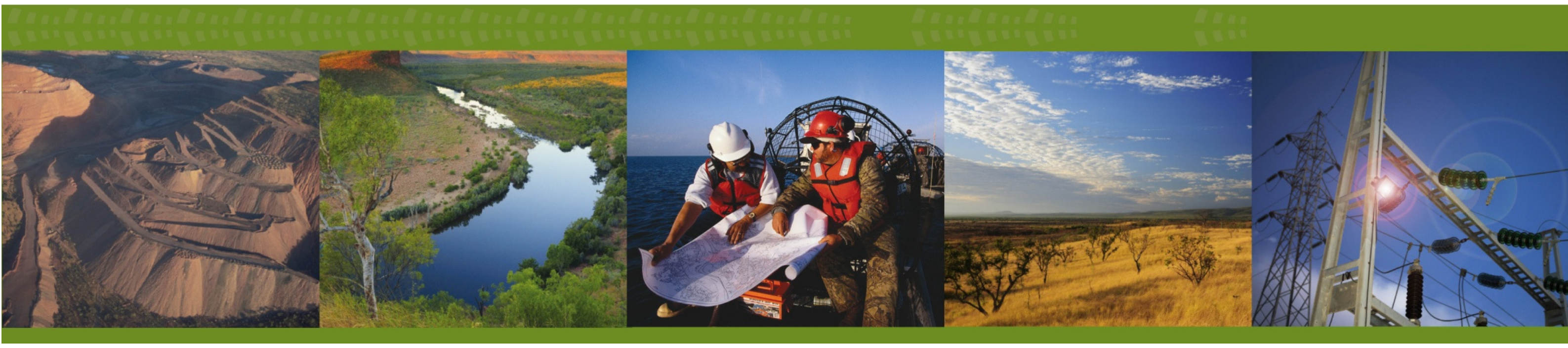

Hazelmere Pyrolysis Waste to Energy Plant

Works Approval Application Supporting Document

DRAFT

Prepared for
Eastern Metropolitan Regional Council
by Strategen

December 2013

STRATEGEN
environmental consultants

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December 2013

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Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: Eastern Metropolitan Regional Council

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	A	Client Review	N. Zago/H. Ventriss	electronic	19/12/13
Final Draft Report	0	Regulator review/ submission	N. Zago/P. Forster	electronic	24/12/13
Final Report					

Filename: EMR12223_01_R001_RevB4 - 24 December 2013

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1. Introduction

Eastern Metropolitan Regional Council (EMRC) proposes to develop the existing Hazelmere Recycling Centre located approximately 14 km from the Perth, by installing a 3 MW Waste Wood to Energy (WWTE) plant located on Part Lot 100 and Lot 201 Lakes Road, Hazelmere (Figure 1). The existing operation 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.

1.1 Project summary

The WWTE plant will be based on pyrolysis technology developed by local company, Ansac, and their parent company, Anergy, using a proven indirect-fired pyrolysis kiln to produce synthetic gas (syngas) for use in gas engines for power generation. The process of pyrolysis involves heating organic materials (wood chip in this case) to greater than 600˚C in the absence of oxygen. The EMRC project will use shredded wood as the fuel source (such as pallets, crates, cable reels.) that would otherwise be disposed to landfill. Resulting products are renewable electricity and bio-char (solid char of carbon and ash).

The proposal will result in air and noise emissions, the effects of both of which have been evaluated. Other potential impacts will be associated with disposal of waste (solid and liquid), traffic management and other amenity issues such as dust (i.e. from the production of bio-char). Management mechanisms will include engineering controls, process design and monitoring.

1.2 Project justification

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

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

Currently, there is a large market for the wood chip fines and a smaller market for the wood chip. The use of this wood chip as a fuel source for power generation is considered a beneficial way to ensure the wood chip is utilised. By diverting this waste wood from landfill by using part of the wood chip for energy generation, EMRC will reduce the greenhouse gas emissions that would otherwise be emitted from landfill, 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 intention to use trees for wood chip for the purpose of electricity generation.

Reprocessing is ranked third out of seven preferred waste management options in the internationally-recognised best practice waste management hierarchy, 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 pilot scale over several years, and construction of the Hazelmere WWTE plant will provide the opportunity to demonstrate new pyrolysis technology at a commercial scale (Anergy 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 the EMRC. This grant was awarded to Ansac in July 2013 and subsequently, a contract was awarded to Ansac by the EMRC for the design and construction of the plant.

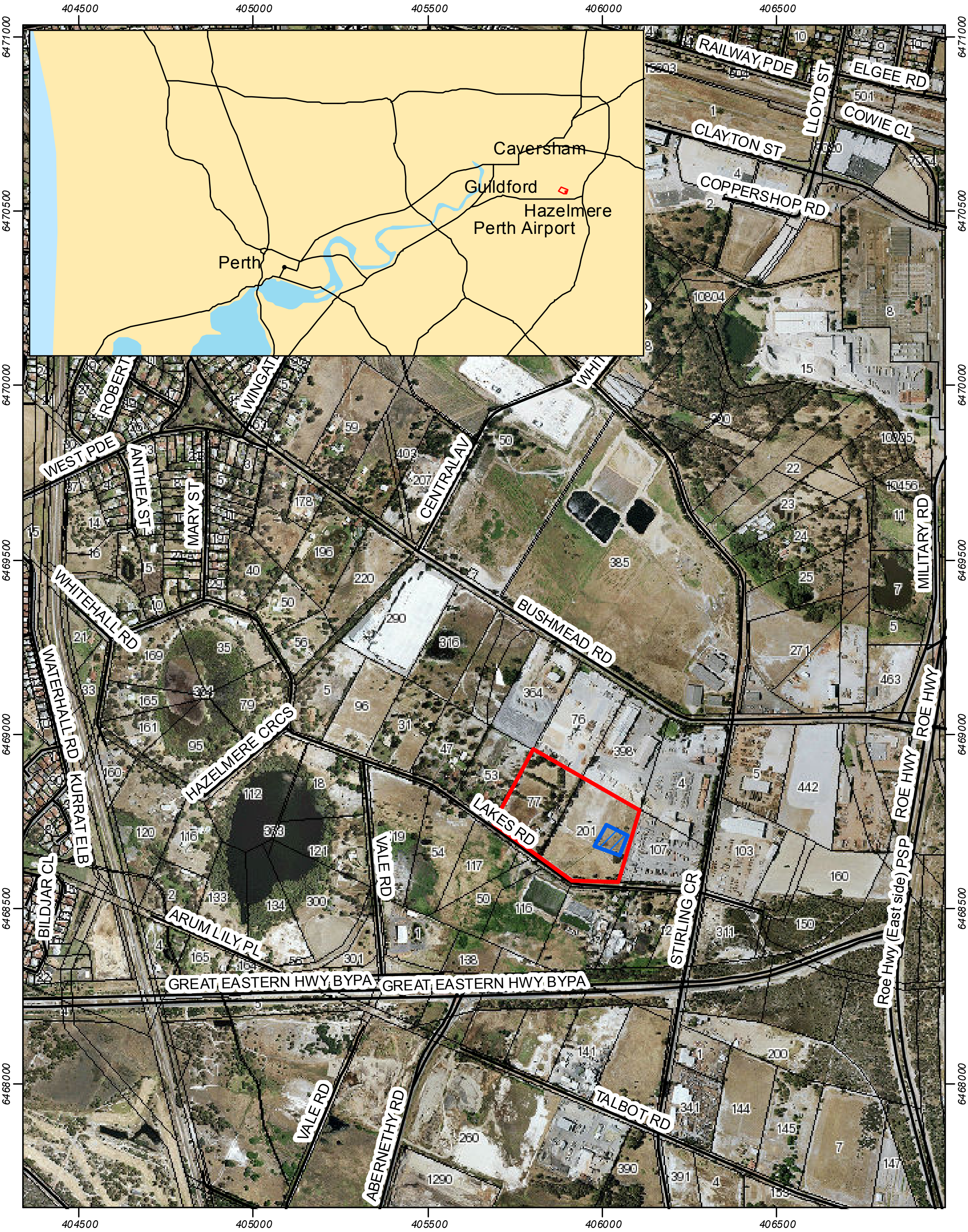


Figure 1 Site location

Scale 1:15,000 at A4

0 100 200 300 400 500 Meters

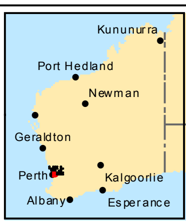
Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 5/11/2013

Author: SFinning

Source: Mosaic:Landgate 2006; Roads: MRWA 2013.



Legend

- Site location
- Indicative WTE plant location
- Roads

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2. Administration

2.1 Applicant details

The applicant and occupier of the premises is:

Eastern Metropolitan Regional Council
1st Floor Ascot Place
226 Great Eastern Highway, Belmont, WA, 6104
Ph: (08) 9424 2222
Fax: (08) 9277 7598
Representative: Steve Fitzpatrick

2.2 Premises details

The site is located approximately 14 km north east of Perth, north of the Perth Airport in the suburb of Hazelmere. Recycling of timber (such as pallets and wooden packaging and crates, off-cuts and cable reels) and mattresses is undertaken at the site.

EMRC is currently in the process of planning the development of the EMRC Resource Recovery Park (RRP) at Hazelmere, which is proposed to occupy Lots 201, 100 and potentially Lot 99(2) Lakes Road bounded by Stirling Crescent and Bushmead Road. The RRP would include other waste management processes in addition to the existing recycling of timber and mattresses, and the WWTP plant; appropriate approvals will be sought for other elements of the RRP as planning is finalised.

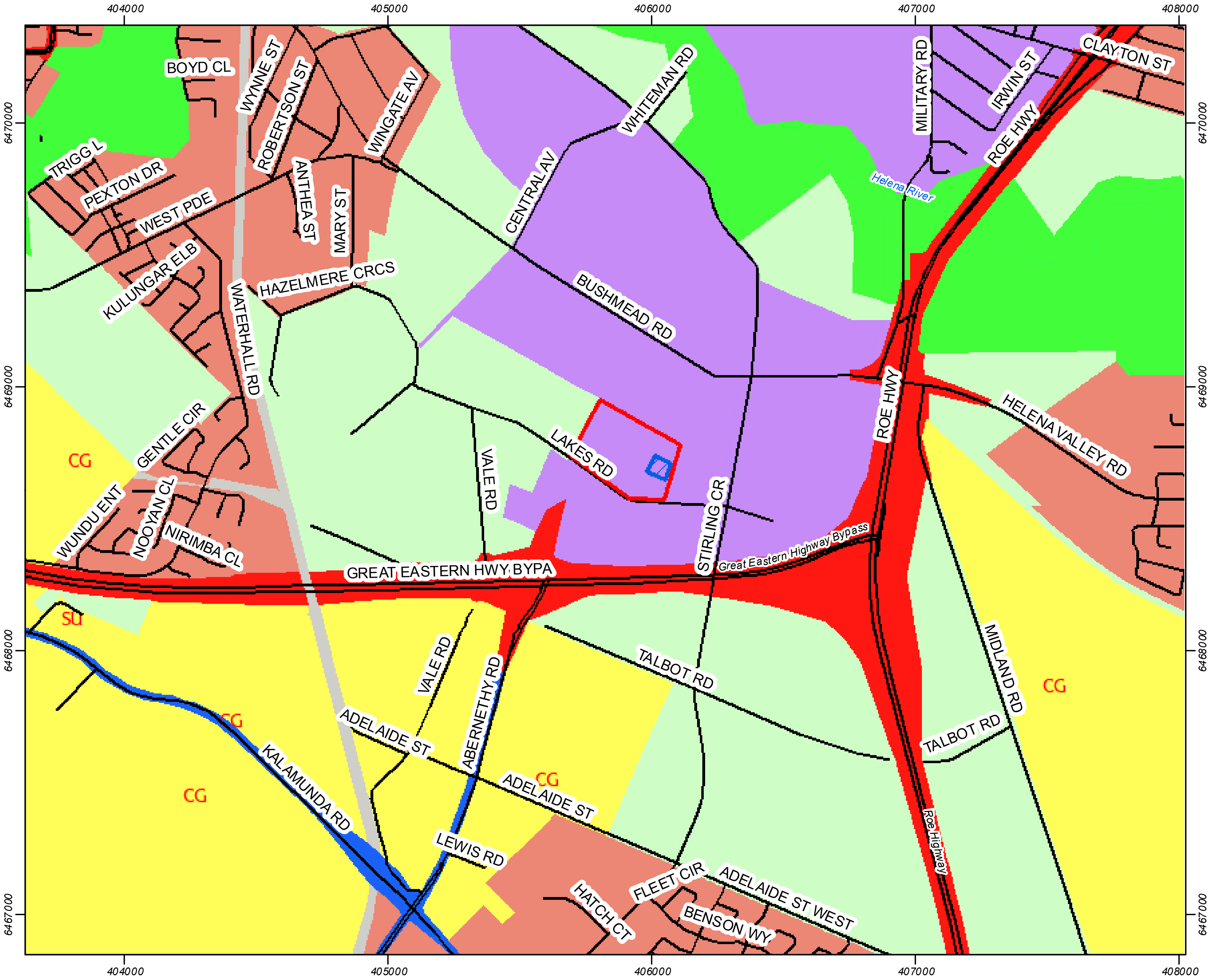
This application only concerns the WWTE plant, which covers approximately 0.2 ha of the 10 ha RRP.

2.2.1 Zoning

The site is zoned ‘industrial’ under the Metropolitan Region Scheme (Figure 2) 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 for inclusion of a community reuse, recycling and drop-off centre for the RRP (approval for which is not being sought in this application).

The Hazelmere Enterprise Area Structure Plan (2011) outlines the potential future zoning changes that are likely to be implemented; the site would remain an industrial area in the structure plan.

Figure 2
Metropolitan Region Scheme Zoning



Legend

- Site location
- Indicative WTE location
- Urban
- Industrial
- Rural
- Primary regional road
- Regional Road
- Parks and Recreation
- Public Purpose

Scale 1:20,000 at A4

0 0.1 0.2 0.3 0.4 0.5 Kilometers

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 5/11/2013
Author: SFinning
Source: Zoning: Landgate 2013; Roads: MRWA 2013

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2.3 Prescribed premises category

The proposal requires approval to construct and operate under prescribed premises categories as specified in Schedule 1 of the EP Act Regulations. Table 1 outlines the categories that EMRC considers applicable for the proposal and the justification for why these are or are not applicable.

Table 1: Prescribed premises categories

Category	Description	Threshold	Considered applicable	Detail/justification
37	Char manufacturing: premises on which wood, carbon material or coal is charred to produce a fuel or material of a carbonaceous nature or of enriched carbon content.	10 tonnes or more per year	Yes	Around 1500 tonnes per year of bio-char will be produced at the WWTE plant.
60	Incineration: premises (other than premises within category 59) on which waste, excluding clean paper and cardboard, is incinerated.	100 kg or more per hour	No	There is no incineration being undertaken on the site. Incineration is a combustion process as a means of waste disposal (and potentially heat can be recovered from this process), rather than the pyrolysis process which uses indirect heating in the absence of air to produce a fuel, which is then used to produce electricity using gas engines..
62	Solid waste depot: premises on which waste is stored, or sorted, pending final disposal or re-use	500 tonnes or more per year	Yes – for the licence	The site currently receives waste wood and mattresses for recycling. These processes are already established at the site and the works approval application will not describe these further. The licence may include provisions for the management of the solid waste depot. An Environmental Management Plan (EMP) which includes groundwater and dust management/monitoring is already established for the site. This EMP will be updated to include noise and air emissions management/monitoring.
67	Fuel burning: premises on which gaseous, liquid or solid fuel is burnt in a boiler for the supply of steam or in power generation equipment.	In aggregate 500 kg or more per hour (fuel with a sulphur content of 0.25% or more) or In aggregate 2000 kg or more per hour (fuel with a sulphur content of less than 0.25%)	Yes	The syngas has a sulphur content of less than 0.01% and the maximum design capacity of the gas engines is for 2042 kg/hr of syngas.

2.4 Timing of construction and operation

Current forecasting for construction of the WWTE plant is outlined in Table 2.

Table 2: Schedule of construction

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

2.5 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 carrying out 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, Belmont, Kalamunda, Mundaring, Swan and Bayswater). The role of WMCRG is to assist EMRC with progressing waste education initiatives by way of active involvement in workshops on resource recovery, guidance, advertising and providing feedback on waste strategies (EMRC 2013c).

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 Resource Recovery Facility 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 (EMRC 2013). A similar session was held on anaerobic digestion in 2011.

More recently, 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 (this is 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 and raised further issues regarding employment opportunities, disposal versus sale of bio-char, and public access to woodchips.

A consolidated list of community concerns are presented in Table 3. Where a resolution was achieved, it has been noted, other issues have been noted within this supporting document.

Table 3: Community consultation

Aspect of WWTE pyrolysis plant	Issue	Resolution
Bio-char	Disposal vs. sale	Bio-char can be used for seeds, possible market to Organic Growers Association.
Feedstock	Concern for 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.

Aspect of WWTE pyrolysis plant	Issue	Resolution
	Issue with market for woodchips	Potential market to horse stables (Belmont).
	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 expected volume? Existing congestion at Stirling St 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 St extension unlikely within next two years – mentioned within ten year timeframe.	City of Swan part of traffic studies. Truck access from Lloyd St (from western end of site). Community input. City of Swan noted to have completed a traffic study.
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.
Facility flexibility	Changing markets.	Appears flexible.
Existing community waste management programs (Suburb Sale)	Synergy.	Good opportunity.
Groundwater	Local concern about quality	None noted.
Amenity	Rendering site attractive	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 unable to attend seminar.	Recommend basic information is distributed around local area.

2.6 Policy/guidance

State Government position on the application of WTE is provided in a Position Statement issued by the Waste Authority in May 2013, on the basis of *Environmental Protection Act 1986* (EP Act) s 16e advice provided to the Minister for Environment containing recommendations relating to WTE in Western Australia.

Western Australian legislation and policy documents outline the State Government commitment to reducing waste and increasing resource recovery, including the *Waste Avoidance and Recovery Act 2007* and the waste strategy '*Creating the Right Environment*' (Waste Authority 2012). Energy recovery is ranked sixth out of seven preferred waste management options, after recycling but above disposal (Waste Authority 2013).

3. Site environmental characteristics

3.1 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 Road along the western boundary of the proposed Resource Recovery Park. 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 south-west, across the Great Eastern Highway bypass.

3.1.1 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.

3.1.2 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 afternoons and evenings.

3.1.3 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 south-east 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.

3.1.4 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); these are discussed further in Section 5.6.1.

3.1.5 Hydrology

Surface water

An unnamed resource enhancement category sumpland is located within the footprint of the proposed WWTE plant; however, as drainage has been interrupted by developments around the site.

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 and 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 north-west, towards the river. The groundwater is located 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 a licence 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.

3.1.6 Contaminated sites

Approximately 1.8 km upgradient of the proposed WWTE plant location is a site listed on the Contaminated Sites Database administered by the Department of Environment Regulation (DER) as Contaminated – Remediation required (Lot 20 Adelaide St, 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 quality of down-gradient groundwater quality beneath the existing Hazelmere Recycling Centre.

Groundwater quality on site is outlined in Table 4.

Table 4: Groundwater quality

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

Source: Anergy 2012a

3.2 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.

3.2.1 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 Naturemap database (DPaW 2013) displayed two priority-listed flora species within 1 km of the existing Hazelmere Recycling Centre (Appendix 1):

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

As the Hazelmere Recycling Centre is sparsely vegetated and highly degraded, it is a poor quality habitat for these flora species and this area 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.

3.2.2 Fauna

A search of the Naturemap database (DPaW 2013) displayed one priority-listed flora species within 1 km of the existing Hazelmere Recycling Centre (Appendix 1); *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 and this area is not expected to be is important for this species.

3.3 Social environment

Various land uses surround the proposed Resource Recovery Park include:

- 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).

3.3.1 Sensitive receptors

Residential premises are located adjacent to the current Hazelmere Recycling Centre to the west and south at 61, 53 and 54 Lakes Rd, 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 Cresent Bushland, Hazelmere, is located 400 m to the south east and the other, BFA 213, Bushmead Bushland, Swan is located further to the east of BFA 481.

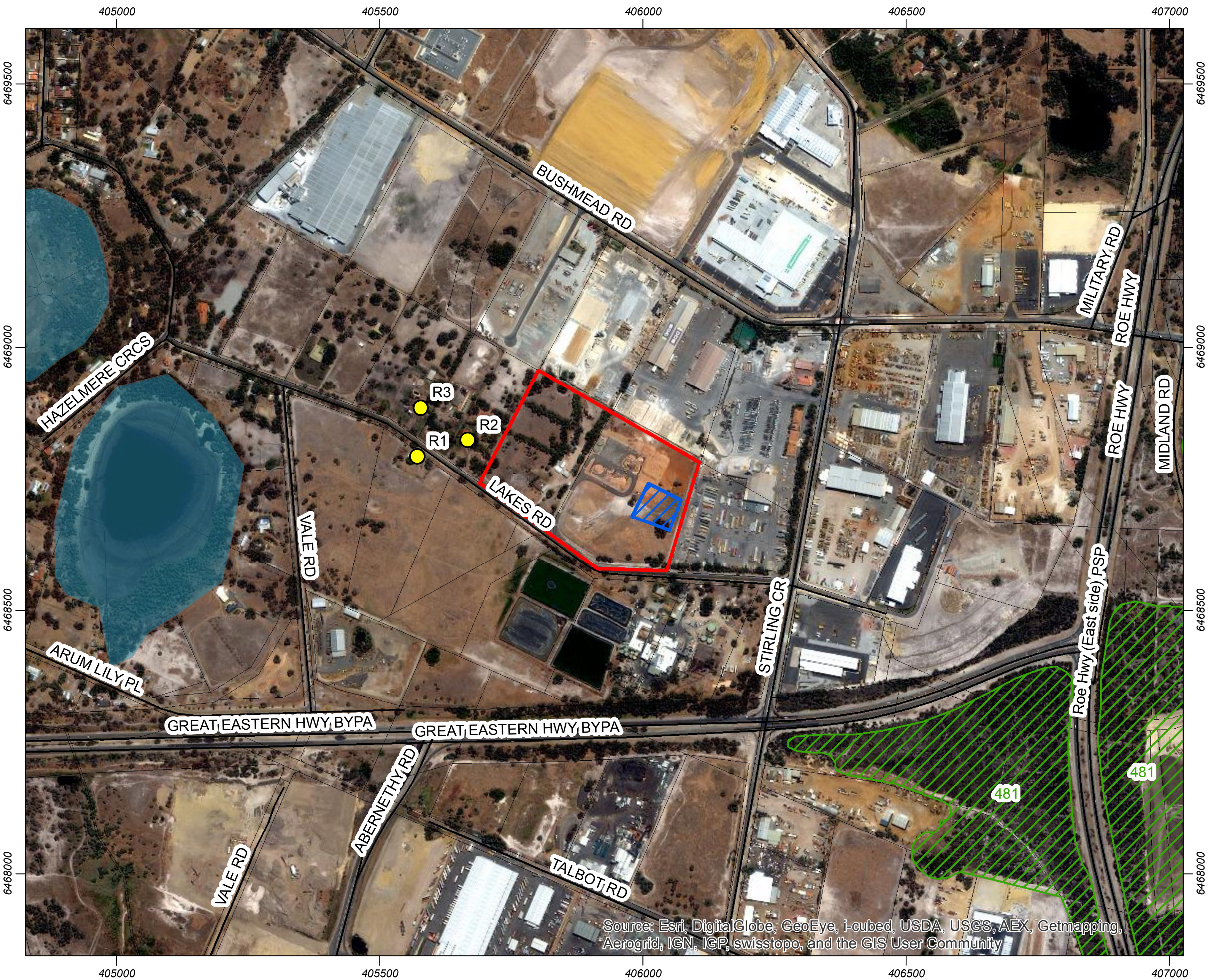
Sensitive receptors are shown in Figure 3.

3.3.2 Areas of significance

A search of the 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 3
Sensitive receptors



Legend

- Sensitive receptors point
- Site location
- Indicative WTE location
- Lake
- Bush Forever Areas
- Major river
- Roads

Scale 1:10,000 at A4

0 50 100 150 200 250 Meters

N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 24/12/2013
Author: SFinning
Source: Zoning: Landgate 2013; Roads: MRWA 2013

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4. Design, construction and operation

4.1 Proposal characteristics

The key characteristics are included in Table 5.

Table 5: Key characteristics table

Summary of the proposal

Proposal title	Hazelmere waste wood to energy plant
Proponent name	Eastern Metropolitan Regional Council
Short description	This proposal is to construct and operate a 3 MW pyrolysis plant at the existing timber recycling facility at Part Lot 100 and Lot 201 Lakes Road, Hazelmere. The plant will convert feedstock of waste wood (derived from pallets, crates, cable reels and particle board shredded to <50 mm) to electricity to contribute to the SWIS. There is no proposal to woodchip trees for this purpose. Process waste will take the form of bio-char (for which there is a potential market) and air emissions. The plant has an expected lifespan of 25 years.

Physical elements

Element	Location	Proposed extent authorised
Pyrolysis plant	Figure 1	To be constructed on 0.2 ha in a pre-cleared lot currently zoned for industrial use

Operational elements

Element	Location	Proposed extent authorised
Feed		Waste wood (pallets, packaging and crates, off-cuts and cable reels)
Excluded waste		All non-wood waste, medium-density fibreboard (MDF), particleboard/chip board, low pressure laminated board Wood chips sourced directly from trees will not be used
Quantity of waste to be processed		3.1 tonnes per hour (or 13 000 tpa)
Bio-char production		up to 1500 tpa
Wastewater		up to 5 ML/day
Power generation		Up to 3 MWe energy generated to delivery to SWIS

4.2 Process summary

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 (conversion of tar materials in a catalytic reformer 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 (at 10 m above ground level).
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).

4.3 Inputs and outputs

Inputs are listed as follows:

- shredded recycled wood chip
- natural gas (for SACTO)
- process water.

Outputs will comprise:

- electricity
- exhaust air
- wastewater
- solid bio-char.

4.4 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 (Anergy 2012a). The plant will be connected to the South West Interconnected System (SWIS) grid. Table 6 shows the operation specification for the plant.

Table 6: Operation specifications

Aspect	Specification
Nominal operating schedule	14 hr/day, 5 days/wk
Total operating hours	3640 hpa
Operating period for power generation	13 hr/day
Total operating hours producing power	3380 hpa
Electrical output	2.81 MWe
Annual energy production	9498 MWh per year

Source: Anergy 2012a

4.5 Feed system

Feedstock of waste wood 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 trees. The feed is shredded wood waste of less than 50 mm pieces and the weight of incoming feed material is measured in the feed bin. The wood chip analysis is presented in Table 7.

Table 7: 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

Source: Anergy 2012a

4.6 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 and a twin screw is utilised to feed material into the kiln (Anergy 2012a).

Pyrolysis occurs inside the heat tube of the rotary indirect fired kiln, where moisture and volatile fractions undergo pyrolysis in the absence of oxygen at approximately 800˚C. Solids (char) separate out at the base of the discharge chamber and syngas is captured and discharged from the chamber for cleaning.

Table 8: 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 are temperature	20˚C	5–35˚C
Specific energy input	1.25 kW/kg	0.80–1.6 kW/kg

Source: Anergy 2012a

4.7 Gas cleanup

Prior to cleaning, the syngas contains a mixture of compounds summarised in Table 9. Cleaning is conducted using a char bed. Tar compounds, dust, remaining tars and excess moisture 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 cleaned gas is then transported back to the kiln for heating fuel and used in the gas engines for energy production.

Table 9: Kiln products

Gas	Cleaning process	Purpose
hydrogen (H_2)		Resultant syngas component
carbon monoxide (CO)		Resultant syngas component
carbon dioxide (CO_2)		Resultant syngas component
steam		Resultant syngas component
light paraffin (methane, ethane, propane)		Resultant syngas component
light olefins (acetylene, ethylene)		Resultant syngas component
light aromatics (benzene, toluene)		Resultant syngas component
ammonia	Condensed at low temperatures	
acid gases (hydrogen sulphide, hydrogen chloride)	Condensed at low temperatures	
nitrogen and inert gases		
light tars - polycyclic aromatic hydrocarbons (PAH)	Reformer and condensed at low temperatures	Recover as much as possible by conversion into H and CO
heavy tars - polycyclic aromatic hydrocarbons (PAH)	Reformer and condensed at low temperatures	Recover as much as possible by conversion into H and CO
Char	Removed as a solid	Not applicable to energy generation
Dust	Condensed at low temperatures	Not applicable to energy generation

Source: Anergy 2012a

4.8 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 which both transports the char and cools it to less than 80℃. Water sprays are also used to ensure the temperature of the product is lowered (which reduces the potential for char dust). The char is then stored for eventual transport offsite. The use for the bio-char is yet to be determined; however, bio-char can be used in applications such as agricultural applications in soil and in brick manufacturing as a fuel substitute. If no market is available for the bio-char, it would report to landfill.

4.9 Wastewater treatment

Once enough 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 discharge into a tank for re-use in the process. Water is tested by manual sampling to ensure appropriate quality. If the activated carbon has reached peak loading, the column will be replaced and sent for reprocessing.

4.10 Thermal oxidiser

A SACTO is used to balance the load of syngas between engines and kilns by combusting all excess gases. 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 for contingency backup. Staged air flow is used to encourage a swirl within the unit to maximise mixing and temperature to achieve complete combustion. Exhaust from the pyrolysis 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 10.

Table 10: SACTO specifications

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

Source: Anergy 2012a

4.11 Gas engines

Syngas is combusted in eight 500 kW gas engines generator sets, each within an audio 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, air-fuel ratio system).

The eight engine sets are controlled using a multiple-generator management system which 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 11.

Table 11: 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	

Source: Anergy 2012a

4.12 Utilities and plant services

The plant will require:

- water
- oxygen
- nitrogen
- natural gas (see specifications in Table 12) and diesel fuel (for contingency backup)
- high voltage power lines.

Table 12: 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

Source: Anergy 2012a

The plant requires general utilities including:

- cooling and process water circuit
- plant air and instrument air compressors and drying service
- oxygen plant for 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.

4.13 Personnel

Operation of the plant will require skilled staff that has 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 staff.

4.14 Procedural controls

Procedural controls will include:

- permits to work
- hot work permits
- isolation
- control system override and maintenance
- confined space entry.

4.15 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) and hearing protection (in limited areas).

5. Environmental management

The environmental factors are considered to be:

- noise emissions
- dust emissions
- air emissions
- odour
- wastewater disposal
- groundwater management
- fire risk
- traffic management.

The listed factors are discussed in this section.

5.1 Noise emissions

Environmental noise can cause disturbance to nearby residents, industrial and commercial operators if noise is above levels designated in state legislation and regulations. Operational noise is considered an environmental factor in assessing possible impacts of the WWTE plant.

Noise modelling has been conducted by Lloyd George Acoustics (2013) to assess the proposed noise levels of the operational WWTE plant. The full report is contained in Appendix 2. Modelling has assumed the plant runs from 0800–2200 hrs, Monday to Friday.

The design goal for the WWTE is to achieve noise levels at each premises at 5 dB below the assigned level to compensate for other potential noise sources in the vicinity and provide an allowance for tonality, if the noise is tonal.

5.1.1 Sensitive receptors

Nine sensitive receptors were identified surrounding the proposed location of the WWTE plant (Figure 3). Each of these sensitive receptors has an individual influencing factor incorporated into their assigned level to take into account the proximity of background noise from industrial or commercial sites or road traffic. The assigned level comprises the criteria of ‘acceptable noise levels’ received by the premises.

Industrial land is located on the northern and eastern boundaries.

5.1.2 Results

Modelling results for daytime hours, summarised in Table 13, shows that noise levels are predicted to comply with assigned levels at all sensitive premises and to comply with the design goal of 5 dB under the assigned noise level.

Table 13: Results of noise modelling (daytime; Mon-Sat 0700-1900)

ID	Location	Baseline assigned level	Influencing factor	Assigned noise level	Predicted noise level	Difference between predicted and assigned noise level
		L_{A10} (dB)	(dB)	L_{A10} (dB)	L_{A10} (dB)	(dB)
1	Lakes Road	45	6	51	42	9
2	Lakes Road	45	9	54	45	9
3	Lakes Road	45	5	50	41	9
4	Lakes Road	45	3	48	37	11

ID	Location	Baseline assigned level	Influencing factor	Assigned noise level	Predicted noise level	Difference between predicted and assigned noise level
5	Lakes Road	45	1	46	34	12
6	Lakes Road	45	1	46	33	13
7	Hazelmere Circus	45	1	46	32	14
8	Bushmead Road	45	7	52	35	17
9	Stirling Crescent	45	4	49	37	12
10	BGC – site within 15 m of building	65	0	65	53	12
11	BGC site – near site boundary	65	0	65	57	8

Source: Lloyd George Acoustics 2013

Modelling results for evening hours, summarised in Table 14, 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.

Table 14: Results of noise modelling (evening; Mon-Sat 1900-2200)

ID	Location	Baseline assigned level	Influencing factor	Assigned noise level	Predicted noise level	Difference between predicted and assigned noise level
		L_{A10} (dB)	(dB)	L_{A10} (dB)	L_{A10} (dB)	(dB)
1	Lakes Road	40	6	46	42	**4**
2	Lakes Road	40	9	49	45	**4**
3	Lakes Road	40	5	45	41	**4**
4	Lakes Road	40	3	43	37	6
5	Lakes Road	40	1	41	34	7
6	Lakes Road	40	1	41	33	8
7	Hazelmere Circus	40	1	41	32	9
8	Bushmead Road	40	7	47	35	12
9	Stirling Crescent	40	4	44	37	7
10	BGC – site within 15m of building	65	0	65	53	12
11	BGC site – near site boundary	65	0	65	57	8

Source: Lloyd George Acoustics 2013

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.

5.1.3 Noise monitoring

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.

5.2 Dust emissions

5.2.1 Potential dust sources

Dust generation is identified as a potential environmental impact resulting from earthworks carried out to prepare the site. Dust may arise from ground disturbance (vehicle traffic and excavation) as well as from errant sources (windblown dust from stockpiled soil).

Once the site is operational, airborne dust may occur as a result of the fuel type (wood chip) as well as the by-product (bio-char).

5.2.2 Construction emissions

Dust management will be carried out throughout clearing and construction to negate or reduce the generation of visible dust across site boundaries. Dust suppression methods to be employed may include:

- restriction of traffic to designated haul roads
- use of soil-binders on haul roads
- use of a water cart and/or sprinklers
- application of hydromulch
- covering stockpiles
- restricting operations to low wind conditions (<20 km/h)
- use of site boundary fencing reinforced with shadecloth along western and eastern boundaries to intercept dust during peak wind conditions
- strict enforcement of speed limits onsite (20 km/h).

5.2.3 Operational emissions

Dust emissions are present currently from the timber grinding operation at the Hazelmere Recycling Centre; therefore, it is considered that the impact from this proposed plant would be no greater than that is currently experienced at the site. Dust may also be generated as the bio-char exits the pyrolysis kiln; however, during transport (by conveyor) and prior to the bio-char being packaged in bulka-bags, the bio-char is quenched with water; therefore, the generation of dust is limited. Particulates from the stack are not in excess of NEPM limits (see Section 5.3.6); therefore, particulates are not expected to be an issue from the stack or the generator sets.

5.2.4 Monitoring

While dust may be present during both construction and operations, it is not envisaged to travel beyond site boundaries. Onsite management during construction will aim to ameliorate airborne dust, similarly onsite management measures will ensure airborne dust does not pose a risk to human or environmental health. The monitoring of levels of airborne particulate matter (whether nuisance dust, respirable or inhalable dust) is not foreseen to contribute effectively to better dust management at the site. As such, no dust monitoring is proposed at this stage.

5.3 Air emissions

An assessment of the impacts of air emissions from point sources within the WWTE plant has been carried out using dispersion modelling as per guidance notes provided by DER (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 WTE facility. Key elements of the assessment include:

- 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 WID (EU 2000)
- collation of background air quality data for the cumulative impact
- assembly of air quality standards (assessment criteria) relevant to impacts from 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
- plume rise assessment as per requirements from the Civil Aviation Safety Authority (CASA).

Further details of these activities are provided in the following sections.

5.3.1 Emissions inventory

The air emissions assessment has focussed on parameters detailed in the EPA report on WTE environmental and health performance (EPA 2013), with these parameters and emission concentration limits derived from the EU WID. Emissions testing data of sufficient quality and quantity from an operating facility were not available for all of these 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 and key process design parameters that influence the formation and fate of air emissions within the process.

The maximum emission rates calculated in the emissions inventory for each of the WID parameters have been used for the dispersion modelling. These reflect a conservative position for the combination of all the potential process operating conditions as envisaged at this stage of the project development. Key process variables will be optimised in the operating facility, with some of those directly affecting air emissions outcomes. In particular, three types of catalyst have been proposed for the raw syngas reformer (dolomite, char and nickel catalyst) which provide different chemistries for some emission parameters or their precursors. In addition, 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. As a consequence, the impact of the different reformation catalysts and scrubbing at both acidic (pH 4) and alkaline (pH 9) conditions has been considered in the emissions inventory.

The exact form of heavy metals that report to the dirty syngas from the pyrolysis kiln is not known with certainty so three metals scenarios have been considered where the physical properties (melting and boiling points) of metals as the free metal, metal sulfides and metal oxides have been used to predict their partitioning in the reformation and scrubbing processes. Full details of these considerations and the emissions inventory are reported in Strategen 2013a.

The emissions data used for the dispersion modelling is presented in Table 15.[1] Details of the emission scenarios for normal and reduced rate operations and emergency bypass conditions (for unplanned plant outages) are presented in Section 5.3.2.

[1] The values have been displayed in the MS Excel scientific format for direct integration into the dispersion model.

Table 15: Emissions data for dispersion modelling

Emissions	Units	Main stack - maximum values			Gas engines - maximum values		
		Normal emissions	Reduced rate emissions	Bypass emissions	Normal emissions	Reduced rate emissions	Bypass emissions
NOx	g/s	6.93E-02	1.74E-01	9.05E-01	1.93E+00	9.63E-01	0.00E+00
SO_2	g/s	2.90E-02	7.43E-02	1.51E-01	9.47E-02	4.73E-02	0.00E+00
CO	g/s	7.60E-02	1.95E-01	4.15E-01	2.97E+00	1.49E+00	0.00E+00
Total VOC	g/s	8.19E-03	2.08E-02	4.00E-02	6.19E-02	3.09E-02	0.00E+00
HCl	g/s	1.51E-04	3.86E-04	2.10E-02	4.92E-04	2.46E-04	0.00E+00
HF	g/s	5.08E-05	1.30E-04	3.94E-04	1.66E-04	8.31E-05	0.00E+00
Hg	g/s	8.05E-08	2.07E-07	5.61E-06	2.63E-07	1.32E-07	0.00E+00
Cd	g/s	4.20E-08	1.08E-07	2.20E-04	1.37E-07	6.87E-08	0.00E+00
Tl	g/s	9.05E-08	2.32E-07	1.89E-04	2.96E-07	1.48E-07	0.00E+00
Sb	g/s	5.37E-09	1.38E-08	3.74E-06	1.75E-08	8.77E-09	0.00E+00
As	g/s	4.89E-06	1.25E-05	3.41E-03	1.60E-05	7.99E-06	0.00E+00
Cr	g/s	1.16E-07	2.97E-07	6.06E-04	3.79E-07	1.89E-07	0.00E+00
Co	g/s	7.16E-11	1.84E-10	3.74E-07	2.34E-10	1.17E-10	0.00E+00
Cu	g/s	1.45E-07	3.71E-07	7.57E-04	4.73E-07	2.37E-07	0.00E+00
Pb	g/s	7.24E-08	1.86E-07	3.79E-04	2.37E-07	1.18E-07	0.00E+00
Mn	g/s	1.43E-13	3.67E-13	7.48E-10	4.68E-13	2.34E-13	0.00E+00
Ni	g/s	9.05E-08	2.32E-07	1.89E-04	2.96E-07	1.48E-07	0.00E+00
V	g/s	3.58E-10	9.18E-10	3.74E-07	1.17E-09	5.85E-10	0.00E+00
Particulates	g/s	9.40E-03	3.61E-03	3.32E-01	7.22E-03	3.61E-03	0.00E+00
Dioxins	g TEQ/s	6.74E-12	1.74E-11	2.88E-11	2.20E-11	1.10E-11	0.00E+00

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 = sum of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofuran congeners factored by their respective toxic equivalency factors

5.3.2 Emissions scenarios

Five operating scenarios have been considered for the air emissions impact assessment, which give rise to three emissions scenarios for the modelling as identified in Table 15. An overview of these operating scenarios is summarised in Table 16.

Table 16: 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
2. High 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 next day

Operating scenario	Emission scenario	Description	Comment
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 assumes continuous emissions for up to 2 hours as a conservative position for emissions impact assessment. Actual duration of this scenario will be < 30 minutes, as the feed rate will be reduced. 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 a failure of the syngas clean-up system is detected and wood feed is terminated to stop production of raw syngas
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.

EMRC expects that the initial operation of the facility would be under a peak power demand operating scenario, which reflects the expected power take-off arrangements that would be negotiated where power is supplied to customer(s) for peak demand periods only, nominally 14 hours per day for 5 days per week. The continuous normal operating scenario (continuous operation 24 hours per day, 7 days per week) may eventuate if demand is identified for power from this facility at all times. The predicted GLCs for the continuous normal operation were assumed to prevail for the peak power demand (normal) operating scenario to provide a conservative approach for assessment of impacts in the initial stages of operation.

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, providing a conservative basis for the emissions assessments.

5.3.3 Main stack emissions concentrations and WID limits

The EPA guidance document (EPA 2013) requires emissions from a WTE facility to be compared with the WID concentration limits. This is appropriate for operation under bypass conditions, when raw syngas is fed directly to the SACTO for combustion. The raw syngas is not a fuel that can be utilised for production of electricity due to the presence of tars, particulates, metals and other contaminants that would otherwise be removed under normal operating conditions in the reformer and scrubber to produce clean syngas.

A comparison of maximum predicted emission concentrations from the main stack with WID limits for normal operation is shown in Table 17. The short duration expected for operation under this scenario (<30 minutes) suggests that the 30-minute average limits are more appropriate for comparison with the predicted stack emissions than the daily average limits.

Table 17: Comparison of emission concentrations and WID limits – bypass operation

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

No exceedances of the WID limits are predicted for the emissions under bypass conditions.

A comparison of the stack emissions from normal operating conditions with the WID is considered by the proponent to be outside the scope of the EPA guidance document. Under those conditions the emissions result from combustion of clean syngas in the kiln burners and a small amount from combustion of natural gas in the SACTO under idle conditions. Similarly, a comparison of stack emissions from reduced rate operating conditions is also considered outside the scope of the EPA guidance document as clean syngas will also be combusted in the SACTO until the clean syngas production rate is reduced to satisfy the reduced demand from the engines that remain on-line.

Emissions from combustion of clean syngas will be predominately CO_2 and water, with smaller amounts of NOx and CO, as the vast majority of contaminants have been removed from the raw syngas in the reformation and scrubbing processes that generates the clean syngas. The clean syngas is a fuel and not a waste.

5.3.4 Gas engine exhaust emissions concentrations and WID limits

Recommendation 8 of the WTE guidance document from WA EPA 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)."

The use of spark ignition 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. However, 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 Hazelmere WTE facility is a fuel that will be comprised of predominately 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 clean 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. As a consequence, a comparison of emission concentrations from the gas engines with the WID limits is considered by the proponent as not 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 which does purify 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.

An assessment of predicted environmental impacts of emissions from the gas engines using dispersion modelling is described in Section 5.3.6.

5.3.5 Background air quality data and assessment criteria

EMRC has previously conducted an air emission assessment as part of environmental approvals for a proposed Resource Recovery Facility (WTE [gasification] or anaerobic digestion technology) at their 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 AQMS and found to be of similar magnitude in concentrations. The Red Hill data are considered appropriate for use in this assessment to determine the cumulative impacts of air emissions from the WWTE plant.

The air quality criteria and standards used in the Red Hill RRF assessment are considered appropriate for the Hazelmere project. A thorough review of air quality criteria was conducted for the Red Hill project that included consultation with the Department of Health (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 WTE projects in WA. No change in that status has occurred since the submission of approvals documentation for the Red Hill project.

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. The oxides of nitrogen (NO_X) emissions from the WTE 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 the remainder of the NO_X emissions.[2] A conservative assumption is made for the impact assessment 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 WTE 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).

VOC emissions have been estimated as TOC; however, ambient air quality standards are not available for this parameter.

Details of the assessment criteria and background concentrations used for the Hazelmere WTE assessment are shown in Table 18.

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

Table 18: Air quality assessment criteria and background concentrations

Pollutant	Assessment criteria averaging Period	Assessment criteria ($\mu g/m^3$)	WA relevant guideline	Background concentration for impact assessment ($\mu g/m^3$)	% 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 h	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 Department of Health - Acid Gases 2007 (DOH 2007)	30	30%
HF	1 hour	100	WA Department of Health - 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%
	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%
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	1	WHO guidelines for air quality (WHO 2000)	0.0001	0.01%
Mn	1 hour	18	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	0.04	0.2%
	Annual	0.15	WHO guidelines for air quality (WHO 2000), Air guideline values for selected substances (Toxikos 2010)	0.003	2%

Pollutant	Assessment criteria averaging Period	Assessment criteria (µg/m^3)	WA relevant guideline	Background concentration for impact assessment (µg/m^3)	% of assessment criteria
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 Ni 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)[3]	1 hour	0.000001	Air guideline values for selected substances (Toxikos 2010)	0.00000048	48%

[3] TEQ calculated from WHO 2005 TEFs

5.3.6 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 TAPM.[4] Full details of the modelling configuration are provided in the report from Environ (2013) located in Appendix 3.

Three residences to the west of the EMRC Hazelmere site were identified as sensitive receptors for the emissions impact assessment (Figure 3), with industrial premises surrounding the remainder of the EMRC site.

Tabulated results are reported in the following sections for predicted ground level concentrations (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 (approval for which is not being sought in this application). Therefore, it is likely that this receptor will be removed in the future.

Results from dispersion modelling – direct impact assessment

The results from the dispersion modelling of Scenarios 1 and 2 (normal operations) are summarised in Table 19 for the R2. 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 4. Predicted GLCs for all other emissions parameters were well below their respective air quality criteria.

The results from the dispersion modelling of Scenario 3 (reduced rate operations) are summarised in Table 20. 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 were 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 5 for comparison with NO_2 impacts for normal operations.

The results from the dispersion modelling of Scenarios 4 and 5 (bypass operations) are summarised in Table 21. 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 operating 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.

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

Table 19: Maximum predicted GLCs at R2 – continuous operations

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%
	0.003	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}	10	1 hour	0.000013	0.00013%
Cr^{VI}	0.0002	Annual	0.000000052	0.026000%
Cu	1	24 hour	0.0000060	0.0006%
Hg	1.8	1 hour	0.0000091	0.0005%
	1	Annual	0.00000036	0.000036%
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%

Figure 4: Contour plot of maximum predicted 1-hour average NO_2 GLCs for normal operations

Table 20: Maximum predicted GLCs at R2 – reduced rate operations

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	100000	15 min	101	0.10%
	60000	30 min	71	0.12%
	30000	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}	10	1 hour	0.0000078	0.00008%
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%

Figure 5: Contour plot of maximum predicted 1-hour average NO_2 GLCs for reduced rate operations

Table 21: Maximum predicted GLCs at R2 – bypass operations

Emission	Assessment criteria (µg/m^3)	Average period	Predicted maximum concentration (µg/m^3)	Percentage of assessment criteria
NO2	246.4	1 hour	11	4.6%
SO2	500	10 min	6.8	1.4%
	571.8	1 hour	1.9	0.33%
CO	100000	15 min	15	0.015%
	60000	30 min	11	0.018%
	30000	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
CrIII	10	1 hour	0.0075	0.08%
CrVI	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%

Results from dispersion modelling – cumulative impact assessment

A cumulative impact assessment has been conducted using the background concentration data (Table 18) and the maximum predicted GLCs for direct impacts of the facility.

The results of the cumulative impact assessment for continuous normal operations (Scenarios 1 and 2) are presented in Table 22, the reduced rate operations (Scenario 3) is presented in Table 23 and the bypass operations (Scenarios 4 and 5) is presented in Table 24

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 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 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.

Table 22: Maximum predicted GLCs at R2 – cumulative impact assessment for continuous normal operations

Emission	Assessment criteria (μg/m^3)	Average period	Predicted maximum concentration (μg/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	100000	15 min	680	0.68%
	60000	30 min	601	1.0%
	30000	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%
	0.003	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}	10	1 hour	0.020	0.20%
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%
	1	Annual	0.00010	0.010%
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 23: Maximum predicted GLCs at R2 – cumulative impact assessment for reduced rate operations

Emission	Assessment criteria (µg/m^3)	Average period	Predicted maximum concentration (µg/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	100000	15 min	581	0.58%
	60000	30 min	531	0.9%
	30000	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}	10	1 hour	0.020	0.20%
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 24: Maximum predicted GLCs at R2 – cumulative impact assessment for bypass operations

Emission	Assessment criteria (µg/m³)	Average period	Predicted maximum concentration (µg/m³)	% 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	100000	15 min	495	0.50%
	60000	30 min	471	0.78%
	30000	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}	10	1 hour	0.028	0.28%
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%

5.3.7 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.

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. 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 part of the commissioning involves introduction of wood feed to the pyrolysis kiln to generate syngas. All systems will be on-line during this stage of commissioning that tests 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. A manual bypass event will be initiated to direct raw syngas direct to the SACTO as would occur during an emergency bypass event. The operation of the SACTO under maximum load conditions will be assessed during bypass commissioning.

Process optimisation

A program of process optimisation testing will follow successful commissioning of the facility. 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 in the works approval under normal operating conditions. Those emissions data will also be used to support the application for an environmental licence for commercial operations.

5.3.8 Plume rise assessment

The location of the main stack for the proposed WTE facility at EMRC Hazelmere site is in the flight path to runway 06/24 at Perth Airport. A plume rise assessment was therefore conducted of the main stack to assess the potential hazard to aviation posed by a vertical exhaust plume following methodology published by CASA (2004) and the revised guidelines published in 2012 (CASA 2012).[5] A summary of the results of that assessment is presented below with full details reported elsewhere (Strategen 2013b).

The assessment has shown that plumes from the stack could exceed the Critical Plume Velocity (CPV) of 4.3 m/s at the Obstacle Limiting Surface (OLS) of 60 m with a Critical Plume Height (CPH) of 86 m as illustrated by the blue plots in Figure 6. However, exceedances of the CPV would only occur under specific meteorological conditions of fast moving (vertical) air which would transport the stack emissions as a narrow plume of no more than 3 m in diameter from the point of discharge. The average plume velocity reaches a maximum of 3.8 m/s at 24 m above ground level (Green plot in Figure 6).

[5] The exhaust stacks from the gas engines were not assessed since they will be of lower height than the main stack

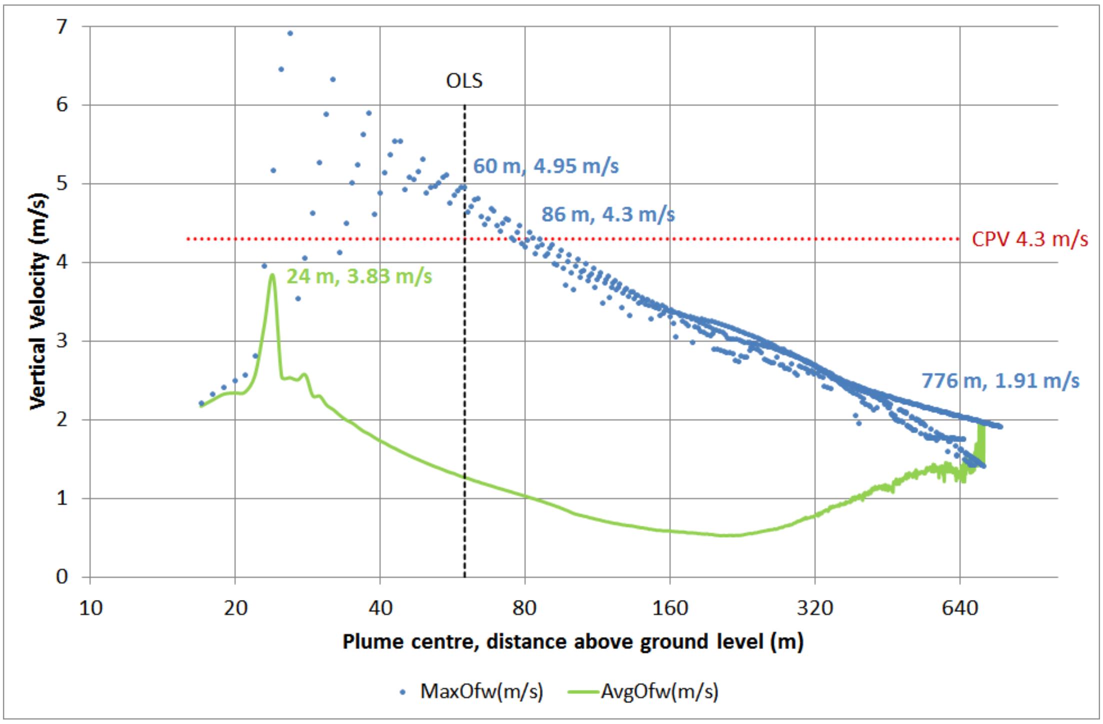

Figure 6: Vertical velocity at plume centre vs height above ground level

Importantly, the probability of the plume vertical velocity exceeding the CPV at and above the OLS height of 60 m is very low, being 0.0024% which is equivalent to 12.8 minutes per year. Under those conditions, the maximum velocity predicted at the OLS is 4.9 m/s.

Closer examination of the locations of the stack and runway shows the stack is 3.26 km from the commencement of the runway, which is 260 m into the second OLS section (Figure 7). That section has a slope of 2.5% which indicates that the actual OLS commences at an altitude of 66 m at the location of the stack. This further reduces the likelihood of plume vertical velocities in excess of the CPV and as such the discharge of air emissions from the 18.3 m main stack at the site is not expected to pose a significant hazard to aviation.

Figure 7: Approach surfaces for Perth Airport runway 06/24

5.4 Odour emissions

Significant odour emissions are not expected from the WWTE plant. Air emissions from the main stack and gas engine exhausts are predominately products of combustion of hydrogen and carbon monoxide, which are carbon dioxide and water. Other emissions include nitric oxide (NO) which has no odour and trace levels of sulfur dioxide. The levels of sulfur dioxide in the ambient air are predicted to be well below the threshold where odour is detected.

A small amount of odour may be present in the air headspace in the scrubber water surge tank from hydrocarbons which may separate from the water, as well as free ammonia and hydrogen sulfide that will be released from the ammonium and hydrosulfide ions in solution. The pH of the scrubber water will be optimised to maximise the solubility of these gases and keep them within solution. In addition, pressure relief for the tank headspace gases will be via a carbon filter to capture any odours.

The handling and stockpiling practices for the wood feed material for the WWTE plant will not result in the formation of fugitive odours. In particular, wood stockpiles would be processed at a rate that would preclude rotting of the wood when wet during the winter months.

The product bio-char material from the pyrolysis kiln will have a similar odour to briquettes used for domestic BBQs. The char will be stored in covered bins and bagged and exported from the site at regular intervals such that any odours from char handling would not impact on locations outside the facility.

5.5 Wastewater disposal

The WWTE plant is anticipated to use approximately 5 ML/day of water for cooling the gas engines, to quench bio-char and for use in the scrubber.

A water balance is being prepared and this will be provided when it has been completed. The water balance will outline the amount of wastewater expected to be disposed from the site, which in turn will define the appropriate method of wastewater disposal and allow for the design of the holding tank before disposal. The holding (storage) tank would be designed to hold the wastewater for up to five days before requiring disposal.

The process of wastewater disposal may be further refined after the water balance has been undertaken, but it is expected that water will be recycled in the process and any effluent would be treated as industrial waste, and disposed of to a licensed facility. Discussions are ongoing relating to the disposal via a neighbouring Water Corp tradewaste connection point to the reticulated wastewater network.

5.6 Groundwater management

The depth to groundwater at the site is considered to be shallow (within 1.5 m of the ground surface) and the direction of groundwater flow is north westerly (JDSi 2013).

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 given the expectation of imported 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).

5.6.1 Acid Sulphate Soils

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 are yet to be undertaken to understand the extent of excavations required for construction; however, ASS management are expected to be required for deep service excavations (such as a sewer). Deep service excavations are not proposed for the WWTE plant.

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.

5.6.2 Contamination

Four sets of nested groundwater monitoring bores were installed at the Hazelmere facility in November 2012 to determine background groundwater quality and 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 through for the WWTE plant.

5.7 Fire risk

Fire is a hazard to this plant. Dust may pose a fire hazard where an atmosphere arises containing an air-fuel mix within explosive limits. This may occur with regards to dust from wood waste, dust from bio-char and from syngas (both prior to cleaning and after cleaning). Explosive limits for dust from wood waste have not been characterised; however, limits will be influenced by the moisture content of the feed material (dependant on age) and particle size (Anergy 2012b). Increased moisture content and larger particles have a diminished risk of ignition.

Hazards posed by wood waste dust will be managed by preventing ignition sources in the area and selecting appropriate instruments for within the feed bin. Hazards posed by bio-char dust will be managed via a quenching system proposed as the bio-char exits the kiln.

Fire risks will be managed using a firewater system designed and incorporated into the plant layout. The firewater system consists of a dedicated firewater tank, two dedicated firewater pumps, each of a different fuel type (diesel/ electric). Firewater mains will be reticulated around the plant, with hose reels at appropriate locations and hydrants along plant boundaries.

5.8 Traffic Management

5.8.1 Onsite traffic

The plant employs vehicles in the form of light vehicles, forklifts equipment, trucks and front-end loaders, as well as requiring pedestrian traffic within the plant boundary.

Traffic within the site will be managed by plant design, whereby the front-end loader movement will be restricted to a single area near the feed bin, and further engineering controls such as bollards may also be employed here. Forklift traffic will be restricted to the site perimeter for movement of char and activated carbon. Light vehicle and truck traffic through the centre of the site will be restricted to maintenance periods. Procedures and permits shall be employed to managed traffic during these times.

Qualified personnel will be required to employ appropriate PPE as directed by procedures, signage and plant safety protocols.

5.8.2 Offsite traffic

Stakeholder consultation identified an increase in traffic movements (primarily truck and trailer movements) as an important factor for the amenity of the area. The proposed route used by trucks and trailers accessing and leaving the site would be along Lakes Road and Stirling Crescent to the Roe Highway. This route may be subject to change over the next three years in accordance with an planned upgrade of Bushmead Road and Lakes Road in conjunction with the extension of Lloyd Street by City of Swan . The increase in traffic impact has been calculated based on the current proposed road-use.

The WWtE plant is likely to produce around 1500 tonnes of bio-char per year. The bio-char will be trucked off site either by two 15-tonne trucks or a 30-tonne truck and trailer. This equates to approximately 100 additional trucks per year or 50 additional trucks and trailers per year. On average, two extra truck movements are anticipated per week from the WtE plant.

Current movements to the Hazelmere facility average around 35 truck movements per day, or 175 movements per week (based on a five day week). Potentially, the count could increase by two trucks per week, which gives 177 movements per week on average. This is an increase of just over 1% of traffic from the Hazelmere facility.

Counts from 2008–2009 show that Bushmead Road east of West Parade was used by 6810 vehicles per weekday on average, having increased from 6060 in 2006–2007 and 5250 in 2004–2005 (Main Roads WA 2009). Around 144 trucks that use Lakes Road on a daily basis, or 720 movements per week (based on a five day week). The increase of two trucks per week equates to an increase of around 0.3%.

6. Further information for EPA referral

6.1 Alignment with EPA recommendations (EPA Report 1468)

EMRC has referred the Proposal to the EPA with a view to obtaining a Level of Assessment (LOA) of Not Assessed, Managed under Part V of the AP Act. EMRC believes that this LOA is appropriate as the Proposal is anticipated to conform with the recommendations in the EPA (2013) report on Waste to Energy plants in Western Australia, the *Environmental and health performance of waste to energy technologies*. These recommendations are outlined in Table 25. Therefore, a Works Approval and Licence to Operate under Part V of the EP Act are believed to represent adequate means for assessing and regulating the potential environmental effects of the Proposal.

Table 25: EPA recommendations for waste to energy technologies

Recommendation		Response	Reference within supporting document
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 (i.e. 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 laminated chip board are not proposed to be used in the process.	Section 2.5
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 woodchips 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.	
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.	The main comparable plant is the Ansac pilot plant, which has been subjected to extensive trials on the pyrolysis process and gas clean-up system to determine the performance of the proposed technology using several different feedstocks. Other WTE technologies being implemented or proposed in WA include gasification and anaerobic digestion at Red Hill Resource Recovery Facility (EMRC), and gasification at Boodarie at East Rockingham (NEC). EMRC have engaged the Centre for Energy at UWA to provide an independent evaluation of proposed engineering designs and drawings to ensure the plant will meet its process and energy generation objectives. Premier Coal Char Plant is also a comparable plant that uses pyrolysis of coal, other international reference facilities include Canada (110 000 tpa green biomass to fuel oil and syngas) and Malaysia (15 000 tpa biomass to fuel oil and syngas),	Section 1.2

Recommendation		Response	Reference within supporting document
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 feedstock has not been extensively investigated; however, the physical processing of other waste materials would be possible using the current technology. EMRC has investigated the suitability of wood chip feedstock from softwood, hardwood and mixtures thereof. Ansac has also trialled other feedstocks including refuse derived fuel (RDF).	Section 4.5
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. This document outlines the proposed feed of the WWTE plant in Table 5 which 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 4.1
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 4.5
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 Table 5 which 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 1.2
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).	Air emission investigations have been undertaken and include the provision to meet the emission standards in the European Union's Waste Incineration Directive (WID) emission criteria (2000/76/EC).	Section 5.3
9	Pollution control equipment must be capable of meeting emissions standards during non-standard operations.	Air emission investigations have been undertaken and have investigated the capability of the pant during non-standard conditions (i.e. reduced rate and bypass conditions.	Section 5.3

Recommendation		Response	Reference within supporting document
10	Continuous Emissions Monitoring must be applied where the technology is feasible to do so (e.g. particulates, TOC, HCl, HF, SO2, 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.	As the predicted air emissions are anticipated to be under threshold limits for all operating scenarios, monitoring is not considered to be required. 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.	Section 5.3
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 established background levels that were used in the assessment.	Section 5.3
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 will have been removed from the clean syngas in the reformer and scrubber, and are not considered to be present at levels of concern.	Section 5.3
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 is not generally an odorous waste. Also measures to ensure that the feed and any water in holding tanks, etc., will not become odorous will be put in place during operations.	Section 5.4
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 using a char bed. Tar compounds, dust, remaining tars and excess moisture 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 char bed material will be treated or disposed of using an appropriate waste facility.	Section 5.3
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 disposed offsite unless it can be sold as a by-product fuel or soil amendment/carbon farming additive.	
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 and not from incineration or gasification, it is unlikely to contain a high level of contaminants. For example, bio-char can be used as a soil amendment as it improved soil health characteristics such as improving water retention and enhanced earthworm attraction.	

Recommendation		Response	Reference within supporting document
17	Long term use and disposal of any by-product must be considered in determining the acceptability of the proposed use.	As above.	
18	Standards should be set which specify the permitted composition of ash for further use.	As above.	
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.	As above.	
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 industrially zoned land which will incorporate sufficient buffering distances from sensitive receptors.	Section 2.2.1
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.	Efficiency is expected to be better than, or similar to, that of the Red Hill Resource Recovery Facility. For that facility, efficiency was expected to be approximately 0.59. Increasing efficiency to the European Union WID standard of 0.65 would have required higher steam pressures which was considered, in EMRC opinion, to be infeasible for Western Australian conditions; the EPA accepted this in its Report and Recommendations (Report 1487) of July 2013 for the facility. As the Hazelmere pyrolysis plant has a pure feedstock and is true pyrolysis, there is no oxygen or nitrogen present in the syngas and, with direct injection into gas engines, the energy efficiency is expected to be high.	

6.2 Significance test

In reaching a decision as to whether a proposal is likely to have a significant effect on the environment, whether it is likely to meet its objectives for environmental factors and consequently, whether a referred proposal should be assessed under Part IV of the EP Act, the EPA may have regard to the following:

- values, sensitivity and quality of the environment which is likely to be affected
- extent (intensity, duration, magnitude and geographic footprint) of the likely impacts
- consequence of the likely impacts (or change)
- resilience of the environment to cope with the impacts or changes
- cumulative impact with other projects
- level of confidence in the prediction of impacts and the success of proposed mitigation
- objectives of the Act, policies, guidelines, procedures and standards against which a proposal can be assessed
- presence of strategic planning framework
- presence of other statutory decision-making processes which regulate the mitigation of the potential effects on the environment to meet the EPA objectives and principles for EIA
- public concern about the likely effect of the proposal, if implemented, on the environment.

A significance test for the proposal has been undertaken against each of these criteria as outlined in Table 26

Table 26: Significance test (EPA referral)

Criteria	Assessment
Values, sensitivity and quality of the environment which is likely to be impacted	The main land uses in the area are for industrial purposes. The Proposal will not affect any environmentally significant areas or land features. There is no vegetation within the Proposal area and therefore, it is not anticipated that any TECs or PECs or Threatened flora would be affected. The site is not expected to provide habitat for native fauna species, thus it is not anticipated that native fauna would be affected.
Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts Consequence of the likely impacts (or change) Resilience of the environment to cope with the impacts or changes	The plant will cover approximately 0.2 ha. The proposal area is located on highly degraded land. Project life is expected to be 25 years. The overall effects of the Proposal are not expected to be significant at a local or regional level.
Cumulative impact with other projects	Cumulative impacts are not expected as, although other industrial land uses surround the site, this plant is the only one of its type proposed for the area.
Level of confidence in the prediction of impacts and the success of proposed mitigation	The environmental impacts of the Proposal will be addressed through management measures within a proposed EMP which will address air emissions, wastewater disposal, groundwater monitoring and dust monitoring.
Objects of the Act, policies, guidelines, procedures and standards against which a proposal can be assessed	The project can be assessed against the EPA Report 1468 which outlines EPA position on environmental and health performance of waste to energy technologies (EPA 2013). An analysis of the recommendations in the EPA (2013) report is located in Table 25 of this document.
Presence of strategic planning framework	Hazelmere Enterprise Area Structure Plan (City of Swan 2011).
Presence of other statutory decision-making processes which regulate the mitigation of the potential effects on the environment to meet the EPA objectives and principles for EIA	A number of key regulatory controls can be applied to the Project to ensure appropriate management includes (but is not limited to): • conditions of a Works Approval issued under Part V of the EP Act for construction of works on prescribed premises • conditions of Licence to Operate issued under Part V of the EP Act for the operation of activities on prescribed premises.
Public concern about the likely effect of the proposal, if implemented, on the environment	There is some public concern regarding increased traffic around the plant; however, traffic is unlikely to increase significantly for the proposal (two additional trucks per week compared with current conditions). Stakeholder consultation has been undertaken in July 2013 and will continue as required.

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Appendices (as attached in CD ROM or in electronic submission in the Industry Licensing System)

Appendix 1: Naturemap database search results

Appendix 2: Environmental Noise Assessment, Lloyd George Acoustics 2013

Appendix 3: Air emissions modelling, ENVIRON 2013