Hazelmere Wood Waste to Energy Plant

Public Environmental Review

Prepared for
Eastern Metropolitan Regional Council
by Strategen

April 2014

Hazelmere Wood Waste to Energy Plant

Public Environmental Review

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April 2014

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Client: Eastern Metropolitan Regional Council

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Draft Report	Rev A	Client review	H Ventriss, P Forster, N Zago	Electronic	17/04/14
Draft Report	Rev B	Client info	H Ventriss, P Forster, N Zago	Electronic	22/04/14
Draft Report	Rev 0	EPA comment	H Ventriss, N Zago, D Walsh	Electronic	22/04/14
Draft Report	Rev 1	EPA comment	H Ventriss, N Zago	Electronic	23/04/14
Final Draft Report	Rev 2	EPA authorisation	H Ventriss, N Zago	Electronic	30/04/14
Final Report	Rev 3	Public Review	H Ventriss, N Zago	Electronic	30/04/14

Filename: EMR14101_01 R001 Rev F3 - 30 April 2014

INVITATION

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

Eastern Metropolitan Regional Council proposes to further develop the existing Hazelmere Recycling Centre by installing a 3.5 MW Wood Waste to Energy (WWTE) plant located approximately 14 km from Perth on Part Lot 100 and Lot 201, Lakes Road, Hazelmere. In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) has been prepared that describes this proposal and its likely effects on the environment. The PER is available for a public review period of four weeks from 5 May 2014, closing on 3 June 2014.

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Where to get copies of this document

Printed copies of this document may be obtained from:

Eastern Metropolitan Regional Council
1st Floor Ascot Place
226 Great Eastern Highway
BELMONT WA 6104
Ph: (08) 9424 2222

The cost of the PER is $10.00 for a hard copy. CD-ROM versions can be provided at no cost.

Copies may also be obtained from the Eastern Metropolitan Regional Council website at *www.emrc.org.au/wwte-per.html.*

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*, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

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

When making comments on specific proposals in the PER:

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

Points to keep in mind.

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

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

Remember to include:

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

The closing date for submissions is: 3 June 2014

The EPA prefers submissions to be made by email to:
https://consultation.epa.wa.gov.au.

Alternatively submissions can be:

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, EAST PERTH WA 6892, or
- delivered to the Environmental Protection Authority, Level 8, The Atrium, 168 St Georges Terrace, Perth.

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

Executive summary

Introduction

Eastern Metropolitan Regional Council (EMRC) proposes to further develop the existing Hazelmere Recycling Centre (located approximately 14 km from the Perth), by installing a 3.5 MW Wood Waste to Energy (WWTE) plant located on Part Lot 100 and Lot 201, Lakes Road, Hazelmere (the Proposal).

An existing operation at the Hazelmere Recycling Centre recycles untreated timber (such as pallets and crates) into wood chip for sale and used mattresses into their components for recycling. The WWTE plant would use part of the wood chip as the feed-source for the plant.

Location

The site is located approximately 14 km north east of Perth, north of the Perth Airport in the suburb of Hazelmere (Figure ES1) and within the City of Swan.

Assessment process

The Proposal was referred to the Environmental Protection Authority (EPA) on 17 January 2014 under s 38 of the *Environmental Protection Act 1986* (EP Act). The Proposal was determined by the EPA as requiring assessment at the level of Public Environmental Review (PER) with a four-week public comment period.

Under the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*, an Environmental Scoping Document (ESD) was prepared identifying the environmental factor relating to the Proposal required to be addressed in the PER and the environmental studies required to provide information for assessment of the environmental impact of the Proposal. The final approved ESD was issued to the Proponent on 17 April 2014. The ESD identified the preliminary key environmental factor to be addressed in the PER to be air quality.

The purpose of this PER is to present an environmental impact assessment of the Hazelmere WWTE plant for public review and EPA consideration. This PER includes a detailed impact assessment and description of proposed mitigation and management measures addressing the relevant environmental factor affected by the Proposal, in accordance with the ESD.

Description of the Proposal

The WWTE plant will be based on pyrolysis technology using an indirect-fired pyrolysis kiln to produce synthesis gas (syngas) for use in internal combustion gas engines for power generation. The pyrolysis process involves heating shredded wood at high temperatures in the absence of oxygen.

The waste (fuel) will be shredded clean wood from timber offcuts, shipping pallets, crates and cable reels, etc. that would otherwise be disposed to landfill. CCA treated wood would not be used. The syngas produced by the wood chip pyrolysis will power eight 500 kW gas engine generator sets. The resulting products are renewable electricity and bio-char (solid char of carbon and ash).

The summary of the proposal description and preliminary key proposal characteristics are provided in Table ES1 through Table ES3.

Table ES1: Summary of the Proposal

Proposal Title	Hazelmere Wood Waste to Energy Plant
Proponent Name	Eastern Metropolitan Regional Council
Short Description	The proposal is to process wood waste in an indirect-fired pyrolysis kiln to produce synthesis gas for use as a fuel in internal combustion gas engines. The outputs are power (electricity) and bio-char.

Figure ES1
Site location

Legend

- Existing cadastre
- Roads
- Site location
- WWTE plant location

Scale 1:10,000 at A4

0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 30/04/2014
Author: JCrute
Source: Aerial and cadastre: Landgate 2006;
Roads: MRWA 2013

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Table ES2: Key proposal characteristics (physical elements)

Element	Location	Proposed Extent
Pyrolysis plant	Proposal site - Part Lot 100 and Lot 201 Lakes Road Hazelmere (Figure ES1).	Constructed on 0.2 hectares of cleared land.

Table ES3: Key proposal characteristics (operational elements)

Element	Location	Proposed Extent Authorised
Operating times	Proposal site	16 hours per day (14 hours per day of peak period electricity generation), 5 days per week.
Wood waste	Proposal site	Up to 13 000 tonnes per annum.
Feed	Proposal site	Waste wood (pallets, packaging, crates, off-cuts, cable reels).
Excluded waste	Proposal site	All non-wood waste, medium-density fibreboard (MDF), particleboard/chip board, low pressure laminated board, CCA treated wood. Wood chip sourced directly from trees will not be used.
Power generation	Proposal site	Up to 3.5 Megawatts to be supplied to the South West Interconnected System and/or nearby industrial consumers.
Wastewater	Proposal site	Up to 5 kilolitres per day.

Environmental impact assessment

The key environmental factor for the Proposal was identified in the EPA-prepared ESD as air quality. The EPA objective for air quality is to maintain air quality for the protection of the environment and human health and amenity.

A study of air emissions from point sources within the WWTE plant has been carried out using dispersion modelling as per guidance notes provided by DoE (2006). The assessment has included direct impacts of emissions as well as cumulative impacts, whereby the background air quality is considered in conjunction with the additional emissions from the WWTE plant.

Atmospheric emissions from the pyrolysis process have the potential to affect air quality, with a consequent impact on the health and amenity at ground level sensitive receptors (residential areas and neighbouring premises) within the dispersion zone. The emissions potentially involve of oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), particulates (TSP, PM_{10}, $PM_{2.5}$ and nano-particles), volatile metals, acid gases (HCl, HF and SO_2), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans.

A comprehensive emissions inventory has been developed from consideration of measured compositional data for the wood feed materials and key process design parameters that influence the formation and fate of air emissions within the process. The emissions data obtained from the emissions inventory have been used in the dispersion modelling. Dispersion modelling considered three emissions scenarios:

1. Normal emissions, where all the engines are on-line and clean syngas is used.
2. Reduced rate emissions, where four of the gas engines are on-line and four off-line, and excess clean syngas combusted.
3. Bypass emissions, where plant outage results in raw syngas being combusted.

Dispersion modelling for normal operations shows no exceedances of the air quality criteria[1] for the maximum predicted ground level concentrations (GLCs). The most significant emission was NO_2 (NOx), with a maximum predicted 1-hour average GLC of 26% of the NEPM air quality criterion of 246 µg/m^3. Similarly, for reduced rate operations, no exceedances of the air quality criteria are predicted, with NO_2 being the most significant emission. Dispersion modelling for bypass operations shows higher maximum ambient concentrations are predicted for metals and particulates compared with the other operating conditions; however, no exceedances of the air quality standards were predicted.

No exceedances of the respective air quality criteria are predicted where the emissions from the proposed WWTE plant operating under any operating scenario are combined with background concentrations. Table ES4 summarises the potential environmental impact, impact assessment, proposed management and predicted environmental outcome for the key environmental factor assessed in the PER.

[1] The different criteria are tabulated in full in Table 20 and incorporate guidance from various sources, for example the National Environment Protection Measures (NEPMs), World Health Organisation (WHO) guidelines and Department of Health (DoH) guidance.

Table ES4: Summary of environmental impact assessment of the key environmental factor

Environmental factor	EPA objective	Existing environment	Potential impact	Impact assessment	Environmental management	Predicted outcome
Air quality	To maintain air quality for the protection of the environment and human health and amenity.	The site is located approximately 14 km northeast of Perth, north of the Perth Airport in the suburb of Hazelmere and within the City of Swan. The site is zoned 'industrial' under the MRS and 'industrial development' under the TPS17. Adjacent lots to the west are zoned 'rural' under the MRS and 'rural residential' under the TPS17. The proposed Hazelmere Enterprise Area (HEA) Structure Plan outlines potential future zoning. The site would be zoned 'general industrial' with lots to the west changing to 'light industrial'. A comprehensive emissions inventory has been developed from consideration of measured compositional data for the wood feed materials and key process design parameters that influence the formation and fate of air emissions within the process. The emissions data obtained from the emissions inventory have been used in the dispersion modelling.	The emissions potentially involve of oxides of nitrogen, carbon monoxide, sulfur dioxide, particulates (TSP, PM_{10}, $PM_{2.5}$ and nano-particles), volatile metals, acid gases, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans.	Dispersion modelling of emissions from the two point sources (main stack and engine exhaust stacks) was carried out using the AERMOD atmospheric dispersion model. Three residences to the west of the EMRC Hazelmere site were identified as sensitive receptors, with industrial premises surrounding the remainder of the EMRC site. The air quality criteria and standards used in the Red Hill Resource Recovery Facility assessment were considered as background air quality data as a substitute for local data. Those data were compared with data from the Midland area and the Department of Environment Regulation Rolling Green Air Quality Monitoring Station data, and found to be of similar magnitude in concentrations. The direct and cumulative air quality impact assessments have shown that acceptable air quality outcomes are predicted in relation to the relevant air quality criteria for the proposed WWTE plant at Hazelmere. In particular, no exceedances of air quality criteria are predicted for direct impacts of air emissions and from cumulative impacts when the emissions combine with background concentrations of pollutants. Overall, the assessment has indicated acceptable air emissions impacts can be provided under normal operations, reduced rate operations (including start-up and controlled shutdown) and bypass conditions that may accompany rapid shut-down in the event of process outage.	Components of design of the WWTE plant have been undertaken to avoid situations where raw syngas is combusted in the generator sets. Therefore, no raw syngas will be directed to the engines at any time and the likelihood of a bypass situation has been reduced as a diesel generator will be installed to be used in the event of mains power outage. Emissions will be minimised/mitigated using the following pollution controls: • raw syngas reformer • reformed syngas wet scrubber • low-NOx kiln burners • high efficiency thermal oxidiser • optimised syngas/air mixture for gas engines. Predicted ground level concentrations of various pollutants will be validated by measurements of emissions from the main stack and engine exhausts, as well as some ambient air monitoring of key parameters. As a contingency, should higher than predicted levels be measured during monitoring, a process to determine the actual GLCs and compliance with air quality standards would be undertaken. This process would then inform any process modifications to reduce emission rates of relevant parameters. If exceedances of air quality standards are predicted from higher actual emission rates, the plant would be shut down while the process and operations review was carried out, and improvements identified to reduce emissions of relevant parameters to comply with air quality standards.	Taking into consideration: • an emissions inventory has been prepared and used in dispersion modelling • operating scenarios have been used to represent the different emission scenarios that are expected and have been used in dispersion modelling • air quality criteria and standards used in the Red Hill Resource Recovery Facility assessment were considered as background air quality data, as a substitute for local data • dispersion modelling has indicated acceptable air emissions impacts can be provided under normal operations, reduced rate operations (including start-up and controlled shutdown) and bypass conditions • dispersion modelling has taken into account cumulative conditions • application of pollution control, monitoring and contingency planning • the Proposal is consistent with EPA Advice to the Minister as outlined in the EPA report on Waste to Energy plants in Western Australia (EPA 2013b), the Proposal is not expected to represent a significant impact to the air quality of the area and is expected to meet the EPA objectives for air quality by maintaining air quality for the protection of the environment and human health and amenity.

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All appendices are in electronic form on a data CD/DVD attached to the inside the back cover of this report or on the disc containing the electronic version of this report.

1. Introduction

Eastern Metropolitan Regional Council (EMRC) proposes to further develop the existing Hazelmere Recycling Centre (located approximately 14 km from Perth [Figure 1]), by installing a 3.5 MW Wood Waste to Energy (WWTE) plant located on Part Lot 100 and Lot 201, Lakes Road, Hazelmere (the Proposal). The site location is presented in Figure 2.

EMRC is in the process of planning the development of the EMRC Resource Recovery Park (RRP) at Hazelmere, which is proposed to occupy Lot 201, Part Lot 100 and potentially Lot 99(2), Lakes Road, Hazelmere. The RRP would include other waste management processes in addition to the existing operations and the WWTP plant. Appropriate approvals will be sought for other elements of the RRP as planning is finalised. Recycling of timber (such as pallets and wooden packaging and crates, off-cuts and cable reels) and mattresses is undertaken at the site. This Proposal only concerns the WWTE plant, which covers approximately 0.2 ha of the 10 ha RRP. Construction of the Proposal is scheduled to commence in late 2014 with commissioning in 2015.

1.1 Background

An existing operation at the Hazelmere Recycling Centre recycles untreated timber (such as pallets, timber off-cuts and crates) into wood chip for sale and recycles used mattresses into their components for recycling. The WWTE plant would use part of the wood chip as the feed-source for the plant.

The Proposal was referred to the Environmental Protection Authority (EPA) on 17 January 2014 under s 38 of the *Environmental Protection Act 1986* (EP Act). The Proposal was determined by the EPA as requiring assessment at the level of Public Environmental Review (PER) with a four-week public comment period. The PER process is summarised in Figure 3.

Under the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*, an Environmental Scoping Document (ESD) identifying the environmental factor relating to the Proposal required to be addressed in the PER and the environmental studies required to provide information for assessment of the environmental impact of the Proposal. The final approved ESD was issued to the Proponent on 17 April 2014. The ESD identified the preliminary key environmental factor to be addressed in the PER to be air quality. The ESD is presented in Appendix 1.

1.2 Purpose of this document

The purpose of this PER is to present an environmental impact assessment of the Hazelmere WWTE plant for public review and EPA consideration. This PER includes a detailed impact assessment and description of proposed mitigation and management measures addressing the relevant environmental factor affected by the Proposal, in accordance with the ESD.

1.3 Proposal location

The site is located approximately 14 km northeast of Perth, north of the Perth Airport in the suburb of Hazelmere (Figure 2), within the City of Swan. The site is zoned ‘industrial’ under the Metropolitan Region Scheme (MRS) and ‘industrial development’ under the current Town Planning Scheme (TPS17). Adjacent lots to the west are zoned ‘rural’ under MRS and ‘rural residential’ under TPS17. No re-zoning is anticipated for the Proposal; however, EMRC is negotiating acquisition of Lot 99(2) (immediately west of Lot 100) to allow for the development of a community reuse, recycling and drop-off centre for the RRP (which does not form part of this Proposal). EMRC already own Lot 99(1). Figure 4 depicts the zoning in the locality of the Proposal.

The Hazelmere Enterprise Area (HEA) Structure Plan (City of Swan 2011) outlines the potential future zoning changes likely to be implemented. The site will be zoned 'general industrial' in the HEA Structure Plan, with lots to the west of the site changing from 'rural residential' to 'light industrial' (City of Swan 2011).

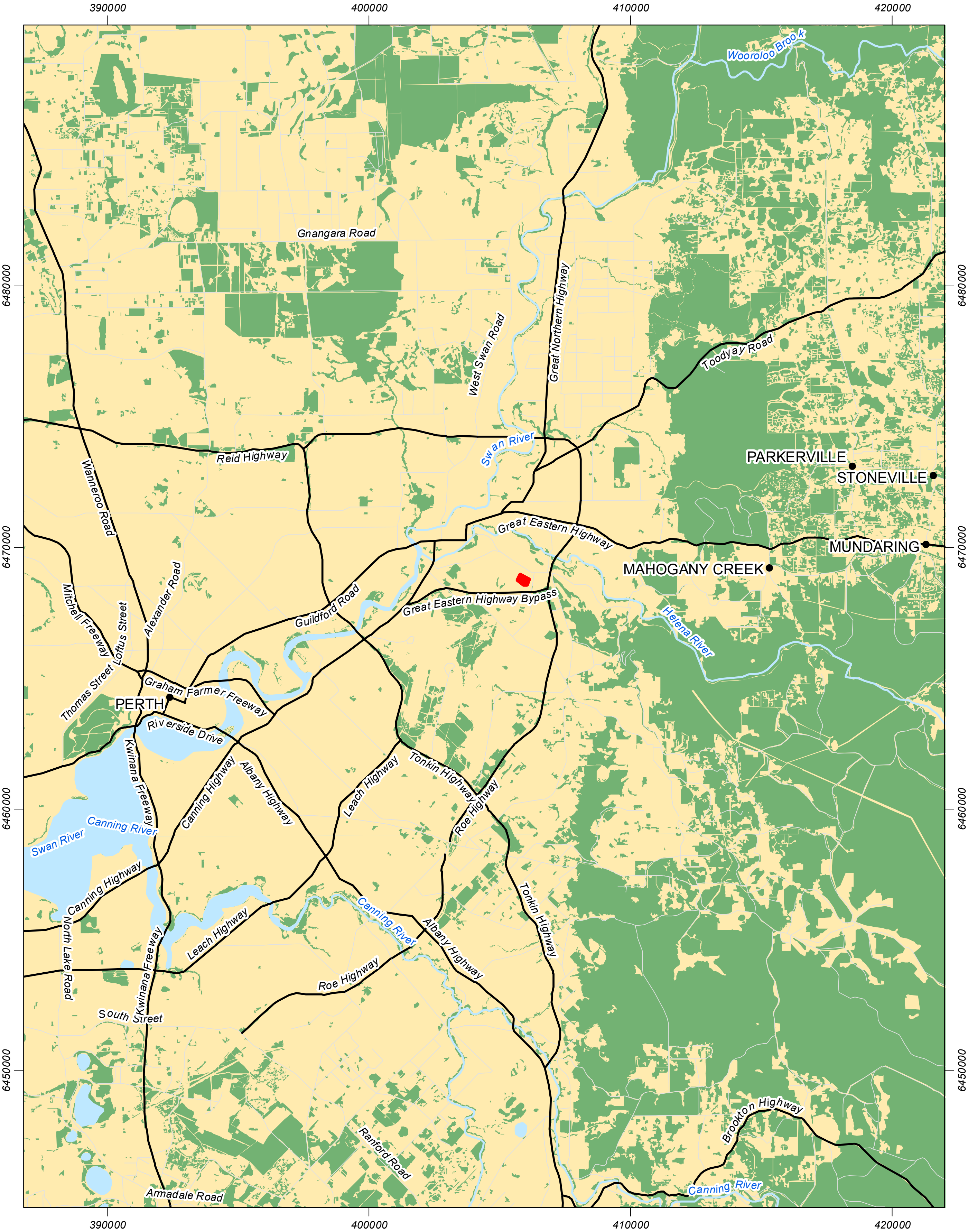

Figure 1 Regional location

Scale 1:200,000 at A4

0 1 2 3 4 5 km

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 30/04/2014
Author: JCrute
Source: Topography: Geoscience Australia 2011.

Legend

- Town
- Major road
- Minor road
- Major river
- Lakes
- Native vegetation
- Site location

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Figure 2
Site location

Legend

- Existing cadastre
- Roads
- Site location
- WWTE plant location

Scale 1:10,000 at A4

0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 30/04/2014
Author: JCrute
Source: Aerial and cadastre: Landgate 2006;
Roads: MRWA 2013

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Figure 3: Public Environmental Review procedure

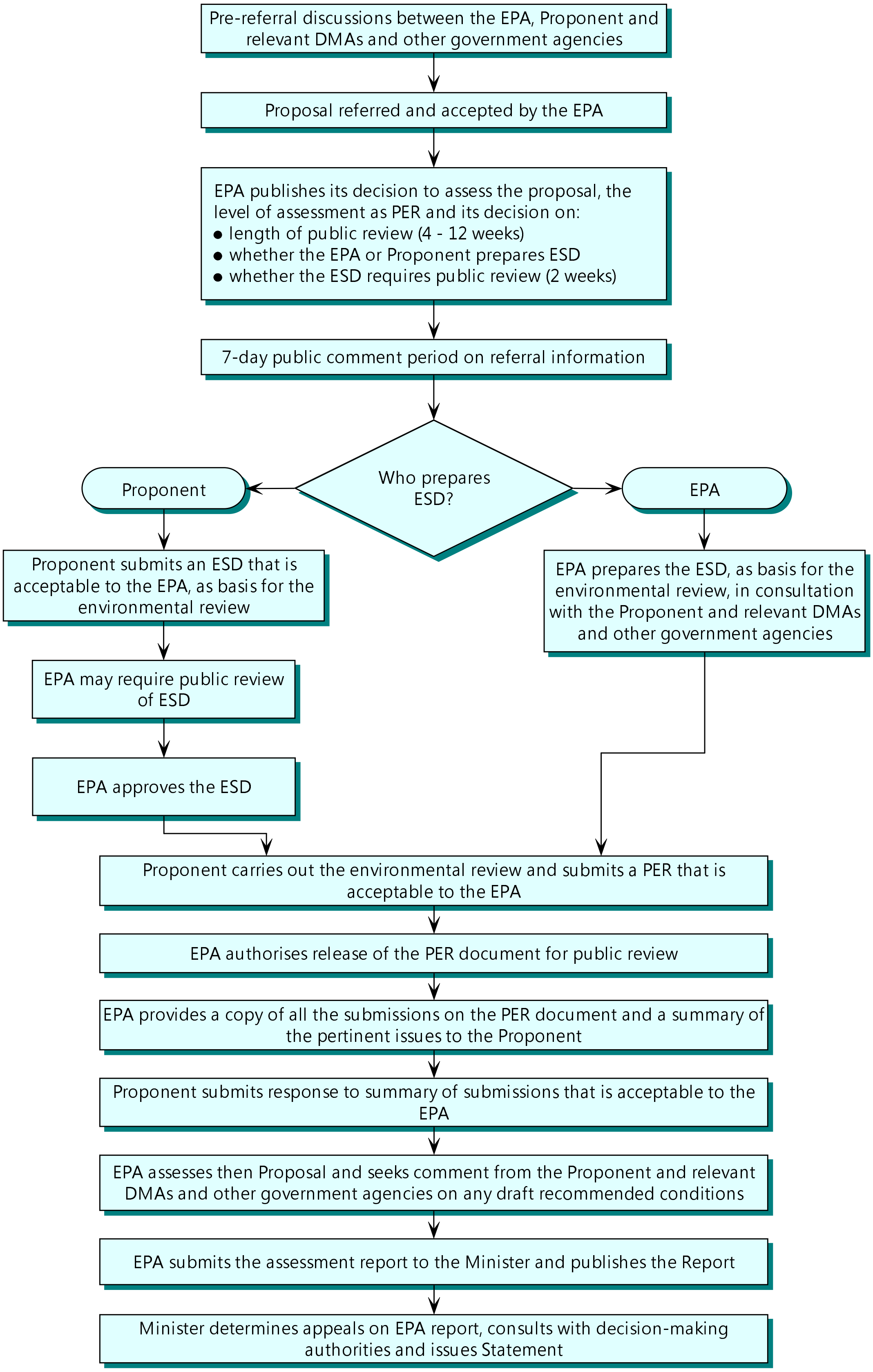
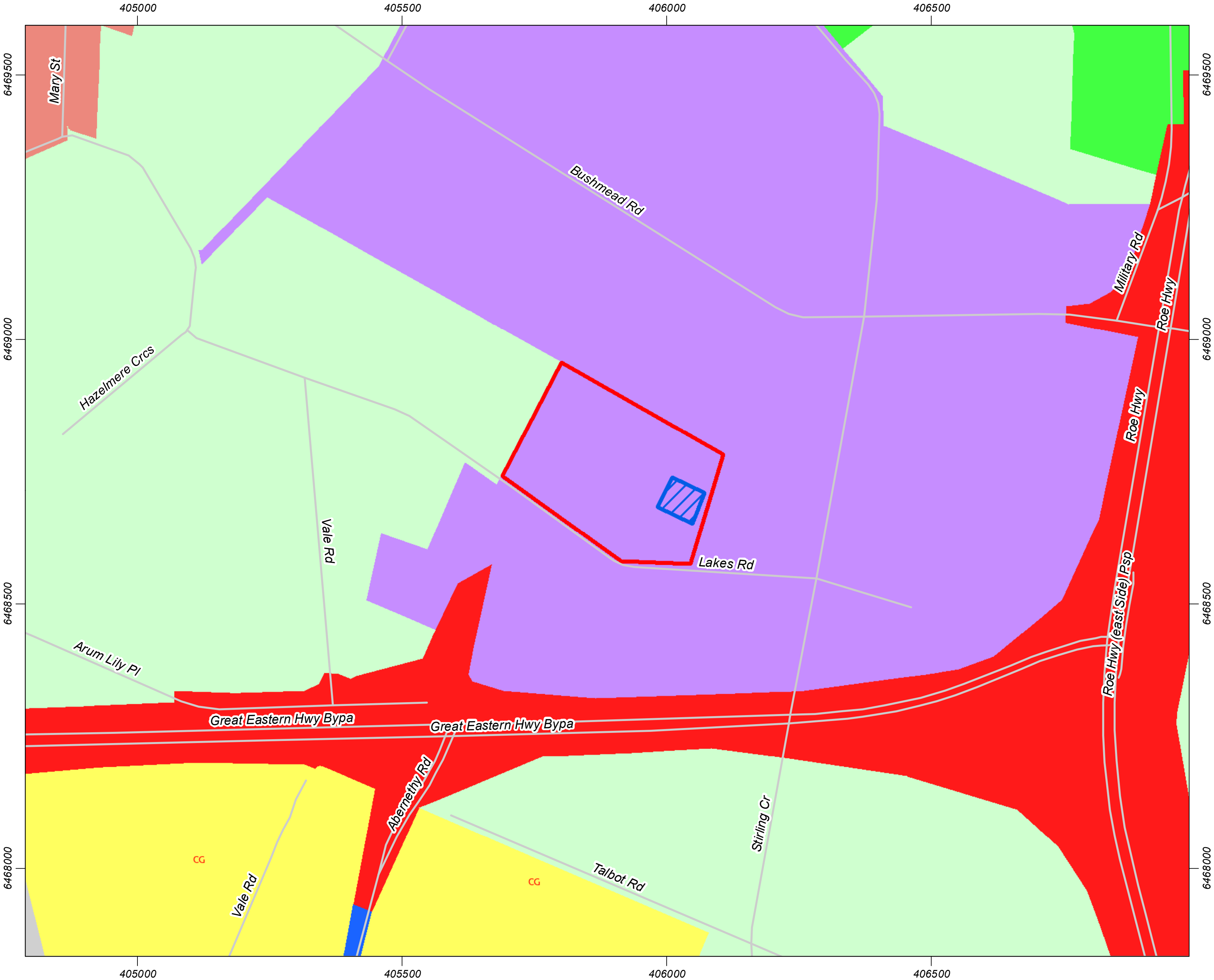


Figure 4
Metropolitan Region Scheme Zoning



Legend

- Roads
- Site location
- WWTE plant location

MRS zoning

- Urban
- Industrial
- Rural
- Primary Regional Road
- Regional Road
- Parks and Recreation
- Public Purpose

Scale 1:10,000 at A4

0 100 200 300 m

N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 30/04/2014
Author: JCrute
Source: Zoning: Landgate 2013;
Roads: MRWA 2013

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1.4 Document structure

In accordance with the requirements of the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*, this document contains the following information:

1. A description of the Proposal and alternatives considered, including alternative locations with a view to minimising environmental impacts (refer Section 2).
2. Identification of the key environmental factor (refer Section 3).
3. Details of stakeholder consultation (refer Section 4).
4. A description of the receiving environment likely to be adversely affected by the Proposal, its conservation values, and key ecosystem processes, and discussion of their significance in a regional setting. Section 5 presents the regional environmental and social setting.
5. Discussion and analysis of the impacts of the Proposal. For the key environmental factor, refer to Section 6 for an assessment of the impacts of the Proposal with respect to that factor. Environmental factors identified by the EPA as not requiring further evaluation are listed in Section 3.2.
6. Findings of surveys and investigations undertaken. The results of the technical studies inform the assessments of the key environmental factor presented in Section 6.
7. Identification of management measures to mitigate significant adverse impacts are presented in Section 6.
8. List of references in Section 7.
9. Demonstration that the Proposal conforms to relevant environmental policies, guidelines, standards and procedures. This information is presented throughout the document as relevant.
10. Spatial datasets, information products and databases are provided in Appendix 2.

The appendices can be found on a data CD/DVD-ROM inside the back cover of this report or on the disc containing the electronic version of this report.

1.5 Proponent details

The Proponent for this Proposal is:
Eastern Metropolitan Regional Council
1st Floor Ascot Place
226 Great Eastern Highway
BELMONT WA 6104

The key contact for this Proposal is:
Stephen Fitzpatrick
Director Waste Services
Eastern Metropolitan Regional Council
1st Floor Ascot Place
226 Great Eastern Highway
BELMONT WA 6104
Ph: (08) 9424 2232
Email: *stephen.fitzpatrick@emrc.org.au*

1.6 Assessment approach

1.6.1 Applicable legislation

Implementation of the Proposal would require compliance with Australian legislation and regulations; these are listed in Section 1.6.2 and 1.6.3. Further to these statutory requirements, a range of other guidelines, standards and policies are also relevant to the Proposal; the generic standards, policies and guidelines are listed in Section 1.6.4.

1.6.2 State legislation

Key Western Australian legislation relevant to the Proposal includes:

- *Environmental Protection Act 1986*
- Environmental Protection Regulations 1987
- Environmental Protection (Controlled Waste) Regulations 2004
- Environmental Protection (Noise) Regulations 1997
- Environmental Protection (Unauthorised Discharges) Regulations 2004
- *Health Act 1911*
- *Rights in Water and Irrigation Act 1914.*

1.6.3 Commonwealth legislation

Key Commonwealth legislation relevant to the environmental aspects of this Proposal includes the *Greenhouse and Energy Reporting Act 2007.*

1.6.4 Standards, guidelines and policies

Assessment of the environmental impacts of the Proposal is based on various Position Statements and Guidance Statements. Standards, guidelines and policies related to specific environmental factors or individual aspects of the Proposal are listed in the individual sections relevant to the environmental factor being addressed. The generic documents considered relevant to assessment by the EPA are:

- *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*
- EPA Position Statement No. 7: *Principles of Environmental Protection* (EPA 2004)
- Environmental Assessment Guidelines No. 1: *Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal Environmental Protection Act 1986* (EPA 2009)
- Environmental Assessment Guidelines No. 8: *Environmental Assessment Guideline for Environmental Factors and Objectives* (EPA 2013a).

1.6.5 Other WA approvals

In addition to any requirements for implementation of the Proposal under Part IV of the EP Act, the Proposal will require a prescribed premises works approval and licence under Part V of the EP Act.

2. Proposal description and key characteristics

2.1 Proposal overview

EMRC proposes to develop a 3.5 MW Wood Waste to Energy (WWTE) plant in Hazelmere. The land is zoned for industrial purposes. The plant will be based on pyrolysis technology using an indirect-fired pyrolysis kiln to produce synthesis gas (syngas) for use in internal combustion gas engines for power generation. The pyrolysis process involves heating shredded wood at high temperatures in the absence of oxygen.

The waste (fuel) would be shredded clean wood from shipping pallets, timber off-cuts, crates and cable reels, etc. that would otherwise be disposed to landfill. Copper chrome arsenic (CCA) treated wood would not be used.

The syngas produced by the pyrolysis will power eight 500 kW gas engine generator sets. The resulting products are renewable electricity and bio-char (solid char of carbon and ash).

2.2 Key characteristics

A summary of the proposal description and preliminary key proposal characteristics are provided in Table 1 through Table 3.

Table 1: Summary of the Proposal

Proposal Title	Hazelmere Wood Waste to Energy Plant
Proponent Name	Eastern Metropolitan Regional Council
Short Description	The proposal is to process wood waste in an indirect-fired pyrolysis kiln to produce synthesis gas for use as a fuel in internal combustion gas engines. The outputs are power (electricity) and bio-char.

Table 2: Key proposal characteristics (physical elements)

Element	Location	Proposed Extent
Pyrolysis plant	Proposal site - Part Lot 100 and Lot 201, Lakes Road, Hazelmere (Figure 1).	Constructed on 0.2 hectares of cleared land.

Table 3: Key proposal characteristics (operational elements)

Element	Location	Proposed Extent Authorised
Operating times	Proposal site	16 hours per day (14 hours per day of peak period electricity generation), 5 days per week.
Wood waste	Proposal site	Up to 13 000 tonnes per annum.
Feed	Proposal site	Waste wood (pallets, packaging, crates, off-cuts, cable reels).
Excluded waste	Proposal site	All non-wood waste, medium-density fibreboard (MDF), particleboard/chip board, low pressure laminated board, CCA treated wood. Wood chips sourced directly from trees will not be used.
Power generation	Proposal site	Up to 3.5 Megawatts to be supplied to the South West Interconnected System and/or nearby industrial consumers.
Wastewater	Proposal site	Up to 5 kilolitres per day.

The location of the Proposal is described in Section 1.3. The isometric layout is presented in Figure 5.

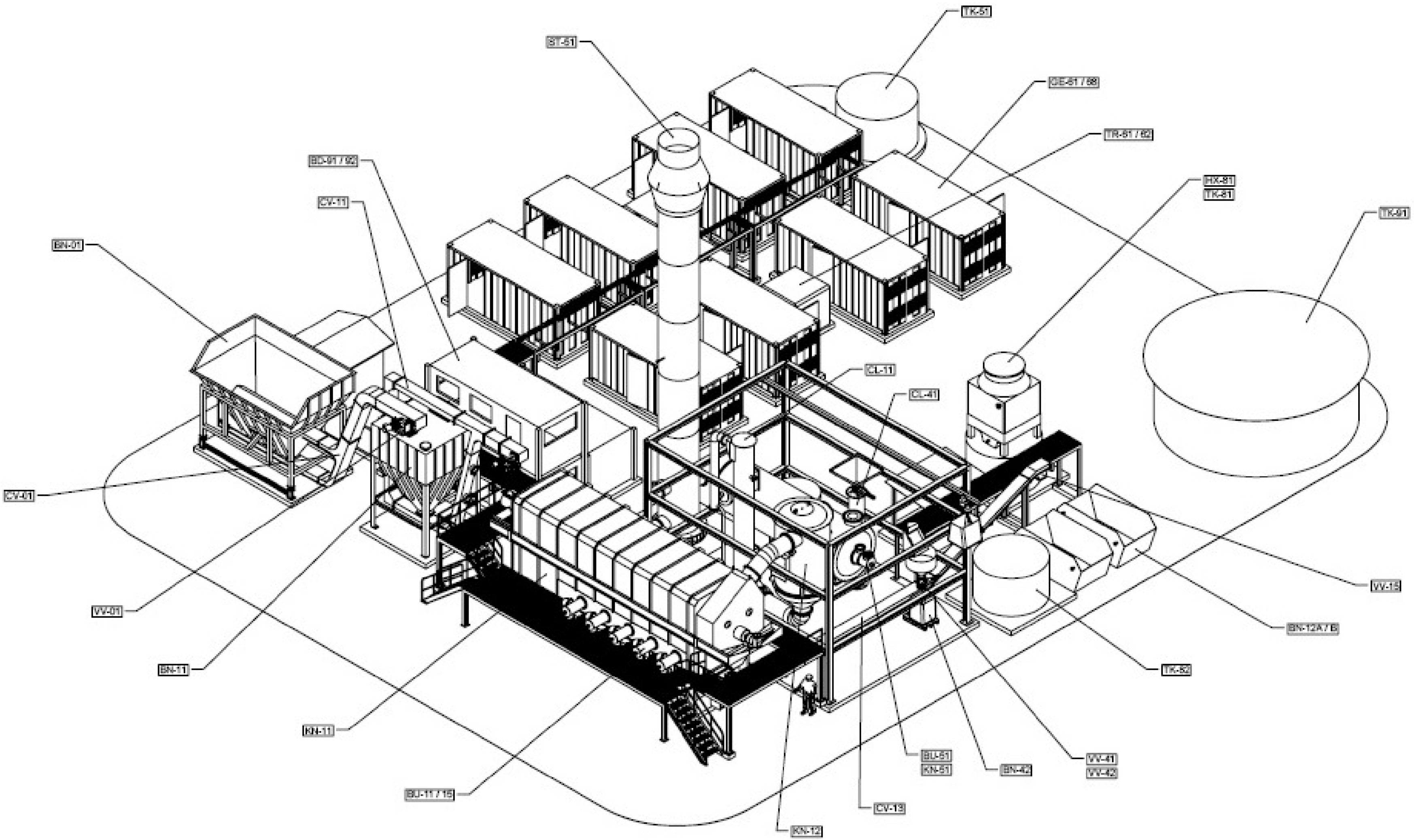

Figure 5
Isometric layout

Legend

BD – Board Diagnostics
BN – Bin
BU – Burner
CL – Column (activated carbon)
CV – Conveyor
GE – Gas Engines and Generators
HX – Heat Exchanger
KN – Kiln
ST – Stack
TK – Tank
TR – Transformer
VV – Valve

Date: 30/04/2014
Author: JCrute
Source: Client 2014.

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2.3 Proposal justification and benefits

Waste minimisation is a priority for both State and Australian Governments. At Hazelmere, waste timber is recovered and reprocessed into wood chip, wood chip fines and coloured chip. These products are sold for animal bedding and landscaping.

The 2012/2013 financial year saw 13 000 t of wood waste (mainly untreated softwood timbers, packaging, pallets, off-cuts and particleboard) diverted from landfill. Since the Hazelmere Recycling Centre was opened in 2008, 40 000 t of wood waste has been diverted from landfill (EMRC 2013a).

There is a large existing market for wood chip fines and a smaller market for wood chip. Use of this wood chip as a fuel source for power generation is considered a beneficial means of ensuring the wood chip is utilised. Hazelmere wood chip does not easily compost because it is derived from seasoned dry timber and is too large to break down quickly. By diverting this waste wood from landfill to be used instead for energy generation, EMRC will reduce the greenhouse gas emissions that would otherwise be emitted from landfill, will generate renewable electricity and produce a potentially saleable bio-char product. The proposed WWTE plant is intended to utilise chip derived from wood waste only; there is no proposal to use trees for wood chip for the purpose of electricity generation.

In the internationally-recognised best practice waste management hierarchy, reprocessing is ranked third out of seven preferred waste management options after reuse but above recycling (Waste Authority 2013). Energy recovery is a recognised option at the lower end of the waste hierarchy, being more favourable than disposal to landfill, but less favourable than waste avoidance, reuse, reprocessing and recovery options (Waste Authority 2013).

Ansac/Anergy technology has been developed at a pilot scale over several years; construction of the Hazelmere WWTE plant will provide the opportunity to demonstrate new pyrolysis technology at a commercial scale (Ansac 2013).

Australian Government endorsement of development of Waste to Energy technology is indicated by provision of funding through the Clean Technology Innovation Fund, received by Ansac on the basis of joint funding from EMRC. This grant was awarded to Ansac in July 2013 and subsequently, a contract was awarded to Ansac by EMRC for design and construction of the plant.

2.4 Schedule

An indicative implementation schedule for the Proposal is presented in Table 4.

Table 4: Indicative implementation schedules for the Proposal

Year	Phase
2013	Completion of design and commence regulatory approval
2014	Environmental approval and procurement program
	Commencement of on-site installation and construction
2015	Complete construction and commissioning of plant
	Process operation optimisation, operational handover and training
	Develop strategic plan for broad commercialisation

2.5 Detailed Proposal description

The WWTE plant is made up of ten components, as listed:

1. Feed (reception for wood chip from the existing shredder).
2. Pyrolysis (continuous and measured feed system for pyrolysis at approximately 800°C using a pyrolysis kiln).
3. Gas cleanup (reaction of tar materials and hydrocarbons in a catalytic reformer to form hydrogen and carbon monoxide, and cleaning using a water scrubber).
4. Char output (cooling of remaining solids and transport off-site).
5. Wastewater treatment (filtration, activated carbon adsorption of organic carbon and inorganic salts).
6. Staged Air Cyclonic Thermal Oxidiser (SACTO, combustion of excess syngas) and exhaust stack.
7. Gas engines (combustion of syngas in generator sets).
8. High voltage (transformation of power generated to grid voltage of 22 kV and step down to 415 V for parasitic load).
9. Utilities (equipment for cooling/process water, oxygen, nitrogen, compressed and instrument air).
10. Other services (control room, switch room, motor control centre, workshop, firewater, drainage).

A process flow diagram is provided in Figure 6 which outlines the process.

2.5.1 Inputs and outputs

Inputs are listed as follows:

- shredded recycled wood chip
- natural gas (for pyrolysis kiln start-up and SACTO standby)
- process water.

Outputs will comprise:

- electricity
- exhaust gases to atmosphere
- wastewater
- solid bio-char.

2.5.2 Project development and operations

The design life of the WWTE plant is estimated to be 25 years. The design capacity of the kiln is 4 tonnes per hour (tph); however, the kiln is expected to operate at a feed rate of 3.1 tph. Table 5 shows the operation specification for the plant.

Table 5: Operation specifications

Aspect	Specification
Nominal operating schedule	16 hr/day, 5 days/wk
Total operating hours	4140 hr/yr
Operating period for peak power generation	14 hr/day
Total operating hours producing power	3680 hr/yr
Electrical output	3.5 MW
Annual energy production	9498 MWh/yr

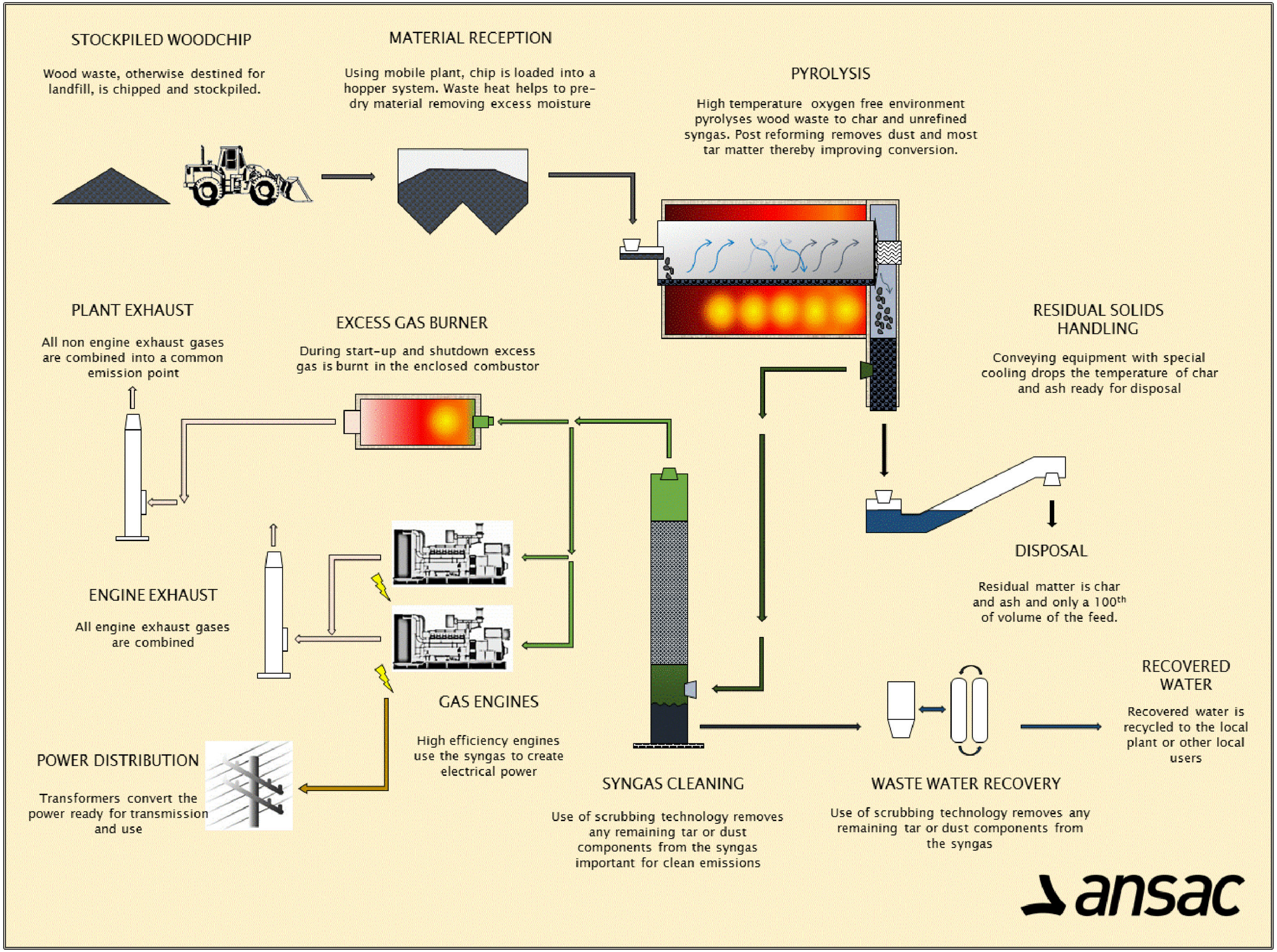

Figure 6
Process flow diagram

Date: 30/04/2014
Author: JCrute
Source: ansac 2014.

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2.5.3 Feed system

Feedstock of waste wood from the existing shredder is loaded into a feed bin using a front-end loader. Such feedstock is being utilised for electricity generation in preference to diversion to landfill; under no circumstances will wood chips be sourced directly from wood chipped greenwaste without approval (involving a testing protocol). The feed is shredded wood waste of less than 50 mm in size; the weight of incoming feed material is measured in the feed bin. The wood chip analysis is presented in Table 6.

Table 6: Wood chip typical analysis

Aspect	Specification	
	Normal	Design range
Density - normal	500 kg/m^3	350–600 kg/m^3
Moisture content	16%w/w	5–25%w/w
Volatiles	74.9%w/w dry	60–80%w/w dry
Fixed carbon	23.5%w/w dry	5–28%w/w dry
Ash content	1.6%w/w dry	0–15%w/w dry
Gross calorific value	18.6 MJ/kg	14–23 MJ/kg

The feedstock for pyrolysis processes are assessed on the basis of fuel properties (determined from proximate and ultimate analyses) and the physical properties of the feedstock being provided. No two feedstocks are identical; therefore, feedstocks should be considered in terms of proportions of moisture, fixed carbon, volatiles and ash, the existence of particular elements such as chlorine and sulfur as well as the physical properties, such as bulk density and hardness.

Based on the proportions of these parameters within the wood feedstock, the process proposed for the WWTE plant can be considered equivalent to the Premier Coal Char Plant, which was built in 2006 by Ansac and ran until 2009 when it was mothballed due to closure of the end-user's facility for the char.

The feedstock at the Premier Coal Char plant closely matches the proportions of ash, fixed carbon, volatile and moisture content of the proposed feedstock at Hazelmere, and is of a similar scale (6000 kg/h nameplate capacity compared to 3100 kg/h for the proposed WWTE plant). The project was built in its entirety by Ansac and demonstrates the engineering capacity of that company regarding major construction projects.

2.5.4 Pyrolysis unit

Material is drawn out of the kiln bin at a nominated rate by a conveyor. Excess moisture is removed from feedstock through exposure to warm flue gases from the kiln combustion chamber. A twin screw is utilised to feed material into the kiln.

Pyrolysis occurs inside the heat tube of the rotary indirect-fired kiln, where the wood feed material undergoes pyrolysis in the absence of oxygen at approximately 800°C to generate free moisture and volatile fractions (raw syngas). Solids (char) separate out at the base of the discharge chamber and raw syngas is captured and drawn from the chamber for cleaning. Table 7 outlines the kiln specifications.

Table 7: Kiln specifications

Aspect	Specification	
	Normal	Design range
Kiln capacity	3.1 t/hr	1.5–4.0 t/hr
Operating tube temperature	750˚C	700–850˚C
Residence time	25 min	20–40 min
Maximum tube temperature	900˚C	900˚C
Ambient combustion air temperature	20˚C	5–35˚C
Specific energy input	1.25 kW/kg	0.80–1.6 kW/kg

The pyrolysis plant being proposed for Hazelmere will utilise a combination of established technologies and suppliers with extensive experience in the field. The pyrolysis process is utilising an Ansac Indirect Fired Kiln as the core pyrolysis operation unit. This technology has been produced by Ansac and exported for pyrolysis processes for over 25 years.

Of the 200+ units supplied by Ansac, the nameplate capacity of the kilns varies from 100 kg/h to 6000 kg/h, all industrial in nature and meeting international emissions levels.

2.5.5 Gas cleanup

Prior to cleaning, the raw syngas contains a mixture of compounds, as summarised in Table 8. Cleaning is conducted using a steam reforming process over a char bed. Tar compounds, dust, remaining tars and excess moisture are removed using a catalyst in the bed (exact catalyst yet to be determined), with some oxygen added to provide the necessary heat for the reaction. The cleaned syngas is then piped to the kiln burners as a fuel for the pyrolysis process and used in the gas engines for electricity generation.

Table 8: Kiln products

Gas	Cleaning process	Purpose
Hydrogen (H_2)	Wet scrubbing to remove entrained particulates	Resultant syngas component
Carbon monoxide (CO)	Wet scrubbing to remove entrained particulates	Resultant syngas component
Carbon dioxide (CO_2)	Wet scrubbing to remove entrained particulates	Resultant syngas component
Water (H_2O)	Equilibrates with water in wet scrubber	Resultant syngas component
Light paraffin (methane, ethane, propane)	Some react in Reformer, residual hydrocarbons cleaned in wet scrubber	Resultant syngas component
Light olefins (acetylene, ethylene)	Some react in Reformer, residual hydrocarbons cleaned in wet scrubber	Resultant syngas component
Light aromatics (benzene, toluene)	Some react in Reformer, residual hydrocarbons cleaned in wet scrubber	Resultant syngas component
Ammonia	Removed in wet scrubber as ammonium ion	Removal of this contaminant
Acid gases (hydrogen sulfide, hydrogen chloride)	Removed in wet scrubber as hydrosulfide ion (from H_2S) and chloride ion (from HCl)	Removal of this contaminant
Nitrogen and inert gases	Wet scrubber to remove impurities	Resultant syngas component
Light tars - polycyclic aromatic hydrocarbons (PAH)	Reformer (convert to H_2 and CO) and residual light tars condensed at low temperatures in wet scrubber	Recover as much as possible by conversion into H_2 and CO
Heavy tars - PAH	Reformer (convert to H_2 and CO), residual heavy tars condensed at low temperatures in wet scrubber	Recover as much as possible by conversion into H_2 and CO
Char	Removed as a solid	Exported, not used for on-site energy production
Dust	Captured in wet scrubber	Scrubber underflow recycled to kiln

In terms of the pollution control technologies, simple and well understood technologies have been selected and a base philosophy of cleaning the resultant syngas has been applied rather than cleaning emissions post combustion. To this end, Ansac has included a steam reforming unit operation and a water scrubbing process that removes tars, particulate matter and other contaminants, to deliver a clean syngas that consists of a mix of H_2, CO, CO_2, H_2O, CH_4 and N_2. Both processes have been utilised for many years in many different industries, are well understood technologies and are 'off the shelf' components with no further engineering development required for application to this proposal. These processes will provide a consistent supply of clean syngas to the engines for electricity generation.

2.5.6 Bio-char output

Bio-char is a by-product of the pyrolysis process. The char exits the kiln at high temperatures and is placed on a cooling conveyor that both transports and air cools the char to less than 80℃. Water sprays are also used to ensure the temperature of the char is lowered (which reduces the potential for char dust and fires). The char is then stored for eventual transport off-site. A use for the bio-char is yet to be determined for this project; however, bio-char has been used elsewhere in applications such as agriculture, soil improvement, CO_2 sequestration and in brick manufacturing as a fuel substitute. If no market is available for the bio-char, it would be exported to the Red Hill Waste Management Facility for use in cell rehabilitation, or as a last resort is sent to landfill.

2.5.7 Wastewater treatment

Once sufficient wastewater is collected in the holding tank, a batch treatment operation is started. During this operation, liquor is pumped through an activated carbon column and then discharged into a tank for re-use in the process. Water is tested by manual sampling to ensure appropriate quality. The activated carbon will be replaced and sent for regeneration off-site once peak loading is reached. The column system will operate on a duty/standby basis so that a back-up operating system is always available.

2.5.8 Thermal oxidiser

A SACTO is used to balance the load of syngas between the engines and kiln by combusting all excess syngas. The SACTO uses a natural gas pilot burner to establish temperature for a given gas residence time and is maintained at 850°C with excess oxygen. It will also have a small diesel generator to provide electrical power for contingency backup of this system. Staged airflow is used to encourage turbulence within the unit to maximise both mixing and temperature to achieve complete combustion. Exhaust from the kiln and the SACTO is delivered to the exhaust stack, where dilution air is added to achieve lower exhaust temperatures. SACTO specifications are outlined in Table 9.

Table 9: SACTO specifications

Aspect	Specification	
	Normal	Design range
SACTO residence time	1.3 s	N/A
SACTO temperature	850˚C	800–1250˚C
Exhaust stack	400˚C	250–425˚C

2.5.9 Gas engines

Syngas is combusted in eight 500 kW spark-ignition engine generator sets, each within an acoustic enclosure. Gas engine generating sets are made up of gas engines, alternators and ancillary equipment (safety valves, pipe-work, coolant system, control panel, ignition system, and air-fuel ratio control system).

The eight engine sets are controlled using a multiple-generator management system that controls the start-up and load of each of the eight units. Roof-mounted radiators with electrically-driven fans are used to cool engines. Specifications for the engines are outlined in Table 10.

Table 10: Engine specifications

Aspect	Specification	
	Normal	Design range
Engine syngas de-rate	75%	70–80%
Gas to generation efficiency	34%	
Syngas demand	1880 kg/hr	1388–2042 kg/hr
Alternator voltage	415 V	
Gas flow requirement per module	235 Nm^3/hr	

For the engine components, Ansac has partnered with Perkins and their gas partners to supply the gas to the electricity generation component of the process. Perkins is a Caterpillar company and can be considered a leader in the gas engine generator market. The engine technology is an 'off the shelf' component for integration into the WWTE plant.

2.5.10 Utilities and plant services

The plant will require:

- water
- oxygen
- nitrogen
- natural gas (see specifications in Table 11) and diesel fuel (for contingency backup)
- high voltage power lines.

Table 11: Service specifications for natural gas

Aspect	Specification
Natural gas pressure	140 kPag
Natural gas gross calorific value	39 MJ/Nm^3
Maximum natural gas rate	4000 MJ/h

The plant requires general utilities including:

- cooling and process water circuit
- plant air and instrument air compressors and drying service
- oxygen plant to generate 90% oxygen for steam reforming
- nitrogen for plant purging.

Plant services equipment required include:

- fire water tank including diesel engine pump and electrical pump
- control room, low-voltage switch room and high-voltage switch room
- maintenance workshop
- office equipment and support facilities
- effluent consolidation and discharge
- distribution transformer.

2.5.11 Personnel

Operation of the plant will require skilled staff that have been provided with appropriate training. Plant maintenance will require regular staff with additional external advice on occasion. The Human Machine Interface (HMI) to be located in the control room allows for two operations staff. In addition, it is proposed there will be a plant engineer and operations supervisor.

2.5.12 Procedural controls

Procedural controls will include:

- standard operating procedures
- power export controls and communications systems
- permits to work
- hot work permits
- isolation
- control system override and maintenance
- confined space entry.

2.5.13 Personal protective equipment control

Compulsory personal protective equipment required on site will comprise hard hats, safety glasses (darkened and clear), gloves (handling and hot surfaces), steel cap boots and hearing protection (in limited areas).

3. Environmental impact assessment methodology

This section identifies the environmental factor relevant to the Proposal and discusses overall assessment methodology. It also discusses consistency of Proposal assessment with the EPA *Principles of Environmental Protection* (EPA 2004).

3.1 Assessment of the key environmental factor

The key environmental factor for the Proposal was identified in the ESD as air quality, as approved by the EPA (see Section 1.1). The EPA objective for air quality is to maintain air quality for the protection of the environment and human health and amenity. The full ESD is provided in Appendix 1. Table 12 outlines the work required as outlined in the EPA ESD and where elements have been addressed in this PER.

Table 12: Work required to be undertaken in the PER for air quality

Work required	Section of PER
The procedures used to assess air quality impacts are broadly described in the Department of Environment Regulation (DER) air quality modelling guidance notes. The Air Quality Management Branch of DER can be further consulted if there are queries relating to modelling requirements for estimating ambient air concentrations and the monitoring of ambient air quality. The DER modelling guidance statement should be used as a template for defining the scope of air quality assessments.	Section 6.2
Identify all atmospheric emissions from all potential points of discharge from the proposal.	Section 6.3
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 DER should be taken into account, where practicable. Where reliance is placed on historical data, modelling should contain a higher degree of conservatism and inter-annual variation of historical data should be taken into account.	Section 6.4.5
Establish the background levels for particulates (PM_{10} and $PM_{2.5}$) and predict the levels of PM_{10} and $PM_{2.5}$ at residential areas and neighbouring industrial premises, including the impacts of existing and proposed facilities.	Section 6.4.5 and Section 6.4.6
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.	Section 6.4.5 and Section 6.4.6
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.	Section 6.4.5 and Section 6.4.6
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.	Section 6.4.6
Model ground level concentrations of particulates, metals, acid gases, organic compounds, dioxins and furans 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.	Section 6.4.6
Compare predicted emissions and ground level concentrations with appropriate standards.	Section 6.4.6
Detail pollution control equipment, including its removal efficiency and expected down time. Compare efficiencies of pollution control equipment with world best practice.	Section 6.5
Describe the proposed management, monitoring and validation of predictions for all air emissions.	Section 6.6
Describe contingency plans should the predicted results not be achieved.	Section 6.7
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*.	Section 6.8

3.2 Factors not requiring further evaluation

The ESD only requires the Proponent to carry out necessary studies for the preliminary key environmental factor identified in the ESD (air quality). The ESD notes the environmental factors (listed in Table 13) as being the environmental factors likely to be affected by the proposal that are not significant or can be regulated and managed to meet EPA objectives. These environmental factors were identified at the time the EPA made its decision to assess the Proposal and/or are based on information provided by decision-making authorities during consultation regarding the ESD.

Table 13: Environmental factors not requiring further evaluation

Environmental factor	Environmental objective	Environmental impact assessment	Predicted outcome and EPA consideration for management
Amenity (noise)	To ensure that impacts to amenity are reduced as low as reasonably practicable.	Noise modelling has been conducted by Lloyd George Acoustics (2013) to assess the proposed noise levels of the operational WWTE plant based on known data from plant components. The full report is provided in Appendix 3. Current noise emitting equipment on-site is the Grinder (which grinds the wood into woodchip). Modelling results for daytime hours shows noise levels are predicted to comply with assigned levels at all sensitive premises and comply with the design goal of 5 dB under the assigned noise level. Modelling results for evening hours shows noise levels are predicted to comply with assigned levels at all sensitive premises; however, noise levels are within the design goal of 5 dB of assigned levels at three premises. This will only occur under worst-case meteorological conditions in the evening. In order to achieve the design target of noise levels below 5 dB of the assigned noise level, acoustic silencers or enclosures will be used on both combustion fans as a form of noise control, with a target of 3 dB reduction in source sound levels. With the inclusion of recommended acoustic silencers or enclosures on combustion fans, no noise monitoring is considered to be required as predicted noise levels at receiver locations are predicted to be below assigned level criteria.	Noise emissions are not considered to be significant as they are predicted to be below assigned levels. Methods to further reduce these will be considered in order to ensure compliance with the Environmental Protection (Noise) Regulations 1997. Noise is regulated by Department of Environment Regulation (DER) under the Environmental Protection (Noise) Regulations 1997 will be controlled to ensure that impacts to amenity are reduced as low as reasonably practicable and within acceptable limits.
Human health (assessed as part of air quality)	To ensure that human health is not adversely affected.	The air emissions were compared to air quality standards (as outlined in Section 6.4.5). EMRC received comment on 20 February 2014 from the Department of Health (DoH) in regards to whether the modelling met DoH air emission guidelines and the predicted emissions met the health-based guidelines. The letter is provided in Appendix 4. DoH confirmed that the predicted modelling meets DoH air emission guidelines. Further, DoH confirmed that the predicted ground level concentrations for the pollutants in the emission inventory comfortably meet the health based guidelines. This means that for all scenarios, none of the predicted levels were more than 60% (conservatively) of the health guidelines for all scenarios and most were well below this percentage. DoH commented that the modelling concentrations are predictions and, importantly, must be verified. Stack monitoring is not appropriate to determine exposure and consequently, DoH requires ground level concentrations for critical emissions. DoH does not accept modelling predictions or compliant stack emission criteria as proof of complying with ambient air criteria. This holds for any facility with air emissions and is not limited to waste to energy facilities. Therefore, EMRC have noted the recommendation to consider ground level concentration monitoring after commissioning; proposed monitoring is outlined in Section 6.6.	Human health is regulated by DoH. Air emissions are expected to conform to health-based guidelines. The environmental objective to ensure human health is not adversely affected will be achieved.

Environmental factor	Environmental objective	Environmental impact assessment	Predicted outcome and EPA consideration for management
Inland water environmental quality (groundwater pollution)	To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.	Dewatering will be required during construction and will have a temporary drawdown effect on the local groundwater. It is currently envisaged that dewatering will be limited to deep service trenches (if these are required) given the expectation of imported inert fill across the site based on the required finished floor levels of building pads. During operation, groundwater may be used in the process (dependent upon the quality of the abstracted water) together with scheme water. If groundwater is proposed to be used, a licence under the *Rights in Water and Irrigation Act 1914* will be sought when the amount of water to be abstracted is known (final water requirement yet to be undertaken). There is a risk of exposing Acid Sulphate Soils (ASS) as the site has a combination of low to moderate and moderate to high risk of ASS occurring within 3 m of the natural soil surface, according to DER ASS mapping. Geotechnical investigations to understand the extent of excavations required for construction are yet to be undertaken; however, ASS management is expected to be required for deep service excavations (such as a sewer). Deep service excavations are not proposed for the WWTE plant. However, if deep excavations are required, further detailed ASS studies will be undertaken prior to development to determine the presence and extent of ASS. From the ASS studies, a management plan would be developed for both soils and water associated with dewatering in accordance with the DER guidance on ASS, the *Proposed framework for managing acid sulfate soils* (DoE 2004) Four sets of nested groundwater monitoring bores were installed at the Hazelmere facility in November 2012 to determine background groundwater quality and to obtain baseline data before the expansion of operations. To date, monitoring data indicates groundwater in the deeper aquifer is uncontaminated but localised surface contamination has been detected from a source beyond the site boundary. Routine groundwater monitoring has been implemented to confirm and track these results. Monitoring will continue for the WWTE plant.	There is an existing bore onsite (for firewater and reticulation); however, if a production bore is required, EMRC will apply for a licence to abstract water to accommodate the increased use. Groundwater abstraction is regulated by the Department of Water (DoW) through relevant licensing under the *Rights in Water and Irrigation Act 1914*, and ASS and contaminated sites are managed by DER. These processes will ensure that the environmental objective to maintain the quality of groundwater is achieved.

3.3 Consistency with environmental principles

In 2003, the EP Act was amended to include a core set of Principles that are applied by the EPA in assessing proposals. These environmental protection principles listed in s 4A of the EP Act are set out in Table 14 together with a summary of how the Proponent has considered these principles in its design and subsequent implementation of the Proposal.

Table 14: Consistency with Principles of Environmental Protection

Environmental Protection Principle	Consideration given in the Proposal
1. **The precautionary principle** 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. In application of this precautionary principle, decisions should be guided by – • careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and • assessment of the risk-weighted consequences of various options.	The Proposal does not involve any threats of serious or irreversible damage. Any unexpected serious impacts will be transient, and addressed through appropriate modifications to the plant technology to ensure compliance with regulatory requirements regarding air emissions.
2. **The principle of intergenerational equity** The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	The project has been designed to minimise waste and reduce landfill disposal of waste material, while producing renewable electricity, which will reduce dependence on other non-renewable fuel sources.
3. **The principle of conservation of biological diversity and ecological integrity** Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The potential impacts of the Proposal do not include any impacts on biological diversity or ecological integrity.
4. **The principles relating to improved valuation, pricing and incentive mechanisms** Environmental factors should be included in the valuation of assets and services. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. The user 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. 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 problem.	The Proponent accepts that the cost of the Proposal must include environmental impact mitigation and monitoring. These requirements have been incorporated into the overall project costs.
5. **The principle of waste minimisation** All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment	The Proposal is directly aimed at minimising waste and is directly in accordance with this principle.

4. Stakeholder consultation

EMRC actively involves the community by conducting various groups including a Waste Management Community Reference Group (WMCRG), a Red Hill Community Liaison Group and undertaking community consultation throughout the course of new projects and developments.

WMCRG members are comprised of local community representatives from each of the six councils that make up EMRC (Bassendean, Bayswater, Belmont, Kalamunda, Mundaring and Swan). The role of WMCRG is to assist EMRC with progressing waste education initiatives through active involvement in workshops on resource recovery, providing guidance and feedback on waste strategies, as well as assisting with advertising (EMRC 2013b).

A Community Task Force (CTF) was developed in 2010/2011 with members comprised of community members and representatives of EMRC. The CTF was formed in the interest of understanding community values in order to integrate such values into planning processes for the proposed RRF at Red Hill.

EMRC hosted a waste to energy information session in April 2010, which was open to members of the community, with presentations by international practitioners in the area of waste to energy. A similar session was held on anaerobic digestion in 2011.

In July 2013 the EMRC was invited to a meeting of the Hazelmere Progress Association for a presentation on the longer-term direction for the Hazelmere Recycling Centre (known as the Resource Recovery Park), incorporating information on the WWTE plant. Concerns raised at this information session centred on amenity issues (such as a potential increase in traffic and visual amenity of the plant), expected emissions and groundwater quality.

Another community consultation session was conducted in July 2013 with the Community Action Network (CAN) and raised further issues regarding employment opportunities, disposal versus sale of bio-char, and public access to woodchips.

Community briefing on the proposed WWTE plant occurred in January and February 2014 with the CAN and the Hazelmere Progress Association, respectively.

During the CAN meeting on 28 January 2014, the main comments were concerning the progress of the RRP (i.e. will the RRP take bulk verge collection and computers/electrical products, and the timeframe for the development of the RRP) and the potential for increased traffic movements to transport the WWTE plant feedstock.

The Hazelmere Progress Association meeting on 17 February 2014 was well attended by members of the community. Comments consisted of the lack of dissemination of information, the location of the plant at Hazelmere and the approval process through EPA and DER that was being undertaken.

A consolidated list of community concerns are presented in Table 15. Where a resolution was achieved, it has been noted, other issues have been noted within this PER.

EMRC followed-up the meeting on 17 February 2014 with a letter sent to 1500 Hazelmere residents on 27 March 2014 to clarify any misinformation about what is being proposed at Hazelmere and addressed some key questions that had been asked about the project.

A community information session is proposed for mid-May 2014 during the PER public comments period.

The Proponent will continue to consult with specific agencies and other stakeholders as appropriate throughout assessment and implementation of the Proposal.

Table 15: Community consultation

Aspect of WWTE plant	Issue	Resolution
Bio-char	Disposal vs. sale.	Bio-char can be used for seeds, possible market to Organic Growers Association.
Feedstock	Concern around lack of woodchips once needed by WWTE plant as feedstock.	Recommend other feedstock material for the timber grinder to allow for maintenance of woodchip supplies.
	Alternative use of woodchips.	Combination with green waste as an end product; however, this would require further research.
	Issue with market for woodchips.	Potential market to horse stables (Belmont); however, would require re-grinding to a finer product.
	Great value of chips once processed into fines.	None noted.
	Fire risk.	None noted.
	Public access to woodchips or mulch.	None noted.
Green waste processing at Red Hill	Location of processing – possible diversion to Hazelmere.	None noted.
Verge collected waste	Concern that currently disposed of to landfill.	None noted.
Traffic	Currently loads of 200 trucks/wk – what is the expected volume? Existing congestion at Stirling Crescent during peak hour illustrates that existing road system is not viable. Due to congestion, no viable site access for trucks without using residential streets. Lloyd Street extension unlikely within next two years – mentioned within ten year timeframe.	City of Swan part of traffic studies. Truck access from Lloyd Street (from western end of site). Community input. City of Swan noted to have completed a traffic study. Expected additional traffic of one to two trucks per week.
Employment opportunities	Local employment.	None noted.
WWTE plant	Type of process proposed.	None noted.
	Type of waste to be burnt.	None noted.
	Use of compressed heat and hydrogen.	None noted.
	Use and storage of explosive gases.	None noted.
	Risk to surrounding residents.	None noted.
Emissions	Type expected.	None noted.
	Minimisation of greenhouse gas emissions.	None noted.
	Public availability of monitoring results.	None noted.
	Concern surrounding atmospheric inversion.	None noted.
	MSDS available for the syngas?	Not needed as the syngas is not a product to be exported, it is used as it is made. Staff onsite will have necessary advice on safety and composition, and safework procedures.
Facility flexibility	Changing markets.	Appears flexible.

Aspect of WWTE plant	Issue	Resolution
Existing community waste management programs	Synergy with community waste management programs.	Good opportunity.
Groundwater	Local concern about quality.	None noted.
Wastewater	Local concern about disposal.	It will either be stored or pumped through a monitoring station to a sewer.
Amenity	Rendering site unattractive.	None noted.
Parking	Ensuring sufficient parking for distinct uses of the site (tip shop/ education centre/ material drop-off).	None noted.
Distribution of information	Hazelmere Progress Association noted that some local residents were unable to attend seminar.	Recommend basic information is distributed around local area.
	Access to information and opportunity to comment on the Proposal via the EPA and DER. Concern at the haste that the plant is being approved and built. Concern that there has been a lack of public consultation and that the consultation period was too short (for the EPA and DER process).	This PER provides further access to the Proposal and opportunity to comment. The EMRC followed statutory process for a proposal under the EP Act.
Location of plant	Why is this plant being located at Hazelmere? Surprise that the technology is not going to Red Hill.	It is an industrial area. Plan for usage of area is not inconsistent with the activities already there and range of potential activities have grown.

The EMRC have also responded to concerns in the media (newspaper and television). Media statements have been prepared and sent to various media:

- general media statement for multiple media, 17 February 2014
- Perth Voice, 9 April 2014
- Echo, 10 February 2014, 20 February 2018 and 8 April 2014
- Advocate, 12 February 2014.

These media statements were provided to give context around where the Proposal was in the approvals process and to clarify the consultation process EMRC had undertaken to date with the community and member councils. The media statements also provided some information on the Proposal and where to find further information (i.e. through the EMRC website, www.emrc.org.au).

5. Site environmental characteristics

5.1 Physical environment

The WWTE plant is proposed to be located within the existing Hazelmere Recycling Centre in the suburb of Hazelmere, bounded by local feeder roads Lakes Road, Stirling Crescent and Bushmead Road. There is a proposed extension of Lloyd Street along the western boundary of the proposed RRP. The site is serviced by regional transport routes including Roe Highway and the Great Eastern Highway Bypass. Perth Airport is located approximately 1.5 km to the southwest, across the Great Eastern Highway Bypass.

5.1.1 Existing infrastructure

Some existing pipework and utilities infrastructure is proposed to be retained. Such infrastructure (water and communications and power services) will need to be protected during earthworks to install new infrastructure. There is no sewer connection on site.

5.1.2 Climate

Hazelmere experiences a Mediterranean climate of hot, dry summer and cold, wet winters. Summer mean temperatures are 31°C, while winter mean temperatures are 17°C. Annual mean rainfall is 868 mm. Prevailing winds are from the east during the mornings and from the west southwest during the afternoon and evening.

5.1.3 Topography

The proposed site of the WWTE plant is on the Swan Coastal Plain, grading from the east at approximately 18 mAHD to the west at approximately 15.5 mAHD (JDSi 2013). The site is generally flat, with higher elevations immediately to the southeast between the Hazelmere Recycling Centre and the bypass. The Darling Scarp is located approximately 4 km to the east, where elevations rise steeply to approximately 220 mAHD.

5.1.4 Soils and geology

Soils are listed as Bassendean Sands over Guildford Formation. There is a risk of acid sulphate soils occurring in the area (JDSi 2013); however, no excavation below the watertable is proposed for implementation of the Proposal, and acidification will not be an issue.

5.1.5 Hydrology

Surface water

An unnamed resource enhancement category sumpland is located within the footprint of the proposed WWTE plant. Drainage has previously been interrupted by developments around the site; however, the Proposal is not expected to affect this sumpland.

Hazelmere Lakes are located approximately 400 m west of the proposed location of the WWTE plant. The lakes are classified as resource enhancement category wetlands and are subject to protection under Environmental Protection (Swan Coastal Plain Lakes) Policy 1992. The site is located outside a buffer protection zone for these wetlands. The development is not expected to have any impact on Hazelmere Lakes (JDSi 2013).

Groundwater

Groundwater flow beneath the Hazelmere Recycling Centre appears to be to the northwest, towards the river. The watertable occurs within 1.5 to 0 m of the natural site surface (JDSi 2013). The site is within the Swan proclaimed groundwater area, which requires any groundwater abstraction to be undertaken in accordance with licence(s) under the *Rights in Water and Irrigation Act 1914*. There is an existing bore onsite (for firewater and reticulation); however, if a production bore is required EMRC will apply for a licence to abstract water to accommodate the increased use.

5.1.6 Contaminated sites

A site located approximately 1.8 km up-gradient of the proposed WWTE plant location is listed on the Contaminated Sites Database (administered by DER) as 'Contaminated – Remediation Required' (Lot 20 Adelaide Street, Hazelmere). The quality of the groundwater at the site is unknown; however, soils are known to be contaminated with heavy metals and polychlorinated biphenyls (PCB) and asbestos. Where leaching may occur on Lot 20, heavy metals dissolved by rainwater and transported through the soil profile may intercept groundwater. This may result in a reduction of down-gradient groundwater quality beneath the existing Hazelmere Recycling Centre.

Groundwater quality on site is outlined in Table 16.

Table 16: Groundwater quality

Analyte	Quality	Unit
pH	6.66–6.75	pH
Total Dissolved Solids (TDS)	362–411	mg/L
Total Suspended Solids (TSS)	<5	mg/L
Turbidity	1.2–20	NTU
Total hardness as $CaCO_3$	50	mg/L

5.2 Biological environment

The Proposal area is situated in a semi-industrial area, neighboured by a paving brick and plasterboard manufacturing site, animal rendering operation, transport depot, waste water treatment area and rural residential land use.

5.2.1 Flora and vegetation

The Proposal area is located in a predominantly cleared area with cropped paddocks in the southwest corner. Boundary trees and shrubs screen the existing woodchip facility and stockpile areas (JDSi 2013).

A search of the Department of Parks and Wildlife (DPaW) Naturemap database displayed two priority-listed flora species within 1 km of the existing Hazelmere Recycling Centre (see Appendix 5):

- *Jacksonia sericea* (P4)
- *Lepyrodia riparia* (P2).

The Hazelmere Recycling Centre is sparsely vegetated and highly degraded, and is consequently a poor quality habitat for these flora species. The Proposal site is not expected to be important for these species.

All scattered trees and vegetation are proposed to be removed prior to undertaking earthworks on the site. Topsoil will also be removed.

5.2.2 Fauna

A search of the DPaW Naturemap database displayed one priority-listed fauna species within 1 km of the existing Hazelmere Recycling Centre (see Appendix 5); *Isoodon obesulus* subsp. *fusciventer*, Quenda or Southern brown bandicoot (P5). As the Hazelmere Recycling Centre is sparsely vegetated and highly degraded, it is a poor quality habitat for this species. The Proposal site is not expected to be is important for this species.

5.3 Social environment

Various land uses surround the proposed RRP, including:

- industrial (warehouses, transport depots, logistics, brickworks)
- rural, rural residential and residential (residential and caravan park)
- environmentally sensitive areas (Hazelmere Lakes, Helena River, remnant vegetation)
- Westralia Airport Corporation (WAC) industrial land
- Department of Defence driver training land (City of Swan 2011).

5.3.1 Sensitive receptors

Residential premises are located adjacent to the current Hazelmere Recycling Centre to the west and south at 53, 54 and 61 Lakes Road, Hazelmere. Industrial premises are located to the north and east.

Hazelmere Lakes are the nearest ecological sensitive receptors at 400 m distance from the existing Hazelmere Recycling Centre location.

Two Bush Forever Areas (BFA) occur within the vicinity of the Proposal area. The nearest, BFA 481: Stirling Crescent Bushland, Hazelmere, is located 400 m to the southeast and the other, BFA 213: Bushmead Bushland, Swan is located further to the east of BFA 481.

Sensitive receptors are shown in Figure 7.

5.3.2 Areas of significance

A search of the Department of Indigenous Affairs (DIA) Aboriginal Heritage Enquiry System displayed several registered heritage sites within the vicinity of the existing Hazelmere Recycling Centre:

- 4387 – Dalgety Holding Paddock: a registered site of artefacts and scatter
- 4388 – Stirling Crescent: an unregistered ‘other heritage place’ site of artefacts and scatter
- 4385 – Bushmead Road complex: a registered site of artefacts and scatter
- 3758 – Helena River: a registered site of ceremonial, mythological, repository.

Figure 7
Sensitive receptors

Legend

- Sensitive receptors
- Roads
- Lake
- Bush Forever areas
- Site location
- WWTE plant location

Scale 1:10,000 at A4

0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 30/04/2014
Author: JCrute
Source: Aerial: Landgate 2006;
Roads: MRWA 2013

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www.strategen.com.au

Path: Q:\Consult\2014\EMR\EMR14101\ArcMap_documents\R001\Rev3\EMR14101_01_R001_Rev3_F007.mxd

6. Air quality

6.1 Relevant environmental objectives, legislation, policies and guidelines

6.1.1 EPA objective

The EPA applies the following objective to the assessment of proposals that may affect air quality:

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

6.1.2 Regulatory framework

The regulation of air quality is covered by the *Environmental Protection Act 1986* (EP Act).

Guidance and position statements

The following EPA guidance and position statements set the framework for identification and assessment of impacts to air quality:

- Advice to the Minister for Environment on the Environmental and Health Performance of Waste to Energy Technologies (EPA 2013b)
- Air Quality Modelling Guidance Notes (DoE 2006)
- EPA Guidance Statement No. 55, Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process (EPA 2003)
- European Directive 2000/76/EC[2] on the incineration of waste
- National Environment Protection Measure standards and goals (NEPC 2003)
- World Health Organisation (WHO) Air Quality and Health guidelines (WHO 2000, 2005)
- Department of Health (DoH) relevant policy and air quality guidelines.

6.2 Studies and investigations

A study of air emissions from point sources within the WWTE plant has been carried out using dispersion modelling as per guidance notes provided by DoE (2006). The assessment included direct impacts of emissions as well as cumulative impacts, whereby the background air quality is considered in conjunction with the additional emissions from the WWTE plant. Key elements of the assessment included:

- construction of an emissions inventory for the two point sources (main stack and gas engine exhaust stacks)
- development of emissions scenarios that reflect normal plant operations and plant outages
- comparison of emissions concentrations with emission limits from the EU waste incineration directive (WID) (EU 2000)
- collation of background air quality data for the cumulative impact
- assembly of air quality standards (assessment criteria) relevant to impacts from waste to energy (WTE) projects
- air dispersion modelling to generate predicted ground level concentrations (GLCs) of air emissions
- comparison of predicted GLCs with air quality standards for direct and cumulative impact assessments.

[2] European Directive 2001/80/EC was referenced in the ESD but is not considered applicable as the WWTE plant is <50 MW and includes gas engines which are excluded from EU 2001/80/EC.

The results from this study forms the basis for the assessment of the air quality factor described in the following sections.

6.3 Potential sources of impact

Atmospheric emissions from the WWTE plant have the potential to affect air quality, with a consequent impact on the health and amenity at ground level sensitive receptors (residential areas and neighbouring premises) within the dispersion zone. The emissions potentially involve oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), particulates (TSP, PM_{10}, $PM_{2.5}$ and nano-particles), volatile metals[3], acid gases (HCl, HF and SO_2), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs)[4], dioxins and furans.

There are two air emission points in the WWTE plant:

1. Main stack (approximately 18 m high), which includes the emissions from the pyrolysis kiln, the SACTO and the feed dryer off-gases.
2. Engine exhaust stack (approximately 2.8 m high).

6.4 Assessment of likely direct and indirect impacts

6.4.1 Emissions inventory

The air emissions assessment has focussed on parameters detailed in the EPA report on WTE environmental and health performance (EPA 2013b), with these parameters and emission concentration limits derived from the WID.

Emissions testing data of sufficient quality and quantity from an operating facility were not available for all parameters for the emissions assessment. As a consequence, a comprehensive emissions inventory has been developed from consideration of measured compositional data for the wood feed materials, the proposed feed rate of those materials (3100 kg/h), and key process design parameters that influence the formation and fate of air emissions within the process (Strategen 2014).

As indicated in Section 2.5.3, compositional data were obtained from analyses conducted on samples of wood chips from the existing operations at the Hazelmere facility. Those data included concentrations of all chemical substances that can potentially give rise to air emissions detailed in Section 6.3. These include carbon, nitrogen, sulfur, chloride, fluoride, heavy metals and volatile organics.

The fate of these substances within the WWTE process is determined from the chemical and physical conditions at each stage of the WWTE process. For example, during pyrolysis, nitrogen in the wood feed material can be converted into nitrogen gas (N_2), ammonia (NH_3) and small amounts of hydrogen cyanide (HCN). The HCN is then reacted in the reformer to produce NH_3, CH_4 and H_2. The reformed syngas then passes through the scrubber where the NH_3 is removed before the syngas is used as a fuel for the kiln burners, SACTO and gas engines. As no NOx is produced during pyrolysis (since NH_3 is removed), the majority of NOx is produced when the N_2 in the syngas is combusted.

Similar considerations have been made of the respective chemistries of the chemical components of the wood feed materials in the WWTE plant to calculate the air emissions of other relevant parameters.

The maximum emission rates calculated in the emissions inventory for each of the WID parameters were used for the dispersion modelling. These reflect a conservative position for the combination of all the process operating conditions. Key process variables such as catalysts and pH ranges will be optimised during the commissioning phase of the proposed WWTE plant, with some of those variables directly affecting air emissions outcomes.

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[3] All metals/metaloids considered were As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Ti, V.

[4] PAHs are not considered in the WID; therefore, have not been considered in the assessment.

The emissions inventory has considered a range of scenarios (or conditions) for the variables that affect air emissions. Details of the emission scenarios are presented in Section 6.4.2. The following sections outline the variables considered and the resulting emissions data from the emissions inventory.

Variables

A char bed catalyst is proposed for the raw syngas reformer at the initial stages of the facility operations. Other catalysts (in particular dolomite and nickel) may be tested at some time thereafter depending on the status of the optimised reformer performance with char. These three types of reformer catalysts provide different chemistries for some emission parameters or their precursors. As a consequence, the emissions inventory has considered those chemistries for the three types of catalysts to determine a conservative outcome for the impact assessment.

The scrubber water operating pH may range from acidic to alkaline depending on the exact composition of the reformed syngas from the three catalyst options, with the pH to be adjusted by either acid or caustic addition during the optimisation process. As a consequence, the impact of scrubbing at both acidic (pH 4) and alkaline (pH 9) conditions has been considered in the emissions inventory.

As the exact form of metals that report to the raw syngas from the kiln is not known, two metal scenarios have been considered. The free metal and the metal sulfides have been used to predict metal partitioning in the reformation and scrubbing processes. The formation of metal oxides is not favoured under the anoxic conditions in the pyrolysis process. As such, these forms of metals were not included in the inventory.

Emissions data

The emissions data obtained from the emissions inventory are presented in Table 17. These have been used in the dispersion modelling.

6.4.2 Emissions scenarios

Five operating scenarios (OS) have been considered for the air emissions impact assessment:

1. Continuous normal operations.
2. Peak power demand normal operation.
3. Reduced rate operations.
4. Syngas clean-up system outage.
5. Plant power outage.

These five OS have been reduced to three emissions scenarios for modelling purposes:

1. Normal emissions (OS 1 and 2), where all the engines are on-line and clean syngas is used.
2. Reduced rate emissions (OS 3), where four of the gas engines are on-line and four off-line, and excess clean syngas combusted.
3. Bypass emissions (OS 4 and 5), where plant outage results in raw syngas being combusted.

An overview of these scenarios is summarised in Table 18.

Table 17: Emissions data for dispersion modelling

Emission parameter	Units	Main stack emissions - maximum values			Gas engine emissions - maximum values		
		Normal	Reduced rate	Bypass	Normal	Reduced rate	Bypass
NOx	g/s	0.0693	0.174	0.905	1.93	0.963	0
SO_2	g/s	0.029	0.0743	0.151	0.0947	0.0473	0
CO	g/s	0.076	0.195	0.415	2.97	1.49	0
Total VOC	g/s	0.00819	0.0208	0.04	0.0619	0.0309	0
HCl	g/s	0.000151	0.000386	0.021	0.000492	0.000246	0
HF	g/s	0.0000508	0.00013	0.000394	0.000166	0.0000831	0
Hg	g/s	$8.05x10^{-8}$	0.000000207	0.00000561	0.000000263	0.000000132	0
Cd	g/s	0.000000042	0.000000108	0.00022	0.000000137	$6.87x10^{-8}$	0
Tl	g/s	$9.05x10^{-8}$	0.000000232	0.000189	0.000000296	0.000000148	0
Sb	g/s	$5.37x10^{-9}$	$1.38x10^{-8}$	0.00000374	$1.75x10^{-8}$	$8.77x10^{-9}$	0
As	g/s	0.00000489	0.0000125	0.00341	0.000016	0.00000799	0
Cr	g/s	0.000000116	0.000000297	0.000606	0.000000379	0.000000189	0
Co	g/s	$7.16x10^{-11}$	$1.84x10^{-10}$	0.000000374	$2.34x10^{-10}$	$1.17x10^{-10}$	0
Cu	g/s	0.000000145	0.000000371	0.000757	0.000000473	0.000000237	0
Pb	g/s	$7.24x10^{-8}$	0.000000186	0.000379	0.000000237	0.000000118	0
Mn	g/s	$1.43x10^{-13}$	$3.67x10^{-13}$	$7.48x10^{-10}$	$4.68x10^{-13}$	$2.34x10^{-13}$	0
Ni	g/s	$9.05x10^{-8}$	0.000000232	0.000189	0.000000296	0.000000148	0
V	g/s	$3.58x10^{-10}$	$9.18x10^{-10}$	0.000000374	$1.17x10^{-9}$	$5.85x10^{-10}$	0
Particu-lates	g/s	0.0094	0.00361	0.332	0.00722	0.00361	0
Dioxins	g TEQ/s	$6.74x10^{-12}$	$1.74x10^{-11}$	$2.88x10^{-11}$	$2.2x10^{-11}$	$1.1x10^{-11}$	0

Notes: *NOx* = oxides of nitrogen, includes nitric oxide (NO) and nitrogen dioxide (NO_2); reported as NO_2 equivalents.
Total VOC = volatile organics as carbon, also known as total organic carbon (TOC).
Particulates = total suspended particulates (TSP), PM_{10} and $PM_{2.5}$ (assume PM_{10} = TSP and $PM_{2.5}$ = TSP for air quality impact assessment).
Dioxins (and Furans) = sum of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofuran congeners factored by their respective toxic equivalency factors.

Table 18: Operating scenarios for air emissions assessment

Operating scenario	Emission scenario	Description	Comment
1. Continuous normal operations	Normal emissions	Plant operating continuously at 3100 kg/h wood feed rate.	Operations 24 hours per day, 7 days per week. This scenario would apply if a customer for power on a continuous basis could be sourced and if EMRC had sufficient woodchip fuel.
2. Peak power demand normal operation	Normal emissions	Plant operating at 3100 kg/h wood feed rate for weekdays only.	Operations 14 hours per day, 5 days per week from 8 am to 10 pm, with start-up from 7 am to 8 am, feed terminated at 10 pm and standby from 11 pm to 7 am the next day.
3. Reduced rate operations	Reduced rate emissions	Four of the gas engines on-line and four off-line. Excess syngas incinerated in SACTO. Feed rate adjusted to match engine availability.	Scenario simulates conservative position for times when engines come-off line for maintenance or breakdown. Assumes continuous emissions for up to 2 hours as a conservative position for emissions impact assessment. Actual duration of this scenario would be <30 minutes, as the feed rate will be immediately reduced, thereby reducing rate of syngas formation. Scenario terminates when either all engines return to service or process is shutdown to standby mode or full shutdown.
4. Syngas clean-up system outage	Bypass emissions	Raw syngas diverted directly to SACTO for incineration, wood feed shut-down.	Scenario covers outage of reformer or syngas scrubber and assumes continuous emissions for up to 1 hour after bypass activated. Actual duration will be <30 minutes as bypass occurs immediately after a failure of the syngas clean-up system is detected and wood feed is terminated to stop production of raw syngas. Highly unlikely this scenario will eventuate due to redundancy of critical components (e.g. pumps) in scrubber circuit. However, some increased emissions may occur until stable scrubbing operation is restored after backup pumps come on-line.
5. Plant power outage	Bypass emissions	Raw syngas diverted directly to SACTO for incineration, other systems off-line.	Scenario covers loss of power supply to the facility. Backup power supply via diesel generator will maintain operation of SACTO and key control systems to ensure syngas in the clean and raw syngas headers is safely diverted to the SACTO for incineration. Actual duration will be <30 minutes as production of raw syngas decays from shut-down of feed and cooling of pyrolysis chamber.

A conservative approach was adopted for assessment of impacts for normal emissions by modelling the predicted GLCs of Scenario 1 (the continuous normal operations) rather than Scenario 2 (the peak power demand normal operation) which is the actual operating scenario that is proposed.

Emissions from start-up and controlled shut-down operations are covered under the reduced rate scenario, which provides a worst-case estimate of the emissions under those conditions. The actual times required to reach steady state operations from start-up and shutdown condition are expected to be less than those assumed in these scenarios (Table 18), thereby providing a conservative basis for the emissions assessments.

A bypass event may occur when raw syngas cannot be fed to the reformer and scrubber for clean-up to produce clean syngas for operation of the gas engines. Under those conditions, the wood feed to the kiln will be immediately shut down and the kiln burners extinguished to stop the pyrolysis process and associated raw syngas production. Raw syngas in the raw syngas header and formed in the kiln while the pyrolysis process ceases will be diverted directly to the SACTO for combustion.

The likelihood of a bypass event occurring is considered very low. Backup equipment for the scrubber will be installed to ensure continuous scrubber availability and a backup diesel generator will be installed to maintain power to key process systems in the event of a mains power outage. These contingencies will ensure any raw syngas in the process will be treated (cleaned) before combustion in the SACTO while a controlled plant shutdown is initiated to implement repairs to the scrubber equipment or while mains power is restored.

6.4.3 Stack emissions and waste incineration directive limits

The EPA advice to the Minister on performance of WTE technologies (EPA 2013b) requires emissions from a WTE facility to be compared with the WID concentration limits.

A comparison of the normal emission scenario with the WID is considered to be outside the scope of the EPA advice to the Minister (EPA 2013b). This is because the reforming and scrubbing processes transform the raw syngas from the pyrolysis of wood to clean syngas which is a fuel for electricity generation and is not a waste product. Emissions from combustion of clean syngas in the gas engines will be predominantly CO_2 and water, with smaller amounts of NOx and CO.

Similarly, the reduced rate emission scenario is also considered outside the scope of the EPA guidance. This is because in this scenario excess clean syngas will be combusted in the SACTO until the clean syngas production rate matches the reduced demand from the engines that remain on-line.

A comparison of the WID is considered appropriate for operation under bypass conditions, when raw syngas that has not been cleaned is fed directly to the SACTO for combustion. The raw syngas cannot be used as a fuel for electricity production and is considered a waste that must be disposed of safely via combustion.

A comparison of maximum predicted emission concentrations with WID limits is shown in Table 19. Table 19 shows that no exceedances of the WID limits are predicted for any emission parameters under bypass conditions.

Table 19: Comparison of emissions from the main stack and WID limits (bypass emissions)

Emission parameter	EU WID limit (mg/Nm^3 @ 11% O_2)	Averaging period	Limit type	Maximum predicted concentration (mg/Nm^3 @ 11% O_2)	Concentration as a percentage of the WID limit
NO_X	200	Daily average	Maximum	64	32%
	400	30 minute average	Maximum		16%
	200	30 minute average	97% of observations over 12 months		32%
SO_2	50	Daily average	Maximum	10.8	22%
	200	30 minute average	Maximum		5.4%
	50	30 minute average	97% of observations over 12 months		22%
CO	50	Daily average	Maximum	30	59%
	100	30 minute average	Maximum		30%
	150	30 minute average	95% of observations over 12 months		20%
TOC (VOCs)	10	Daily average	Maximum	2.85	28%
	20	30 minute average	Maximum		14%
	10	30 minute average	97% of observations over 12 months		28%
HCl	10	Daily average	Maximum	1.5	15%
	60	30 minute average	Maximum		2.5%
	10	30 minute average	97% of observations over 12 months		15%
HF	1	Daily average	Maximum	0.028	2.8%
	4	30 minute average	Maximum		0.70%
	2	30 minute average	97% of observations over 12 months		1.4%
Hg	0.05	30 minute to 8 hour average	Maximum	0.00025	0.49%
	0.1	30 minute to 8 hour average	97% of observations over 12 months		0.25%
Cd + Tl	0.05	30 minute to 8 hour average	Maximum	0.018	36%
	0.1	30 minute to 8 hour average	97% of observations over 12 months		18%
Other metals (As, Sb, Co, Cr, Cu, Pb, Mn, Ni, V)	0.5	30 minute to 8 hour average	Maximum	0.23	47%
	1	30 minute to 8 hour average	97% of observations over 12 months		24%
Particulates	10	Daily average	Daily average	3.2	32%
	30	30 minute average	Maximum		11%
	10	30 minute average	97% of observations over 12 months		32%
Dioxins	0.1 ng TEQ/Nm^3	6 to 8 hour average	Maximum	0.00000057 ng TEQ/Nm^3	0.00057%

6.4.4 Gas engine emissions and waste incineration directive limits

Recommendation 8 of the EPA advice to the Minister on performance of waste to energy technologies (EPA 2013b) specifies that:

> *"…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 (2000/76/EC)."*

Use of gas engines for generation of electricity from combustion of clean syngas at the scale of the proposed facility is best practice technology in terms of energy utilisation, availability, reliability, emissions performance and cost effectiveness.

There are no emissions standards in the WID applicable to combustion of clean syngas from WTE facilities using gas engines. Clean syngas from the proposed WWTE plant is a fuel that will be comprised predominantly of carbon monoxide, hydrogen, carbon dioxide and water vapour. Key precursors for air emissions such as acid gases (HCl, HF and SO_2), heavy metals and dioxins will have been removed from the syngas in the reformer and scrubber.

The WID is specifically designed to manage emissions from incineration of waste, whereas syngas is not a waste material but a fuel with similar combustion emission properties to natural gas. Consequently, a comparison of emission concentrations from the gas engines with the WID limits is considered by the proponent as not being applicable to this project.

Support for this position is provided in the judgement from the EU Court in the matter of Lahti Energia Oy and the combustion of non-purified syngas in a power plant boiler (EU 2010). The judgement states that:

> *"A power plant which uses as an additional fuel, in substitution for fossil fuels used for the most part in its production activities, gas obtained in a gas plant following thermal treatment of waste is to be regarded, jointly with that gas plant, as a 'co-incineration plant' within the meaning of Article 3(5) of Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste when the gas in question has not been purified within the gas plant."*

The implication of that judgement is that a facility that purifies the syngas for combustion in a power plant is not considered a co-incineration plant and as a consequence, the WID (and associated emission limits) is not applicable to the combustion of clean syngas to generate electricity.

Dispersion modelling of emissions from the gas engines is described in Section 6.4.6.

6.4.5 Background air quality data and assessment criteria

The project timeframes have not been sufficient to enable background air quality data to be obtained at the specific Proposal site; therefore, comparative background air quality data have been sourced to determine cumulative impacts of air emissions.

EMRC conducted an air emission assessment while applying for environmental approvals for a proposed RRF (WTE [gasification] or anaerobic digestion technology) at the Red Hill operations on Toodyay Road, which includes ambient air data from monitoring carried out on the Red Hill site and in the nearby communities (EMRC 2012). In that work, those data were compared with other public domain data from the Midland area and the DER Rolling Green Air Quality Monitoring Station (AQMS) data and was found to be of similar magnitude in concentrations.

The air quality criteria and standards used in the Red Hill RRF assessment are considered appropriate for the Proposal, as a substitute for local data. A thorough review of air quality criteria was conducted for the Red Hill project that included consultation with the DoH toxicology section. The criteria selected reflected the view of that agency and were considered as best practice for assessment of air emission impacts of WTE projects in WA.

Included in the criteria is a concentration limit for nitrogen dioxide (NO_2), which is the oxide of nitrogen with the greatest health impact significance. Oxides of nitrogen (NO_X) emissions from the WWTE have been estimated as both nitric oxide (NO) and NO_2, since these are the dominant forms present in air emissions from combustion sources, with NO typically constituting 90% and NO_2 comprising the remainder of the NO_X emissions.[5] The assumption made for this impact assessment is conservative in that the NO emissions immediately contribute to ground level impacts as NO_2, even though considerably longer time is required for conversion of NO to NO_2 in the atmosphere.

The assessment criteria include a concentration limit for hexavalent chromium (Cr^{VI}), which is the most toxic form of chromium that potentially can be emitted from thermal processes. A conservative estimate of the Cr^{VI} concentrations was made using the approach adopted by EMRC for the Red Hill assessment, in that Cr^{VI} is 10% of the total Cr (EMRC 2012).

Air quality criteria are available for particulate matter (PM) as total suspended particulates (TSP) and the PM_{10} and $PM_{2.5}$ size fractions. The emissions inventory includes predictions of TSP concentrations in the emissions from the WWTE facility, which can be compared with the Kwinana Environmental Protection Policy 1992 (TSP Area C) standard (90 µg/m^3). Reliable estimates of fine particle emission rates from the facility cannot be made so a conservative assumption has been made that the TSP is 100% PM_{10} for the air quality assessment of that size fraction and similarly, TSP is 100% $PM_{2.5}$. The concentrations have been compared with the Ambient Air Quality NEPMs (50 and 25 µg/m^3 for PM_{10} and $PM_{2.5}$, respectively).

Volatile Organic Carbon (VOC) emissions have been estimated as Total Organic Carbon (TOC); however, ambient air quality standards are not available for this parameter.

Details of the assessment criteria and background concentrations used for the WWTE plant assessment are shown in Table 20.

6.4.6 Dispersion modelling

Methodology

Dispersion modelling of emissions from the two point sources (main stack and gas engine exhaust stacks) was carried out by Environ Australia Pty Ltd (Environ 2013) using the AERMOD atmospheric dispersion model. Meteorological data were obtained from the Perth Airport station and upper air data generated using The Air Pollution Model (TAPM).[6] Full details of the modelling configuration are provided in the report from Environ (2013) located in Appendix 6.

Three residences to the west of the EMRC Hazelmere site were identified as sensitive receptors for the emissions impact assessment (Figure 7), with industrial premises surrounding the remainder of the EMRC site.

Tabulated results are reported in the following sections for predicted GLCs at receptor R2, which is the nearest sensitive receptor to the proposed WWTE plant and is predicted to experience the highest impact from the facility. The receptor is located on Lot 99(2), which EMRC is negotiating acquisition of for inclusion of a community reuse, recycling and drop-off centre for the RRP. Therefore, this receptor is likely to be removed in the future. EMRC own Lot 99(1). Lot 99(1) and the western portion of Lot 99(2) will be required for the proposed extension of Lloyd Street under the HEA Structure Plan.

[5] Small amounts of nitrous oxide (N_2O) can also be formed.

[6] The same meteorological data were used for the plume rise assessment.

Table 20: Air quality assessment criteria and background concentrations

Pollutant	Assessment criteria averaging Period	Assessment criteria (µg/m^3)	WA relevant guideline	Background concentration for impact assessment (µg/m^3)	% of assessment criteria
NO_2	1-hour	246	AAQ NEPM (NEPC 2003)	30	12%
	Annual	61.6	AAQ NEPM (NEPC 2003)	2	4%
SO_2	10-min	500	WHO guidelines for air quality (WHO 2000), WHO AQ guidelines global update (WHO 2005)	18	4%
	1-hour	571.8	AAQ NEPM (NEPC 2003)	18	3%
	24-hour	228.7	AAQ NEPM (NEPC 2003)	19	8%
	Annual	57.2	AAQ NEPM (NEPC 2003)	1	3%
CO	15 min	100 000	WHO guidelines for air quality (WHO 2000)	480	0.5%
	30 min	60 000	WHO guidelines for air quality (WHO 2000)	460	1%
	1-hour	30 000	WHO guidelines for air quality (WHO 2000)	460	2%
	8-hour	11 249	AAQ NEPM (NEPC 2003)	380	3%
VOCs (as TOC)	N/A	No criterion	No criterion	N/A	N/A
HCl	1-hour	100	WA DoH - Acid Gases 2007 (DoH 2007)	30	30%
HF	1-hour	100	WA DoH - Acid Gases 2007 (DoH 2007)	5	5%
As	1-hour	0.09	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	0.01	14%
	24-hour	0.03	Air guideline values for selected substances (Toxikos 2010)	0.001	33%
	Annual	0.003	Air guideline values for selected substances (Toxikos 2010)	0.001	33%
Cd	1-hour	0.018	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	0.006	35%
	Annual	0.005	WHO guidelines for air quality (WHO 2000)	0.0005	10%
Co	24-hour	0.1	Ontario's Ambient Air Quality Criteria (Ontario MOE 2008)	0.01	10%
Cr^{VI}	Annual	0.0002	Air guideline values for selected substances (Toxikos 2010)	0.00007	35%
Cr^{III}	1-hour	10	Air guideline values for selected substances (Toxikos 2010)	0.02	0.2%
	24-hour	0.05	Air guideline values for selected substances (Toxikos 2010)	0.02	40%
Cu	24-hour	1	Air guideline values for selected substances (Toxikos 2010)	0.008	0.8%
Hg	1-hour	1.8	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	0.001	0.1%
	Annual	0.2	Air guideline values for selected substances (Toxikos 2010)	0.001	5%
Mn	1-hour	18	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	0.04	0.2%

Pollutant	Assessment criteria averaging Period	Assessment criteria (µg/m³)	WA relevant guideline	Background concentration for impact assessment (µg/m³)	% of assessment criteria
	Annual	0.15	WHO guidelines for air quality (WHO 2000), Air guideline values for selected substances (Toxikos 2010)	0.003	2%
Ni	1-hour	0.18	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	0.01	7%
	Annual	0.003	DoH Esperance Nickel annual guideline (DoH 2011)	0.001	33%
Pb	Annual	0.5	AAQ NEPM (NEPC 2003), WHO guidelines for air quality (WHO 2000)	0.02	4%
Sb	1-hour	9	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	0.01	0.1%
Tl	1-hour	1	TCEQ Effect Screening Levels (TCEQ 2011)	0.01	1%
	Annual	0.1	TCEQ Effect Screening Levels (TCEQ 2011)	0.001	1%
V	24-hour	1	WHO guidelines for air quality (WHO 2000)	0.008	0.8%
PM as TSP	24-hour	90	Kwinana Environmental Protection Policy 1992 (TSP Area C) (WA Government 1992)	32	36%
PM_{10}	24-hour	50	AAQ NEPM (NEPC 2003), WHO AQ guidelines global update (WHO 2005)	20	40%
$PM_{2.5}$	24-hour	25	AAQ NEPM (NEPC 2003), WHO AQ guidelines global update (WHO 2005)	6	26%
	Annual	8	AAQ NEPM (NEPC 2003)	1	16%
Dioxins (TEQ)[7]	1-hour	0.000001	Air guideline values for selected substances (Toxikos 2010)	0.00000048	48%

[7] TEQ calculated from WHO 2005 TEFs.

Results from dispersion modelling – direct impact assessment

Normal operations

The results from the dispersion modelling of Scenarios 1 and 2 (normal emissions as detailed in Table 18) are summarised in Table 21 for the R2 receptor. This includes a comparison with the respective assessment criteria to provide a direct impact assessment for the emissions of interest.

No exceedances of the air quality criteria were observed for these maximum predicted GLCs. The most significant emission was NO_2 (NO_X), with a maximum predicted 1-hour average GLC of 26% of the air quality criterion. A contour plot showing the distribution of maximum predicted 1-hour average NO_2 GLCs is shown in Figure 8. Predicted GLCs for all other emissions parameters were well below their respective air quality criteria and contour plots for these parameters can be found in the Environ (2014) report provided in Appendix 6.

Reduced rate operations

The results from the dispersion modelling of Scenario 3 (reduced rate emissions) are summarised in Table 22. This includes a comparison with the respective assessment criteria for the short duration averaging times (where available) for the emissions of interest since longer averaging time criteria are not applicable for reduced rate operating conditions which would not prevail for more than 2 hours at a time.

These results show no exceedances of the air quality criteria predicted for the maximum GLCs under reduced rate conditions. A contour plot of predicted maximum 1-hour average NO_2 GLCs is presented in Figure 9 for comparison with NO_2 impacts for normal emissions. Contour plots for these parameters can be found in the Environ (2014) report provided in Appendix 6.

Bypass operations

The results from the dispersion modelling of Scenarios 4 and 5 (bypass emissions) are summarised in Table 23. This includes a comparison with the respective assessment criteria for the short duration averaging times (where available) for the emissions of interest since longer averaging time criteria are not applicable for bypass conditions which would not prevail for more than 1 hour at a time.

Higher maximum ambient concentrations are predicted for metals and particulates under bypass conditions compared with normal and reduced rate conditions, which reflect the higher emission rates of these parameters from combustion of raw syngas. However, no exceedances of the air quality standards were predicted. Contour plots for these parameters can be found in the Environ (2014) report provided in Appendix 6.

Table 21: Maximum predicted GLCs at R2 – normal emissions (Scenarios 1 and 2)

Emission	Assessment criteria ($\mu g/m^3$)	Average period	Predicted maximum concentration ($\mu g/m^3$)	% of assessment criteria
NO_2	246.4	1-hour	65	26%
	61.6	Annual	2.4	4%
SO_2	500	10-min	8.0	1.6%
	571.8	1-hour	3.3	0.6%
	228.7	24-hour	1.2	0.5%
	57.2	Annual	0.13	0.23%
CO	100 000	15-min	200	0.20%
	60 000	30-min	141	0.24%
	30 000	1-hour	100	0.33%
	11 249	8-hour	64	0.6%
VOCs (as TOC)	No criterion	N/A	2.1	N/A
HCl	100	1-hour	0.017	0.017%
HF	100	1-hour	0.0057	0.006%
As	0.09	1-hour	0.00055	0.6%
	0.03	24-hour	0.0002	0.7%
	0.003	Annual	0.000022	0.7%
Cd	0.018	1-hour	0.0000047	0.0%
	0.005	Annual	0.00000019	0.00%
Co	0.1	24-hour	0.0000000030	0.0000030%
Cr^{III}	9	1-hour	0.000013	0.00013%
	0.5	24-hour	0.0000048	0.00096%
Cr^{VI}	0.0002	Annual	0.000000052	0.026%
Cu	1	24-hour	0.0000060	0.0006%
Hg	1.8	1-hour	0.0000091	0.0005%
	0.2	Annual	0.00000036	0.00018%
Mn	18	1-hour	0.000000000016	0.00000000009%
	0.15	Annual	0.00000000000064	0.0000000004%
Ni	0.18	1-hour	0.000010	0.006%
	0.003	Annual	0.00000040	0.013%
Pb	0.5	Annual	0.00000032	0.00006%
Sb	9	1-hour	0.00000060	0.000007%
Tl	1	1-hour	0.000010	0.0010%
	0.1	Annual	0.00000040	0.0004%
V	1	24-hour	0.000000015	0.0000015%
TSP	90	24-hour	0.13	0.14%
PM_{10}	50	24-hour	0.13	0.26%
$PM_{2.5}$	25	24-hour	0.13	0.5%
	8	Annual	0.013	0.17%
Dioxins (TEQ)	0.000001	1-hour	0.00000000076	0.08%

Table 22: Maximum predicted GLCs at R2 – reduced rate emissions (Scenario 3)

Emission	Assessment criteria ($\mu g/m^3$)	Average period	Predicted maximum concentration ($\mu g/m^3$)	% of assessment criteria
NO_2	246.4	1-hour	33	13%
SO_2	500	10-min	4.8	1.0%
	571.8	1-hour	2.0	0.34%
CO	100 000	15-min	101	0.10%
	60 000	30-min	71	0.12%
	30 000	1-hour	51	0.17%
VOCs (as TOC)	No criterion	N/A	1.1	N/A
HCl	100	1-hour	0.010	0.010%
HF	100	1-hour	0.0034	0.0034%
As	0.09	1-hour	0.00033	0.37%
Cd	0.018	1-hour	0.000003	0.016%
Co	No criterion	1-hour	0.0000000049	N/A
Cr^{III}	9	1-hour	0.0000078	0.000087%
Cr^{VI}	No criterion	1-hour	0.00000078	N/A
Cu	No criterion	1-hour	0.000010	N/A
Hg	1.8	1-hour	0.0000054	0.00030%
Mn	18	1-hour	0.000000000010	0.000000000054%
Ni	0.18	1-hour	0.0000061	0.0034%
Pb	No criterion	1-hour	0.000005	N/A
Sb	9	1-hour	0.00000036	0.0000040%
Tl	1	1-hour	0.0000061	0.0006%
V	No criterion	1-hour	0.000000024	N/A
TSP	No criterion	1-hour	0.14	N/A
PM_{10}	No criterion	1-hour	0.14	N/A
$PM_{2.5}$	No criterion	1-hour	0.14	N/A
Dioxins (TEQ)	0.000001	1-hour	0.00000000046	0.046%

Table 23: Maximum predicted GLCs at R2 – bypass emissions (Scenarios 4 and 5)

Emission	Assessment criteria ($\mu g/m^3$)	Average period	Predicted maximum concentration ($\mu g/m^3$)	Percentage of assessment criteria
NO_2	246.4	1-hour	11	4.6%
SO_2	500	10-min	6.8	1.4%
	571.8	1-hour	1.9	0.33%
CO	100 000	15-min	15	0.015%
	60 000	30-min	11	0.018%
	30 000	1-hour	5.2	0.017%
VOCs (as TOC)	No criterion	N/A	0.50	N/A
HCl	100	1-hour	0.0026	0.0026%
HF	100	1-hour	0.0049	0.0049%
As	0.09	1-hour	0.042	47%
Cd	0.018	1-hour	0.0027	15%
Co	No criterion	1-hour	0.0000047	N/A
Cr^{III}	10	1-hour	0.0075	0.08%
Cr^{VI}	No criterion	1-hour	0.00075	N/A
Cu	No criterion	1-hour	0.0094	N/A
Hg	1.8	1-hour	0.000070	0.0039%
Mn	18	1-hour	0.0000000093	0.000000052%
Ni	0.18	1-hour	0.0024	1.31%
Pb	No criterion	1-hour	0.0047	N/A
Sb	9	1-hour	0.000046	0.00052%
Tl	1	1-hour	0.0024	0.24%
V	No criterion	1-hour	0.0000047	N/A
TSP	No criterion	1-hour	4.1	N/A
PM_{10}	No criterion	1-hour	4.1	N/A
$PM_{2.5}$	No criterion	1-hour	4.1	N/A
Dioxins (TEQ)	0.000001	1-hour	0.00000000036	0.036%

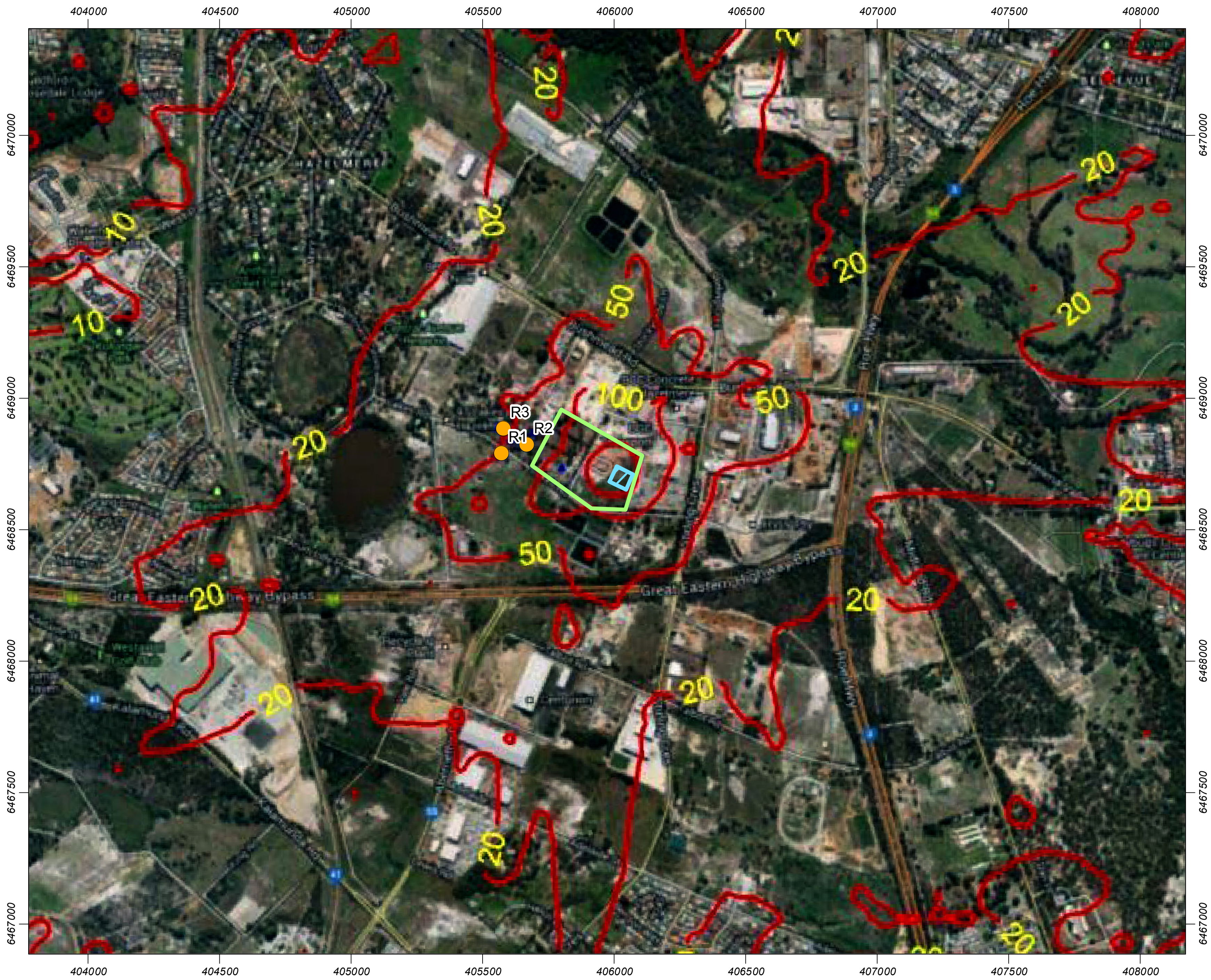

Figure 8
Contour plot of maximum predicted direct 1-hour average NO_2 GLCs in µg/m^3 for normal emissions (Scenarios 1 and 2), assessment criterion of 246 µg/m^3

Legend

- Sensitive receptors
- Site location
- WWTE plant location

Scale 1:20,000 at A4

0 100 200 300 400 500 m

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 30/04/2014
Author: JCrute
Source: Air dispersion: Environ 2014;
Roads: MRWA 2013

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www.strategen.com.au

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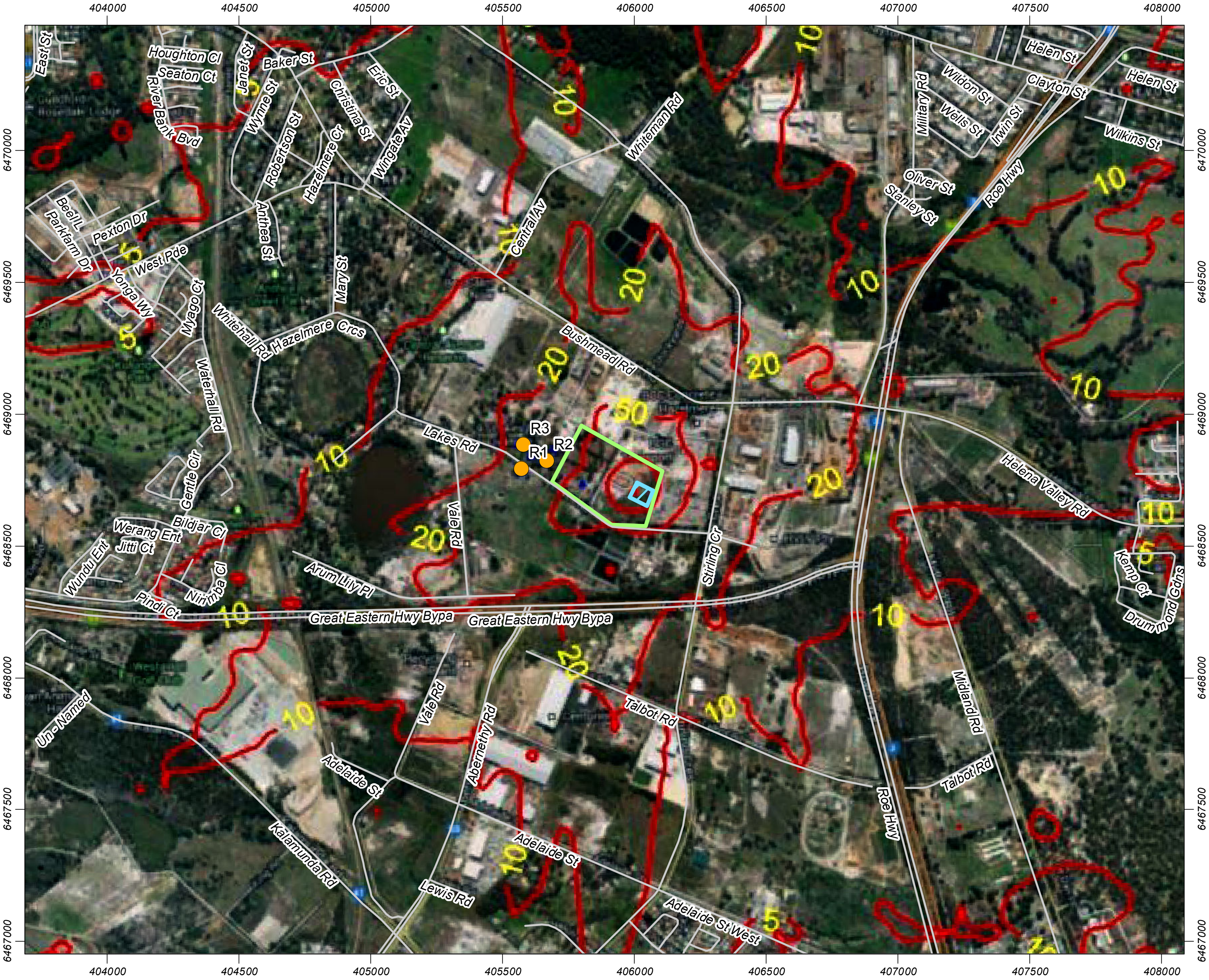

Figure 9
Contour plot of maximum predicted direct 1-hour average NO_2 GLCs in µg/m^3 for reduced rate emissions (Scenario 3), assessment criterion of 246 µg/m^3

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Results from dispersion modelling – cumulative impact assessment

A cumulative impact assessment has been conducted using the background concentration data (Table 20) and maximum predicted GLCs for direct impacts of the facility.

The results of the cumulative impact assessment for normal emissions (Scenarios 1 and 2) are presented in Table 24, the reduced rate emissions (Scenario 3) is presented in Table 25 and the bypass emissions (Scenarios 4 and 5) is presented in Table 26.

No exceedances of the respective air quality criteria are predicted where the emissions from the proposed WWTE plant operating under any scenario are combined with background concentrations.

Conclusions– direct and cumulative impact assessments

The direct and cumulative air quality impact assessments have shown that acceptable air quality outcomes in relation to the relevant air quality criteria (Table 20) are predicted for the proposed WWTE plant at Hazelmere. In particular, no exceedances of air quality criteria are predicted for direct impacts of air emissions and from cumulative impacts when the emissions combine with background concentrations of pollutants.

Overall, the assessment has indicated acceptable air emissions impacts can be provided under normal conditions, reduced rate conditions (including start-up and controlled shutdown) and bypass conditions that may accompany rapid shut-down in the event of process outage.

Table 24: Maximum predicted GLCs at R2 – cumulative impact assessment for normal emissions

Emission	Assessment criteria ($\mu g/m^3$)	Average period	Predicted maximum concentration ($\mu g/m^3$)	% of assessment criteria
NO_2	246.4	1-hour	95	39%
	61.6	Annual	4.4	7%
SO_2	500	10-min	26	5.2%
	571.8	1-hour	21	3.7%
	228.7	24-hour	20	8.8%
	57.2	Annual	1.1	2.0%
CO	100 000	15-min	680	0.68%
	60 000	30-min	601	1.0%
	30 000	1-hour	560	1.9%
	11249	8-hour	444	4.0%
VOCs (as TOC)	No criterion	N/A	N/A	N/A
HCl	100	1-hour	30	30%
HF	100	1-hour	5.0	5.0%
As	0.09	1-hour	0.011	12%
	0.03	24-hour	0.010	34%
	0.003	Annual	0.0010	34%
Cd	0.018	1-hour	0.0060	33%
	0.005	Annual	0.00050	10%
Co	0.1	24-hour	0.010	10%
Cr^{III}	9	1-hour	0.020	0.20%
	0.5	24-hour	0.020	40%
Cr^{VI}	0.0002	Annual	0.000070	35%
Cu	1	24-hour	0.0080	0.80%
Hg	1.8	1-hour	0.0010	0.056%
	0.2	Annual	0.00010	0.050%
Mn	18	1-hour	0.040	0.22%
	0.15	Annual	0.0030	2.0%
Ni	0.18	1-hour	0.010	5.6%
	0.003	Annual	0.0010	33%
Pb	0.5	Annual	0.020	4.0%
Sb	9	1-hour	0.010	0.11%
Tl	1	1-hour	0.010	1.0%
	0.1	Annual	0.0010	1.0%
V	1	24-hour	0.0080	0.80%
TSP	90	24-hour	32	36%
PM_{10}	50	24-hour	20	40%
$PM_{2.5}$	25	24-hour	6.1	25%
	8	Annual	1.0	13%
Dioxins (TEQ)	0.000001	1-hour	0.00000048	48%

Table 25: Maximum predicted GLCs at R2 – cumulative impact assessment for reduced rate emissions

Emission	Assessment criteria ($\mu g/m^3$)	Average period	Predicted maximum concentration ($\mu g/m^3$)	% of assessment criteria
NO_2	246.4	1-hour	63	26%
SO_2	500	10-min	23	4.6%
	571.8	1-hour	20	3.5%
CO	100 000	15-min	581	0.58%
	60 000	30-min	531	0.9%
	30 000	1-hour	511	1.7%
VOCs (as TOC)	No criterion	N/A	N/A	N/A
HCl	100	1-hour	30	30%
HF	100	1-hour	5.0	5.0%
As	0.09	1-hour	0.010	11%
Cd	0.018	1-hour	0.0060	33%
Co	No criterion	1-hour	0.010	N/A
Cr^{III}	9	1-hour	0.020	0.22%
Cr^{VI}	No criterion	1-hour	0.000071	N/A
Cu	No criterion	1-hour	0.0080	N/A
Hg	1.8	1-hour	0.0010	0.056%
Mn	18	1-hour	0.040	0.22%
Ni	0.18	1-hour	0.010	5.6%
Pb	No criterion	1-hour	0.020	N/A
Sb	9	1-hour	0.010	0.11%
Tl	1	1-hour	0.010	1.0%
V	No criterion	1-hour	0.0080	N/A
TSP	No criterion	1-hour	32	N/A
PM_{10}	No criterion	1-hour	20	N/A
$PM_{2.5}$	No criterion	1-hour	6.1	N/A
Dioxins (TEQ)	0.000001	1-hour	0.00000048	48%

Table 26: Maximum predicted GLCs at R2 – cumulative impact assessment for bypass emissions

Emission	Assessment criteria ($\mu g/m^3$)	Average period	Predicted maximum concentration ($\mu g/m^3$)	% of assessment criteria
NO_2	246.4	1-hour	41	17%
SO_2	500	10-min	25	5.0%
	571.8	1-hour	20	3.5%
CO	100 000	15-min	495	0.50%
	60 000	30-min	471	0.78%
	30 000	1-hour	465	1.6%
VOCs (as TOC)	No criterion	N/A	N/A	N/A
HCl	100	1-hour	30	30%
HF	100	1-hour	5.0	5.0%
As	0.09	1-hour	0.052	58%
Cd	0.018	1-hour	0.0087	49%
Co	No criterion	1-hour	0.010	N/A
Cr^{III}	9	1-hour	0.028	0.31%
Cr^{VI}	No criterion	1-hour	0.00082	N/A
Cu	No criterion	1-hour	0.017	N/A
Hg	1.8	1-hour	0.0011	0.059%
Mn	18	1-hour	0.040	0.22%
Ni	0.18	1-hour	0.012	22%
Pb	No criterion	1-hour	0.025	N/A
Sb	9	1-hour	0.010	0.11%
Tl	1	1-hour	0.012	1.24%
V	No criterion	1-hour	0.0080	N/A
TSP	No criterion	1-hour	36	N/A
PM_{10}	No criterion	1-hour	24	N/A
$PM_{2.5}$	No criterion	1-hour	10	N/A
Dioxins (TEQ)	0.000001	1-hour	0.00000048	48%

6.4.7 Commissioning

Commissioning program

A staged commissioning program is planned following completion of construction and individual systems testing. The program will involve the following activities:

Cold commissioning

This involves operation of all mechanical, electrical and control systems to ensure specified functionality can be achieved without production of syngas. The kiln burners, SACTO and gas engines would not be operating during cold commissioning. Wood chip feed material would be introduced into the kiln to test conveyors and solids transfer through the kiln and the char handling circuit. The scrubbing circuit would be operating to test flow rates and level controls.

Hot commissioning – natural gas fuel

This essentially replicates the first stage of the start-up process, when the pyrolysis kiln burners and the SACTO are operated on natural gas to a point where wood feed material could be introduced into the kiln. Tests of the burner management system would be required to satisfy requirements of Energy Safety WA for Type B industrial gas appliances. The gas engines would also be commissioned on natural gas to generate electricity for testing of the export systems to the Western Power grid.

Hot commissioning – syngas fuel

This commissioning stage involves introduction of wood feed to the pyrolysis kiln to generate syngas. All systems will be on-line during this stage of commissioning to test the performance of the facility under normal operating conditions.

Hot commissioning – syngas emergency bypass

At some point during hot commissioning using syngas fuel, a test of the emergency bypass system will be carried out. This test will be two-fold:

1. To test that the diesel generator would engage under this scenario.
2. To test the SACTO under bypass, assuming failure of the diesel generator. Operation of the SACTO under maximum load conditions will be assessed during bypass testing.

Process optimisation

A program of process optimisation testing will follow successful commissioning of the WWTE plant. Key aspects include optimisation of the syngas production rate with the gas engine demand, optimisation of scrubber pH and flow rate, and operation of the reformer. Once those processes are optimised, emissions testing will be carried out from the main stack and gas engine exhausts to confirm the emissions predictions under normal operating conditions (refer to Section 6.6). Those emissions data will also be used to support the application for an environmental licence for commercial operations.

6.5 Pollution control equipment

As previously discussed, air emissions from combustion of syngas in the kiln burners and SACTO are discharged from the main stack, and emissions from the engines from the exhaust stacks. These emissions are controlled by the following pollution control equipment/methods:

- raw syngas reformer (shown as Syngas Cleaning in Figure 6)
- reformed syngas wet scrubber (shown as Syngas Cleaning in Figure 6)
- low-NOx kiln burners (in the Pyrolysis kiln, shown in Figure 6)
- high efficiency thermal oxidiser (SACTO, shown as Excess Gas Burner in Figure 6)
- optimised syngas/air mixture for gas engines.

The following sections further describe these equipment/methods.

6.5.1 Raw syngas reformer

The reformer is a vessel packed with a bed of char (or other catalyst material) where the raw syngas and a small amount of oxygen are reacted to generate sufficient heat and steam for the conversion of hydrocarbons to CO and H_2. The reformer also removes char fines (and adsorbed metals) entrained in the raw syngas from the pyrolysis kiln, and removes tars, volatile metals, some sulfides (which would produce SO_2 after combustion), hydrogen cyanide and some ammonia (which would produce NOx after combustion).

The reformation conditions are optimised to maximise the production of CO and H_2, and minimise the residual levels of condensable organics in the reformed syngas which could increase the demand on downstream wet scrubbing.

6.5.2 Wet scrubber

This device is a conventional spray tower vessel whereby the reformed syngas flows upward against a counter-current flow of scrubbing wateand, sprayed into the syngas stream from sprays at the top of the tower. The scrubber removes residual particulates and adsorbed metals, volatile metals, residual tars and condensable organics, hydrogen sulfide and ammonia. Mist eliminators are installed on the syngas discharge stream from the scrubber to remove entrained water droplets. The scrubber water underflow is returned to the tower after filtration to remove solids and heat is exchanged to cool the water for return to the sprays. A bleed stream reports to the waste water surge tank for subsequent removal of dissolved and entrained condensed hydrocarbons on an activated carbon column. The cleaned water is returned to the process water stream and the wet scrubber as required.

6.5.3 Kiln burners

Low-NOx burners will be installed in the pyrolysis kiln to minimise NOx emissions. Gaseous emissions from the kiln burners will report to the main stack for discharge to atmosphere.

6.5.4 SACTO

Excess clean syngas from the syngas header will report to the SACTO for high efficiency thermal oxidation (combustion) before discharge of combustion products to the atmosphere via the main stack. Dilution air will be added to the SACTO (and kiln burner) exhaust gases prior to entry to the stack in order to control the discharge temperature to a nominal 400°C.

Raw syngas can also be destroyed in the SACTO in the event of an emergency shutdown requiring bypass of the syngas stream in the event of failure of the standby diesel generator. The SACTO will efficiently destroy all CO, H_2, residual aliphatic and aromatic hydrocarbons. Low-NOx burners will be installed to minimise thermal NOx emissions.

6.5.5 Gas engine fuel/air mixture

The gas engines will be operated with optimal fuel to air mixtures that minimise NOx and CO emissions while delivering required power output.

6.6 Management, monitoring and validation of predictions

The assessment of air emission impacts has involved dispersion modelling to predict ground level concentrations of various pollutants. Those predictions will be validated by measurements of emissions from the main stack and engine exhausts, as well as some ambient air monitoring of key parameters.

6.6.1 Stack testing for commissioning

Measurements of NOx, CO, SO_2, O_2 and CO_2 will be made during commissioning to assist in the optimisation process. At the completion of commissioning when the facility is operating under optimal conditions and delivering target power output, a campaign of stack emission testing will be undertaken to formally validate predictions of emission concentrations and rates. That campaign is envisaged to involve the following tests:

1. All WID parameters from the main stack when clean syngas is combusted in the kiln burners and SACTO under normal operating conditions.
2. Combustion gases (NOx, CO, O_2, CO_2 and SO_2) from the engine exhaust stack when operating on clean syngas under normal operating conditions.
3. Combustion gases from the main stack during start-up and shut-down conditions.
4. All WID parameters from the main stack when raw syngas is combusted in the SACTO.
5. Combustion gases (NOx, CO, O_2, CO_2 and SO_2) from the engine exhaust stack when operating on natural gas. This is undertaken to compare syngas combustion emissions and natural gas emissions to demonstrate equivalent emission outcomes and confirm impacts.

Particulate emissions would not be measured from the main stack for start-up and shut-down conditions, since the durations of start-ups and shut-downs are relatively short (30 to 60 minutes) compared with the two to four hours required to collect sufficient particulate matter on a filter for meaningful analysis.

The tests of emissions from the main stack during combustion of raw syngas in the SACTO will simulate the initial stages of an emergency shut-down involving of raw syngas bypass to the SACTO from the pyrolysis kiln.

All emissions testing will be carried out using appropriate sampling and analysis methods as approved by DER, with a National Association of Testing Authorities (NATA) accredited emissions testing company engaged for that work. Measurements of combustion gases for process optimisation will be made by EMRC operations personnel, using a combustion gas analyser calibrated by a NATA accredited laboratory.

6.6.2 Ambient air monitoring

The air quality assessment has identified NOx as the emission of greatest significance relative to air quality standards, with the maximum hourly concentration for direct impacts of 26% of the air quality standard (NEPM) at the nearest sensitive receptor and 39% of that standard for a cumulative assessment where background NOx concentration is included. These results suggest ambient monitoring would only detect a significant increase in NOx above background levels for the (small number of) days in a year when extremes of meteorology provide unfavourable conditions for dispersion. At other times, the NOx emissions would blend into the background and not be detected above the normal variability in background concentrations.

The proponent proposes to conduct a campaign of ambient NOx monitoring at a suitable location as close as possible to the Hazelmere site. The impact of emissions will be determined from examination of the wind direction and velocity data from Perth Airport, in that higher NOx levels can be expected to occur when winds blow across the WWTE plant toward the monitoring location. The actual duration of the monitoring campaign would be determined after consultation with DER and from consideration of the results for the first month of monitoring.

6.6.3 Independent audit of emissions outcomes

The proponent will submit results from stack testing and ambient air monitoring to a suitably qualified and experienced organisation to conduct an independent audit. The scope of that audit and selection of the auditor would be finalised in consultation with DER. It is envisaged the scope would include a review of methodology, instrumentation, standards, field notes and data, laboratory QC records and analysis results, plant operating data, traceability of information and accuracy of reporting by the proponent.

6.6.4 Continuous emission monitoring system

The emissions inventory and dispersion model predictions suggest that NOx is the key parameter of greatest potential risk (notwithstanding the risk is predicted to be within acceptable limits). As a consequence, the proponent will install a continuous emission monitoring system (CEMS) for NOx on the main stack and engine exhaust stacks. That would be in addition to any gas monitoring instrumentation required for process control. The specifications for NOx CEMS will be determined at final design stage of the project and consider requirements in the WA CEMS code and the Australian Standard (AS4323.1:1995) for sampling plans.

Data processing and reporting protocols for the CEMS will be developed from consideration of the CEMS code and in consultation with DER.

6.6.5 Campaign-based emissions monitoring

The findings from the commissioning stack testing will provide advice on emissions parameters of significance and an appropriate frequency for emissions testing on a campaign basis. Based on the level of risk predicted in the air emissions assessment, the proponent suggests that an appropriate frequency of stack testing (after the commissioning testing) would be biannual in the first year of operation, then annually thereafter should the first year's results be fully compliant with emission limits stated in the environmental license for the facility.

The parameters of interest for testing in the first year of operation will be the parameters detailed in the EU WID. Assuming that the emission rates are as predicted, the proponent may consult with DER with a view to removing parameters from the future test programs that are not present in significant concentrations and do not constitute a significant risk to the environment and human health and amenity.

6.7 Confidence levels and contingency plans

6.7.1 Confidence levels

Where necessary, assumptions have been made in predicting emission rates in the emissions inventory. In most cases, those assumptions have been made on a conservative basis. This means that higher emission rates have been predicted than are likely to occur for many parameters. In addition, the maximum predicted ground level concentrations from the dispersion modelling have been found to be well below the air quality standards. As a consequence, the proponent is confident of achieving the predicted emissions outcomes.

The risk of actual emissions being greater than predicted and exceeding air quality standards can be evaluated from a sensitivity analysis of the emissions inventory. That analysis considers the possibility of higher levels of emission precursors in the wood feed material processed in the facility compared with the levels measured in the wood chip sample that provided the basis for inputs in the emissions inventory.

The worst case scenario from a bypass emissions event is used for this analysis. For the heavy metals, arsenic shows the highest impact at 47% of the air quality standard (see Table 23). This means the concentration of this metal in the wood feed could be double yet the emission impact remains below the air quality standard. Concentration of other metals could be increased even more before the emissions ground level concentrations would reach the standards.

Chlorine and fluorine were not detected in wood; therefore, the emissions inventory utilised the detection limit concentration. Those concentrations would have to be increased by more than four orders of magnitude before the acid gases HCl and HF would exceed the air quality standards.

Similar outcomes were observed from examination of the predicted GLCs for other parameters compared with the respective standards. NOx emissions are predominantly due to thermal NOx formation, with an increase in nitrogen in the wood having only a small impact (as fuel NOx).

These elevated levels of emissions precursors in wood feed are highly unlikely to occur, which suggest a very low likelihood (risk) of actual emissions exceeding air quality standards from variability of precursor concentrations in wood feed materials, compared with the analysed sample.

6.7.2 Contingency

Notwithstanding the very low risk of actual emissions exceeding air quality standards, the Proponent will develop and implement contingency plans in the event that the actual emission rates are significantly higher than those predicted. These plans would include an initial investigation to confirm results were valid and the status of operating conditions for the tests. If necessary, the stack testing would be repeated for relevant parameters (if the initial result was invalid) or repeated for all parameters if the operating conditions were outside normal specifications.

Should the initial investigation indicate that higher than predicted results were valid for normal operating conditions then the Proponent would immediately advise the regulator (i.e. DER). An appropriate action plan would be developed with DER involvement to identify risks of environmental harm and improvements that could be made to ensure acceptable emissions performance.

Subject to DER approval, operations would continue for the purpose of gathering additional process operating and/or air emissions data to facilitate a review of process inputs, operating conditions and all factors involved in generation of the relevant emissions.

As indicated, the implementation of the contingency plan in the event of higher than predicted emissions are observed would be the subject of discussions with the DER and approval of the actions necessary to acceptable emissions outcomes at all times. A report on the investigations, assessments, proposed process modifications to reduce emission rates of relevant parameters and any other relevant information to emissions performance, would be provided to DER at an agreed time.

If exceedances of air quality standards are predicted from higher actual emission rates, then the plant would be shut down while the process and operations review was carried out, and improvements identified to reduce emissions of the relevant parameters to comply with air quality standards. The DER would be immediately notified and discussions held to develop action plan to deliver acceptable emissions outcomes. A report would be provided to DER for consideration prior to implementation of improvements and to facilitate approval for re-start of the plant. Additional emissions testing would be carried out to verify the success of the improvements, with the results reported to DER.

6.8 Consistency with EPA Advice to the Minister

The Proposal conforms with the recommendations in the EPA (2013b) report on Waste to Energy plants in Western Australia, the *Environmental and health performance of waste to energy technologies*. These recommendations and associated conformances are presented in Table 27.

Table 27: EPA recommendations for waste to energy technologies

Recommendation		Conformance	Reference
1	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.	EMRC is engaging in stakeholder consultation and will use best practice technology, including managing emissions using best practice methods for syngas clean up before use in the engines and continuous monitoring. EMRC has committed to restricting feedstock to waste wood, with no intention to process trees for wood chipping. Products such as MDF or CCA treated pine are not proposed to be used in the process.	Section 4
2	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.	EMRC has accounted for each of the five life-cycle components in feasibility studies. Waste wood material proposed as feedstock is currently reprocessed as woodchip for a limited market – diversion for electricity production is preferable to disposal to landfill. Process water can be recycled for reuse onsite. Solid waste (bio-char) has a potential market as soil and compost additive, and as a solid fuel.	Section 2.5
3	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.	See further information provided in Section 6.8.1.	Section 6.8.1
4	Waste to energy proposals must characterise the expected waste feedstock and consideration made to its likely variability over the life of the proposal.	Variability of existing woodchip composition that is representative of the WWTE plant feedstock has not been extensively investigated. However, a sensitivity analysis has been conducted for the emissions inventory where input rates for key emission parameters have been increased and the impact on emission rates tested. The results show that considerable variability in feedstock composition can be accommodated without significant change in emission rates due to the efficiency of removal in the reformer and scrubber. The physical processing of other waste materials would be possible using the current technology. EMRC has investigated the suitability of woodchip feedstock from softwood, hardwood and mixtures thereof.	Section 2.5.3
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. Conditions should be set to require monitoring and reporting of the waste material accepted over the life of a plant.	The Hazelmere site diverts untreated timber from landfill and converts it to useable wood chip and woodfine products. This process will use part of the wood chip to generate renewable power and bio-char. The proposed feed of the WWTE plant is in line with the criteria that is already in place at the Hazelmere Recycling Centre (http://www.emrc.org.au/acceptance-criteria.html).	Section 2.3

Recommendation		Conformance	Reference
6	Waste to Energy operators should not rely on a single residual waste stream over the longer term because it may undermine future recovery options.	EMRC has investigated the suitability of woodchip feedstock from softwood, hardwood and mixtures thereof. Ansac has also trialled other feedstocks including refuse derived fuel (RDF). The feasibility of converting greenwaste from member Councils to bio-char will be investigated by the EMRC.	Section 2.5.3
7	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.	Hazardous waste will not be processed. This document outlines the proposed feed of the WWTE plant in Section 2.2, which is in line with the criteria and operating practices that are already in place at the Hazelmere Recycling Centre (http://www.emrc.org.au/acceptance-criteria.html).	Section 2.2 and 2.3
8	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 (2000/76/EC).	The WWTE plant will employ best practice technologies and practices to minimise emissions. These are necessary to produce clean syngas as a fuel for the engines that power the generators. Any failure of the raw syngas clean up processes (reformer and wet scrubber) would preclude operation of the engines and require a plant shutdown. Air emission investigations has demonstrated compliance with the emission standards in the European Union's WID emission criteria (2000/76/EC) under steady state (normal operations) and non-steady state (start-up and shut-down) conditions.	Section 6
9	Pollution control equipment must be capable of meeting emissions standards during non-standard operations.	Air emission investigations have been undertaken and have demonstrated compliance with emission standards during non-standard operations (i.e. reduced rate and bypass conditions).	Section 6
10	Continuous Emissions Monitoring must be applied where the technology is feasible to do so (e.g. particulates, TOC, HCl, HF, SO_2, NOx, 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.	NOx is predicted to be the most significant of emissions in terms of predicted ground level concentrations being 26% of the air quality standard for direct impact at the nearest sensitive receptor. As a consequence, the proponent proposes to install CEMS for NOx emissions monitoring. The concentrations of other parameters are either too low to accurately measure with CEMS or have lower impacts compared with air quality standards. The proponent also proposes to conduct a short campaign of continuous monitoring of ambient air NOx at a location nearby to the plant, to confirm model predictions. Stack emissions testing will be carried out during commissioning from the main stack and gas engine exhausts to confirm the emissions predictions under normal operating conditions. The composition of wood waste feedstock is not dependent on seasonal effects. The sensitivity analysis conducted for the emissions inventory suggests that ongoing emission testing for all parameters can be conducted on a biannual basis for the first year of operation to adequately assess impacts of feedstock variability. Emission testing could then be conducted annually thereafter, subject to acceptable performance in the first year.	Section 6

	Recommendation	Conformance	Reference
11	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.	Air emission investigations have been undertaken and have included background levels of pollutants. Those background data were obtained from measurements made by EMRC at Red Hill and benchmarked against data published by DEC from the Midland Air Quality Study. A conservative approach was adopted in that the 95^{th} percentile concentrations for continuously measured parameters and the maximum concentration for other parameters measured at Red Hill were used for background concentrations for this assessment. The modelling considers all hours in a year but only the maximum predicted GLCs have been used for comparison against air quality standards. These show all parameters below those standards, so other emissions scenarios have not be reported since they will show even lower GLCs. Background monitoring is proposed for NOx, which is predicted to be the parameter of most significance from the WWTE plant (maximum GLC of 26% of the air quality standard). Background monitoring of other parameters is not warranted since the predicted GLCs are all well below air quality standards and the incremental increase from the WWTE emissions is negligible.	Section 6
12	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.	Air emission investigations have been undertaken and have investigated dioxin and furan emissions to establish potential levels and inform project design. Dioxins/furans are not expected to be formed in the process, due to the absence of significant levels of chlorine (not detected in wood feedstock) and oxygen (anoxic pyrolysis process). Any dioxins that may form and any chlorine that may be present below limits of detection will have been removed from the clean syngas in the reformer and scrubber, and are not available for dioxins to form in the syngas combustion processes. Raw syngas that is combusted in the SACTO during bypass events may give rise to dioxins formation, due to trace levels of chlorine that may be present below the detection limit in the wood feedstock. However, emissions could only continue for a short period (<30 minutes) since the wood feed will be immediately terminated and kiln burners shut-down for a bypass event so that raw syngas generation decays rapidly.	Section 6
13	Proposals must demonstrate that odour emissions can be effectively managed during both operation and shut-down of the plant.	Odour emissions are not expected to be an issue for the WWTE plant as the wood waste has been demonstrated from current site operations to be a low odour waste. Some odour may be produced from the waste water in holding tanks, and if necessary that can be controlled with installation of carbon filters on tank vents.	Section 6.3
14	All air pollution control residues must be characterised and disposed of to an appropriate waste facility according to that characterisation.	Cleaning of the syngas is conducted in the reformer and wet scrubber. Tar compounds and char fines are removed using a steam reforming catalyst (exact catalyst yet to be determined), with oxygen used to maintain the necessary heat for the reaction. The catalyst bed material will be exported for regeneration or disposed of using an appropriate waste facility.	Section 6
15	Bottom ash must be disposed of at an appropriate landfill unless approval has been granted to reuse this product.	Bottom ash (bio-char) will be exported for landfill at the Red Hill Waste Management Facility or for sale as a by-product fuel or soil amendment/carbon sequestration media.	Section 0

Recommendation		Conformance	Reference
16	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.	Extensive research has been undertaken in the bio-char area to establish the health and environmental aspects of this material. As the bio-char is produced from clean wood waste feed it is unlikely to contain a high level of contaminants, such as heavy metals, and as such, leachate testing is not required. For example, bio-char can be used as a soil amendment media to improve soil health characteristics such as water retention. The bio-char may contain particles in the nano scale size distribution range. However, those fine particles and all other sized particles will be bound together with the moisture added during the char cooling and moistening process. Therefore, risks from exposure to nanoparticles from handling of bio-char are low.	Section 0
17	Long term use and disposal of any by-product must be considered in determining the acceptability of the proposed use.	The bio-char will be characterised and a Materials Safety Data Sheet (MSDS) prepared and supplied with exported bio-char detailing suitable beneficial uses (as known at the time) and disposal options.	N/A
18	Standards should be set which specify the permitted composition of ash for further use.	These will be specified in the MSDS.	N/A
19	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.	A single waste feedstock stream is to be used for the WWTE plant, therefore additional testing is not required.	N/A
20	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.	The plant is to be located on land zoned for industrial purposes with an appropriate buffer distance from sensitive receptors. The proposed development of the Hazelmere waste management precinct that includes the WWTE plant will ensure buffer integrity is maintained.	Section 1.3
21	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.	The R1 Efficiency Indicator is not considered applicable to the WWTE plant as the proposed feed is wood chip and not municipal solid waste as indicated in EU Directive 2008/98/EC, which states that "*this includes incineration facilities dedicated to the processing of municipal solid waste only…*" (footnote to Recovery Operation R1, Annex II). The R1 Efficiency Indicator calculation considers energy associated with raising steam for electricity generation and/or export of heat. As the WWTE plant does not raise steam or export heat, the calculation would not be accurate, and is not considered applicable for the WWTE plant.	Section 6

6.8.1 Further information on Recommendation 3 in EPA Advice to the Minister

The pyrolysis plant being proposed for Hazelmere will utilise a combination of established technologies and suppliers with extensive experience in the field. The pyrolysis process is utilising an Ansac Indirect Fired Kiln as the core pyrolysis operation unit. This technology has been produced by Ansac and exported for pyrolysis processes for over 25 years.

Of the 200+ units supplied by Ansac, the nameplate capacity of the kilns varies from 100 kg/h to 6000 kg/h, all industrial in nature and meeting international emissions levels.

The feedstock of pyrolysis processes are assessed on the basis of fuel properties (determined from proximate and ultimate analyses) and the physical properties of the feedstock being provided. No two feedstocks are identical; therefore, feedstocks should be considered in terms of proportions of moisture, fixed carbon, volatiles and ash, the existence of particular elements such as chlorine and sulfur as well as the physical properties, such as bulk density and hardness.

Based on the proportions of these parameters within the wood feedstock, the process proposed for the WWTE plant can be considered equivalent to the Premier Coal Char Plant, which was built in 2006 by Ansac and ran until 2009 when it was mothballed due to closure of the end-user's facility for the char.

The feedstock at the Premier Coal Char plant closely matches the proportions of ash, fixed carbon, volatile and moisture content of the proposed feedstock at Hazelmere, and is of a similar scale (6000 kg/h nameplate capacity compared to 3100 kg/h for the proposed WWTE plant). The project was built in its entirety by Ansac and demonstrates Ansac's engineering capacity with regards to a full construction project.

This facility was not intended to recover syngas for generation of electricity. However, the front-end syngas management and heat recovery systems are similar to that proposed for the WWTE plant at Hazelmere. In particular, approximately 30% of the syngas recovered from the kiln was utilised in the kiln burners to provide the energy for the char process. Also, waste heat from the kiln burner exhaust was recovered and utilised for combustion air preheating. These processes are key elements of the proposed WWTE plant flowsheet and the successful utilisation of those processes at the Premier Coal facility demonstrates Ansac's capability in that regard.

Ansac has also supplied several woodchip pyrolysis units into the United Kingdom of various scales between 50 kg/h up to 1000 kg/h. This includes a commercial woodchip charring facility in the UK that has been operating for 12 months and produces 7 tonnes of char per day for a new line of barbeque fuels to replace coal briquettes. The syngas produced from the char manufacturing is used to fire the kiln with excess syngas flared. That facility operates under an environmental license from the UK Environment Authority, which is consistent with the EU air quality standards specified by EPA (WA) in their WTE guidance document (EPA 2013b).

Other major projects in which Ansac has supplied pyrolysis equipment include the Martarbe Project in Indonesia (kiln of 2.5 tph nameplate capacity) and the Chatree Project in Thailand (kiln of 3 tph nameplate capacity). These are activated carbon regeneration plants for the gold industry and include downstream mercury recovery systems due to the relatively higher levels of this metal in the ore.

Ansac has invested substantial capital into its capacity to determine the exact pyrolysis requirements for a range of feedstocks through the use of the Ansac pilot facility in Bunbury. As previously described, the particular properties that make up a feedstock in its original form can be used as a predictor for constituents in the pyrolysis gas which can then be used to model the post-combustion air emissions.

This work has been undertaken in conjunction with the University of Western Australia as well as being supported by the Federal Government Climate Ready Grant. Ansac has tested a series of various feedstocks including woodchips, coals, straws and grasses, saw dust, animal waste and RDF mixes. From these trials, Ansac has been able to develop and verify a proprietary model in order to predict the characteristics of the air emissions based on the feedstock characteristics.

In terms of the pollution control technologies, simple and well understood technologies have been selected and a base philosophy of cleaning the resultant syngas has been applied rather than cleaning emissions post-combustion. To this end, Ansac has included a steam reforming unit operation and a water scrubbing process which removes tars, particulate matter and other contaminants, to deliver a clean syngas that consists of a mix of H_2, CO, CO_2, H_2O, CH_4 and N_2. Both of these processes have been utilised for many years in many different industries, are well understood technologies and are 'off the shelf' components with no further engineering development required for application to this proposal. These processes will provide a consistent supply of clean syngas to the engines for electricity generation.

The effectiveness of the steam reformation and water scrubbing processes to produce clean syngas has been assessed from a first principles basis. In particular, the capture of particulates and heavy metals, and the reaction and partitioning of heavy metals, chlorine, fluorine, nitrogen and sulfur in the reformer and scrubber, have been modelled using a mass balance approach that considered the physical and chemical properties of these processes. A conservative approach has been adopted in the modelling, whereby higher levels of these parameters have been assigned to the syngas than are expected from the physics and chemistry of the process. Considering this conservative approach, the levels of precursors for formation of HCl, HF, SO_2 and dioxin emissions are predicted to be very low and, as a consequence, the emissions of these parameters are predicted to be very low. Similarly, the levels of heavy metals and particulate emissions are also predicted to be very low due to the dual stage removal process afforded by the reformer and wet scrubber.

The primary source of emissions will be from combustion of clean syngas in the engines and kiln burners, which results in production of CO_2, H_2O, some CO and NOx, with the NOx (as NO) arising from thermal NOx formation (as described in Section 6.4.1). The emission rates calculated from the mass balance and the ground level concentrations of pollutants predicted from dispersion modelling are reported in Section 6.4.6.

For the engine components, Ansac has partnered with Perkins and their gas partners to supply the gas to electricity component of the process. Perkins is a Caterpillar company and can be considered a leader in the Gas Engine Generator market. The engine technology is also an 'off the shelf' component for integration into the WWTE plant.

6.9 Predicted environmental outcome

Having regard to the following outcomes in relation to air quality, the Proposal is not expected to represent a significant impact to the air quality of the area:

1. A comprehensive emissions inventory has been developed from consideration of measured compositional data for the wood feed materials and key process design parameters that influence the formation and fate of air emissions within the process. The emissions data obtained from the emissions inventory have been used in the dispersion modelling.

2. Five operating scenarios have been considered for the air emissions impact assessment to represent the different emission scenarios that may be experienced at the WWTE plant. The scenarios have been used in the dispersion modelling.

3. The air quality criteria and standards used in the Red Hill Resource Recovery Facility assessment were considered as background air quality data, as a substitute for local data. A thorough review of air quality criteria was conducted for the Red Hill project that included consultation with the DoH toxicology section. The criteria selected reflected the view of that agency and were considered at that time as best practice for assessment of air emission impacts of WTE projects in WA.

4. Dispersion modelling for normal operations shows no exceedances of the air quality criteria for the maximum predicted GLCs. The most significant emission was NO_2 (NOx), with a maximum predicted 1-hour average GLC of 26% of the air quality criterion. Similarly for reduced rate operations, no exceedances of the air quality criteria were predicted, with NO_2 the most significant emission.

5. Dispersion modelling for bypass operations shows higher maximum ambient concentrations are predicted for metals and particulates compared with the other operating conditions; however, no exceedances of the air quality standards were predicted.

6. No exceedances of the respective air quality criteria are predicted where the emissions from the proposed WWTE plant operating under any scenario are combined with background concentrations.

7. Components of the design of the WWTE plant have been undertaken to avoid situations where raw syngas is combusted. Therefore, no raw syngas will be directed to the engines at any time and the likelihood of a bypass situation has been reduced as a diesel generator will be installed to be used in the event of mains power outage.

8. Application of pollution control, monitoring and contingency planning to manage and control air emissions is proposed.

9. The Proponent has shown how the Proposal is consistent with EPA Advice to the Minister as outlined in the EPA report on Waste to Energy plants in Western Australia, the *Environmental and health performance of waste to energy technologies* (EPA 2013b).

In considering the outcome as described, the Proposal is expected to meet the EPA objective for air quality, that is to maintain air quality for the protection of the environment and human health and amenity.

7. References

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