum predicted concentration of PM<sub>10</sub> and PM<sub>2.5</sub> (using conservative WID/IED limit values) occur at the same time as the maximum recorded concentrations.***

The maximum increase in the cumulative PM<sub>10</sub> and PM<sub>2.5</sub> concentrations predicted at each receptor using the 99.5<sup>th</sup> percentile<sup>1</sup> 24-hour averages (the second highest 24-hour average GLC predicted by the model) is expected to be minimal, equal to no more than 0.6% of the measured concentrations at any site.

The increase in the annual average NO<sub>2</sub> and PM<sub>2.5</sub> GLCs predicted at the nominated receptors is expected to be minimal, equal to no more than 0.9% of the measured concentrations at any site.

As noted in 10.2.1.5.4 from page 98, the ambient concentrations of arsenic, antimony, cadmium, chromium, copper, lead, manganese, mercury and nickel as measured by the DER at the Hope Valley, Calista and Hillman monitoring sites remain well below the applicable guidelines (<10%). The maximum GLCs of these compounds predicted over the modelled domain is

<sup>1</sup> The 99.5<sup>th</sup> percentile 24-hour GLC represents the maximum second highest 24-hour average GLC predicted for any of the three modelled years (i.e. the predicted 24-hour average concentrations are equal to or less than this value for 364 days of each modelled year)

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similarly small, representing no more than 1% of the relevant criteria (Table 29). The GLCs predicted at the Hope Valley, Calista and Hillman monitoring sites represent an even smaller fraction of the relevant criteria. As such, the cumulative impacts of emissions of these compounds from the proposed WtE facility at the nominated monitoring sites are considered negligible.

Ambient monitoring data and/or suitable regional emissions inventories are not available to undertake a quantitative

cumulative assessment for HF, HCl and dioxins and furans. The maximum predicted GLCs for these compounds (each very conservatively estimated to be at their respective WID limits), however, are either at or below 10% of the relevant guidelines (Table 29). As such, the contribution of these emissions from the proposed WtE facility is not expected to be significant in terms of cumulative air quality impacts within the region.

**Table 32 – Summary of Maximum (and 99.9th percentile) Predicted Cumulative Impacts for Normal Operations (Maximum Emission Rates) over various short-term and long-term averaging periods (corresponding to Table 21, Appendix F)**

Receptor	Units	NO <sub>2</sub>		PM <sub>10</sub>	PM <sub>2.5</sub>		
		1-hour Max. / 99.9 <sup>th</sup> Percentile	Annual	24-hour Max. / 99.5 <sup>th</sup> Percentile	24-hour Max. / 99.5 <sup>th</sup> Percentile	Annual	
Hope Valley	Measured <sup>[1]</sup>	µg/m <sup>3</sup>	173	10			
	Cumulative	µg/m <sup>3</sup>	179 <sup>[2]</sup> / 178 <sup>[3]</sup>	10 <sup>[4]</sup>			
	% Change	%	3.5% / 2.8%	0.9%	n.a.	n.a.	n.a.
Calista Primary School	Measured <sup>[1]</sup>	µg/m <sup>3</sup>	101	10		57 <sup>[6]</sup>	8.7
	Cumulative	µg/m <sup>3</sup>	105 <sup>[2]</sup> / 103 <sup>[3]</sup>	10 <sup>[4]</sup>		57 <sup>[2]</sup> / 57 <sup>[5]</sup>	8.7 <sup>[4]</sup>
	% Change	%	3.4% / 1.9%	0.1%	n.a.	0.5% / 0.4%	0.1%
Hillman Child Care Centre	Measured <sup>[1]</sup>	µg/m <sup>3</sup>	88	12		61 <sup>[6]</sup>	9.0
	Cumulative	µg/m <sup>3</sup>	91 <sup>[2]</sup> / 90 <sup>[3]</sup>	12 <sup>[4]</sup>		61 <sup>[2]</sup> / 61 <sup>[5]</sup>	9.0 <sup>[4]</sup>
	% Change	%	3.8% / 2.2%	0.08%	n.a.	0.3% / 0.2%	0.1%
Abercrombie Road	Measured <sup>[1]</sup>	µg/m <sup>3</sup>			63 <sup>[6]</sup>		
	Cumulative	µg/m <sup>3</sup>			63 <sup>[2]</sup> / 63 <sup>[5]</sup>		
	% Change	%	n.a.	n.a.	0.6% / 0.5%	n.a.	n.a.
Kwinana Shopping Centre	Measured <sup>[1]</sup>	µg/m <sup>3</sup>				32 <sup>[6]</sup>	7.5
	Cumulative	µg/m <sup>3</sup>				32 <sup>[2]</sup> / 32 <sup>[5]</sup>	7.5 <sup>[4]</sup>
	% Change	%	n.a.	n.a.	n.a.	0.9% / 0.6%	0.1%
<b>Standard<sup>7</sup></b>		µg/m <sup>3</sup>	<b>246</b>	<b>62</b>	<b>50</b>	<b>25</b>	<b>8</b>

Notes:

1. Measured = Maximum ambient GLC as measured by DER (i.e. excluding the proposal).
2. The maximum cumulative GLCs have been calculated by adding the maximum GLC predicted for the three modelled years at the nominated receptor (using maximum emission rates), to the maximum measured GLCs at each site.
3. The cumulative 'Measured + Predicted 99.9th highest GLCs' have been calculated by adding the highest of the 99.9th percentile 1-hour average GLCs predicted at the nominated receptor for each of the three modelled years (using maximum emission rates), to the maximum measured GLCs at each site.
4. The cumulative annual GLCs have been calculated by adding the maximum annual average GLC predicted at the nominated receptor for the three modelled years, to the highest annual average GLC measured at each site.

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5. The cumulative 'Measured + Predicted 99.5th percentile GLCs' have been calculated by adding the highest 99.5th percentile 24-hour average GLC predicted at the nominated receptor for each of the three modelled years (using maximum emission rates), to the maximum measured GLCs at each site.
6. **Smoke haze identified as contributing factor to measured concentration.**
7. NEPM Ambient Air Quality Standard.
8. 'n.a.' indicates compound is not monitored at receptor.
9. All concentrations are referenced to 0°C and 101.325 kPa

**10.2.1.5.12 For other pollutants, compare the WtE plants emission load with NPI data for the Kwinana airshed. Should the WtE plant load be greater than 10% of the total load to the Kwinana airshed, undertake investigations into the potential impact of these pollutants**

A search of the Commonwealth of Australia National Pollution Inventory data base was conducted for all air pollutants which are measured and reported for the Kwinana airshed. The output was then refined to exclude those pollutants which are already addressed directly by the WID/IED. The following Table 33 presents a summary of non-WID/IED controlled substances emitted into the Kwinana airshed by existing operations in the Kwinana Industrial Area. Note that the total emission rate for each pollutant was determined by summing the reported emission rates for all existing emitters. To test whether the emission rates of those non-WID/IED components might be significant to the Kwinana airshed; the analysis considered whether the estimated WtE plant emission rate for each non-WID/IED controlled component is greater than 10% of the total existing emission load to the Kwinana airshed.

While some relevant reference data is available on some the non-WID/IED controlled components such as ammonia, formaldehyde, Polycyclic Aromatic Hydrocarbons (PAHs) and some of the inorganic components such as beryllium, selenium and zinc, data on emission rates of the other non-WID/IED controlled substances is not readily available for a WtE plant using the same technology and of a similar same scale as the Kwinana WtE proposal. A further complication is that the pollutant emission rates are naturally dependent on the nature and composition of the feedstock, which differs from season to season as well as geographically. From the limited available reference plant data, the analysis shows that the Kwinana WtE plant will not significantly contribute to the pollutant inventory in the Kwinana airshed.

Given the prevalence of WtE facilities of similar capacity and technology to the proposed facility operating under the WID/IED, with many operating close to major population centres, suffice to say that if any of these non-WID/IED controlled components were regularly being emitted at rates which would be of potential harm to human health or the environment, they would be included in the WID/IED.

Table 33 – Summary of Non-WID/IED controlled substances emitted into the Kwinana Airshed from NPI data base search for the Kwinana Airshed (downloaded October 2013)

Year	Substance	Destination	Quantity by component group (kg)	10% of quantity by group (kg)	Reference Plant Emission Rate (g/s)	Est. Emission Rate Scaled for Kwinana WtE (kg/yr)	Exceeds 10% of NPI? (Y/N)	Reference details & Comments
2012	1,2-Dibromoethane	Air Total	2.92	0.292	n/a			
2012	1,3-Butadiene (vinyl ethylene)	Air Total	386	38.6	n/a			
2012	Acetaldehyde	Air Total	18,051	1,805	n/a			
2012	Acetone	Air Total	23,009	2,301	n/a			
2012	Acrylamide	Air Total	38	3.78	n/a			
2012	Acrylic acid	Air Total	206	20.64	n/a			
2012	Ammonia (total)	Air Total	151,717	15,172	3.11E-02	1,694	N	Based on actual stack test result for UNIT 3 Lee County, FL, 635 tpd, 0.247 lb/hr max. stack emission rate.
2012	Benzene	Air Total	6171	617.1	n/a			
2012	Beryllium & compounds	Air Total	4.10	0.41	1.53E-05	0.32	N	Emission rate from Montgomery County RRF with all 3 x 544 tpd units operating at max. load
2012	Biphenyl (1,1-biphenyl)	Air Total	0.21	0.021	n/a			
2012	Boron & compounds	Air Total	2.7	0.27	n/a			
2012	Carbon disulfide	Air Total	33,706	3,371	n/a			
2012	Chlorine & compounds	Air Total	2,691	269.1	See Comment			HCL is a WID component
2012	Cumene (1-methylethylbenzene)	Air Total	458	45.84	n/a			
2012	Cyanide (inorganic) compounds	Air Total	3,615	361.5	n/a			
2012	Cyclohexane	Air Total	9,743	974	n/a			
2012	Ethanol	Air Total	280	28	n/a			
2012	Ethylbenzene	Air Total	1,652	165	n/a			
2012	Fluoride compounds	Air Total	20,775	2,078	See Comment			HF is a WID component
2012	Formaldehyde (methyl aldehyde)	Air Total	45,634	4,563	1.97E-03	42	N	Emission rate from Montgomery County RRF with all 3 x 544 tpd units operating at max. load
2012	Glutaraldehyde	Air Total	0.387	0.039	n/a			
2012	Hydrogen sulfide	Air Total	22434	2,243	n/a			
2012	n-Hexane	Air Total	28,274	2,827	n/a			
2012	Nitric acid	Air Total	67.50	6.75	n/a			
2012	Phenol	Air Total	11.72	1.172	n/a			
2012	Polycyclic aromatic hydrocarbons (B[a]Peq)	Air Total	128.7	12.87	6.81E-07	0.01	N	Emission rate from Montgomery County RRF with all 3 x 544 tpd units operating at max. load
2012	Selenium & compounds	Air Total	144.2	14.42	1.10E-04	2.33	N	Emission rate from Montgomery County RRF with all 3 x 544 tpd units operating at max. load
2012	Styrene (ethenylbenzene)	Air Total	17.12	1.712	n/a			
2012	Sulfuric acid	Air Total	183.6	18.36	n/a			
2012	Toluene (methylbenzene)	Air Total	34,449	3,445	n/a			
2012	Xylenes (individual or mixed isomers)	Air Total	19,128	1,913	n/a			
2012	Zinc and compounds	Air Total	1,011	101.1	1.66E-03	35	N	Emission rate from Montgomery County RRF with all 3 x 544 tpd units operating at max. load

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**10.2.1.6 Proposed Management and Mitigation Measures**

**10.2.1.6.1 Detail pollution control equipment, including its removal efficiency and expected down time. Compare efficiencies of pollution control equipment with world best practice. Show that hazardous pollutants (like dioxins) would be controlled to the Maximum Extent Achievable (MEA) (EPA Guidance Statement 55)**

In their report to the EPA, Whiting et al (Stage 2, 2013) state that “modern WtE combustion plants are required to meet among the most stringent emissions requirements of any industrial process” (p18). Indeed, the European WID in 2000 and US EPA regulations in the 1990s, which were specifically targeted at the gaseous and aqueous emissions from waste incineration with energy recovery, have been brought about by concerns about potential health and environmental impacts from those emissions.

In order to meet these stringent emission limits, flue gases are passed through a series of proven Air Pollution Control (APC) technologies, before being emitted at elevation, for final dispersion, via an appropriately sized flue within the flue gas stack. While the combination of combustion process, followed by flue gas cleaning prior to atmospheric dispersion of flue gases via a stack is common to modern coal fired power stations, the combination and requirements of the pollutant abatement technologies are typically more onerous, in order to ensure the facility stays within its licensed emission limits.

A summary of the typical pollutant abatement techniques applied to modern WtE facilities processing MSW is provided in Table 34 (Whiting et al, Stage 2, 2013). However, it is important to note that all of the available techniques are consistent with international best practice e.g. the European Commission BREF for Waste Incineration (2006) and are tried and proven techniques with multiple operating reference sites, as detailed in the BREF (2006).

Table 34 – Air emissions abatement technologies (Source: Whiting et al, Stage 2, 2013)

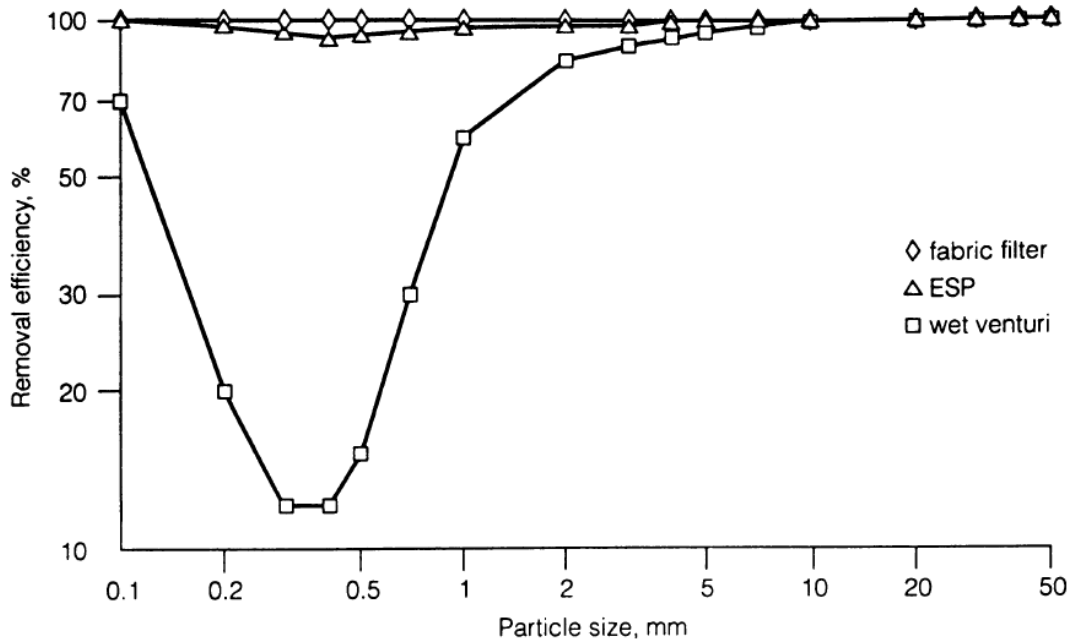
Pollutant	Typical Best Available Abatement Techniques
Particulates	Fabric filters, Electrostatic precipitators (ESP), Cyclones
Oxides of Nitrogen (NOx)	Flue gas recirculation, SNCR and SCR
Acid Gases (Sulphur Dioxide, Hydrogen Chloride, Hydrogen Fluoride)	Wet, Semi-dry or Dry scrubbers, Fabric filters, with lime injection upstream
Heavy Metals (Mercury, Cadmium, Lead, Copper etc.)	Fabric filters, Activated carbon injection
Dioxins and Furans	Flue gas recirculation, Fabric filters, Activated carbon injection

**10.2.1.6.1.1 Particulate Removal**

Whiting et al (2013) identify that the fabric filter, also known as a baghouse, is now the most common technique for particulate removal, since it is the most effective

technique for removing fine particles (see Figure 60), whereas ESPs and cyclones typically require a combination of techniques to achieve the required removal efficiencies.

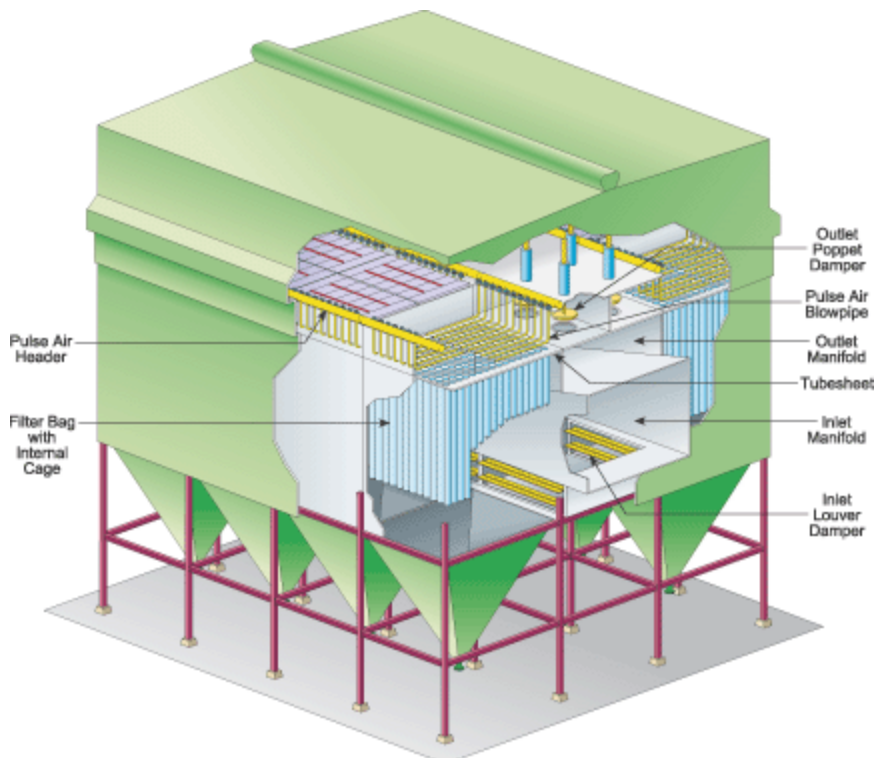
Figure 60 – Particle Size Distribution and Filtration Effectiveness (from Lighty, Varanth and Sarofim (2000) Note: units on the particle size are incorrect and should read  $\mu\text{m}$ , not mm)



An illustration of a typical fabric filter (baghouse) is provided in Figure 61. Fabric filters have the added advantage of providing a surface on which reagents such as lime can deposit and neutralisation reactions with acid

gases (such as Sulphur Dioxide,  $\text{SO}_2$  and Hydrogen Chloride,  $\text{HCl}$ ) can occur. As such, they are typically located at the back end of the APC system, downstream of the scrubber (Whiting et al, Stage 2, 2013).

Figure 61 – Typical Fabric Filter (Baghouse) (Whiting et al, 2013) Source: Babcock & Wilcox Volund



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Particulate matter and reaction products which collect on the surface of the bag are periodically removed using a pulse of air that rapidly expands the bag and dislodges the solid residue for collection and removal below.

**10.2.1.6.1.2 Acid Gas Scrubbing Systems**

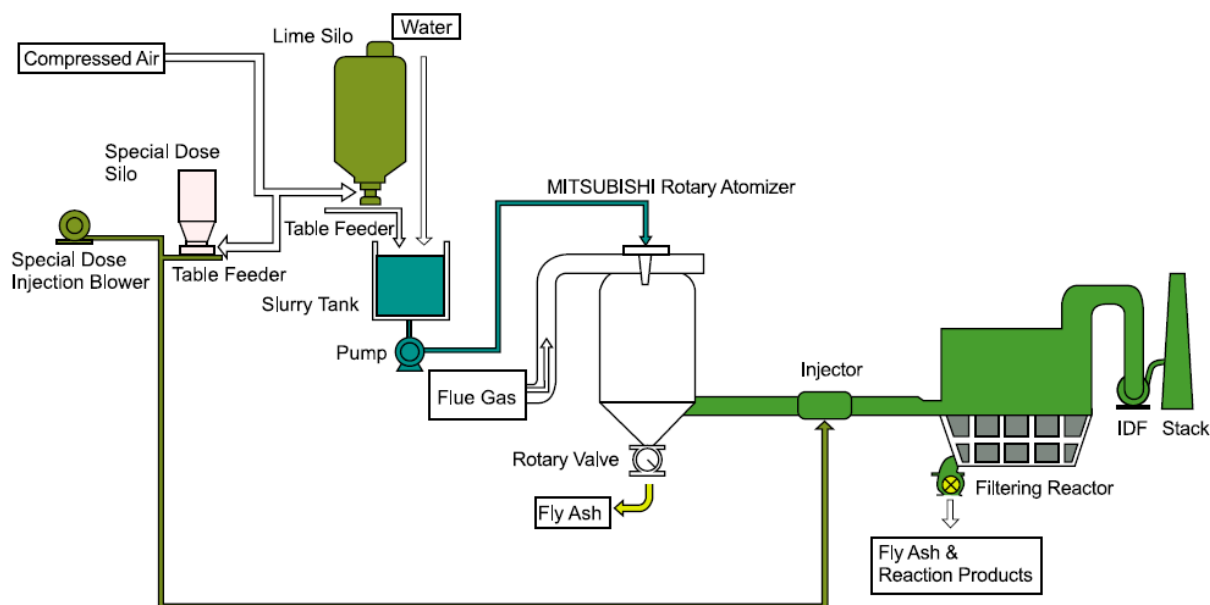
Acid gases such as sulphur dioxide, hydrogen chloride and hydrogen fluoride are typically removed by chemical reaction with a neutralising agent such as hydrated lime ( $\text{Ca}(\text{OH})_2$ ), sodium hydroxide ( $\text{NaOH}$ , or caustic soda) or sodium carbonate ( $\text{Na}_2\text{CO}_3$ ).

In order to reduce water consumption and eliminate the need to discharge process waste water from the site, the Kwinana WtE

Project will utilise the MHIEC semi-dry acid gas scrubbing system (as shown in Figure 62). A slurry of hydrated lime is injected into the flue gas in a quench chamber and activated carbon is injected into the quenched flue gas.

As mentioned earlier, these types of systems are typically used upstream of a fabric filter, which provides a surface for the acid gas neutralisation reactions to take place, and facilitates the adsorption of residual heavy metals, dioxins and furans. Fly Ash, the neutralisation reaction products and spent activated carbon are periodically recovered from the baghouse and will be sent to the Brick Plant for processing.

Figure 62 – The MHIEC Semi-Dry System with Filtering Reactor



**10.2.1.6.1.3 Heavy Metal and Dioxin/Furan Removal**

Stanmore (2011) describes dioxins, or polychlorinated dibenzo-*p*-dioxins and furans (PCDD/PCDF) as a series of chlorine-containing, triple ring compounds, which are present in extremely low concentrations (nanograms/ $\text{Nm}^3$ ) in WtE flue gases. These compounds along with volatile heavy metals (mercury, cadmium, lead) are insoluble in water. To remove them to the maximum extent achievable, activated carbon is injected into flue gas upstream of the fabric filter (see Special Dose injection in Figure 62).

Whiting et al (2013) explain that the activated carbon has an exceptionally high specific surface area and is very effective at adsorbing such compounds. The carbon and adsorbed compounds are captured by the fabric filter (Whiting et al, 2013).

**10.2.1.6.1.4 De-NOx Technologies**

As noted in section 5.1.2.4 Flue gas cleaning Air Pollution Control (APC) system on page 48, all combustion processes produce NOx by two pathways: the nitrogen in the combustion air and the nitrogen compounds in the waste itself (i.e. the waste composition). Whiting et al (2013) describe two techniques



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which are used to minimise NOx emissions from a WtE plant:

1. Minimising the formation of NOx – by careful combustion control, and
2. Reduction of NOx to nitrogen using either Selective Non-Catalytic Reduction (SNCR); the injection of ammonia or urea into the combustion zone at high temperatures, and Selective Catalytic Reduction (SCR); the injection of ammonia at lower temperatures in the presence of a catalyst. Higher NOx removal is possible with SCR than SNCR, so SCR is usually employed where lower NOx emission concentrations are required for local conditions. The SCR reaction vessel is typically located at the back end of the APC system due to the sensitivity of the catalyst to poisoning by other pollutants which may be present in the flue gas.

The proposal will utilise a combination of combustion control in conjunction with Selective Catalytic Reduction (SCR) to

control NOx emission rates below WID/IED limits under all operating scenarios.

**10.2.1.6.1.5 Typical Best Available Technique (BAT) Operational Emissions Levels**

The European Commission’s BREF for waste incineration (2006) provides a summary of operational emission limit level ranges from actual data for Best Available Techniques (BAT). Table 35 presents actual BAT operational emission level ranges against the WID/IED limits, to show how actual performance compares to the WID/IED limits.

The overall combination of Best Available Techniques selected for the proposal will include a quench/scrubber, fabric filter baghouse followed by a Selective Catalytic Reduction reactor (please refer to **Attachment 5** in section 16 ATTACHMENTS, page 185), in combination with activated carbon injection and automated combustion control will ensure that atmospheric emissions from the proposal will achieve world’s best practice performance.

**Table 35 – Operational emission level ranges associated with the use of BAT (BREF for waste incineration (2006)) (Kamuk, 2013)**

Substance(s)	Half-hour average (mg/Nm <sup>3</sup> )		Daily average (mg/Nm <sup>3</sup> )	
	WID/IED Limits in 2000/76/EC and 2010/75/EU	Actual BAT (measured)	WID/IED Limits in 2000/76/EC and 2010/75/EU	Actual BAT (measured)
Total dust	20	1-20	10	1-5
Hydrogen Chloride (HCl)	60	1-50	10	1-8
Hydrogen Fluoride (HF)	4	<2	1	<1
Sulphur dioxide (SO <sub>2</sub> )	200	1-150	50	1-40
NOx using SNCR <sup>[1]</sup>	400	30-350	200	120-180
Gaseous and vaporous organic				
Gaseous and vaporous organic substances, expressed as TOC	20	1- 20	10	1-10
Carbon monoxide (CO)	100	5-100	50	5-30
Mercury and its compounds (as Hg)	n/a	0.001-0.03	0.05	0.001-0.02
Total cadmium and thallium	n/a	0.005-0.05 <sup>[2]</sup>	0.05	0.005-0.05 <sup>[2]</sup>
Sum of other metals	n/a	0.005-0.5 <sup>[2]</sup>	0.5	0.005-0.5 <sup>[2]</sup>

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Substance(s)	Half-hour average (mg/Nm <sup>3</sup> )		Daily average (mg/Nm <sup>3</sup> )	
	WID/IED Limits in 2000/76/EC and 2010/75/EU	Actual BAT (measured)	WID/IED Limits in 2000/76/EC and 2010/75/EU	Actual BAT (measured)
Dioxins and Furans (in ng TEQ/Nm <sup>3</sup> )	n/a	0.01-0.1 <sup>[2]</sup>	0.1	0.01-0.1 <sup>[2]</sup>
Ammonia	n/a	1-10	n/a	<10

1.) Lower NO<sub>x</sub> emission concentrations can only be achieved with selective catalytic reduction using an SCR.

2.) From non-continuous samples

#### 10.2.1.6.1.6 Availability and Reliability

Each line (integrated grate/boiler system) will have its own dedicated APC system, ID fan, CEMS and flue. As such, the Stack will consist of multiple flues, one for each line. That way, each APC system can be sized for the full operating range of the grate to which it is dedicated, and an upset in one APC system will not necessarily trigger a full plant shutdown. As such, Whiting et al (Stage 2, 2013) report that overall availability for large scale WtE plants can exceed 90%, though equipment suppliers typically only provide guarantees in the range of 7,800 – 8000 hours uptime per annum.

#### 10.2.1.6.2 Consult with the Department of Health. Undertake a preliminary health risk assessment for people occupying public areas, residential areas and neighbouring industrial premises

In preparing its Public Environmental Review for the Kwinana WtE project, Phoenix Energy consulted with and briefed the Department of Health on the methodology employed in undertaking a qualitative preliminary public Health Risk Assessment for the proposal.

##### 10.2.1.6.2.1 Introduction

Thermal treatment technologies of waste are sometimes seen as controversial because of perceived health risks from air pollution, especially dioxins (Cardno, 2012). Historically such concerns were due to inferior technologies, lack of abatement and inferior regulatory standards. However, as Cardno (2012) state, the decisions to be considered now concern current generation technologies,

which provide superior emissions performance that readily satisfy stringent regulations such as those from European WID/IED, to ensure NEPM and WHO air quality standards can be achieved. As a result of the new limit values and more efficient flue gas cleaning, emissions to air from thermal processes recovering energy from MSW have reduced considerably between 1990 and the present day (DEFRA, 2013). Consequently, the emissions from modern WtE facilities can be considered almost negligible relative to urban ambient air conditions resulting from day to day emissions from traffic and wood fires (Stanmore, 2011).

Currently there are ~1000 WtE plants operating world-wide (Whiting et al, 2013), many of which are within or adjacent to major cities and population centres, such as Paris, Tokyo and London with no identified health risks. Due to the large number of existing WtE facilities using grate type WtE technology and modern Air Pollution Control systems, data is readily available on operating performance and emissions. For example, during the preparation work of European Union Reference Document on the Best Available Techniques for Waste Incineration (2006), the emissions data from a survey of 142 European non-hazardous waste incineration plants was collected.

Numerous Human Health Risk and Health Impact Assessments and Human Health Studies have been undertaken over the past two decades by government/regulatory bodies (such as the US EPA, UK Health Protection Agency, now known as Public Health England, the UK Food Standards Agency and DEFRA (the UK Department for

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Environment, Food & Rural Affairs), existing plant operators (e.g. ENSR's 2006 updated Health Risk Study for the Covanta operated Montgomery County Solid Waste Resource Recovery Facility) and new proponents (such as the Covanta Durham & York Energy Recovery Centre, currently under construction and Viridor's proposed South London Energy Recovery Facility in Beddington). Terence O'Rourke (2012), which recently undertook the health risk and a health impact assessment for the South London ERF in Beddington, concluded:

[With regard to metals and dioxins:] "Given the conservative nature of the assessment, it can be demonstrated that the maximally exposed individual is not subject to a significant carcinogenic risk or non-carcinogenic hazard, arising from exposures via both inhalation and the ingestion of foods."

[With regard to significance:] "These health effects are extremely small in magnitude, in absolute terms and when judged against the background rates. There is no accepted methodology for judging how significant health outcomes are, but it is self-evident that in this case the ERF will have an impact that can very reasonably be described as imperceptible."

Indeed the EPA WA sponsored 'Investigation into the Performance (Environmental and Health) of Waste to Energy Technologies Internationally' by Whiting et al (2013) resulted in an in-depth literature review in relation to both environmental and human health impacts and benefits associated with modern WtE technologies. Each of these studies has concluded or found that modern, well designed and well managed WtE facilities do not pose a significant risk to human health or the environment, and in most cases the risks are negligible.

#### 10.2.1.6.2.2 Preliminary Public Health Risk Assessment

In order to assess potential human health impacts associated with the Kwinana WtE project proposal, qualified consultants familiar with the special environment protection policy requirements for the Kwinana area, were engaged to undertake modelling of factors

such as air quality (including odour) and noise emissions. For conservatism, the data provided for the air quality assessment assumed that the WtE plant was operating at full capacity with emission concentrations at 100% of the WID/IED emission limit values (the international benchmark for emissions from such facilities), for the majority of pollutants. This is highly conservative because modern WtE facilities employing Best Available Techniques (or BAT) typically operate well within these limits, as highlighted in Table 35 in section 10.2.1.6.1.5 on page 145.

After completing its Air Quality Assessment for the proposal, ENVIRON (the air quality consultant) drew the following conclusion in relation to potential chronic health impacts associated with air emissions from the proposal: 'Comparison of the predicted annual averages against the annual average concentrations associated with an excess lifetime risk concentration (the concentration at which one in a million people may be expected to develop cancer from lifetime exposure to the atmospheric concentrations of the carcinogenic compound) for each of the modelled carcinogenic pollutants indicates that the incremental carcinogenic risks (IRCs) associated with emissions from the proposed WtE facility are expected to be well below the USEPA recommended *de minimus* (i.e. so small as to be considered negligible) risk value of one-in-one-million.'

While not specifically considered a health impact, if odour was to become a persistent issue then it may potentially affect health. Odour is readily managed under normal operation and by employing BAT, however, the air quality modelling also considered the potential impacts of fugitive odour emissions. The results of the air quality and odour impact assessments are discussed in section 10.2.1.5 Air Quality and Odour Impact Assessment, from page 96 onwards, of this Environmental Factor.

The acoustic consultant utilised conservative sound power levels from its database of similar noise sources to model the significant external noise emission sources identified, which include the multi-flue stack, air cooled condensers and on-site truck traffic, without

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considering potential abatement measures for point source emissions, in order to determine the potential impacts of the proposal on neighbouring and sensitive far-field receptors. The results of the acoustic impact assessment are discussed in section 10.3.1.5.1.4 Acoustic Assessment Results on page 163.

As the proposal will be designed to minimise water consumption and maximise water re-use on-site in order to eliminate the requirement to treat and discharge process wastewater, water emissions are not considered to be a health hazard.

10.2.1.6.2.3 Methodology

The Department of Health has released a document entitled Health Risk Assessment (Scoping) Guidelines, A health risk assessment process for risk assessors for use within the scoping stages of environmental and health impact assessments (2010).

The HRA Guidelines present a health risk matrix, which comprises a range of consequences along with their potential probabilities (likelihood), to determine a risk level. A health risk matrix is shown in Table 36. The health risk matrix has been used to provide a qualitative preliminary assessment of potential health risks associated with the proposal.

Table 36 – Risk Matrix for a Public Health Risk Assessment (Qualitative) (DoH, 2010)

Likelihood	Consequences					
	Slight/negligible	Minor	Moderate	Major	Massive	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme	Extreme
Likely	Low	Low	Medium	High	Extreme	Extreme
Possible	Very Low	Low	Low	Medium	High	Extreme
Unlikely	Very Low	Very Low	Low	Low	Medium	High
Rare/remote	Very Low	Very Low	Very Low	Low	Low	Medium

10.2.1.6.2.4 Overview of the Proposal

The proposal is a world scale and world class waste to energy facility, using only tried and proven technology appropriate to the feedstock, with an on-site brick plant to re-processes solid residues into value added bricks, pavers and/or construction aggregate. The proposal will divert MSW away from surrounding landfills, thus eliminating potential environmental and health impacts associated with landfill disposal of MSW, while also preventing the requirement to develop new landfills and the need to produce and consume fossil fuels for base load power generation. The proposal will be built to modern standards and employ Best Available Techniques for the health and

safety of the workers, the community and the environment.

10.2.1.6.2.5 Scoping

The scope of the preliminary assessment covers impacts associated with construction and the operation of the facility. Construction and commissioning will occur over a 24 month period, while operation will be continuous, 24 hours a day, seven days a week, 365 days a year, except for plant turnarounds, to overhaul of major plant and equipment. Approximately 85% of the site is cleared with existing buildings and both sealed and unsealed areas. The site is designated a contaminated site due to past land uses.

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10.2.1.6.2.6 Risk Components for the Proposal

Table 37 – Summary of risk components for the proposal in terms of potential health hazards and pathways

Risk Terminology	Descriptions
Health Hazards	<ul style="list-style-type: none"> <li>▪ air emissions including particulates;</li> <li>▪ residual solids and liquids;</li> <li>▪ dust;</li> <li>▪ litter, flies, vermin and birds</li> <li>▪ noise;</li> <li>▪ odour;</li> <li>▪ traffic;</li> <li>▪ contaminated soil, surface water and groundwater;</li> <li>▪ rainwater quality;</li> <li>▪ fire</li> <li>▪ working conditions; and</li> <li>▪ community wellbeing.</li> </ul>
Health Pathways	<ul style="list-style-type: none"> <li>▪ Respiratory system</li> <li>▪ Eyes</li> <li>▪ Cancer and other chronic health issues</li> <li>▪ Stress from noise and odour</li> <li>▪ Nuisance and stress from loss of amenity/aesthetics of the area</li> </ul>

10.2.1.6.2.7 Qualitative Preliminary Public Health Risk Assessment Risk Matrix

Table 38 – Qualitative preliminary public Health Risk Assessment Risk Matrix

Health Impacts	Acute Health Consequences	Chronic Health Consequences	Consequences to Health Services	Comment on Likelihood / Mitigation and Management
<b>Air Emissions including Particulates</b>	<p>Negligible consequences associated with respiratory issues, due to the presence of Air Pollution Control systems, continuous monitoring of emissions and automated combustion controls, covering all operating scenarios. In the event of a system failure, MSW feed can be suspended, with the natural gas fuelled auxiliary burners automatically activated to maintain combustion temperatures while there is still MSW on the grate.</p> <p>If the gaseous and particulate emissions were uncontrolled and automated combustion controls were not in place, then like any solid fuel combustion process, there could be significant acute</p>	<p>Negligible consequences associated with chronic health issues, due to the presence of Air Pollution Control systems, continuous monitoring of emissions and automated combustion controls, covering all operating scenarios. In the event of a system failure, MSW feed can be suspended, with the natural gas fuelled auxiliary burners automatically activated to maintain combustion temperatures while there is still MSW on the grate.</p> <p>If the gaseous and particulate emissions were uncontrolled and automated combustion controls were not</p>	<p>Negligible consequences to health services, due to the presence of Air Pollution Control systems, continuous monitoring of emissions and automated combustion controls, covering all operating scenarios. In the event of a system failure, MSW feed can be suspended, with the natural gas fuelled auxiliary burners automatically activated to maintain combustion temperatures while there is still MSW on the grate.</p> <p>If the gaseous and particulate emissions were uncontrolled and automated combustion controls were not</p>	<p>Rare to remote likelihood</p> <p>Mitigation and Management: Best Available Techniques for combustion control and Air Pollution Control and continuous emissions monitoring for the majority of criteria pollutants, common to most large scale combustion and power generation processes.</p> <p>"[Item] 130. The HPA has reviewed research undertaken to examine the suggested links between emissions from municipal waste incinerators and effects on health. It notes that modern, well managed incinerators make only a small contribution to local concentrations of air pollutants. The HPA's view is that while it is possible that such small additions could have an impact on health, such effects, if they exist, are likely to be very small and not detectable" DEFRA (2013)</p> <p>The Waste Incineration Directive (2000/76/EC) aims to reduce the impact of waste incineration on human health and the environment. From the directive, item (7) on page 1 states that "The limit values set should prevent or limit as far as practicable negative effects on the environment and the resulting risks to human health."</p> <p>Best Available Techniques for combustion of MSW and Air Pollution Control ensure that actual emissions from modern WtE plants are well within WID/IED limits.</p> <p>As previously noted, particulate matter emissions are readily controlled by standard</p>

Health Impacts	Acute Health Consequences	Chronic Health Consequences	Consequences to Health Services	Comment on Likelihood / Mitigation and Management
	<p>health consequences. Hence the stringent operating requirements, emission limits and requirements to employ Best Available Techniques (BAT), as described in the European WID/IED, or to utilise Maximum Achievable Control Technologies (MACT) as defined by the US EPA etc.</p> <p>With regard to the track record of the Kwinana WtE project team, environmentally, Covanta owned and/or operated facilities achieve extremely high records of compliance with rigorous US Federal, state and local air, water and solid waste environmental standards.</p>	<p>in place, then like any solid fuel combustion process, there could be significant acute health consequences. Hence the stringent operating requirements, emission limits and requirements to employ Best Available Techniques (BAT), as described in the European WID/IED, or to utilise Maximum Achievable Control Technologies (MACT) as defined by the US EPA etc.</p> <p>Environmentally, Covanta owned and/or operated facilities achieve extremely high records of compliance with rigorous US Federal, state and local air, water and solid waste environmental standards.</p>	<p>any solid fuel combustion process, there could be significant acute health consequences. Hence the stringent operating requirements, emission limits and requirements to employ Best Available Techniques (BAT), as described in the European WID/IED, or to utilise Maximum Achievable Control Technologies (MACT) as defined by the US EPA etc.</p> <p>Environmentally, Covanta owned and/or operated facilities achieve extremely high records of compliance with rigorous US Federal, state and local air, water and solid waste environmental standards.</p>	<p>Fabric Filters (Baghouses), such as “[Item] 126...energy from waste plants are a low source of environmental pollutants and contribute only a small fraction of both local and national total emissions of particles. [Item] 127. For example, other much larger sources of small particulates include: vehicle exhausts; paved and unpaved roads; burning of conventional fuels in power stations; wood burning; open burning; industrial activities including grinding and milling; and construction works.” DEFRA (2013)</p> <p>Also note that the control of CO, VOCs and dioxins, in terms of their concentration, is primarily through correct combustion conditions being maintained by the automated combustion control system.</p> <p>To put the emissions from a modern WtE into perspective, DEFRA (2013) notes that the emissions from an WtE plant with a capacity of ~230,000 tonnes per year, are approximately equivalent to:</p> <ul style="list-style-type: none"> <li>(a) Oxides of nitrogen – Emissions from a 7 km stretch of typical motorway.</li> <li>(b) Particulate matter – Emissions from a 5 km stretch of typical motorway.</li> <li>(c) Dioxins and furans – Emissions from accidental fires in a town the size of Milton Keynes.</li> <li>(d) Cadmium – A twentieth of the emissions from a medium sized UK coal-fired power station.</li> </ul>
<p><b>Residual solids and liquids</b></p>	<p>Slight/negligible consequences due to proposed methods for materials handling and re-processing.</p> <p>Any residues or products leaving the Facility will be characterised and subjected to a testing regime to confirm quality and ensure compliance with building and environmental standards for their proposed use or disposal (in the event of a market failure such that by-products cannot be utilised as alternative building materials).</p>	<p>Slight/negligible consequences due to proposed methods for materials handling and re-processing.</p> <p>Any residues or products leaving the Facility will be characterised and subjected to a testing regime to confirm quality and ensure compliance with building and environmental standards for their proposed use or disposal (in the event of a market failure such that by-products cannot be utilised as alternative building materials).</p>	<p>Slight/negligible</p>	<p>Rare to remote likelihood.</p> <p>Mitigation and Management: Waste water to be used for bottom ash discharger quench, brick making and other process uses.</p> <p>Ash and other solid APC reaction products to be used to make bricks and pavers and/or to convert bottom ash to construction aggregate in the on-site Brick Plant.</p> <p>Ferrous and non-Ferrous metals are readily recovered from the bottom ash for recycling.</p> <p>A number of residue studies undertaken in the US using US EPA approved sampling and testing methods (Roffman Associates, Inc. 2002) and in Europe (e.g. Denmark Department of Environment and Energy) have consistently shown that bottom ash and even combined bottom ash and fly ash are non-leaching and therefore pose minimal risks to groundwater contamination. Even so, the Kwinana WtE project is proposing to incorporate an on-site brick plant to convert solid combustion ashes and APC reaction products into bricks and pavers to standard specifications, which will also be non-leaching.</p> <p>All combustion residues will be periodically characterised and any residues or products</p>

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Health Impacts	Acute Health Consequences	Chronic Health Consequences	Consequences to Health Services	Comment on Likelihood / Mitigation and Management
				<p>leaving the Facility will be subjected to a testing regime (including leach testing) to confirm quality and ensure compliance with building and environmental standards for their proposed use or disposal (in the event of a market failure such that by-products cannot be utilised as alternative building materials).</p> <p>All products and residues will be handled in accordance with tried and proven materials handling techniques learnt from the on-going operation of hundreds of similar facilities processing similar feedstocks and in accordance with relevant regulations and guidance.</p> <p>Case study:</p> <p>"Ballast Phoenix worked with Skanska / Balfour Beatty Joint Venture to provide Incinerator Bottom Ash Aggregate (IBAA) product for use in the project to widen junctions 29 – 30 of the M25. IBAA was applied as a backfill material to a retaining wall in 250mm layers, using 40,000 tonnes of IBAA graded to &lt;10mm and complying with a variety of specifications." DEFRA (2013)</p>
<b>Dust</b>	<p>Negligible during day to day operation due to waste delivery vehicles being covered and deliveries occurring within an enclosed tipping hall (Building) with negative air pressure</p> <p>Slight to moderate during construction</p>	<p>Negligible during day to day operation</p> <p>Slight to moderate during construction</p>	<p>Negligible during day to day operation</p> <p>Slight to moderate during construction</p>	<p>Rare to remote likelihood for day-to-day operation. Possible likelihood during construction hours.</p> <p>Mitigation and Management:</p> <p>During construction – managed by appropriate construction planning and standard dust control practices and procedures.</p> <p>During day-to-day operation - minimised by good building design, performing all operations under controlled conditions indoors, good working practices and effective management undertaken for dust suppression from vehicle movements.</p> <p>Each of the major project partners has direct experience in the design, construction and commissioning of WtE facilities similar to the proposal.</p>
<b>Litter, vermin birds, flies, and</b>	<p>Slight/Negligible consequences</p> <p>These are readily managed by ensuring that all waste is handled within buildings under controlled and monitored conditions</p>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>Rare to remote likelihood</p> <p>Mitigation and Management: All waste handling will be indoors and under controlled conditions. Pest control will be employed in the waste bunker area as part of routine site operation &amp; maintenance services.</p>
<b>Odour</b>	<p>Slight/Negligible consequences</p> <p>Odour is readily managed by ensuring that all waste is handled within buildings under negative air</p>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>Rare to remote likelihood</p> <p>Mitigation and Management: All waste handling will be indoors and under controlled conditions. The tipping hall and waste bunker areas will be equipped with doors and will be held under constant negative air pressure, with combustion air drawn from those areas to encourage</p>

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Health Impacts	Acute Health Consequences	Chronic Health Consequences	Consequences to Health Services	Comment on Likelihood / Mitigation and Management
	pressure			ambient air in-flow.
<b>Noise</b>	<p>Slight/Negligible consequences</p> <p>As most noisy plant and equipment is housed within buildings, on-site noise tends to be dominated by truck traffic. Furthermore, existing buffer zones will ensure that the minor contribution of the WtE facility will not impact on far-field sensitive receptors</p>	Slight/Negligible consequences	Slight/Negligible consequences	<p>Rare to remote likelihood</p> <p>Mitigation and Management: Most equipment is housed inside buildings. The main contributors to noise associated with plant operations include: truck and vehicle movements, typically occurring in 2 x 2 hour shifts during weekdays and the multi-flue stack and air cooled condensers. The ID Fan will be equipped with a silencer to reduce stack noise emissions, while abatement measures for the air coolers will depend on air cooler fan selection and configuration, in order to ensure compliance with assigned levels for neighbouring premises receiving noise.</p> <p>As the site is a heavy industry zoned area, construction noise is not expected to be of concern, due to existing buffer zones.</p> <p>Each of the major project partners has direct experience in the design, construction and commissioning of WtE facilities similar to the proposal.</p>
<b>Traffic</b>	<p>Slight/Negligible consequences</p> <p>The site is in a heavy industry zoned precinct with substantial existing heavy vehicle movements. The Department of Transport has plans in place to upgrade road infrastructure (such as the Anketell Road extension) and rail to support the new port expansion</p>	Slight/Negligible consequences	Slight/Negligible consequences	<p>Rare to remote likelihood</p> <p>Mitigation and Management:</p> <p>Truck and vehicle movements, typically occurring in 2 x 2 hour shifts during weekdays. The site is in a heavy industry zoned precinct and is situated centrally to much of the existing waste management infrastructure in the region, hence waste transportation will either be little effected or may even be optimised, once a central resource recovery site is established.</p> <p>A traffic study will be undertaken as part of the detailed design and will be an important input into the Works Approval application for the proposal.</p>
<b>Contamination of soil, surface water and groundwater</b>	<p>Slight/Negligible consequences during normal operation:</p> <p>As waste processing will occur within sealed bunkers within buildings, with design expertise from MHIEC and operational expertise from Covanta, process waste water is not expected to come into contact with surface and ground water. Furthermore, stormwater will be harvested and managed in accordance with City of Kwinana Planning</p>	Slight/Negligible consequences	Slight/Negligible consequences	<p>Rare to remote likelihood</p> <p>Mitigation and Management: All waste handling will be indoors on or within sealed surfaces. All process areas will be contained within buildings, thus minimising the likelihood of contamination of soil, surface water and ground water by any process waste water or solid residues.</p> <p>All solid by-products leaving the site will be subjected to periodic leach testing to confirm that they are appropriate for their intended use or disposal destination (in the event of a market failure such that by-products cannot be utilised as alternative building materials).</p> <p>Construction risks will be managed by carefully considered site preparation activities and site surveys to determine soil contamination and groundwater baselines and to develop construction plans accordingly.</p> <p>Each of the major project partners has</p>



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Health Impacts	Acute Health Consequences	Chronic Health Consequences	Consequences to Health Services	Comment on Likelihood / Mitigation and Management
	<p>regulations.</p> <p>Slight to Moderate during construction due to existing soil contamination due to past land use.</p>			<p>direct experience in the design, construction and commissioning of WtE facilities similar to the proposal.</p>
<b>Rainwater quality</b>	<p>Slight/Negligible consequences</p> <p>All processing areas will be contained within buildings, thus providing a physical barrier to rainwater contamination.</p>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>Rare to remote likelihood</p> <p>Mitigation and Management: While buildings will provide a physical barrier to prevent potential contamination of rainwater, good operating practices will ensure that no contamination occurs on site. As an operator of 45 WtE facilities similar to the proposal world-wide, Covanta is well placed to ensure that best practice operations and lessons learnt are utilised for the benefit of the Kwinana WtE project.</p>
<b>Fire</b>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>Rare to remote likelihood</p> <p>Mitigation and Management: Like any large process facility, the plant will be equipped with a fire water system, on-site fire water storage and diesel engine driven pumps. Deluge systems will be installed in staffed areas and fire water monitors will be available within the waste bunker area and tipping hall.</p> <p>Both MHIEC and Covanta have experience in operating and maintaining WtE facilities similar to the proposal over the past 20-30 years.</p>
<b>Working conditions</b>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>The facility manager and operations and maintenance service provider (Covanta) prides itself in maintaining a safe, diverse and stimulating work environment where employees can develop both personally and professionally.</p> <p>Safety is Covanta's first priority. Through its companywide safety program, Step Up (Safety Today and Every day is Paramount—Unleash the Power!), Covanta evaluates and addresses leading indicators of safety (such as near misses) in addition to traditional lagging indicators like accidents and injuries. Employees are trained as new hires and receive ongoing instruction on both skills-based and leadership-based safety practices.</p> <p>For example, Covanta uses a Use a “near-miss” reporting system to incentivize safe behaviour by identifying and eliminating unsafe practices that could lead to accidents.</p> <p>In North America, 40 of Covanta's 41 WtE operations have now qualified as OSHA Voluntary Protection Program (VPP) STAR sites, administered by the U.S. Federal Occupational Safety and Health Administration to acknowledge facilities demonstrating outstanding ongoing safety records achieved through leadership cooperation between facility management</p>

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Health Impacts	Acute Health Consequences	Chronic Health Consequences	Consequences to Health Services	Comment on Likelihood / Mitigation and Management
<b>Community Wellbeing</b>	<p>Slight/Negligible consequences</p> <p>Community wellbeing and acceptance of the proposal will be important to the achievement of stated operating targets such as 100% landfill diversion of waste feedstock, while maximising renewable electricity generation. Furthermore international WtE communities tend to recycle at higher rates than non-WtE communities.</p>	<p>Slight/Negligible consequences</p>	<p>Slight/Negligible consequences</p>	<p>and employees. Covanta has a stated goal to ensure all of its facilities will qualify for the Program.</p> <p>Rare to remote likelihood</p> <p>Mitigation and Management: Community Engagement and involvement will be an increasing focus as the proposal moves through planning and approvals and into construction.</p> <p>As described in section 13 Public Consultation on page 176, a number of community forums have occurred, to provide details on the project and to address questions and concerns from the community. Furthermore, a Community Advisory Group has been established, to provide a direct line of communication with interested community members.</p> <p>As a major infrastructure project, the facility will play an important role in regional waste management, by providing a resource recovery alternative to landfill disposal, while also providing significant new local renewable electricity generation capacity. By eliminating the need to build new putrescible landfills and reducing the reliance on fossil fuel fired electricity generation, the project is a win-win for the community and the region as a whole.</p> <p>As the future facility manager and operations and maintenance service provider, Covanta has a wealth of experience in working closely with the 44 communities/regions that its existing facilities serve around the world.</p> <p>Covanta has long recognised the importance of maintaining a strong positive relationship and a high level of acceptance, in delivering more sustainable waste management outcomes for the communities and municipalities it serves. An important and tangible aspect of developing and maintaining the relationship between the resource recovery facility and the community is the implementation of a localised Community Outreach plan, consisting of a range of programs and activities designed to increase community awareness about sustainable waste management and protecting the environment. Covanta has successfully developed and implemented programs to encourage community participation to remove mercury from residual waste streams, established a program to recover energy from end-of-life fishing nets and to establish its Rx4Safety program to help prevent the abuse of prescription pharmaceuticals (a leading cause of accidental death in the United States) and to mitigate the negative impacts on drinking water and harm to fish, aquatic organisms, and wildlife when prescription pharmaceuticals are flushed down the drain or disposed of in landfills. By the end of 2012, more than 600,000 pounds of</p>

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Health Impacts	Acute Health Consequences	Chronic Health Consequences	Consequences to Health Services	Comment on Likelihood / Mitigation and Management
				<p>pharmaceutical drugs had been safely and securely converted to energy in Covanta's EfW plants through the Rx4Safety program.</p> <p>With an ongoing focus on the triple bottom line, the proposal stands to benefit the community in three primary ways, by providing:</p> <p>(1) an economic benefit to the region through construction jobs, facility operational and maintenance jobs and new work for local service providers,</p> <p>(2) a more environmentally friendly alternative to landfill waste disposal through the recovery of energy and resources from waste otherwise destined for landfill disposal, and through the generation of clean, renewable electricity, and</p> <p>(3) a clean and efficient focal point for the community understanding of waste management.</p>

**10.2.1.6.2.8 Preliminary Public HRA findings**

In summary, this preliminary public health risk assessment has considered a number of the health impact areas, which are typically identified in relation to these types of developments and has determined that the risk to human health due to the proposal is Very Low. With almost 1000 operating WtE plants of a similar nature to the proposal, with many operating under strict EU, US and Japanese emissions standards in close proximity to major population centres, there is a wealth of literature and data to support the finding of this preliminary HRA; that a well-designed and well operated WtE facility will generally pose a very low risk to human health. By employing the world's preeminent WtE technology (the Martin GmbH reverse acting (stoker) grate) for the recovery of energy from MSW, supplied by one of the most reputable WtE EPC/technology providers (MHIEC), supported by a reputable local construction and EPC firm (John Holland), and operated by the leading private provider of WtE facility management, operating and maintenance service (Covanta), Phoenix Energy has every confidence that health and environmental risks will be minimised as far as practicable throughout the lifecycle of the proposal.

**10.2.1.6.3 Consider the impact of deposition of toxic and/or bio-accumulating air emissions over the life of the proposal, including deposition into Cockburn Sound**

Polychlorinated dioxins and furans are formed primarily as a by-product of combustion or chemical manufacturing processes. Other significant regional sources of polychlorinated dioxins and furans emissions not captured within the National Pollution Inventory (NPI) database include bushfires, motor vehicles and domestic fuel burning (e.g. wood fired heaters). Air quality consultant ENVIRON notes that the national inventory identifies uncontrolled combustion sources as the greatest source of dioxin emissions in Australia, contributing nearly 70% of total emissions to the air and approximately 75% of all emissions in Australia.

Dioxins are known to bio-accumulate and may build up in the food chain, resulting in measurable concentrations in animals. Human exposure to dioxins may occur through breathing, ingestion or absorption through the skin (ingestion being the most common exposure-pathway).

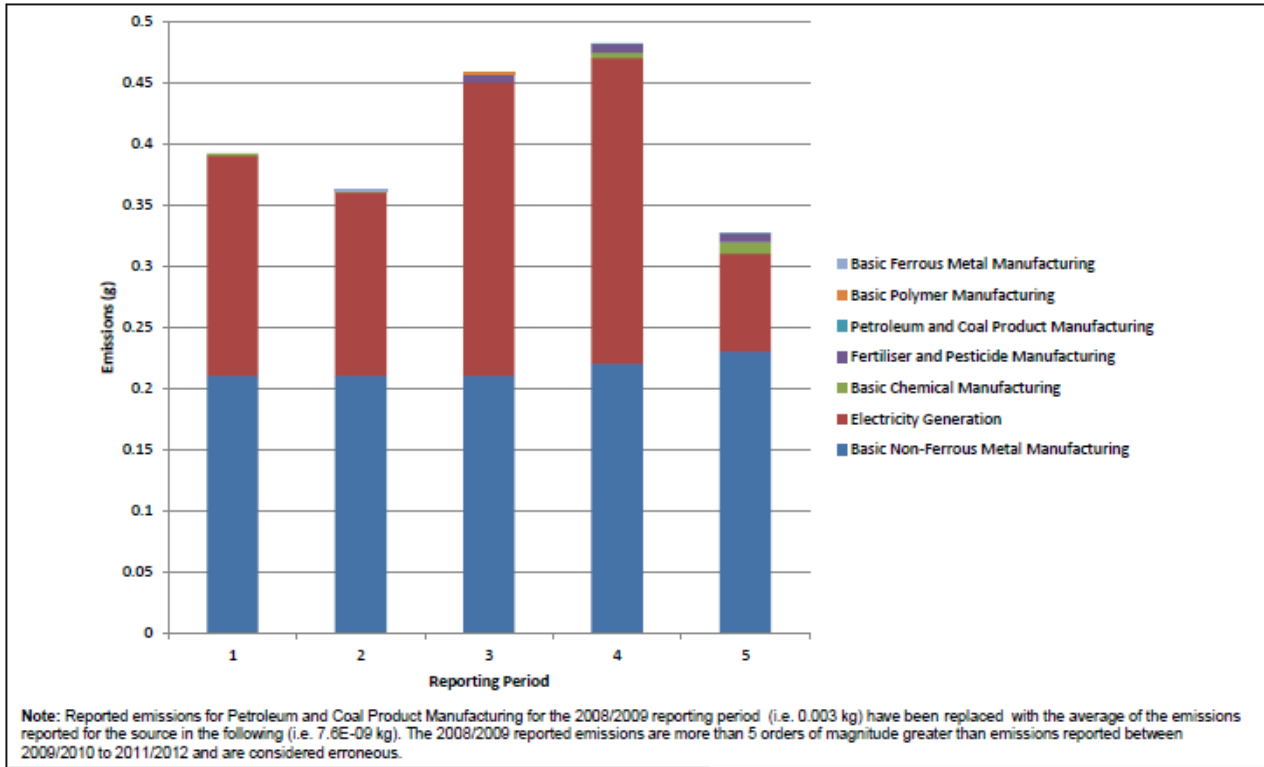
Industrial sources of polychlorinated dioxins and furans within the Kwinana region

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currently include electricity generation, alumina and petroleum refining and chemical manufacturing. A summary of the polychlorinated dioxins and furans emissions reported to the National Pollutant Inventory (NPI) within the Kwinana airshed between

2007 and 2012 is presented in Figure 63, indicating that the primary sources of polychlorinated dioxins and furans emissions reported to the NPI for the Kwinana airshed are non-ferrous metal manufacturing (i.e. alumina refining) and electricity generation.

Figure 63 – Summary of NPI reported emissions of dioxins and furans with the Kwinana Airshed – 2009-2012



For air dispersion modelling purposes, ENVIRON conservatively assumed that the emission rate was equivalent to the Kwinana WtE plant operating at full capacity with a dioxin emission rate based on the WID/IED limit value. In practice, and as presented earlier in Table 24, when comparing model inputs to actual reference plant stack test results, both the combustion control system and the Air Pollution Control system will ensure that the actual concentrations of dioxins and furans emitted will be significantly below the WID limit.

Utilizing the air dispersion modelling software package, DISPMOD, and applying the highly conservative WID/IED dioxin limit value of 0.1 ng.ITEQ/m<sup>3</sup> concentration, a maximum deposition rate of approximately 3.0E-5 g per year was predicted for dioxin and furan emissions from the proposed Kwinana WtE facility. Environ notes in its assessment, that: "This estimate is considered conservative on

the basis that Phoenix Energy expects that the actual operating emission rates for dioxins and furans will be below the WID emission limits modelled as part of this assessment. Stack testing data collected from similar facilities operating internationally indicates dioxin and furan emissions could be up to four orders of magnitude lower than the WID emission limits."

The contribution of emissions from the proposed WtE facility to the total dioxin and furan emissions released within the Kwinana airshed is therefore expected to be negligible. The predicted deposition rate associated with such emissions would also be expected to be negligible, particularly in comparison to other significant regional sources including bushfires, motor vehicles and domestic fuel burning.

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**10.2.1.6.4 Describe the proposed management, monitoring and validation of predictions for all air emissions.**

In accordance with international best practice, i.e. the European WID/IED, monitoring of exit flue gases will be accomplished through the use of a continuous emissions monitoring system (CEMS) – one for each grate line.

As a minimum, the components to be measured will be those stipulated by current legislation, which comprise:

- Sulphur dioxide (SO<sub>2</sub>)
- Nitrogen oxides (NO<sub>x</sub>, expressed as NO<sub>2</sub>)
- Hydrogen chloride (HCl)
- Hydrogen fluoride (HF)
- Volatile organic compounds (Total Organic Carbon)
- Particular matter (PM<sub>10</sub>)
- Carbon monoxide (CO)

In addition, Oxygen (O<sub>2</sub>), water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), pressure, temperature and flue gas flow will also be monitored.

If measurements are assessed in strict accordance with the European WID/IED (i.e. Annex VI Part 8), the emission limit values for air would be regarded as being complied with if:

- (a) -none of the daily average values exceeds any of the emission limit values set out in Table 39;
- (b) either none of the half-hourly average values exceeds any of the emission limit values set out in Table 39, 100<sup>th</sup> percentile column or, where relevant, 97 % of the half-hourly average values over the year do not exceed any of the emission limit values set out in Table 39;
- (c) none of the average values over the sample period set out for heavy metals and dioxins and furans exceeds the emission limit values set out in Table 39;
- (d) the provisions of Table 39 note (c) and (g) are met.

**Table 39 – Waste Incineration Directive (WID/IED) Emission Limit Values (mg/Nm<sup>3</sup>)(a)(g)**

Substance	30-Minute (Half-hourly) Mean		
	Daily Mean	100th Percentile	97th Percentile
Particles	10	30 <sup>(h)</sup>	10
Nitrogen Dioxide	200	400	200
Sulphur Dioxide	50	200	50
Carbon Monoxide	50 <sup>(f)</sup>	100 <sup>(b) (h)</sup>	150 <sup>(c)</sup>
Hydrogen Fluoride	1	4	2
Hydrogen Chloride	10	60	10
Total Organic Carbon (TOC)	10	20 <sup>(h)</sup>	10
Group I metals - Cd and Tl <sup>(d)</sup>		0.05	
Group II metals - Hg <sup>(d)</sup>		0.05	
Group III metals - Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V <sup>(d)</sup>		0.5	
Dioxins and Furans <sup>(e)</sup> ng TEQ/m <sup>3</sup>		0.1	

**Notes:**

(a) Units are mg/Nm<sup>3</sup> (273K, dry and 11% O<sub>2</sub>) unless stated otherwise

(b) 100th percentile of half-hourly average concentrations in any 24-hour period

(c) 95th percentile of ten-minute average CO concentrations

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- (d) Average over a sample period between 30 minutes and 8-hours
- (e) Average over a sampling period of 6 to 8 hours
- (f) at least 97 % of the daily average values over the year do not exceed the daily average emission limit value
- (g) (From WID Article 11 Measurement Requirements: Paragraph 11, or IED Annex VI, Part 8 point 1.2) The half-hourly average values and the 10-minute averages shall be determined within the effective operating time (excluding the start-up and shut-off periods if no waste is being incinerated) from the measured values after having subtracted the value of the confidence interval specified in point 3 of WID Annex III (IED Annex VI Part 6, 1.3). The daily average values shall be determined from those validated average values.  
  
To obtain a valid daily average value no more than five half-hourly average values in any day shall be discarded due to malfunction or maintenance of the continuous measurement system. No more than ten daily average values per year shall be discarded due to malfunction or maintenance of the continuous measurement system.
- (h) Under abnormal operating conditions, such as a plant breakdown, the total dust concentration in the emissions into the air shall under no circumstances exceed 150 mg/Nm<sup>3</sup> expressed as a half-hourly average. The half-hourly (100%) air emission limit values for TOC and CO shall not be exceeded.

The monitoring system is required to operate at all times. If any item of monitoring equipment fails, a stand-by will be brought into use; if this fails the line will be shut down until repairs are completed. Should the electricity supply fail, a stand-by generator will be available to power the CEMS.

The system incorporates an 'approach to limit' alarm in order to provide warning of any potential problem. Should the alarm be triggered the system will inhibit the feeding of waste until the reason for the alarm has been fully investigated and the cause determined and rectified.

The CEMS system converts instantaneous emissions and process data values in increments of one minute. Data analysis then uses the one minute average values to generate reports in a range of time spans, including thirty minute, hourly, daily and monthly average readings as required by environmental legislation.

Emissions reporting will be publicly available via the plant website and in accordance with future operational licensing requirements, to be determined prior to operation of the facility.

The CEMS will be serviced and calibrated at least once a year in accordance with manufacturer and regulatory standards.

In addition to the continuous monitoring of emissions, there are a range of emissions (including dioxins, furans and heavy metals) for which extractive emissions testing must be undertaken in accordance with the European WID/IED. For the first two years of operation this will take place on a quarterly

basis and all the results of the analysis will be reported to the EPA for checking. Provided good performance is proved during the first two years of operation, the EPA may reduce the frequency of extractive emission testing to six monthly, in accordance with the requirements of the European WID/IED.

The continuous measurements of carbon monoxide (CO) will provide the most reliable evidence that the combustion process has provided a high conversion of CO to CO<sub>2</sub> and that other pollutants of interest have also been destroyed. Furthermore, compliance with the flue gas temperature condition (minimum 850°C for two seconds) will be demonstrated by determination of flue gas temperature at an appropriate temperature measurement location in the furnace. Natural gas fired auxiliary burners are in place and on standby to automatically act to maintain the temperature at a minimum of 850°C, whenever there is waste on the grate. Operationally, the auxiliary burners are required to warm up the plant from a cold start, to ignite the first feed of waste to the grate and to permit the burnout and controlled cool down of the plant during a plant shutdown.

Validation of predicted air emissions will be achieved by the continuous online monitoring and sampling regime described herein, to ensure that measured emission concentrations are less than the limit values or standards used to confirm compliance with ground level concentrations within the KIA and at sensitive receptors.

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With regard to testing for ultra-small diameter particles, Phoenix Energy and its project partners are committed to ensuring the WtE process meets its operational performance objectives whilst minimising its environmental impacts. This PER document describes the application of best available techniques for air pollution control, which meet internationally benchmarks for minimising environmental impacts, as well as continuous emission monitoring and periodic sampling, in order to confirm compliance with both local and internationally recognised regulatory limits on emissions from the facility. While there may be instrumentation and techniques available for measuring particulates in the ultra-small size range, such measurements would be premature in the absence of a regulatory framework with benchmarks or limits established for acceptable levels of ultra-small particulate emissions and standardised methods for their measurement.

**10.2.1.6.5 Describe contingency plans should the predicted results of the proposed management, monitoring and validation of all air emissions not be achieved.**

It is important to note that there will be two lines (each consisting of a grate/boiler/flue gas cleaning APC system, ID Fan, CEMS and flue) operating in parallel and independently of each other. Some equipment, such as the steam turbine, air cooled condensers and generator will be shared. Where there is no impact to shared instrumentation or equipment items, the unaffected line will continue to operate normally, so as to continuously process the incoming MSW.

The yet to be released Department of Environmental Regulations (DER) Over-arching Emissions & Discharges Assessment Framework (Industrial Regulation Emissions and Discharges Assessment Framework) is expected to make an allowance for justified departures i.e. to provide a level of flexibility by the regulator to accommodate temporary departures from emission limits. It is understood that this will give the plant operator the opportunity to justify why a temporary departure (e.g. due to the failure of an item of equipment or instrumentation) has

occurred and detail what corrective actions were undertaken to return the facility, as quickly as possible, to operation within its licensed limits.

**10.2.1.6.5.1 Operating Procedure for failure of a component of the Air Pollution Control (APC) system**

1. Approach to limit alarms will alert the operations staff of a problem with the APC system.
2. If there is a risk that an exceedance of an emission limit may occur, the operator can stop the feed of MSW to the line on which the alarm has occurred.
3. Both instrumentation and the likely equipment item will need to be checked to ensure they are functioning correctly and to identify the likely cause of the alarm.
4. If the waste level on the grate is depleted, the auxiliary burners will automatically act to maintain minimum combustion conditions and bring the grate/line to a hot standby condition.
5. If an emission limit exceedance occurs, this shall be documented and reported to the EPA along with any corrective actions undertaken by plant staff to mitigate the upset condition and either to bring the line to a safe shutdown condition, or to rectify the problem and re-start the feed to the line.

**10.2.1.6.5.2 Operating Procedure for failure of the CEMS**

If any item of monitoring equipment fails, where applicable, a stand-by will be brought into use; if this fails the line will be shut down (feed stopped and auxiliary burners used to bring the line to a safe shut down condition) until repairs are completed. Should the electricity supply fail, a stand-by diesel generator will continue to power the CEMS.

Validation of the emissions monitoring will be achieved by:

- (a) continuous reporting of measured emission results against licensed limits, and

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(b) ensuring that the CEMS and any other critical items of instrumentation are maintained and calibrated in accordance with the manufacturer's instructions and/or any regulatory guidelines in relation to CEMS.

**10.2.1.6.6 Describe how the proposal is consistent with the EPA Advice to the Minister for Environment on the Environmental and Health Performance of Waste to Energy Technologies.**

Please refer to the **Executive Summary** section 2.3 Demonstrate compliance with Advice and Recommendations beginning on page 18, for responses to each of the 21 recommendations contained in the EPA Advice to the Minister of Environment (EPA Report 1468, April 2013).

**10.2.1.7 Predicted Environmental Outcome**

By employing tried and proven, best available Air Pollution Control techniques, in conjunction with automated controls and proven operating practices and expertise, the EPA objectives for air quality and odour amenity will be met at all times. Indeed, the community can be confident that the vast international experience with the proposed approach to waste management and energy recovery will actually improve existing amenity and net environmental outcomes by diverting putrescible waste away from landfill disposal for the purpose of recovering renewable energy and other resources.



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## 10.3 Both Facilities

### 10.3.1 Amenity – Noise

For the WtE plant in its entirety, the focus of this environmental factor is on potential local and cumulative impacts of noise emissions from the facility, with due consideration of allowable noise limits and available abatement technologies and techniques for consideration and incorporation, as necessary, during detailed design.

#### 10.3.1.1 EPA Objective:

To ensure that impacts to amenity are reduced as low as reasonably practicable.

#### 10.3.1.2 Applicable Standards, Guidelines or Procedures:

- Draft EPA Guidance Statement No. 8 Environmental Noise.
- *Environmental Protection (Noise) Regulations 1997.*
- *Environmental Protection (Noise) Amendment Regulations 2013*

#### 10.3.1.3 Existing Environment

The site is situated in the heart of the Kwinana Industrial Area, with pre-existing buffer zones. The nearest sensitive receptor (the Naval Base Hotel) is approximately 2 km from the site. In 2010, the Kwinana Industries Council (KIC) commissioned an update to the KIC acoustic model to incorporate current KIC member acoustic model data, covering most existing major noise emitters in the KIA. The consultant also undertook a noise measurement program to compare measured levels with model outputs for reference locations throughout the Kwinana area, including residential areas. As such, the KIC model can be used to generate overall KIC source predicted noise contours for use by individual members to facilitate the assessment of their own proposals and to determine the cumulative effects.

#### 10.3.1.4 Potential Impacts

Potential Impacts include:

- There are numerous adjacent heavy industrial premises, which could

potentially be impacted by noise emissions from the proposal.

- Noise associated with the proposal and cumulative noise impacts, associated with the proposal in conjunction with existing noise emission sources, could impact neighbouring receptors and sensitive far field receptors.

#### 10.3.1.5 Assessment of Potential Impacts and Consistency with EPA Objectives and Environmental Principles

**10.3.1.5.1 Undertake a detailed assessment and demonstrate that the noise from the proposal can be managed to comply with the Noise Regulations at residential properties and at the boundary of the proposal site. Where cumulative noise exceeds the assigned levels, demonstrate that the proposal will not significantly contribute to the level of noise**

##### 10.3.1.5.1.1 Detailed Acoustic Assessment

Herring Storer Acoustics (HSA) was commissioned to undertake a detailed acoustic analysis of the proposal, as specified by the draft EPA Guidance Statement No. 8 in order to:

- (a) demonstrate that the noise from the proposal can be managed to comply with the Noise Regulations at residential properties and at the boundaries of the proposal site, and
- (b) demonstrate that the proposal will not significantly contribute to cumulative noise levels at both neighbouring industrial premises and at sensitive far field receptors.

The complete Herring Storer Acoustics report is provided in **Appendix G**.

##### 10.3.1.5.1.2 Acoustic Criteria

The criteria used are in accordance with the *Environmental Protection (Noise) Regulations 1997 (as amended)*. In section 2 Acoustic Criteria on page 2 of the HSA report in

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**Appendix G**, the consultant noted that “The 2000 Regulation Review has been ongoing and it is understood that there is a proposal to amend the regulation ‘assigned level’ for industrial receivers, increasing the  $L_{A10}$  assigned level to 75 dB(A).” These amendments are now finalised in *Environmental Protection (Noise) Amendment Regulations 2013* and have not changed in relation to the  $L_{A10}$  assigned levels referred to in **Appendix G**.

The criteria for industrial receiver premises are shown in Table 40.

These levels are conditional on there being no annoying characteristics existing in the

noise of concern, such as tonality, amplitude modulation or impulsiveness. If such characteristic exist then any measured level is adjusted according to Table 41.

The most significant ‘assigned level’ acoustic parameter for the proposed Waste to Energy Plant operation is the  $L_{A10}$  noise level, with adjustment for tonal characteristic due to the trucks circulating on the on-site ‘ring’ road external to the building.

This means that the technical compliance design level at the nearest industrial premises is an  $L_{A10}$  of 70 dB(A).

**Table 40 – Baseline Assigned Outdoor Noise Level**

Premises Receiving Noise	Time of Day	Assigned Level (dB) <sup>(1)</sup>		
		$L_{A10}$	$L_{A1}$	$L_{Amax}$
Industrial and utility premises	All hours	75	85	90

**Notes:**

1. From *Environmental Protection (Noise) Amendment Regulations 2013*, gazetted on 5 December 2013, No. 214 Special.

**Table 41 – Adjustment to Measured Levels**

Where tonality is present	Where modulation is present	Where impulsiveness is present
+5dB(A)	+5dB(A)	+5dB(A)

**10.3.1.5.1.3 Noise Modelling Methodology**

The assessment was undertaken with consideration given to expected emission sources associated with the proposal and using the Kwinana Industries Council (KIC) Acoustic Model, to facilitate an assessment of cumulative noise impacts associated with including the proposal in the existing model.

However, as the plant layout is only preliminary and major plant items have yet to be selected, the detailed assessment has focused on establishing the Acoustic Design Criteria for the Kwinana WtE Project. This includes establishing the industrial receiver ‘assigned level’, which should not be exceeded at the boundary of each neighbouring industrial site, for use during the

detailed engineering design phase of the proposal.

As the majority of equipment will be housed and operated inside buildings and or appropriately designed acoustic enclosures, only the major expected external emission sources were included in the detailed assessment. Those primary emission sources included the multi-flue stack, aircooled condenser fans and on-site truck movements. HSA used representative sound power levels for each of these emissions sources as inputs to the acoustic software package known as SoundPlan, to assess worst case daytime wind conditions as required by *Draft EPA Guidance Statement No. 8 Environmental Noise*. The representative source sound power levels used in the acoustic assessment are presented in Table 42.

Table 42 – Source sound power levels used for acoustic modelling assessment (Source: HSA, Appendix G)

Source	Sound Power Level, Lw (dB)
Nominal Rooftop Cooling Fans & Exhaust	106
Flue Gas Noise at Top of Stack	97
PE Nominal Truck Entering Site 7	103
PE Nominal Truck Entering Site 6	103
PE Nominal Truck Entering Site 3	103
PE Nominal Truck Entering Site 4	103
PE Nominal Truck Entering Site 2	103
PE Nominal Truck Entering Site 8	103
PE Nominal Truck Entering Site 5	103
PE Nominal Truck Entering Site 1	103

**10.3.1.5.1.4 Acoustic Assessment Results**

The predicted LA10 noise levels and LA10 design criteria can be found in Table 43.

Predicted noise contour plots are presented in Figure 64, with no boundary acoustic barriers in place, and Figure 65, Figure 61

with no acoustic barriers and Figure 65, where a 2.4m high acoustic barrier is assumed to be constructed along the east boundary. The pink 70 dB(A) contour indicates compliance for tonal noise emissions under amended regulation ‘assigned levels’.

Table 43 – Predicted LA10 Noise Levels and LA10 Design Criteria

Description	Current LA10 Criteria, dB(A) (Note 1)	Assumed Eastern Boundary Wall to 2.4m
Western Premises	75 (70)	58
Southern Premises	75 (70)	60
Northern Premises	75 (70)	62
Eastern Premises	75 (70)	63
Naval Base Hotel (Night assigned level is LA10 54 dB(A))	54 (49)	39
Hope Valley (location)	Not known > 35 (<30)	33
Kwinana Townsite	35 (30)	21

**Notes:**

1. Note that assessment of compliance for tonal noise sources (such as trucks) requires adjustment of +5 dB(A) to the predicted noise level for closer receiver locations, and where predicted noise emissions may be also affected by noise emissions from others the contribution needs to be 5 dB(A) below the ‘assigned level’, so the criteria in brackets is the design sound level not to be exceeded to achieve compliance.

Figure 64 – Predicted noise emissions from nominal sources with no boundary acoustic barriers

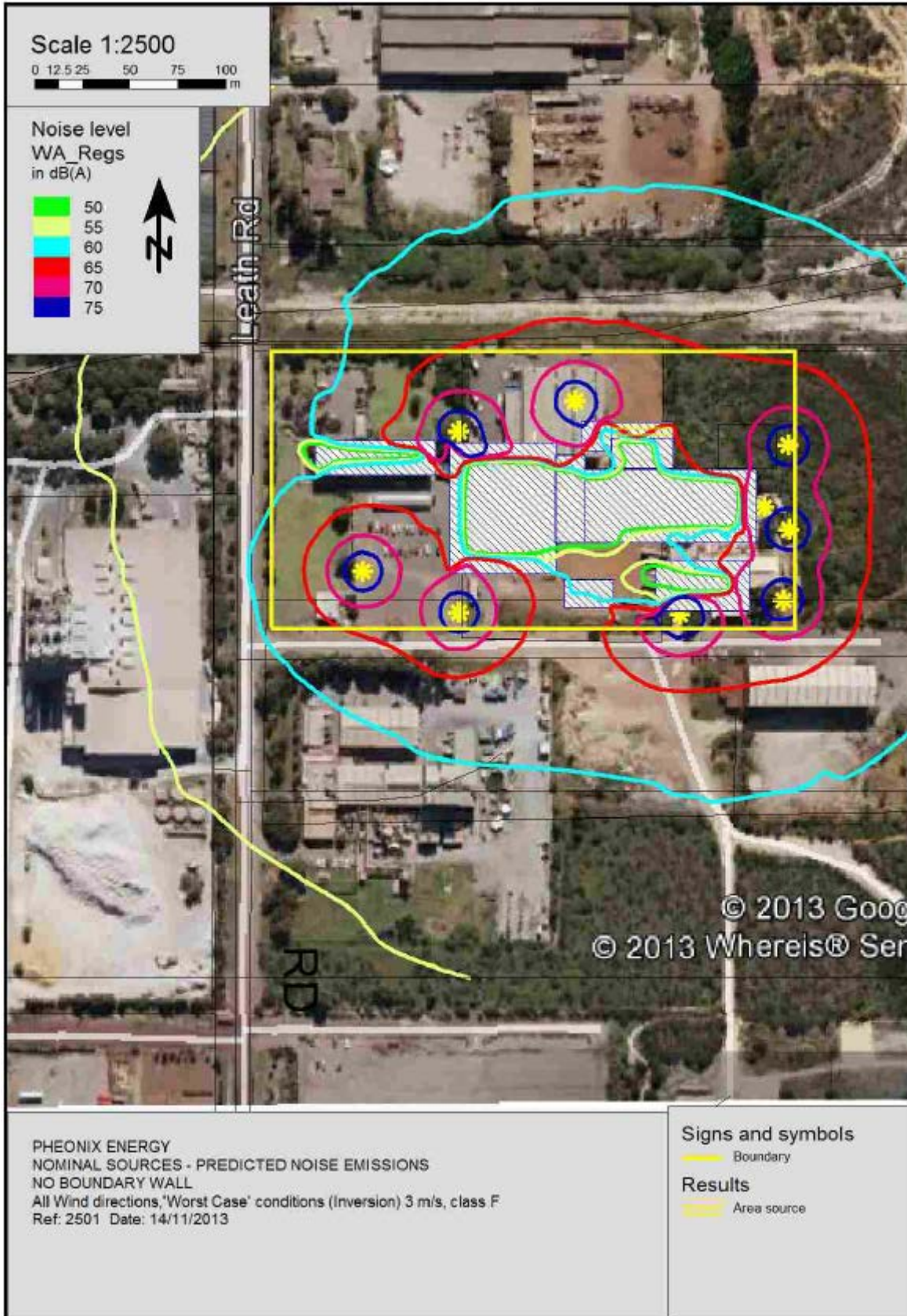
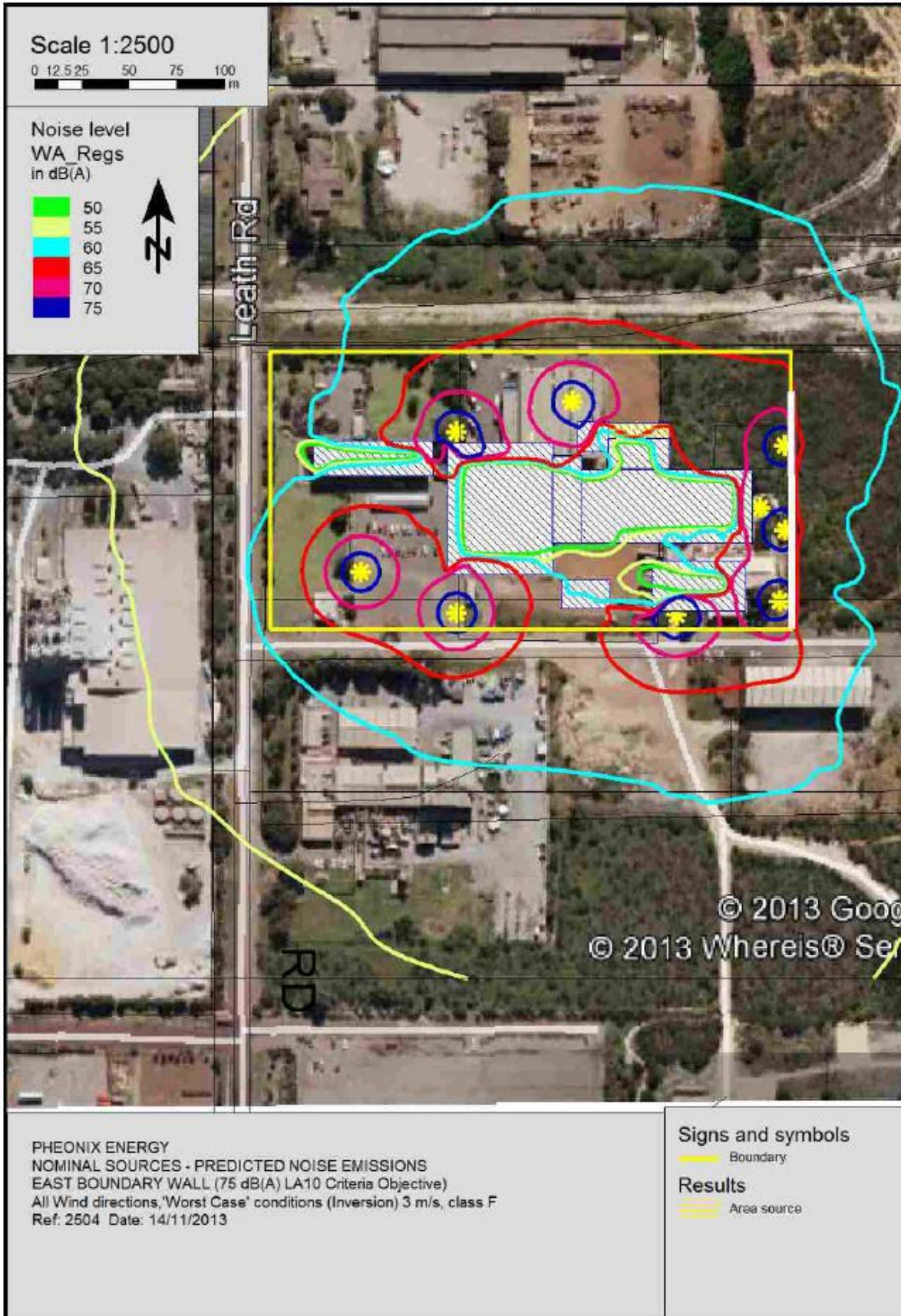


Figure 65 – Predicted noise emissions from nominal sources, with a 2.4m acoustic barrier to the east boundary



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The main outcomes and conclusions of the HSA acoustic assessment report are as follows:

The acoustic modelling noise emissions are dominated by the truck noise emissions, while the proposed buildings are predicted to be effective in controlling environmental noise emissions from the other plant. The only potential exceedance of the noise regulation assigned level is at the nearby eastern boundary common to another industrial premises and across transport routes to the north and south. **Compliance at all other locations including the noise sensitive 'Naval Base Hotel' and Kwinana town-site is comfortably achieved.**

There are no significant neighbouring noise contributors close to the site boundary, and noise emissions are considerably lower than the 'assigned levels' at noise sensitive receivers, so cumulative noise effects do not need to be considered close to the site boundary.

The exception is the Cockburn Cement premises, where predicted cumulative noise levels at the Cockburn Cement eastern boundary is 65 dB(A). However, this boundary is not an assessment location for Cockburn Cement noise emissions, it being their own premises. The cumulative noise from all other premises in the KIC model together with the proposed Waste to Energy plant at the eastern boundary of Cockburn Cement site is 59.6 dB(A), the contribution

from the Kwinana WtE Plant is 57.9 dB(A). Both the cumulative and the contribution from the Kwinana Waste-to-Energy Plant comply with the existing regulation 'assigned level' for an industrial receiver.

With the amendment of the *Environmental Protection (Noise) Regulations 1997* to incorporate changes to the industrial premises assigned level to an  $L_{A10}$  of 75 (before adjustment for tonality), the proposal would require a 2.4m high acoustic barrier wall on the eastern boundary to remain fully in compliance, solely due to the expected on-site truck traffic along the eastern boundary (as shown in Figure 65).

**10.3.1.5.1.5 Management and Mitigation Measures**

Typical noise sources and noise power levels for WtE facilities such as the proposal are well documented. The most comprehensive summary is provided in the European Commission's 2006 Integrated Pollution Prevention and Control (IPPC) Reference Document on the Best Available Techniques (BREF) for Waste Incineration. Section 3.6 of the BREF for Waste Incineration is dedicated to noise and presents a table detailing both the plant area relevant to the noise/main emitters and typical reduction measures. This table has been reproduced as Table 44 below, though, in the case of the Kwinana WtE project, the "Disposal of residues" would be replaced by the brick plant, which will be housed in a fully enclosed building.

**Table 44 – Sources of noise at WtE plants (Source: Section 3.6 BREF for Waste Incineration, 2006)**

Area relevant to noise/ main emitters	Available reduction measures
Delivery of waste i.e. noise from lorries etc.	Tipping hall closed to all sides
Waste bunker	Noise insulation of the building with gas concrete, gates with tight design
Boiler building	Enclosure with multi-shell construction or gas concrete, ventilation channels with connecting link silencers, tight gates
Machine building	Use of low-noise valves, noise-insulated tubes, noise insulation of the building as described above

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Area relevant to noise/ main emitters	Available reduction measures
Flue-gas cleaning: - ESP - Scrubbing - Suction draught - Chimney - Total flue-gas cleaning system	Noise insulation, enclosure of the facility e.g. with sheets with trapezoidal corrugations, use of blimps for the suction draught and silencer for the chimney
Handling of residues - Bottom ash discharge - Loading - Transportation from the plant - Total waste management residues	Enclosure, loading in the bunker
Air cooler	Silencers on the suction and pressure sides (see also BREF on cooling systems for further information)
Energy transformation facility	Low-noise design, within specially constructed noise proofed building

The BREF (2006) concludes that with the noise reduction measures described in the table, noise emission limits for a specific project can be safely met both day and night.

However, due to local regulations governing noise emissions in the KIA (*Environmental Protection (Noise) Regulations 1997* as amended by *Environmental Protection (Noise) Amendment Regulations 2013*), the predicted noise emissions from potential truck movements on site along the east boundary were assessed to be non-compliant because: (a) the ring road for truck movements on site is currently assumed to be adjacent to the east boundary, and (b) there is currently no easement between the subdivisions of Lot 14 along the east boundary of the site.

To ensure full compliance with the *Environmental Protection Noise Regulations 1997*, the proposal will incorporate a number of design features and abatement techniques, as noted below:

- The majority of plant and equipment will be housed within appropriately designed buildings.
- For the few significant potential external equipment noise sources, equipment selection and attenuation will be undertaken on the basis of ensuring the facility will comply with assigned levels at the boundaries of neighbouring industrial sites, and will not significantly contribute to cumulative noise impacts at far field sensitive receptors, at all times of day and night.

- The majority of on-site truck movements will only occur during a 2-hour mid-morning and mid-afternoon shift during weekdays.
- Compliance with assigned noise levels for industrial receivers along the eastern boundary will be achieved by adjustments to plant layout, such as the re-location of the ring road or by the construction of an appropriately sized noise barrier, as proposed in the Acoustic consultant’s report.

The BREF (2006) also notes that noise is generated during the three main phases of construction including:

- digging the excavation;
- laying the foundations (including pile-driving); and
- erecting the outer shell of the building.

The BREF (2006) notes best practice measures for managing construction noise, which include: restrictions on operating hours, particularly during the night, use of low-noise construction machinery and temporary structural sound insulation measures, may be taken. While, such measures are likely to be excessive for the Kwinana Industrial Area, with its heavy industry zoning and existing buffer zones, noise will be taken into consideration when the construction management plan is developed during the detailed engineering phase.

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**10.3.1.6 Predicted Environmental Outcome**

The proposal will fully comply with *Environmental Protection Noise Regulations 1997*.

Given that the majority of these types of facilities are located within heavily populated urban areas rather than heavy industrial precincts such as the KIA, the community can be confident that the EPA objectives for noise amenity will be met at all times, through review of the plant layout during detailed design, the appropriate application of proven abatement techniques, and the careful management of construction activities and future operations and maintenance procedures.



## 10.4 Other Environmental Matters

### 10.4.1 Native Vegetation Clearing

The focus of this environmental factor is on the likely clearing of a small parcel of native vegetation or re-growth, in accordance with Environmental Protection objectives and principles, to make way for roads and buildings required for the proposal.

#### 10.4.1.1 EPA Objective:

- With respect to the environmental factor, Flora and vegetation: To maintain representation, diversity, viability and ecological function at the species population and community level.
- With respect to the environmental factor, Terrestrial Fauna: To maintain representation, diversity, viability and ecological function at the species population and assemblage level.

#### 10.4.1.2 Existing Environment

The site, situated in the heart of the Kwinana Industrial Area, and is zoned Industrial. It currently consists of three developed sections associated with previous activities and a small section of uncleared vegetation of ~0.6 ha (see Figure 66), primarily in the north east corner. The site has been subjected to detailed assessment and remediation activities by its former owner, to the satisfaction of the current land owner, Landcorp, on behalf of the Government of Western Australia. The remaining vegetation is possibly re-growth after the discontinuation of past land use activities and/or native vegetation in a degraded condition.

#### 10.4.1.3 Potential Impacts

Potential impacts include:

- The potential for a loss of representation, diversity, viability and ecological function

of flora and vegetation and terrestrial fauna, due to the likely clearing of a small parcel of native vegetation or re-growth, to make way for roadways, fences and buildings required for the proposal.

#### 10.4.1.3.1 Noting the land is zoned Industrial, describe the extent of native vegetation clearing and whether there are any specific requirements with respect to the clearing of native vegetation

A small section of vegetation of ~0.6 ha (see Figure 66) will be cleared for the purposes of constructing roadways, buildings and fences associated with the proposal. This vegetation has been surrounded by heavy industry and a services easement for decades and is either re-growth or native vegetation in a generally degraded condition. As such, clearing of this vegetation is assessed as being insignificant with respect to representation, diversity, viability and ecological function at the species population and community level for flora, vegetation and terrestrial fauna. This assessment is based on the following observations:

- (a) the vegetation on the site is unlikely to be considered significant habitat for indigenous Western Australian fauna,
- (b) the site is approximately 2.5 km from the nearest wetland and is hydrologically up-gradient, and
- (c) the site is approximately 2.5 km from the nearest Bush Forever site.

As this small area of land, which is expected to be cleared as part of this proposal, is less than 1 ha and it is proposed to clear this vegetation for the purpose of constructing buildings, fences and roadways, an exemption from the requirement to obtain a clearing permit would apply in this instance.

Figure 66 – Photo of the proposed site on Lot 14 highlighting the area of vegetation expected to be cleared under the proposal



#### 10.4.1.4 Proposed Management and Mitigation Measures

The clearing of up to 1 ha of primarily degraded vegetation and re-growth, which is not considered to be significant habitat for indigenous fauna, for the purpose of constructing roads and buildings, will be undertaken in accordance with good construction practices and in accordance with statutory requirements.

#### 10.4.1.5 Predicted Outcomes

Given the minimal extent of land clearing required for the proposal and the existing condition of the remaining undeveloped portion of this Industrial zoned site, the EPA principles and objectives will not be compromised by land clearing in relation to the proposed new land use activity.

## 11 Principles of Environmental Protection

In 2003, the Environmental Protection Act 1986 was amended to include the following principles of Environmental Protection:

- The precautionary principle;
- The principle of intergenerational equity;
- The principle of the conservation of biological diversity and ecological integrity;
- Principles relating to improved valuation, pricing and incentive mechanisms; and
- The principle of waste minimisation.

These principles have been considered in the preparation of this PER as outlined in Table 45.

**Table 45 – A summary of consideration given to the principles of environmental protection**

Principle	Response
<p>1. <i>The precautionary principle.</i></p> <p>Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.</p> <p>In application of this precautionary principle, decisions should be guided by –</p> <p>(a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and</p> <p>(b) an assessment of the risk – weighted consequences of various options.</p>	<p>Whilst the proposal is a first of its kind in both WA and Australia, the proposal is very similar to ~1000 reference sites around the globe (Whiting et al (2013)). Of those, Martin GmbH is the market leader with approximately 400 commercial reference sites world-wide (please refer to <b>Appendix D</b> for a reference site listing for Martin GmbH. Of those sites which have been operating for 12 months or longer, there are around 36 plants processing more than 400,000 t/yr and 117 plants processing between 200,000 t/yr and 400,000 t/yr, with the majority operating successfully under stringent European, US and Japanese emissions regulations.</p> <p>Mitsubishi Heavy Industries Environmental &amp; Chemical Engineering Co., Ltd. (MHIEC) is the regional partner and license holder for the Martin Great reverse acting stoker technology. MHIEC has engineered and/or constructed more than 180 such facilities since 1964 of which 99 are using the proposed Martin GmbH grate technology (see <b>Appendix E</b>). As such, the community can have confidence that the underlying WtE technology is both appropriate to the proposed waste stream and tried and proven, with numerous operating reference sites of a similar capacity to the proposal. Importantly, the site will be operated and maintained by an experienced specialist WtE service provider.</p> <p>Furthermore, environmental conservation is also a core value of the proponent’s project team.</p> <p>Section 10 Environmental Factors and Management and in particular: section: 10.1.1.6.2 page 66 provides a qualitative lifecycle assessment, section 10.1.2.5 page 88 provides a fugitive odour impact assessment, section 10.2.1 Air Quality – Stack Emissions page 95 provides details of the air quality assessment and a preliminary Public Health Risk Assessment, while section 10.3.1 Amenity – Noise page 161 details the acoustic assessment for the proposal.</p>

Principle	Response
<p>2. <i>The principle of intergenerational equity.</i></p> <p>The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.</p>	<p>The premise of waste to energy is to treat waste as resource and to do something useful with the materials our communities reject. A key aspect of waste to energy is diverting waste away from landfill in order to recover energy and other recyclable and reusable materials from it, thus avoiding the legacy issues associated with storing waste in landfills (e.g. on-going fugitive landfill gas emissions, which are approximately 50% methane, Smith et al (2012), and potential for leachate contamination of groundwater courses).</p> <p>Section 4 Project Justification on page 40 and section 10.1.1.6.2 Compare the environmental risks and benefits of the existing disposal method (landfill) with the proposed technology on a lifecycle basis from page 66 detail the substantial sustainability benefits of the proposal compared to the current practice of landfill disposal and the use of fossil fuels for base load electricity generation.</p>
<p>3. <i>The principle of the conservation of biological diversity and ecological integrity.</i></p> <p>Conservation of biological diversity and ecological integrity should be a fundamental consideration.</p>	<p>A very small parcel of vegetation of up to 1 ha, which is either re-growth or native vegetation in a degraded condition is expected to be cleared for the purpose of constructing roadways, fences and buildings related to the proposal. As this vegetation is in a degraded condition, surrounded by heavy industry and an existing services easement and ~2.5 km to the nearest wetland and Bush Forever site, it has been assessed that clearing of the land will not impact on biological diversity. However, as environmental conservation is a core value of the proponent’s project team, the proponent and its engineering and technology partners are guided by this principle, especially in relation to preparation of the land for construction and during the operation and maintenance of the facility over its operational life.</p> <p>Section 9 The Receiving Environment on page 59 provides background on the site, while section 10.4.1 Native Vegetation Clearing beginning on page 169 provides details of the assessment undertaken in relation to this Environmental Impact Assessment.</p>

Principle	Response
<p>4. <i>Principles relating to improved valuation, pricing and incentive mechanisms.</i></p> <p>(1) Environmental factors should be included in the valuation of assets and services.</p> <p>(2) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.</p> <p>(3) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.</p> <p>(4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.</p>	<p>The proposal will work within the established principles relating to improved valuation, pricing and incentive mechanisms. In fact the long-term waste supply agreements will provide local councils with greater price certainty and security. In addition, the project will generate base load renewable electricity, thus offsetting the requirement to utilise a substantial amount of fossil fuels to generate the equivalent amount of electricity. Few of the current renewable electricity generation technologies can be considered to be base load.</p> <p>It should also be noted that the principle of Best Available Techniques (e.g. for Air Pollution Control) also considers the cost/benefit of each technology option available to developers and operators in the process and energy generation industries.</p> <p>These principles are considered in section 4 Project Justification beginning on page 40, section 5 Description of the Proposal beginning on page 44 and section 14 Conclusions beginning on page 177.</p>
<p>5. <i>The principle of waste minimisation.</i></p> <p>All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.</p>	<p>Waste minimisation is a core principle of waste to energy in that a waste to energy facility aims to minimise or eliminate waste to landfill, by recovering energy and recyclable materials from residual material which would otherwise have been destined for landfill. This proposal is also specifically considering the beneficial re-use of the solid by-products (ashes) of the combustion process, and will also utilise solutions which eliminate aqueous process emissions. Furthermore, flue gases will be treated using best available air pollution control techniques, to ensure that atmospheric emissions meet or are superior to international best practice.</p> <p>International experience has shown that WtE is complementary to composting and recycling activities and those communities with WtE facilities tend to have higher rates of recycling than those without (Berenyi, 2009). Please refer to the section addressing the environmental impact 'Describe how the proposal would meet the waste hierarchy of waste avoidance, recovery and safe disposal', for further details and examples.</p> <p>A detailed discussion is included in sections 4 Project Justification beginning on page 40 and 10.1.1.6.1 Describe how the proposal would meet the waste hierarchy of waste avoidance, recovery and safe disposal beginning on page 63.</p>

## 12 Proposed Environmental Management Program

As a waste to renewable energy project development company, Phoenix Energy is committed to sustainable waste management practices through matching the most appropriate technology to the available waste streams and bringing together a team of committed professional service firms, with the passion and knowledge required to deliver complex infrastructure projects, for the benefit of all stakeholders. Sound environmental management is at the heart of sustainability, as we seek to ensure the integrity of our environment and maintain the longevity of our natural resources, for the benefit of future generations.

Phoenix Energy and its project partners are committed to project delivery and operational excellence. The project team believe the prevention of accidents, ill health and environmental protection are essential to the efficient operation of our business. It is our joint aim to become one of the recognised leaders in occupational health, safety and environmental protection for plant design, construction and operation and ultimately achieve the goal of preventing all accidents, injuries and incidents.

To fulfil the commitment made in this policy the project team will ensure that:

- As a minimum the project team will comply with all relevant legislation and statutes, codes of practice and industry standards;
- The project team will ensure that all project personnel demonstrate a commitment and leadership in health, safety and environment (HSE) protection and performance;
- The project team provide a safety conscious and competent workforce and ensure that our employees, sub-contractors and co-workers are familiar with the HSE systems implemented and are competent and trained to carry out their work safely and with due regard for the environment;

- The project team identify and assess the risks which arise from the performance of our activities, such that the project team is able to either eliminate these risks, or reduce them to an acceptable level;
- The project team establish both safe places of work, and safe systems of work;
- The project team identify and assess accident hazards associated with the design and eventual operation of the facility and eliminate these risks or reduce them to an acceptable level;
- The project team prevent pollution and reduce environmental risks by appropriate proactive measures;
- The project team communicate and consult effectively on health, safety and environmental matters both within our companies and externally by evaluation and responding to concerns;
- The project team develop procedures to ensure safe design, construction and eventual operation & maintenance of the plant equipment including an assessment of relevant changes;
- The project team establish a management system with clear objectives, targets, roles and responsibilities with the measurement of our progress towards the attainment of these targets, and report our performance;
- The project team provide effective health, safety and environmental monitoring, auditing and review processes, and take corrective action where appropriate;
- The project team promote a culture of continual improvement for health, safety and environmental performance.

No task is so important that project team staff and contractors cannot take time to plan and

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implement it in a healthy, safe and environmentally sound manner.

### 12.1 Environmental Management

Phoenix Energy will adopt the best practice Environmental Management System (EMS) of its preferred Australian EPC contractor throughout the project development and delivery. An excerpt from the preferred EPC contractor’s Environmental Management Manual is attached to **Appendix I** along with a Certificate of Conformity. This EMS has been assessed and registered as complying with the requirements of the Australian/New Zealand Standard AS/NZS ISO 14001:2004 - Environmental management systems - Requirements with guidance for use. The Scope of Works covered by Registration includes: provision of design management, project management, construction, fabrication, installation, operations and maintenance, tunnelling, civil, building, rail, communications, waste management, water, marine, mechanical and engineering, manufacturing, energy including high voltage transmission, oil and gas industries, equipment hire for permanent and temporary works or structures.

Once the WtE facility becomes operational, an EMS will be developed by the plant manager and Operations & Maintenance service provider, Covanta, in conjunction with Phoenix Energy and its technology partner, MHIEC.

#### Excerpt from BREF for Waste Incineration 2006

The Kwinana WtE facility EMS will be guided by the Reference Document on the Best Available Techniques (BREF) for Waste Incineration (2006). As such, the EMS will incorporate, as appropriate to individual circumstances, the following features:

- definition of an environmental policy for the installation by top management (commitment of the top management is regarded as a precondition for a successful application of other features of the EMS)
- planning and establishing the necessary procedures

- implementation of the procedures, paying particular attention to:
  - structure and responsibility
  - training, awareness and competence
  - communication
  - employee involvement
  - documentation
  - efficient process control
  - maintenance programme
  - emergency preparedness and response
  - safeguarding compliance with environmental legislation.
- checking performance and taking corrective action, paying particular attention to:
  - monitoring and measurement (including publication of online emissions data on the project/facility website, once fully operational)
  - corrective and preventive action
  - maintenance of records
  - independent (where practicable) internal auditing in order to determine whether or not the environmental management system conforms to planned arrangements and has been properly implemented and maintained.
- review by top management.
- having the management system and audit procedure examined and validated by an accredited certification body or an external EMS verifier
- preparation and publication (and possibly external validation) of a regular environmental statement describing all the significant environmental aspects of the installation, allowing for year-by-year comparison against environmental objectives and targets as well as with sector benchmarks as appropriate implementation and adherence to an internationally accepted voluntary system such as ISO 14001:2004.

## 13 Public Consultation

This Public Environmental Review is but one aspect of the public consultation and engagement process, which Phoenix Energy has been progressing since plans for the proposed Kwinana WtE facility were made public in 2010.

Phoenix Energy has a stakeholder engagement strategy for the Kwinana WTE project and has been implementing an engagement plan since the inception of the project. In addition, the Conceptual Engineering Study undertaken by Hatch Associates has generated a formal stakeholder engagement strategy and implementation plan specifically for the Kwinana WTE Project. In 2012, Phoenix Energy established the Kwinana WTE

Project's **Community Advisory Group (CAG)** to allow local residents to participate directly in the consultation and engagement process, as the project progresses. Local residents can register their interest in participating in the CAG via the Phoenix Energy website (<http://www.phoenixenergy.com.au/contact/>). A summary of key stakeholder consultation and engagement activities is presented in Table 46.

At each of the community forums, the management of environmental impacts was specifically addressed, using published, publicly available information, collected from some of the ~1000 technology reference sites world-wide.

**Table 46 – Stakeholder engagement and public consultation activities for the Kwinana WtE Project**

Stakeholder	Date	Method of Consultation
State Government – DER, DSD, Office of Energy, Waste Authority, DPI and Landcorp	ongoing	presentation
Kwinana Industries Council	ongoing	Various
Wandi Progress Association (approx. 17 guests)	9 April 2014	Project presentation. Hosted at the project site.
Kwinana Rotary Club Briefing (approx. 35 guests) & Homestead Progress Association	11 February 2014	Project presentation. Hosted at the project site.
Community Forum #3	3rd July 2012	Public Forum
Rivers Regional Council	17th May 2012	Project Presentation
Local Government – City of Rockingham	10th March 2011	Reference site visit, Tokyo, Japan
State Government	7 <sup>th</sup> March 2011	Reference site visit, Tokyo, Japan
Community Forum #2	2-Feb-2011	Public forum
Local Government – City of Cockburn	2011	Project Presentation
Local Government – City of Freemantle	2011	Project Presentation
Local Government – City of Canning	2011	Project Presentation
Local Government – SMRC	2011	Project Presentation
Community Forum #1	7-Dec-2010	Community and Industry forum
Local Government – Town of Kwinana	2010	Reference site visit, Tokyo, Japan



## 14 Conclusions

Phoenix Energy is a privately owned Australian WtE project development company. Phoenix Energy and its project partners are proposing to construct and operate a world scale and world class WtE facility with the capacity to process up to 400,000 t/yr of residual MSW into an estimated 32 MW<sub>e</sub> of clean electricity, net to grid, using the best available WtE technology for processing variable and heterogeneous waste, such as MSW. Ferrous and non-ferrous metals will be recovered from the ash by-product and recycled. Furthermore, it is proposed to further process all solid by-products and residues into bricks and pavers, in an on-site Brick Plant, and/or to convert those materials into an aggregate for construction purposes, as is common place in Japan and Europe.

### 14.1 Project benefits

With approximately 1000 thermal WtE plants operating worldwide (Whiting et al, 2013), the majority of which utilise mass combustion technology (including ~400 Martin Grate plants) in close proximity to major population areas, the underlying WtE technology is considered to be commercially and environmentally proven. Even within this number of reference sites the benefits to the communities vary according to their needs. The key synergies and benefits known at this stage for this project are:

- Reduction of up to 400,000t/yr of waste being disposed of in landfill resulting in:
  - A large reduction in potential greenhouse gas emissions, odours and litter from existing or new landfills
  - Over four times the energy recovery from the waste when compared to gas extraction from landfill
  - Potential to provide a renewable energy source (as high pressure steam) for neighbouring facilities currently utilising fossil fuel fired boilers
  - Greatly extended life expectancy of current landfills
- Removal of the need to build new putrescible landfills
- Removal of future need to long haul waste out to new landfill
- Greater beneficial end of life options of current landfills as they will only be receiving inert material
- Enhanced energy security for WA by providing an alternative base load, renewable alternative to existing base load fossil fuel energy generation, while supplementing existing intermittent renewable electricity generation from wind and solar
- Existing infrastructure:
  - The existing municipal council, 2-3 bin collection systems remain in place thus the Facility will not impact on current collection infrastructure and practices. In fact, international experience has demonstrated that communities with WtE facilities for processing their residual waste tend to recycle more than communities which rely only on landfill (Berenyi, 2009)
  - Transfer stations, drop off and recycling centres would not be affected
  - A location near to existing/planned rail infrastructure will be beneficial to allow the Facility to potentially receive waste movements via rail
- Resource Recovery
  - Additional ferrous and non-ferrous metals will be recovered from the waste streams
  - Bricks, pavers and/or construction aggregate will be created from the ash by-products

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- Environmental
  - According to lifecycle assessments of waste to energy facilities using the US EPA’s MSW Decision Support Tool (DST) (RTI International, 2008) and the UK Waste and Resources Assessment Tool for the Environment (WRATE) (SLR, 2010), WTE facilities actually represent a net reduction in greenhouse gas emissions, when processing feedstocks with a substantial biomass content, such as MSW
  - In the absence of the proposal, a large quantity of post-source separated (residual) MSW will continue to be sent to landfill, thus creating a legacy of fugitive emissions to both the air and groundwater, with minimal or no beneficial recovery of energy or resource.
  - Modern waste to energy facilities conform to some of the most stringent environmental regulations and directives applied to combustion processes

**14.2 Stakeholder Engagement**

Phoenix Energy and its project partners are pleased to offer this PER document to the public to further raise public awareness about the challenges of waste management and renewable energy generation, and how waste to energy is an important element of any sustainable waste management system.

**14.3 Environmental Assessment**

The Environmental Protection Authority (EPA) assessed a referral of the project by New Energy and concluded that the proposal would be subject to a formal environmental impact assessment process guided by an

Environmental Scoping Document prepared by the Office of the EPA (**Appendix A**).

The key environmental factors identified by the EPA in its scoping document for the Storage and Handling Facilities were:

- Terrestrial Environmental Quality and Inland Waters Environmental Quality;
- Amenity – Odour;

The key environmental factor identified by the EPA in its scoping document for the Combustion Facilities was:

- Air Quality – Stack Emissions;

The key environmental factor identified by the EPA in its scoping document for Both Facilities was:

- Amenity – Noise;

Other Environmental Matters included:

- Native vegetation clearing

Each environmental factor associated with the proposal has been assessed in terms of:

- The EPA's objective for that factor;
- Any applicable legislation, standards, guidelines or procedures;
- Potential sources of impact;
- An assessment of the potential impacts for that factor;
- Proposed management/mitigation measures; and
- An expected environmental outcome.

The assessment has also considered and responded to the 21 recommendations made by the EPA to the Minister for the Environment, in relation to the Environmental and health performance of waste to energy technologies (EPA Report 1468, 2013). On the basis of these assessments, Phoenix Energy concludes that the project is environmental beneficial and consistent with all identified EPA objectives.

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## 16 ATTACHMENTS

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**ATTACHMENT 1** – Lot 14, Kwinana site – regional context map#1

**ATTACHMENT 2** – Lot 14, Kwinana site – regional context map#2

**ATTACHMENT 3** – Lot 14, Kwinana site – local context map

**ATTACHMENT 4** – Preliminary Plant Layout Drawing

**ATTACHMENT 5** – Preliminary Process Flow Diagram

**ATTACHMENT 6** – Simplified Preliminary Overall Facility Mass & Energy Balance

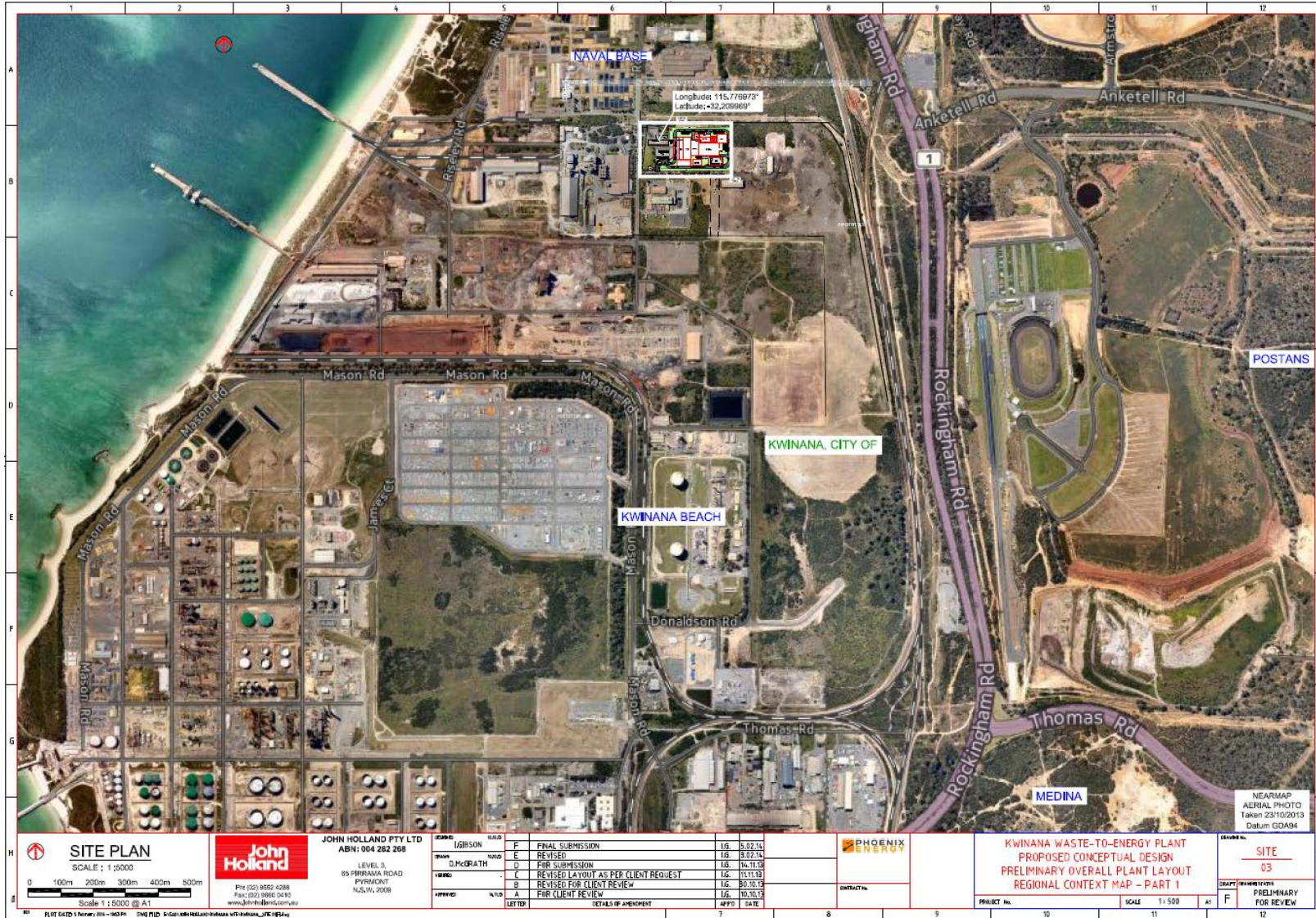


# Kwinana Waste to Energy Project

## Public Environmental Review



### ATTACHMENT 1 – Lot 14, Kwinana site – regional context map#1



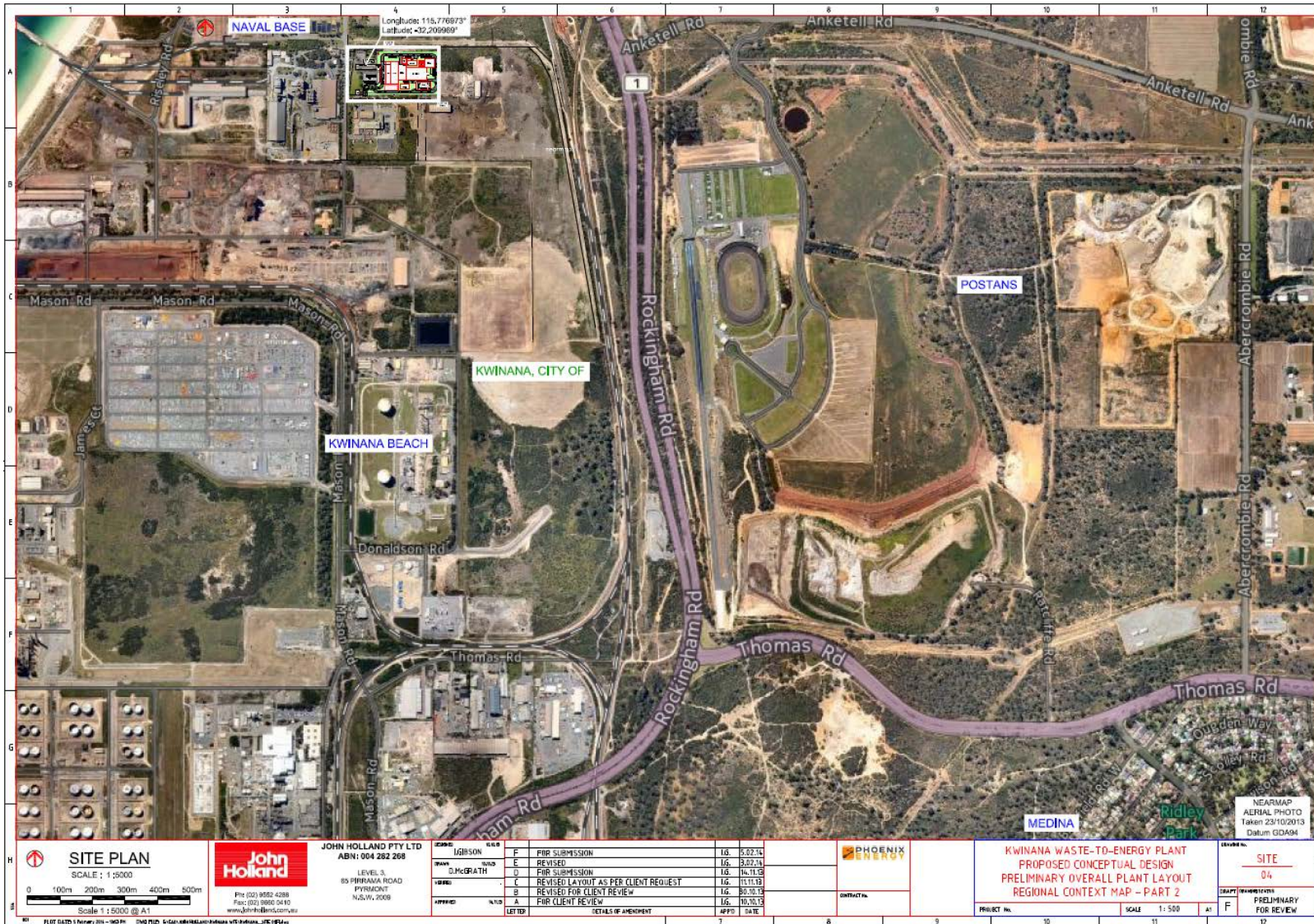


# Kwinana Waste to Energy Project

## Public Environmental Review



### ATTACHMENT 2 – Lot 14, Kwinana site – regional context map#2



**SITE PLAN**  
SCALE: 1:5000

Scale: 1:5000 @ A1

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NO	DATE	BY	REVISION	DATE
01	15/01/2013	IGIBSON	F PIR SUBMISSION	15/01/2013
02	16/01/2013	IGIBSON	E REVISED	16/01/2013
03	16/01/2013	IGIBSON	D PIR SUBMISSION	16/01/2013
04	16/01/2013	IGIBSON	C REVISED LAYOUT AS PER CLIENT REQUEST	16/01/2013
05	16/01/2013	IGIBSON	B REVISED FOR CLIENT REVIEW	16/01/2013
06	16/01/2013	IGIBSON	A PIR CLIENT REVIEW	16/01/2013
07	16/01/2013	IGIBSON	REVISED FOR CLIENT REVIEW	16/01/2013

**PHOENIX ENERGY**

CONTRACT NO.

**KWINANA WASTE-TO-ENERGY PLANT  
PROPOSED CONCEPTUAL DESIGN  
PRELIMINARY OVERALL PLANT LAYOUT  
REGIONAL CONTEXT MAP - PART 2**

NEARMAP  
AERIAL PHOTO  
Taken: 23/10/2013  
Datum: GDA94

SCALE: 1:500

**SITE 04**

DATE: 16/01/2013

STATUS: PRELIMINARY FOR REVIEW



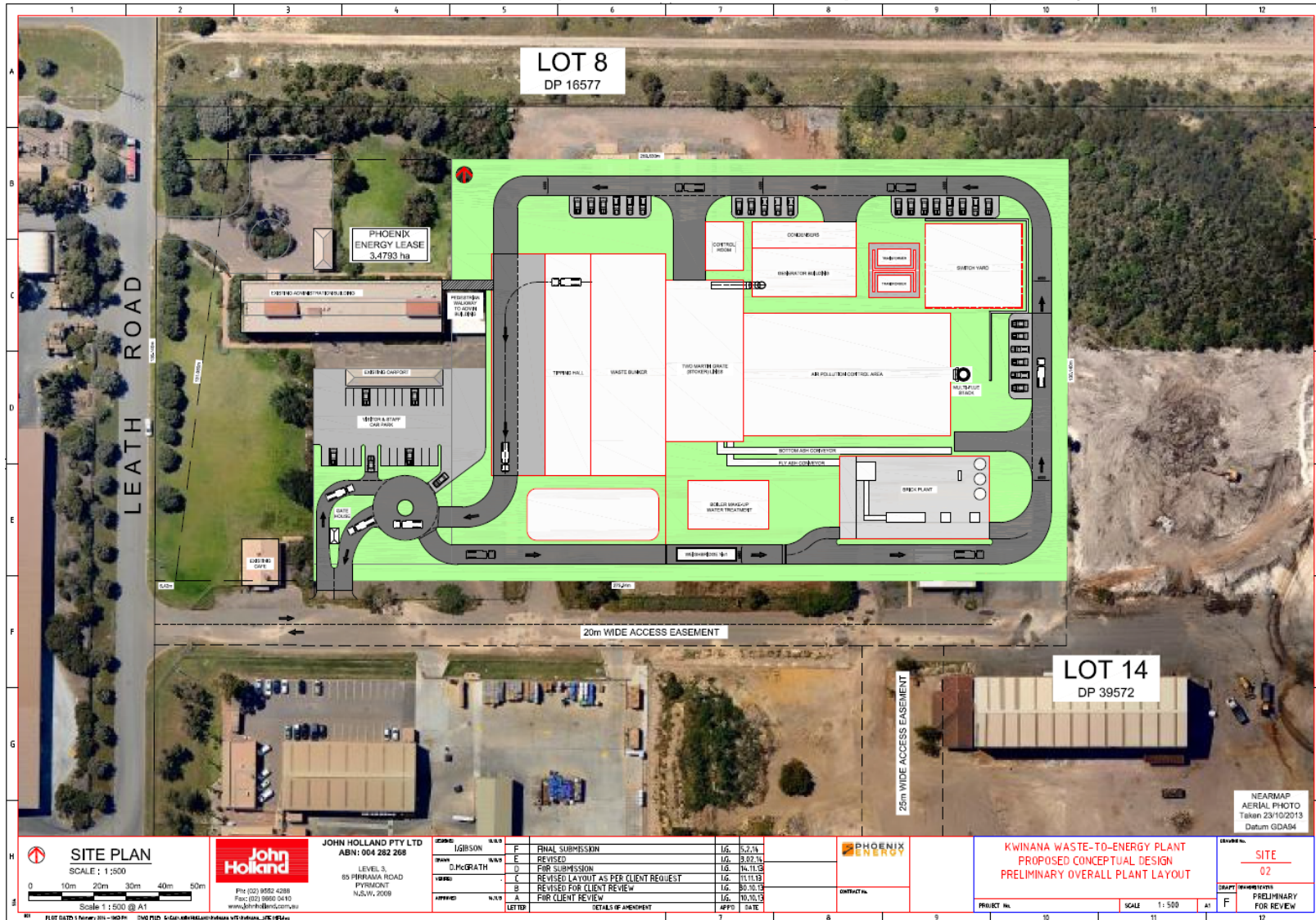


# Kwinana Waste to Energy Project

## Public Environmental Review



### ATTACHMENT 3 – Lot 14, Kwinana site – Local context map overlaid with the conceptual overall plant layout





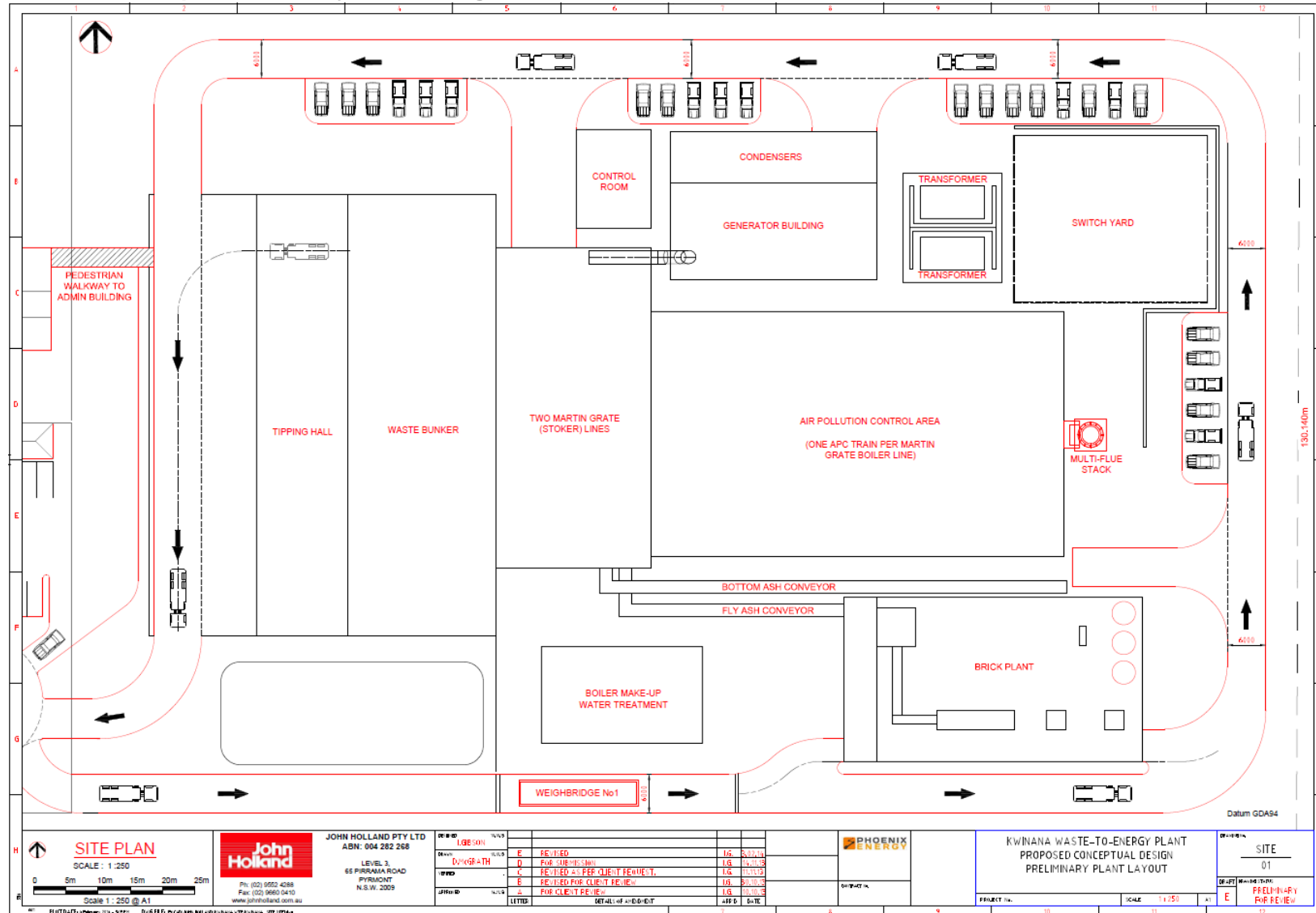


# Kwinana Waste to Energy Project

## Public Environmental Review



### ATTACHMENT 4 – Conceptual Plant Layout Drawing



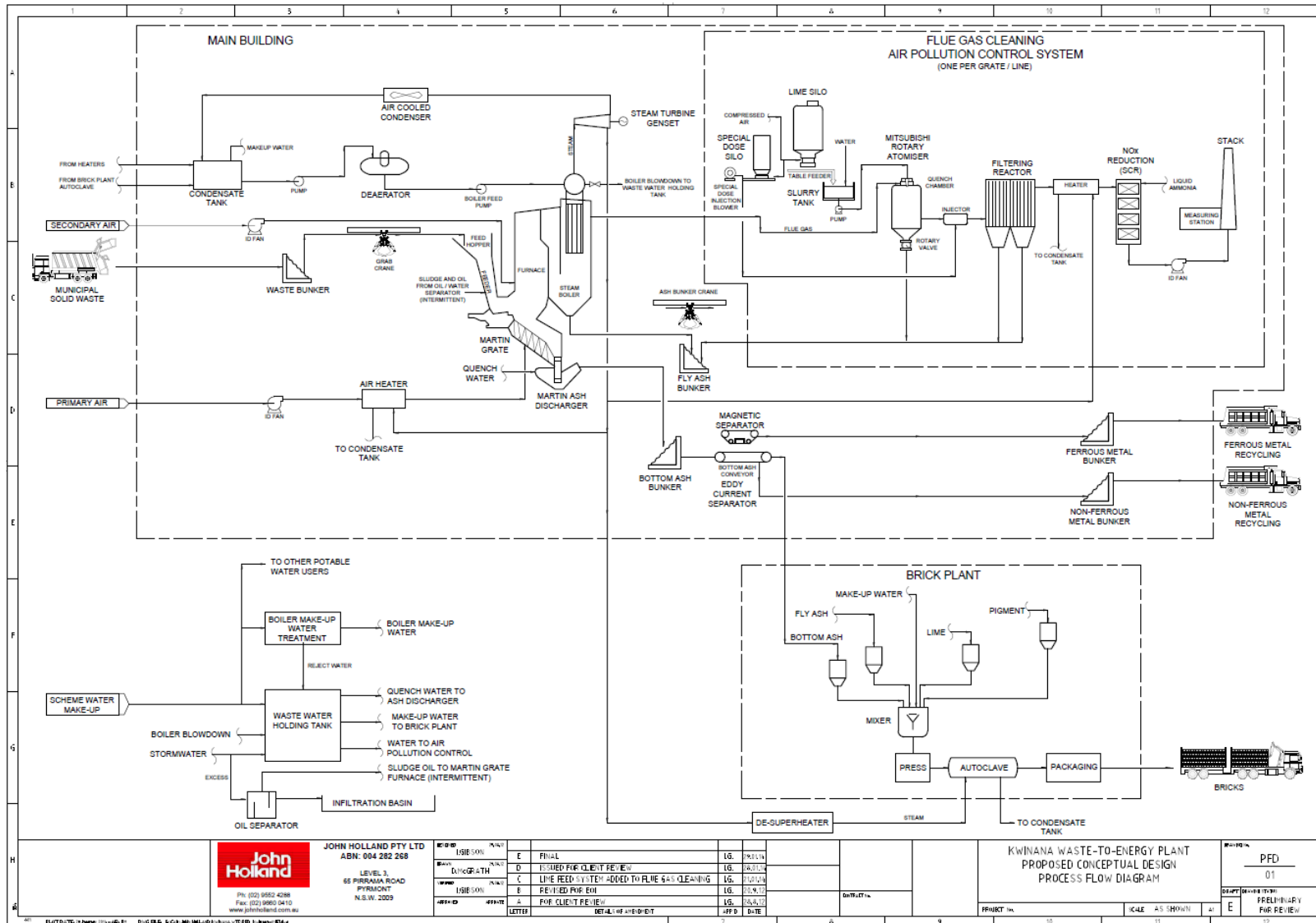


# Kwinana Waste to Energy Project

## Public Environmental Review



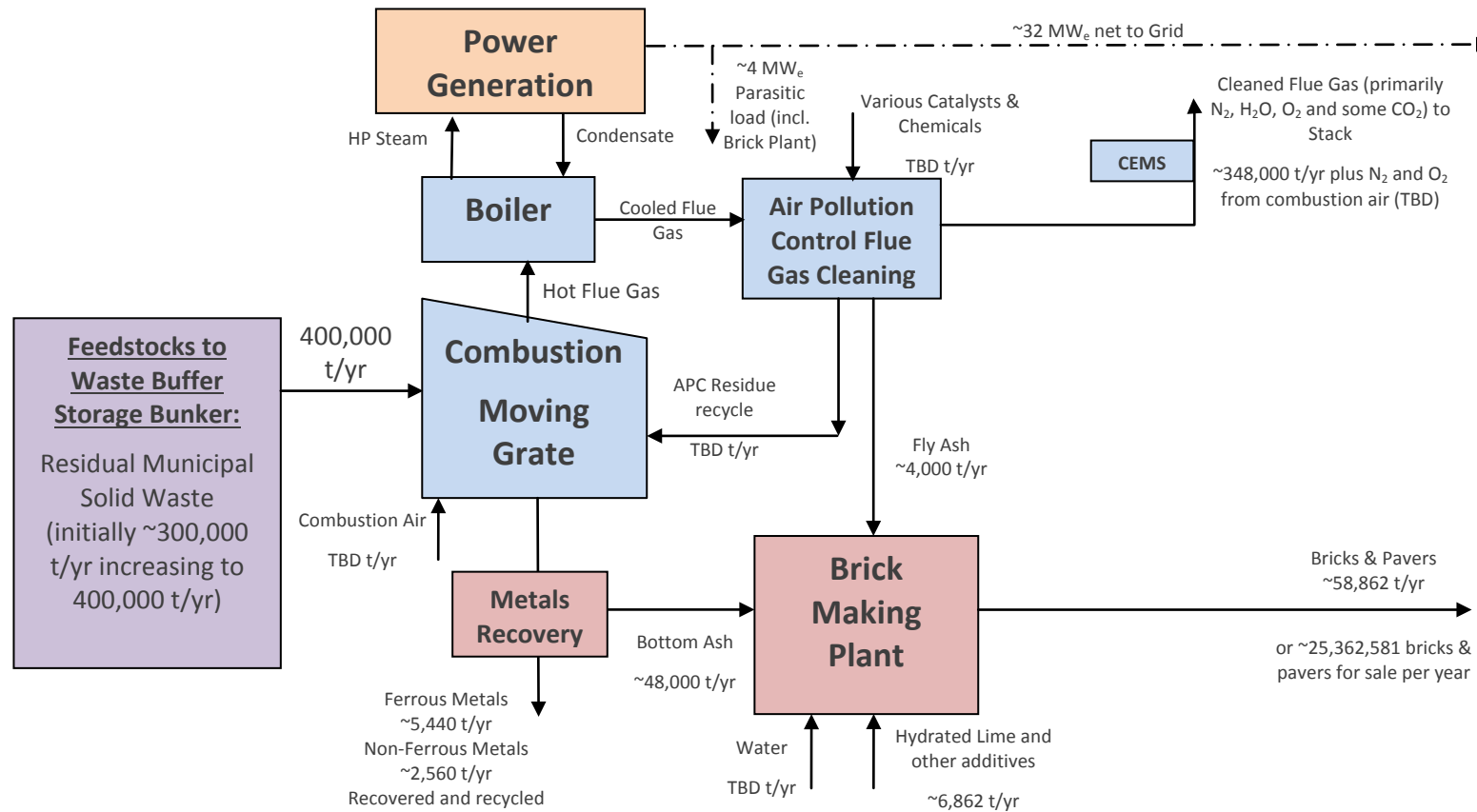
### ATTACHMENT 5 – Conceptual Process Flow Diagram





ATTACHMENT 6 - Simplified Conceptual Overall Facility Mass & Energy Balance

All mass rates and energy recovery figures are preliminary and subject to change during detailed design.



TBD = To be determined once actual feedstock flow rates and typical compositions are known and engineering has been undertaken to determine the final process configuration.