Public Environmental Review

EMRC Resource Recovery Facility Project

Prepared for Environmental Protection Authority

July 2012

Project Number V9090-015

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Eastern Metropolitan Regional Council	

INVITATION TO MAKE A SUBMISSION ON THIS PROPOSAL

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

The Eastern Metropolitan Regional Council (EMRC) proposes to develop a Resource Recovery Facility (RRF) to process Member Council kerbside MSW within the Red Hill Waste Management Facility. In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of **8** weeks from **23 July 2012,** closing on **17 September 2012**.

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

Where to get copies of this document
Printed copies (CD included) of the complete PER can be purchased for $10.00 (inc. GST, postage and handling), or free of charge in CD format only, from:

EMRC
1st Floor, Ascot Place
226 Great Eastern Highway
Belmont WA 6104
Tel: (08) 9424 2222

Red Hill Administration Office
Red Hill Waste Management Facility
1094 Toodyay Road
Red Hill WA 6056
Tel: (08) 9574 6235

The document/s may also be accessed through the proponent's website at www.emrc.org.au/per.html.

Why write a submission?
A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

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

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

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

When making comments on specific proposals in the PER:

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

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

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

Remember to include:

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

The closing date for submissions is: **17 September 2012**

The EPA prefers submissions to be made by email to submissions@epa.wa.gov.au.

Alternatively submissions can be

- posted to: Chairman, Environmental Protection Authority, Locked Bag 33, CLOISTERS SQUARE WA 6850, Attention: (Ann Stubbs); or
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth, Attention: (Ann Stubbs).

If you have any questions on how to make a submission, please ring the EPA assessment officer, Ann Stubbs on 6467 5409.

Executive Summary

Introduction

The project proponent, the Eastern Metropolitan Regional Council (EMRC), is a formally constituted Regional Council under the Local Government Act and comprises the following Member Councils: Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and the City of Swan.

The EMRC proposes to develop a Resource Recovery Facility (RRF) to process Member Council kerbside municipal solid waste (MSW) within the Red Hill Waste Management Facility (Red Hill WMF). RRFs are used to process domestic waste collected from the kerbside (excluding comingled recyclables) to produce valuable resources such as compost and/or energy and recyclables. The establishment of a RRF is intended to assist the EMRC in:

- Diverting waste from landfill and increasing the life expectancy of Red Hill WMF;
- Reducing the environmental impacts associated with landfilling, including greenhouse gas emissions and potential contamination of soil and groundwater;
- Increasing the recovery of resources from waste by generating marketable products, such as compost and/or energy and recyclables; and
- Producing renewable energy, primarily in the form of electricity.

The Environmental Protection Authority (EPA) set a level of assessment for the proposal of Public Environmental Review (PER) in September 2010. After the determination of appeals by the Minister for Environment, the EMRC prepared an Environmental Scoping Document (ESD) for the proposal which was approved by the EPA in October 2011. The PER document has been prepared to satisfy the requirements of the ESD.

This document describes the environmental factors and issues associated with each aspect of the proposal in detail and the approaches required to prevent, mitigate and manage environmental impacts.

Assessments carried out in preparing this report confirm that while protected species of national environmental significance may be present within a 1 km radius of the site the development is unlikely to have a significant impact on any matters of national environmental significance and as such a referral to the Minister for Sustainability, Environment, Water, Population and Communities is not required.

This report and all the background documents prepared for the purpose of this proposal are provided on a CD attached to the hardcopy of this document. Documents can also be downloaded from the EMRC website http://www.emrc.org.au/per.html. A list of these documents is provided in **Appendix E**.

Details of the Proposal

The EMRC has not yet determined the final technology that will be used to process the waste in the RRF, but the choice has been reduced to two options – anaerobic digestion and gasification. This will be determined following the receipt and assessment of tenders that will be invited from a list of Acceptable Tenderers developed through an Expression of Interest process. As such, the EMRC has undertaken detailed studies of the two preferred technology options as part of the PER process (see **Section 4.1**):

- **Anaerobic Digestion (AD)** – to produce biogas for energy production and compost.
- **Energy from Waste (EfW)** – gasification to produce renewable power.

The annual capacity of the proposed facility will depend on the technology implemented and the staging of the development, and in the case of AD technology, the type of domestic kerbside collection system used (i.e. two or three bin kerbside collection system). However, for the purposes of the proposal, a maximum capacity of 200,000 tonnes per annum is proposed for EfW and 150,000 tonnes per annum for AD.

The RRF is proposed to be located within a portion of Lot 12 which forms part of the Red Hill WMF and has been positioned adjoining the proposed future northern boundary with the road reserve for the realigned Perth - Adelaide Highway. The size of the site (Subject Site) required to locate the facility will also vary depending upon the technology chosen, but a 4 hectare area will cater for the options being considered. Landfilling operations are expected to continue at the Red Hill WMF for at least another 25 years.

The main potential environmental impacts/issues arising from the proposal are summarised below.

Air Emissions

In order to understand the impact of the proposed RRF on the current ambient air quality, Synergetics Environmental Engineering was commissioned to undertake ambient air monitoring and dispersion modelling. The results of the monitoring and modelling were compared to current air quality standards to ensure the AD and gasification technologies are compliant with these standards and to develop appropriate management where necessary.

The modelling of emissions from gasification and AD technologies found that no exceedances of ambient air quality standards or guidelines are predicted at nearby sensitive receptors for all emissions parameters associated with the respective technologies. This includes the predicted direct impact of emissions from the RRF, measured as Ground Level Concentrations (GLCs), or when background concentrations of pollutants are considered in the assessment along with predicted GLCs from the RRF.

Hence, it is considered unlikely that adverse community health impacts would arise from the operation of an RRF using either gasification or AD technologies.

Noise

The EMRC commissioned Lloyd George Acoustics Pty Ltd (LGA) to conduct a baseline noise emission study of the current operations at the Red Hill WMF. The study measured the noise levels of equipment on site and used computer modelling to predict these levels at the nearest residences of the Red Hill WMF.

This assessment has found that the baseline noise levels exceed the assigned night noise levels for two residences (R01 and R04), predominantly due to the noise emanating from the Landfill Gas and Power Pty Ltd (LGP) Power Station. This issue has been referred to LGP for attention and they are taking remedial action.

The modelling of the noise levels from the proposed RRF using the two technology options being considered by the EMRC has found that with appropriate design the facility would achieve compliance with the assigned noise levels at the nearby sensitive land uses if it were located at the Subject Site.

Odour

The EMRC commissioned SLR Consulting Australia Pty Ltd (SLR Consulting) to undertake baseline odour monitoring of a range of odour sources at the existing Red Hill WMF. The monitoring results were used with a dispersion model to predict offsite impacts from current operations and the two technology options being considered for the RRF located at the Subject Site.

Based on the results of the dispersion modelling, it is predicted that the Red Hill WMF currently operates within WA Department of Environment and Conservation (DEC) odour guidelines. Operation of a gasification RRF is not predicted to change this situation. However, operation of the AD option may pose problems at 3 receptors to the north and east of the Red Hill WMF, on Toodyay Road. Odour from the biofilters associated with the AD RRF together with current greenwaste windrows have been identified as the causes of this potential problem. Appropriate management measures are available to address this possibility. During the detailed design stage of the project reduction of odour emissions from the biofilters and/or the relocation or reduction of the size of the greenwaste windrows will be investigated to ensure odour limits are not exceeded. It is anticipated that if AD is introduced odour emissions from the current greenwaste windrows will reduce due to the diversion of the Mobile Garbage Bin (MGB) greenwaste to the AD facility. In order to control odours from the biofilter, an enclosed biofilter design could be installed if required.

Traffic

Waste that will be delivered to the RRF is already being transported to the Red Hill WMF for landfill disposal. The additional traffic generated by the RRF will be limited to trucks associated with removal of products of the RRF. These will predominantly be compost for the AD technology (which will be taken from the RHWMF), and ash residues in the case of the gasification technology (which is expected to be taken from the RRF to be landfilled within the Red Hill WMF). The increased traffic represents a negligible increase in flow at the intersection of the access road to the Red Hill WMF and Toodyay Road. The existing intersection arrangement will adequately cater for this marginal increase in traffic.

Residual Solid and Liquids

The gasification process results in the creation of both bottom ash and fly ash. The composition of both is dependent on the constituents of the fuel and the air emissions cleaning system, however as generated from gasification is expected to contain heavy metals and other hazardous materials.

Residual solid or digestate is produced by the AD processes and is separated from the residual liquid by a filter press or centrifuge and matured through aerobic composting or a drying process. The liquid is recirculated to the digester, used as a liquid fertiliser, treated in a waste water treatment plant or disposed of onsite (i.e. in the landfill leachate system). The incorrect disposal of the residual liquid may cause contamination of surrounding soil, surface water or groundwater.

Appropriate management measures are available to address these risks. The EMRC will implement safe handling and correct disposal methods for residual solid and liquid wastes. In addition, disposal of residual bottom ash and fly ash from the gasification process will occur in the appropriate class of landfill located at the Red Hill WMF. If the AD technology is adopted, then disposal of the residual liquid waste will occur in a waste water treatment plant or it will be passed through the leachate management system of the landfill cells. Also the residual digestate solids from the AD process will be processed to meet an appropriate standard such as AS-4454-2003 Australian Standards for Compost, Soils Conditioners and Mulches, depending on the use of that material.

Human Health

Possible effects on human health by the RRF have been assessed. Air quality, noise and odour standards are established to protect human health. Therefore compliance with these standards ensures that human health can be protected. Detailed assessment of the RRF has shown that breaches of these standards are not anticipated with appropriate design and management systems. As the RRF will comply with these standards there should not be any impacts on human health.

This conclusion has been supported by two international studies into the possible human health impacts on the proposed RRF technologies which have been examined as part of the assessment of this proposal. These studies, from the Department for Environment, Food and Rural Affairs (DEFRA) in the UK (DEFRA 2004) and for the Montgomery County Waste Resource Recovery facility in Maryland, USA (AECOM 2007) confirmed the results from this study that human health from gaseous emissions is not at significant risk for either technology proposed.

Management

A number of management measures have been proposed that will ensure that the RRF does not produce adverse impacts on the environment and the EPA objectives are met for all identified environmental factors. These are detailed in **Table ES2.**

Conclusions

This assessment of the EMRC's proposed RRF to be developed in the Red Hill WMF has shown that there will not be significant impacts on the environment for either technology option proposed. In fact, by implementing an alternative to landfilling of the waste from the EMRC Member Councils, the RRF will produce environmental benefits.

The EPA takes into account the principles of Environmental Protection in assessing the development proposals. **Table ES1** outlines how these principles have been considered in this proposal.

Table ES1: The EPA's Principles of Environmental Protection

Principles	Relevant	Consideration of Principle	PER Section
1. The Precautionary Principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by – a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and b) an assessment of the risk-weighted consequences of various options.	Yes	Specialist surveys and assessment have been undertaken to evaluate the existing environment and determine the likelihood to serious or irreversible damage to the environment. EMRC has conducted a risk assessment of possible environmental impacts. EMRC will adopt various environmental management measures, plans and procedures to minimize the risk to the environment.	Air Quality : Section 9 Noise: Section 10 Odour: Section 11 Residual liquids and solids: Section 12.1 Artificial Light: Section 12.2 Visual Amenity: Section 12.3 Groundwater and Surface Water Quality: Section 12.4 Terrestrial Vegetation and Flora: Section 12.5 Terrestrial Fauna: Section 12.6 Aquatic Flora: Section 12.7 Aquatic Fauna: Section 12.8 Section 8 Sections 9-12
2. The Principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	Suitable management measures will be adopted to prevent or minimize long-term environmental impacts.	Sections 9-12
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	The proposed RRF will be designed to avoid impacts where possible or minimize impacts through planning and design. Planning and design of the proposed RRF will be conducted according to the applicable standards and guidelines.	Sections 9-12
4. Principles relating to improved valuation, pricing and incentive mechanisms Environmental factors should be included in the valuation of assets and services. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximize benefits and/or minimize costs to develop their own solution and responses to environmental problems.	Yes	Environmental management costs will be incorporated into planning and financing the project. The RRF gate fee will reflect the full cost of waste treatment, disposal and long term management of residuals and the costs associated with State Government landfill levy and the Federal Government's carbon pricing mechanism.	Sections 9, 10, 11 and Sections 5.1, 5.2
5. The principle of waste minimization All reasonable and practicable measures should be taken to minimize the generation of waste and its discharge into the environment.	Yes	Proposed RRF will minimize the discharge of waste into the environment by: diverting waste from landfill increasing the recovery of resources; developing resource recovery options; and generating marketable products, such as renewable power, compost and recyclables. Proposed RRF will meet the Waste Authority's strategies and targets for MSW as detailed in the Western Australian Waste Strategy (2012).	Section 5

Table ES2: Key Environmental Factors, Impacts and Management

No.	Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Predicted impacts	Management
1 Pollution						
1.1	Air quality	Surrounding area	To maintain the environmental values, health, welfare and amenity of nearby land uses, and the wider Perth airshed by meeting the statutory requirements of air emissions, including dust emissions. To comply with EPA Guidance Statement No.18 – *Prevention of Air Quality Impacts from Land Development Sites,* Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses* and Statement No. 12 – *Minimising Greenhouse Gas Emissions.*	Human and faunal health issues due to exposure Deterioration of nearby terrestrial and aquatic ecosystems Degradation of buildings and structures Increased pollution of the wider Perth air shed Amenity and nuisance issues	AD: No exceedances of the ambient air assessment criteria for the various emissions parameters are produced, for both the direct impact and when background concentrations of the parameters are considered. Gas emissions are predicted to meet the NEPM and WHO air quality standards within the studied area, therefore no adverse health impacts are likely to occur. EfW: None of the pollutant Ground Level Concentrations (GLCs) are predicted to exceed the air quality assessment criteria. Operation of a gasification facility would be highly unlikely to give rise to unacceptable health impacts, even in the presence of existing air pollutants from other sources.	Prepare and implement an Air Quality Management Plan (AQMP) and a Dust Management Plan Employ appropriate pollution control equipment to remove contaminants from flue gases or composting aeration prior to emission into the atmosphere Undertake monitoring in line with requirements of licence Undertake regular Greenhouse Gas (GHG) accounting in accordance with National Carbon Accounting System.
1.2	Noise emissions	Surrounding area	To maintain the environmental values, health, welfare and amenity of nearby land uses by meeting the statutory requirements of noise emissions. To comply with EPA Guidance Statement No. 8 – *Environmental Noise (Draft)* and Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Human health issues and loss of amenity due to exposure Disruption to normal faunal behaviours Minor increase in traffic related noise due to the increase in traffic along Toodyay Road	AD: The noise assessment has found that there will be marginal exceedances during the night relative to the assigned noise levels of the Regulations at one of the receptors (worst case AD option was modelled). This is primarily due to noise from an existing power generation plant on site and corrective action is currently being assessed by its owner. With appropriate design, the AD facility would achieve compliance with the assigned noise levels at all times at the subject site. EfW: Gasification facility would achieve compliance with the assigned noise levels at all times at the subject site.	Prepare and implement a Noise Management Plan (NMP) Design of plant and equipment to comply with the *Environmental Protection (Noise) Regulations 1997* Continue to monitor traffic entering and leaving the site
1.3	Artificial light pollution	Surrounding area including the prescribed airspace of the Perth Airport	To maintain the environmental values, health, welfare and amenity of nearby land uses by meeting the statutory requirements for artificial light pollution.	Human health issues and reduced amenity from light trespassing into neighbouring properties/houses Impacts on flora and fauna physiology and local ecosystems Increased occurrence of pests attracted to light Blinding or confusing pilots of aircraft operating in a prescribed airspace Wasting energy on instances of unnecessary lighting	Facility will utilise outdoor lighting systems and some light will unavoidably spill outside the property boundaries, either directly or by reflection. Facility operates during day light hours therefore, only minimal security lighting is currently utilised at night minimising the impact during the night time.	Design the RRF and landscape in a way to protect receptors from artificial light Obtain approval from Civil Aviation Safety Authority, (CASA)through the Western Airports Corporation (WAC) to ensure lights will not intrude into prescribed airspace
1.4	Solid and liquid residuals	Surrounding area	To protect surrounding residents and workers from any adverse health risks associated with the by-products generated from the RRF; To maintain the quality of soil, surface water and groundwater so that existing and potential environmental values are protected.	Human health issues due to exposure.	AD: Produces digestate and liquid residue with predominantly biological composition that may include pathogens as well as trace elements, inorganic salts, and synthetic chemicals such as pesticides and naturally occurring organics. A number of management measures involving safe handling, containment and disposal have been developed to ensure the health and safety of the RRF employees and the surroundings residents are maintained. EfW: process creates both bottom ash and fly ash. Employee exposure to these ashes may occur by inhalation during incorrect handling and disposal. With appropriate management measures in place, it is unlikely that residual ashes will present any health impacts on RRF employees or the general public.	▪ Implement safe handling and correct disposal methods for residual solid and liquid waste. ▪ Dispose residual bottom ash and fly ash in the appropriate class of landfill located at the Red Hill WMF ▪ Dispose of the residual liquid waste (from AD) to landfill leachate system or to a waste water treatment plant. ▪ Ensure that the residual digestate solid meets an appropriate standard such as AS-4454-2003 Australian Standards for Compost, Soils Conditioners and Mulches, depending on the use of that material.

			2 Social Environment			
2.1	Odour emissions	Surrounding area	To maintain the amenity of nearby land uses by meeting the statutory requirements for odour emissions. To comply with EPA Guidance Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Reduced amenity	AD: Odour modelling, based on the assumptions adopted, show that operation may pose problems at 3 Receptors to the north and east of the Red Hill WMF, on Toodyay Road. These can be resolved through appropriate design of the odour management system. EfW: None of the predicted concentrations exceed the respective odour impact assessment criteria.	Prepare and implement Odour Management Plan (OMP) Operate within sealed buildings under negative air pressure, in odorous parts of the facility. Design and install appropriate Odour Control Systems to service the RRF Reduce the size of and therefore the odour emissions from the Mobile Garbage Bins (MGB) greenwaste windrows
2.2	Public Health	Surrounding area	To protect neighbouring residents and workers from any adverse health risks associated with the proposed RRF or increased traffic.	Health impacts, including physiological and/or mental impacts, due to any one of the following causes: Direct or indirect exposure to air emissions at elevated levels Noise emissions at prolonged excessive levels Dust emissions at excessive levels Artificial light 'trespassing' into neighbouring properties Increased traffic levels.	Public Health impacts can be considered minimal when all the management procedures presented in this report are adopted.	Refer to Section 13 for management information
2.3	Aboriginal heritage	Aboriginal heritage sites in proximity of Subject Site	To maintain the Aboriginal heritage and cultural values associated with nearby sites of significance. To comply with EPA Guidance Statement No. 41 – *Assessment of Aboriginal Heritage*.	Changes to the physical and biological proposal may disturb or impact on an Aboriginal heritage site	No Aboriginal heritage sites recorded within the Subject Site.	Comply with *Aboriginal Heritage Act 1972*
2.4	Visual amenity	Surrounding area	To maintain the aesthetic amenity of nearby land uses by meeting the community's expectations of the current land use	Reduced visual amenity of facility on the Subject Site	The Subject Site is located within the existing Red Hill WMF and therefore no changes are predicted as visual amenity of the site is already low.	Design the RRF taking into account the community's recommendations Landscape the area surrounding the RRF with native flora species
			3 Biophysical Factors			
3.1	Surface water and groundwater	Jane Brook and Susannah Brook catchments	To maintain the quality of surface and groundwater so that existing and potential environmental values are protected. To comply with EPA Guidance Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*. To comply with Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 where applicable.	Human/livestock/native fauna health impacts from exposure to contaminated water Degraded aquatic ecosystem quality Soil contamination from movement of contaminated groundwater through soil profile Decrease in water quality	Potential for any spills to contaminate surface water or groundwater is minimised due to the sealing of all roads and hardstand areas. No exceedances of ambient air quality standards and guidelines are predicted; therefore it is highly unlikely that adverse effects on surface water or ground water from air borne pollutants will exist.	Continue groundwater and surface water monitoring and sampling Design RRF to minimise and retain leakages of liquids Implement procedures to prevent and contain spills during emergencies
3.2	Terrestrial vegetation/flora	Vegetated areas on and surrounding the site	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge To comply with EPA Guidance Statement No. 51 - *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* and Statement No. 19 – *Environmental Offsets – Biodiversity*	Loss of priority species Weeds Excessive dust emissions Decrease in vegetation quality Fire ignition Reduced colonisation ability.	Minimal to no clearing of remnant vegetation is required as the Subject Site has been historically cleared for grazing purposes. It is unlikely that there will be adverse effects on the terrestrial vegetation and flora from air borne pollutants.	Prepare and implement a Vegetation Clearing Management Plan. Employ best practice clearing methods. Comply with the conditions of the Licence 6833/1997/11 issued by the DEC for the landfill operations at Red Hill WMF Establish monitoring program if impacts to vegetation exists.
3.3	Terrestrial fauna	Habitat areas on and surrounding the site	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge To comply with EPA Guidance Statement No. 56 - *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* and Statement No. 19 – *Environmental Offsets – Biodiversity*.	Loss of habitat and foraging extent Increase in pests species Fauna deaths or injury during clearing Reduction in wildlife corridor Disruption to faunal behaviours Decrease in health of fauna species due to pollution Bioaccumulation and/or biomagnification of contaminants	The proposed development will lead to the localized loss of some fauna habitat. However, there is extensive intact habitat close to the project area, supporting similar fauna and fauna habitats in a landscape that is generally in good condition. It is unlikely that there will be adverse effects on the terrestrial fauna from air borne pollutants.	Comply with the conditions of the Licence 6833/1997/11 issued by the DEC for the landfill operations at Red Hill WMF

3.4	Aquatic flora	Nearby surface water bodies in Jane Brook and Susannah Brook catchments	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. To comply with EPA Guidance Statement No. 19 – *Environmental Offsets – Biodiversity* and Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Reduce water quality Excessive dust emissions Change in biomass.	Facility is unlikely to have an environmental impact on Jane Brook and Susannah Brook with appropriate management. It is unlikely that there will be adverse effects on the aquatic flora from air borne pollutants. Dust mitigation can be managed appropriately.	Continue surface water monitoring and sampling.
3.5	Aquatic fauna	Nearby surface water bodies in Jane Brook and Susannah Brook catchments	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. To comply with EPA Guidance Statement No. 19 – *Environmental Offsets – Biodiversity* and Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Increase in algae and decrease in oxygen Invasive pest species Excessive dust emissions Degraded habitat Reduced water quality Disruption to normal faunal behaviours	Facility is unlikely to have an environmental impact on Jane Brook and Susannah Brook with appropriate management. It is unlikely that there will be adverse effects on the aquatic fauna from air borne pollutants. Dust mitigation can be managed appropriately.	Continue surface water monitoring and sampling

Table of Contents

List of Tables

List of Figures

List of Tables in Appendices

List of Graphs in Appendices

List of Diagrams in Appendices

Definitions

Defined Term	Description
Acceptable Tenderers	In accordance with the *Local Government (Functions and General) Regulations 1996*, Acceptable Tenderers are individuals, organisations or joint ventures that have been pre-qualified through an Expression of Interest evaluation process.
ADC	Alternative daily cover
AHD	Australian Height Datum
AIC	Australian Interaction Consultants
Anaerobic Digestion (AD)	The breakdown of organic materials by naturally occurring micro-organisms in the absence of oxygen to produce biogas (predominantly methane and carbon dioxide) which can be used as a fuel, compost and in some instances, liquid fertilisers.
ALS	ALS Environmental
APC	Air Pollution Control
AQGs	*WHO Air Quality Guidelines*
AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
AQMS	Air Quality Monitoring Stations
ARI	Assessment on Referral Information
ASS	Acid Sulfate Soils
AWT	Alternative Waste Treatment – processing waste as an alternative to disposing to landfill. The treatment processes can be categorised as biological (aerobic composting and anaerobic digestion) and thermal processes (combustion, gasification, and pyrolysis).
BCE	Bamford Consulting Ecologists
Benchmark	Benchmark Monitoring Pty Ltd
BOM	Bureau of Meteorology
CALMET	Meteorological model associated with CALPUFF modelling system
CALPUFF	Advanced non-steady-state meteorological and air quality modelling system
CALPOST	Post-processing package for CALPUFF modelling system
CASA	Civil Aviation Safety Authority
CCWA	ChemCentre Western Australia
Contract Delivery Models	The alternative methods for procurement of the project.
COPC	Compounds of Potential Concern
CFU	Colony Forming Units
CPA	Community Partnership Agreement
CTF	EMRC Community Taskforce
D&C	Design and Construct
dB	Decibels

DBOM	Design, Build, Operate and Maintain
DEC	Department of Environment and Conservation (WA)
DEWHA	Department of Sustainability, Environment, Water, Population and Communities (Aus), now Department of Sustainability, Environment, Water, Population and Communities (DSWEPC)
DIA	Department of Indigenous Affairs (WA)
Dioxins and furans	Class of polyzchlorinated organic compounds based on the dibenzo-p-dioxin and dibenzofuran structures
DMAS	Decision Making Authorities
DMP	Dust Management Plan
DoE	Department of Environment (WA) - now the DEC
EA	UK Environment Agency
Eastern Region	The district of the EMRC, being the combined districts of its Member Councils.
EIA	Environmental Impact Assessment
EMRC	Eastern Metropolitan Regional Council
EMS	Environmental Management System
Energy from Waste (EfW)	The breakdown of waste material under high temperature conditions to produce, among other things, energy.
EOI	Expression of Interest
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPS	Environmental Protection Statement
ERMP	Environmental Review and Management Programme
ESA	Environmentally Sensitive Areas
ESD	Environmental Scoping Document
EU	European Union
GHG	Greenhouse gases
GLCs	ground level concentrations
GWU	Global Warming Units
HCWA's	Heritage Council of Western Australia's
HMfUR	Hessisches Ministry for Environmental Protection and Reactor Safety (Germany). One of the agencies that provides emission standards for biogas combustion and flaring in Germany (state of Hessen).
HpCDD	Heptachlorodibenzo-*p*-dioxin
HpCDF	Heptachlorodibenzofuran
HxCDD	Hexachlorodibenzo-*p*-dioxin
IBRA	Interim Biogeographic Regionalisation for Australia
IFH	Isolation Flux Hood
IPCS	International Programme on Chemical Safety
LGA	Lloyd George Acoustics Pty Ltd

LGP	Landfill Gas and Power Pty Ltd
LPG	Liquefied Propane Gas
LOR	limit of reporting
MBT	Mechanical Biological Treatment
Member Councils	The six Local Governments which form the EMRC, comprising: Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and City of Swan.
MGB	Mobile garbage bin used to collect waste.
MSW	Municipal Solid Waste is classified as household domestic waste that is set aside for kerbside collection in a MGB. MSW can also include some commercial waste such as waste from food preparation premises, supermarkets etc. which is collected as part of domestic waste collection rounds.
NEPM	National Environment Protection Measure
NES	National Exposure Standards
NMP	Noise Management Plan
NMVOC	non-methane volatile organic compound
OCDD	Octachlorodibenzo-*p*-dioxin
OCDF	Octachlorodibenzofuran
OER	Odour Emission Rate
OLS	Obstacle Limitation Surface
OMP	Odour Management Plan
OTEK	DEC accredited auditors
OU	Odour unit
PAH	Polycyclic aromatic hydrocarbon
PANS-OP	Procedure for Air Navigation Systems Operations
PBDDs	polybrominated dibenzo-*p*-dioxins
PBDFs	Polybrominated dibenzofurans
PCBs	Polychlorinated biphenyls
PCDDs	polychlorinated dibenzo-*p*-dioxins
PCDFs	Polychlorinated dibenzofurans
PDWSAs	Public Drinking Water Source Areas
PEC	Priority Ecological Communities
PeCDD	Pentachlorodibenzo-*p*-dioxin
PeCDF	Pentacholorodibenzofuran
PER	Public Environmental Review pursuant to Part IV of the EP Act
PM	Particulate matter
PPE	Personal Protection Equipment
Proponent	The EMRC

PUEA	Proposal Unlikely to be Environmentally Acceptable
Radiello	Radiello® Passive Air Sampling System
Red Hill WMF	Red Hill Waste Management Facility
Resource Recovery Facility. (RRF)	Also known as an Alternate Waste Treatment Facility for the processing of MSW to recover useful products such as recyclables, compost, fertilisers and energy.
RHCLG	Red Hill Community Liaison Group
RIWI Act	*Rights in Water and Irrigation Act 1914*
Scoping Document	Environmental Scoping Document
SEAAP	State Environment (Ambient Air) Policy
SLR	SLR Consulting Australia Pty Ltd
SNC	Single Noongar Claim
SOER	Specific Odour Emission Rate
STELs	Short term exposure limits
Subject Site	The preferred site (B2) for the RRF within the Red Hill WMF
SWALSC	South West Aboriginal Land and Sea Council
Synergetics	Synergetics Environmental Engineering
TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TCDF	2,3,7,8-tetrachlorodibenzofuran
TEC	Threatened ecological communities
TEF	Toxic Equivalency Factors
TEQ	Toxic Equivalency Quotient
TOC	Total organic carbon
TSP	Total suspended particulates
TWA	Time-weighted average
UPS	Uninterruptable Power Supply
VOC	Volatile organic compound
WA	Western Australia
WAC	Westralian Airports Corporation
WAHERB	Western Australian Herbarium Specimen Database
WHO	World Health Organisation
WID	EU Waste Incineration Directive
WMCRG	EMRC Waste Management Community Reference Group
WTS	Waste Transfer Station

1 Introduction

1.1 Background

The Eastern Metropolitan Regional Council (EMRC), the project proponent, was formally constituted in 1983 and includes the following Member Councils: Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and the City of Swan. Collectively, the EMRC's six Member Councils cover a geographic area that extends over one-third (2,100 km^2) of the Perth Metropolitan Area (**Figure 1**). The EMRC currently has a population of approximately 300,000 with this number expected to increase to 400,000 by 2030.

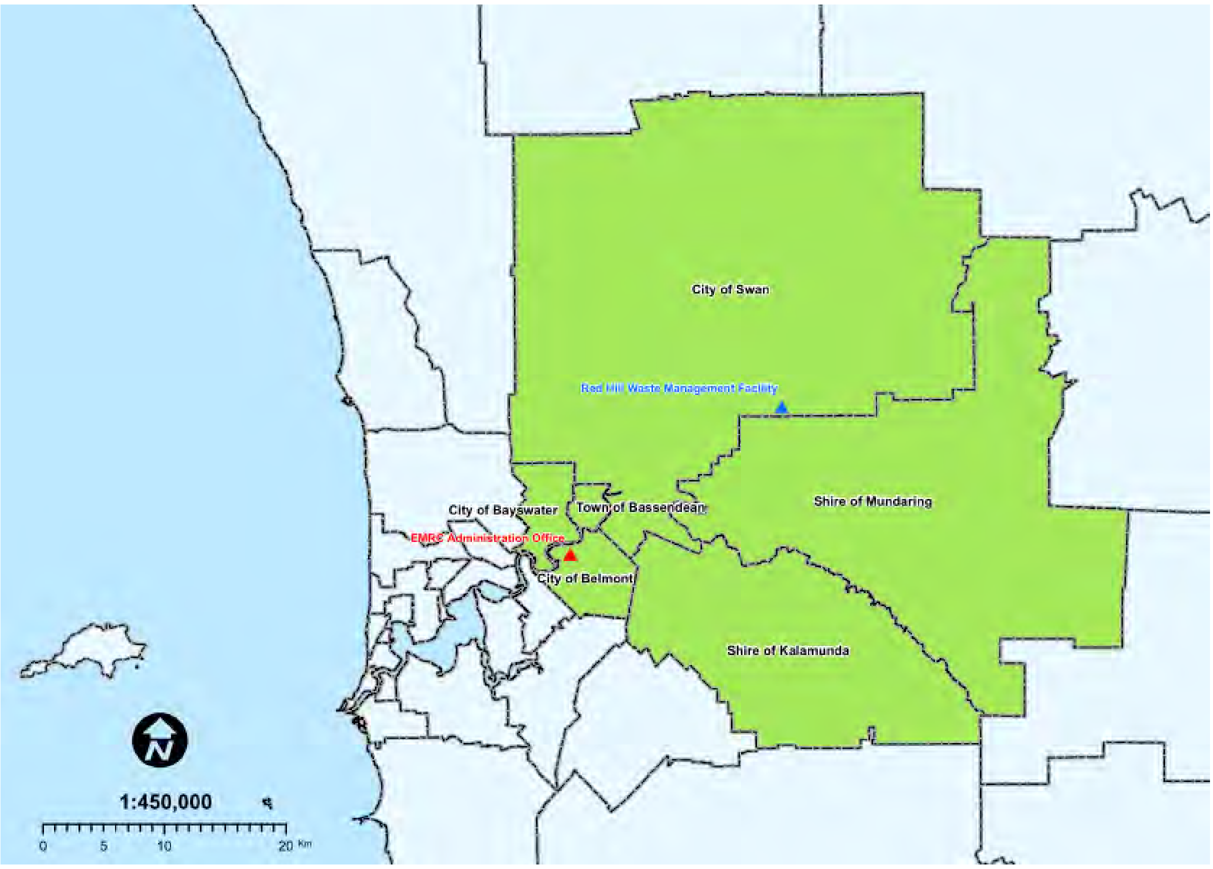

Figure 1 EMRC Geographic Extent

The EMRC was originally established to manage the waste disposal of its Member Councils. Although the EMRC's range of services has since expanded to include other areas such as regional development and environmental services, waste management is still considered the Regional Council's primary role. The EMRC's operations are governed by the Council which comprises 12 Councillors (two Councillors from each Member Council), with another six Councillors (one from each Member Council) appointed to deputise in their absence. The Chairman of the Council is elected by the 12 Councillors.

Currently, all non-recycled waste generated by Member Councils within the Region is landfilled at the EMRC-owned and operated Red Hill Waste Management Facility (Red Hill WMF) (**Figure 2**). The Red Hill WMF is an approved Class III and IV landfill and is currently operated under Licence 6833/1997/11 which was issued by the then Department of Environment (now the Department of Environment and Conservation (DEC)). The facility accepts a range of wastes, including inert waste, putrescible waste, contaminated wastes, and also acts as a collection and storage area for dry recyclables and household hazardous waste received at the transfer station. Red Hill WMF accepts waste from various organisations within and outside the region including the general public, commercial operators, and Local, Regional, State and Federal Government organisations.

Approximately 126,000 tonnes of Member Council municipal solid waste (MSW) was disposed at the Red Hill WMF in 2010/2011. Based on recent projections, the total amount of Member Council MSW is expected to increase to 185,000 tonnes per annum by the year 2034/35. The Red Hill WMF has an estimated 25 year lifespan for the landfilling of Class II/III (putrescible) materials, and an estimated lifespan of 14 years for the landfilling of Class IV (contaminated wastes) materials (based on current and projected landfilling rates).

The EMRC proposes to develop a Resource Recovery Facility (RRF) to process Member Council kerbside MSW within the Red Hill WMF. RRFs are used to process domestic waste collected from the kerbside (excluding comingled recyclables) to produce valuable resources such as compost and/or energy and recyclables. The establishment of a RRF is intended to assist the EMRC in:

- Diverting waste from landfill and increasing the life expectancy of Red Hill WMF;
- Reducing the environmental impacts associated with landfilling, including greenhouse gas emissions and potential contamination of soil and groundwater;
- Increasing the recovery of resources from waste by generating marketable products, such as compost and/or energy and recyclables; and
- Producing renewable energy, primarily in the form of electricity.

The Western Australian Waste Authority has proposed strategies and targets for the reduction of waste to landfill in the *Western Australian Waste Strategy* (2012). The EMRC's movement towards establishing a resource recovery facility to reduce MSW to landfill is aligned with this document.

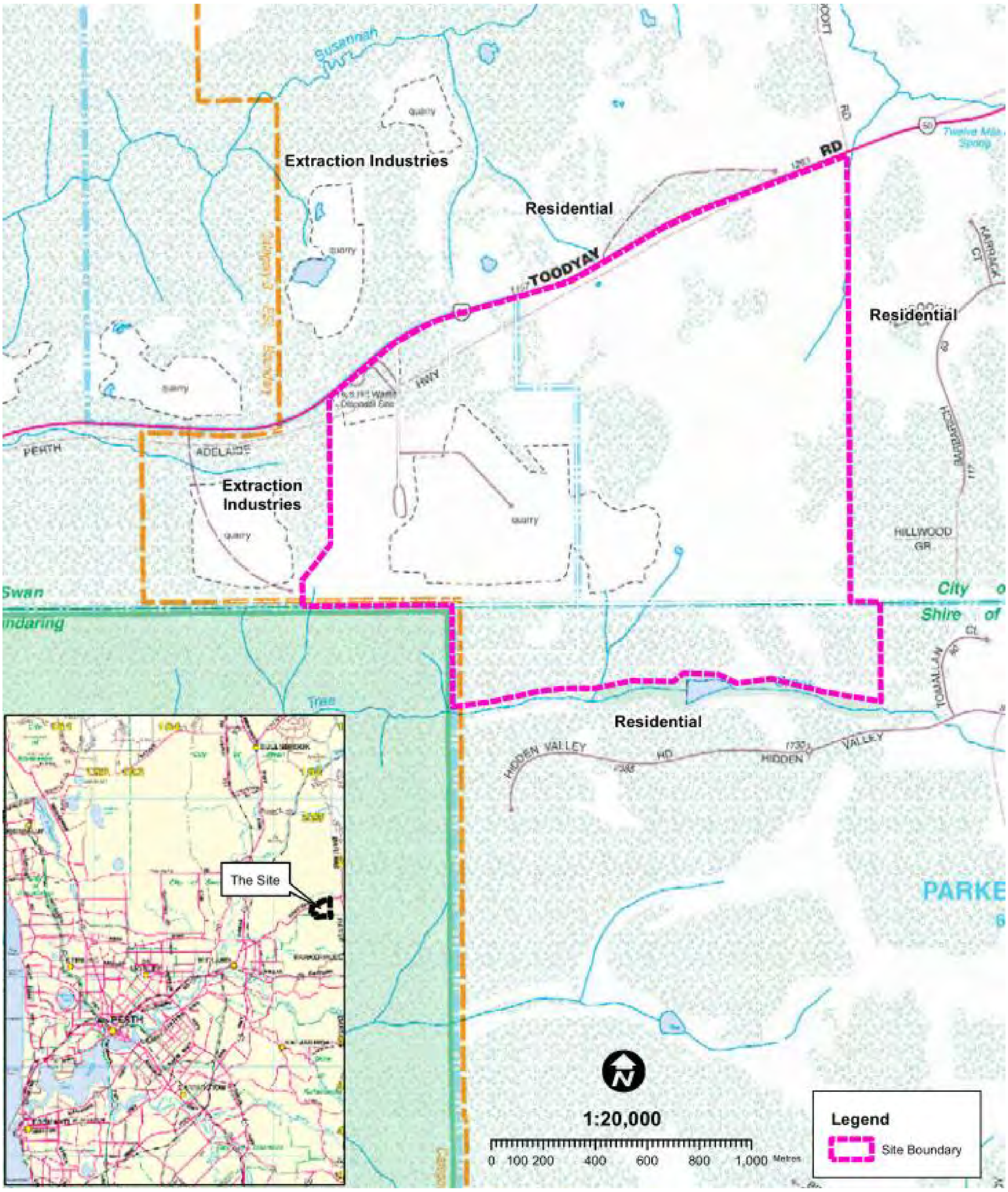

Figure 2 Locality Plan

1.2 Purpose of Document

The Environmental Protection Authority (EPA) set a level of assessment for the proposal of Public Environmental Review (PER) in September 2010. After the determination of appeals by the Minister for Environment, the EMRC prepared an Environmental Scoping Document (ESD) for the proposal which was approved by the EPA in October 2011. This PER document has been prepared to satisfy the requirements of the ESD.

This document describes the environmental factors and issues associated with each aspect of the proposal in detail and the approaches required to prevent, mitigate and manage environmental impacts. Detailed environmental assessments and studies such as air quality, odour and noise emissions assessments for the proposed technologies have been undertaken during the PER process and the results have been discussed and incorporated within this document.

The EPA's *Guidelines for Preparing a Public Environmental Review (2010)* and *Guide to EIA Environmental Principles, Factors and Objectives (2010)* have been utilised in the preparation of this document to ensure it is consistent with the requirements of these guidelines and is suitable for consideration by the EPA.

1.3 Statutory Requirements

The EP Act is the principal statute relevant to environmental protection in Western Australia. The Act makes provision for the establishment of an independent EPA, for the prevention, control and abatement of pollution and environmental harm and for the conservation, preservation, enhancement and management of the environment and for matters incidental to or connected with the foregoing.

The EPA is an independent authority and one of its primary functions is to conduct environmental impact assessments (EIA). The EPA prepared the *Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2010* to outline the process of EIA undertaken in WA. These Procedures also detail requirements placed on proponents and decision-making authorities (DMAs) in relation to referral of proposals and on proponents once the EPA has determined that the proposal will be subject to assessment under Part IV Division 1 of the Act.

Under the 2002 Procedures, the EPA normally adopts one of five levels of assessment for assessing proposals and this sets the general form, content, timing and procedure of the environmental review to be undertaken by the proponent. The five levels of assessment are:

- Assessment on Referral Information (ARI);
- Proposal Unlikely to be Environmentally Acceptable (PUEA);
- Environmental Protection Statement (EPS);
- Public Environmental Review; and
- Environmental Review and Management Programme (ERMP).

Where the level of assessment of PER or ERMP is set by the EPA, proponents are required to prepare and submit to the EPA an Environmental Scoping Document (ESD). The ESD should include:

- a summary description of the project;
- a summary description of the existing environment;
- a preliminary impact assessment with identification of the environmental issues/factors arising from the project;
- a Scope of Works setting out the proposed environmental surveys/investigations to be carried out as part of the EIA for preparation of the PER/ERMP;
- a list of people, if any, proposed to provide peer reviews of findings and conclusions of the environmental surveys/investigations;
- a planned programme of consultation with the public, key stakeholders and relevant government agencies; and
- a proposed timeframe for undertaking the environmental surveys/investigations and submission of the draft PER/ERMP.

The EPA advises the proponent of its acceptance of the ESD and the included Scope of Works, when that occurs. This enables the proponent to prepare the PER or ERMP consistent with the approach and timetable agreed with the EPA. The ESD has been submitted to the EPA which set the level of assessment for this project as a PER, and has been accepted.

It is a legislative requirement that any project which will have a significant impact on a matter of national environmental significance, is referred to the Minister for Sustainability, Environment, Water, Population and Communities (Federal Environment Minister) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Assessments carried out and detailed in **Section 3.2** and **Section 12.4** confirm that while protected species may be present within a 1 km radius of the site the development is unlikely to have a significant impact on any matters of national environmental significance and as such a referral to the Minister for Sustainability, Environment, Water, Population and Communities is not required.

2 Identification of the Proponent and Consultant

2.1 Proponent Details

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2.2 Environmental Consultant Details

Organisation:	Cardno (WA) Pty Ltd ABN 77 009 119 000
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3 Applicable Legislation

3.1 State Government Legislation

State Government Legislation has been listed below which highlights the statutory requirements that the EMRC has considered during the preparation and development of this PER:

- *Aboriginal Heritage Act 1972*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Contaminated Sites Act 2003*
- *Dangerous Goods Safety Act 2004*
- *Environmental Protection Act 1986*
- *Health Act 1911*
- *Heritage Act 1990*
- *Local Government Act 1995*
- *Occupational Health and Safety Act 1984*
- *Planning and Development Act 2005*
- *Rights in Water and Irrigation Act 1914*
- *Waste Avoidance and Resource Recovery Act 2007*
- *Waste Avoidance and Resource Recovery Levy Act 2007*
- *Wildlife Conservation Act 1950.*

A number of EPA guidance statements, national standards, local government policies, strategies and schemes are also applicable to this proposal. These documents are listed within the relevant environmental assessment sections.

3.2 Commonwealth Government Legislation

As noted in **Section 1.3**, where a significant impact on a matter of national environmental significance is determined, the proposal will be referred to the Federal Environment Minister under the EPBC Act. In this instance, the EMRC would seek to have the matter assessed under provisions of the bilateral agreement between the Commonwealth of Australia and State of Western Australia.

A desktop search of the proposal area was undertaken of the Department Environment, Water, Heritage and the Arts (DEWHA, now DSWEPC) - Protected Matters Search Tool. The search was undertaken to determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur on, or close to the Subject Site. This search indicated that five threatened species, five migratory species and five listed marine species could potentially occur within a 1 km radius of the entire Red Hill WMF site (DSWEPC 2010a). These species include:

- Threatened species:
  - *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo)
  - *Calyptorhynchus baudinii* (Baudin's Black Cockatoo, Long-billed Black Cockatoo)
  - *Calyptorhynchus latirostris* (Carnaby's Black Cockatoo, Short-billed Black Cockatoo)
  - *Dasyurus geoffroii* (Chuditch, Western Quoll)
  - *Thelymitra stellata* (Star Sun-orchid).
- Migratory species:
  - *Haliaeetus leucogaster* (White-bellied Sea Eagle)
  - *Merops ornatus* (Rainbow Bee-eater)
  - *Ardea alba* (Great Egret, White Egret)

  - *Ardea ibis* (Cattle Egret)
  - *Apus pacificus* (Fork-tailed Swift).
- Listed marine species:
  - *Apus pacificus* (Fork-tailed Swift)
  - *Ardea alba* (Great Egret, White Egret)
  - *Ardea ibis* (Cattle Egret)
  - *Haliaeetus leucogaster* (White-bellied Sea Eagle)
  - *Merops ornatus* (Rainbow Bee-eater).

Assessments of the potential impacts on these species have been undertaken and are reported in **Sections 8.3** and **12.6**.

Approval to carry out a controlled activity in a prescribed airspace is required from the Secretary of the Civil Aviation Safety Authority (CASA) under the *Airports Act 1996*. A prescribed airspace is above any part of either an Obstacle Limitation Surface (OLS) or a Procedure for Air Navigation Systems Operations (PANS-OP) surface. The nominated proposed location of the RRF (the Subject Site) is located beneath Perth Airport's prescribed airspace, being a Runway 24 Approach, PAN-OPS surface (Australian Government 1996). Controlled activities, relevant to this proposal, that may trigger an approval process under the *Airports Act 1996* include:

- construction of a building or other structure that intrudes into the prescribed airspace;
- any other activity (e.g. operation of cranes) that causes a thing attached to, or in physical contact with, the ground to intrude into the prescribed airspace;
- operating a source of artificial light in a manner which interferes with the operation of an aircraft;
- operating prescribed plant, or a prescribed facility which reflects sunlight in a manner which interferes with the operation of an aircraft;
- an activity caused by an emission or stack that results in air turbulence (upward vertical velocity of 4.3 m/s or more at the point of emission); and
- an activity that results in the emission of smoke, dust, other particulate matter, steam or other gas where the emission affects operation of an aircraft.

Discussions with the Westralian Airports Corporation (WAC), suggest that the proposed RRF would be a controlled activity and consideration would need to be given to the intrusion of airspace and air turbulence. Further investigations by the EMRC and Cardno clarified that due to the Australian Height Datum (AHD) of the Subject Site (including building / stack height) being less than that stipulated by WAC (368 mAHD) the EMRC would likely gain approval to undertake a controlled activity in a prescribed airspace from the Secretary of CASA.

4 Description of the Proposal

To address the waste management needs of the Eastern Region in a more environmentally sustainable manner, the EMRC proposes to develop a RRF to treat domestic kerbside MSW generated in the Region. Significant research, assessment and consultation have been undertaken to reach this stage of the process. Key tasks relevant to the proposal include:

- ongoing community and stakeholder engagement;
- preferred options assessment in relation to site suitability, Alternative Waste Treatment (AWT) technologies, contract delivery models and waste collection systems; and
- evaluation of Expression of Interest (EOI) submissions and pre-qualification of five (5) Acceptable Tenderers for the future tender process.

An initial assessment of six potential sites within the Eastern Region identified the EMRC's Red Hill WMF as the preferred site for the RRF. A number of potential locations within the boundary of the Red Hill WMF were subsequently investigated for the proposed RRF. The preferred site (Subject Site) is within Lot 12 and is located on the proposed future northern boundary with the road reserve for the realigned Perth - Adelaide Highway. The area required for locate the facility will vary depending upon the technology chosen, however the maximum area required is estimated to be 4 hectares. The location of the Subject Site is shown in **Figure 3**.

The EMRC has yet to decide a number of key planning decisions for the project, the most significant being the selection of the waste processing technology. Other key project planning decisions that have not yet been made are the contract delivery model and the waste collection system (two or three bins per household). It should be noted, however, that whichever technology is chosen kerbside recyclable collections will continue uninterrupted as both technologies will only treat the remaining household waste (i.e. waste not collected as part of the recycling collection systems).

The final decision on the waste processing technology is expected to be made following the evaluation of tenders, which will be invited following receipt of the environmental approvals (under Part IV of the EP Act). As such, the EMRC has undertaken detailed studies of each of the following technologies as part of this PER process, including:

- **Anaerobic Digestion (AD)** – to produce biogas for energy production and compost.
- **Energy from Waste (EfW)** – gasification to produce renewable energy.

The type and quantity of usable products generated out of the process, such as compost, energy and/or recyclables will depend on the RRF technology implemented. The proposed technology options and their expected outputs are explained further in **Section 4.1** below.

The annual capacity of the proposed facility will also depend on the technology implemented, the staging of the RRF implementation and in the case of AD technology, the type of domestic kerbside collection system used (i.e. two or three bin kerbside collection system). However, for the purposes of the proposal, a maximum capacity of 200,000 tonnes per annum is proposed for EfW and 150,000 tonnes per annum for AD in the RRF. The EfW option would process waste from a two bin collection system comprising a recycling bin and a residue (or rubbish) bin, with the residue waste processed. This waste comprises the non-recycling fraction of the domestic waste stream generally containing normal household waste excluding dry recyclables such as paper, cardboard and plastics. The reduced capacity for the AD option assumes that the organic waste processed has been source separated through a three bin household collection system comprising an organics bin (for processing in the RRF), a recycling bin and a residue or 'dry' bin. The residue waste (mostly inorganics) would be landfilled. More information about the waste collection is presented in the **Section 4.2.1.2**.

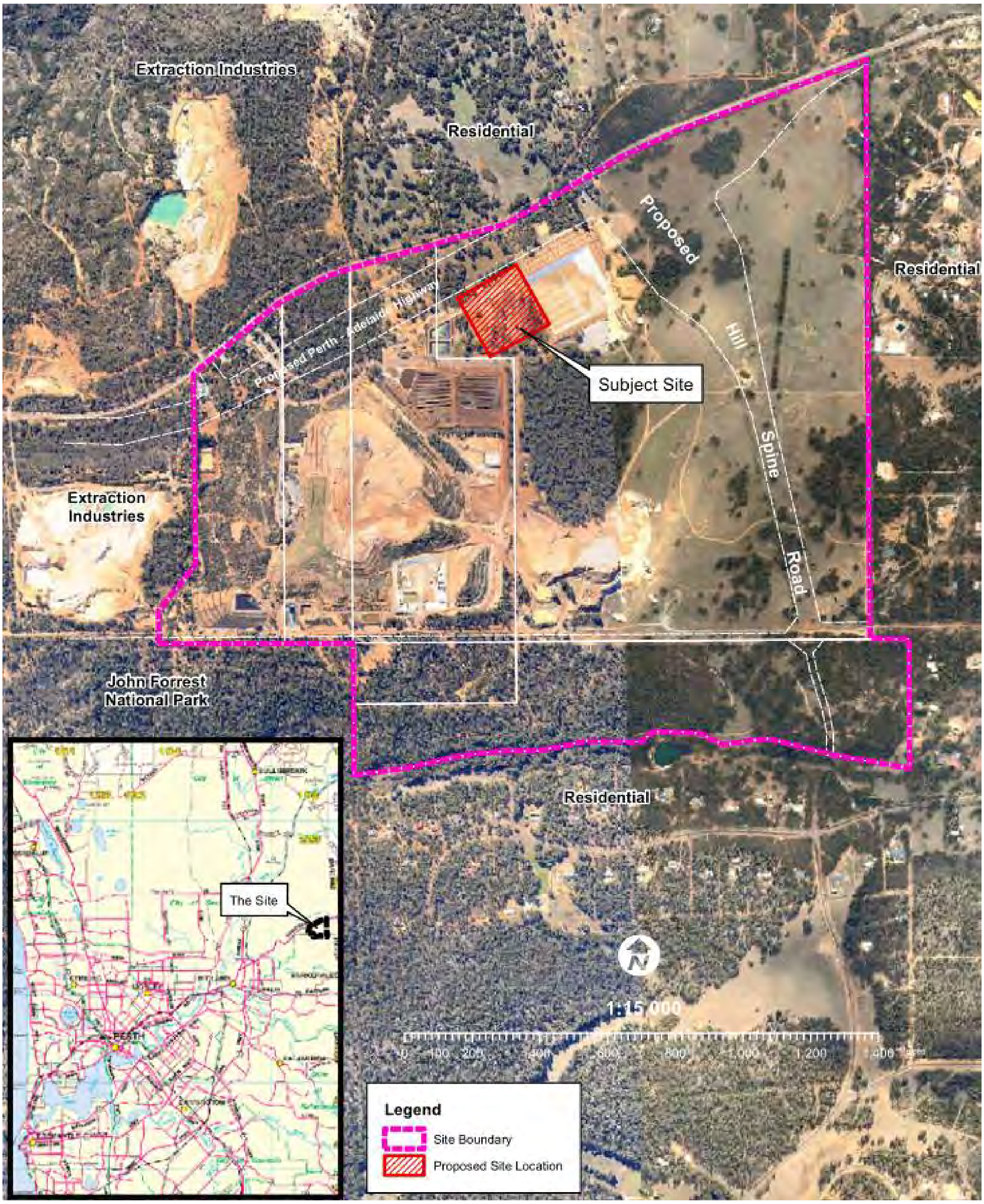

Figure 3 Proposed Facility Locations

Following the EIA process and assuming the proposal is approved by the Minister for the Environment, the EMRC will resolve whether to proceed with a tender process. The EMRC will subsequently invite the Acceptable Tenderers (pre-qualified through the EOI process) to submit a tender for the chosen technology types (limited to the two technology types referred to above). The tenders will be assessed using environmental, technical, economic and social tender evaluation criteria. These criteria are currently being developed by the EMRC with community input.

The EMRC's currently preferred contract models are the Design and Construct (D & C) model and the Design, Build, Operate and Maintain (DBOM) model. Under a D & C contract the EMRC would own the facility, while the contractor would design, construct and undertake initial operation of the facility (for an approximate operating period of up to two years). Under the DBOM model the EMRC would own the facility, while the contractor would design, construct, operate and maintain the facility for an extended period (10–20 years). Under both models the EMRC would require the contractor to comply with the environmental responsibilities specified in the Ministerial Statement for the duration of its contract. The contractor would be required to obtain and comply with a Works Approval (construction) and Licence (operation) pursuant to Part V of the EP Act.

At the end of the operating period of the contract, the contractor would transfer operations to the EMRC, or an appropriate operator contracted by the EMRC. Consequently, the new operating party will be required to comply with conditions of the Ministerial Statement, Works Approval and Licence.

4.1 Key Characteristics - Waste Material

4.1.1 Waste Composition

Waste audits have been undertaken previously by Nolan ITU and APrince Consulting for the EMRC to determine the likely composition of the refuse MGBs presented at the kerbside by householders within the region. The Nolan ITU audit was conducted between 2nd and 9th of December 2002, while the APrince Consulting audit was conducted between 17th and 30th of September 2004. Both audits categorised waste disposed in refuse MGBs from a sample of 600 randomly selected households with similar socio-economic suburbs (based on statistics obtained from the Australian Bureau of Statistics).

The results of the waste audits have indicated the following composition of waste from the refuse MGBs (**Table 4-1**).

Table 4-1 Refuse MGB Composition and waste stream quantities (at moisture)

Waste Category	Nolan ITU	APrince
Recyclables	11%	7.9%
Paper and Cardboard	12%	10%
Organics	64%	62.7%
Non-Recyclable Plastics	5%	8.7%
Other Waste	8%	10.7%
Total	100%	100%

The waste categories outlined in **Table 4-1** are broken into waste streams defined in **Table 4-2** below.

Table 4-2 Waste Stream Categories

Waste Category	Waste Streams
Recyclables	Glass, Polyethylene Terephthalate (PET) (type 1), High Density Polyethylene (HDPE) (type 2), Polyvinyl Chloride (PVC) (type 3), aluminium, other non-ferrous, steel, other ferrous.
Paper and Cardboard	Newspaper, magazines, miscellaneous packaging, corrugated cardboard, package board, liquid paper containers, disposable paper product, printing and writing paper.
Organics	Food / kitchen waste, garden, other putrescibles, contaminated paper.
Non-Recyclable Plastics	Low Density Polyethylene (LDPE) (type 4), polypropylene (type 5), polystyrene (type 6), other (type 7).
Other Waste	Household hazardous waste, ceramics, dust, dirt, rock, ash, special, wood, textile / rags, leather, rubber, oils.

4.1.2 Waste Characteristics

Moisture analysis of the six Member Councils MSW streams was conducted by APC Environmental Management during the April 2009 waste audit. The waste categories audited include source-separated food waste, source-separated green waste, as well as total garbage (from the general household refuse MGB).

Table 4-3 below shows the overall average moisture content of each of the MSW components, aggregated across the six councils, with a low-high range. The table also shows the overall average moisture content for the two major components (food waste and green waste) and of all of the components added together (Total MSW).

Table 4-3 Average moisture content of components of MSW with ranges

Waste Category	Average Moisture Content	Range
Food waste	65%	49 - 77%
Green waste	54%	17 - 76%
Total MSW	33%	16 - 46%

Other waste characteristics of the MSW (Energos, 2009) are detailed in **Table 4-4.**

Table 4-4 Waste Characteristics

Waste Category	Unit	Range
Net Caloric Value	MJ/kg	8-18
Ash Content	Weight % (dry)	6-30
Nitrogen Content	Weight % (dry)	< 1.0

4.2 Key Characteristics - Proposed Technologies

Key characteristics of the two proposed AWT technology options are summarised in **Table 4-5** and the following sections.

Table 4-5 Key Characteristics of the Project

Element	Description
Life of project (facility operation)	20 years or more
Area of disturbance	4 hectares
Facility operation	Continuous processing operation. Waste delivery 7am to 5pm with limited vehicle access outside of these hours.
Major facility components – Anaerobic Digestion	**Section 4.2.1**
Major facility components – Energy from Waste	**Section 4.2.2**
Site of Facility	**Section 4.3**
Proposed facility capacity	AD: 150,000 tonnes per annum EfW: 200,000 tonnes per annum
Solid residue material	AD: 50,000 tonnes residue per annum for 150,000 tonnes per annum facility EfW: 45,000 tonnes residue per annum for 200,000 tonnes per annum facility (bottom ash and fly ash)
Liquid residue	AD: Up to 15,000 tonnes per annum (residue is mostly recycled in the process) EfW: Minimal
Air quality	EfW: Table 9-6 AD: Table 9-10
GHG emissions	Table 9-13
Project timeline	6 years

4.2.1 Anaerobic Digestion

4.2.1.1 AD Technology Types

Anaerobic Digestion (AD) refers to the process in which organic materials are decomposed by naturally occurring micro-organisms in the absence of oxygen to produce biogas (partly comprising methane and which is used as a fuel), compost and in some instances, liquid fertilisers.

There are a number of different forms of AD technologies available in the market. These include technologies that can be separated into categories based on being:

- wet systems (which treat suspensions and slurries and are <15% dry matter) or dry systems (minimal water is added and are 15-45% dry matter);
- mesophilic AD (which operates at a temperature of approximately 35°C (20-45°C) or thermophilic AD (which operates at approximately 55°C (50-65°C);
- single stage (where decomposition of organic material takes place in one reactor) or multi-stage digestion (where organic material is broken down in separate reactors to optimise the AD process); and
- continuous process (where waste is continually fed to, and outputs removed from the process vessel) or batch process (where the vessel is fed with waste and digestate and left to digest before the vessel is emptied).

In some facility designs, a number of batch digesters are used to form what is effectively a continuous process. For example, with one of the available technologies, 48 batch digesters would be used to process 150,000 tpa of source separated organic waste. The processing cycle takes about 28 days for each digester. Following completion of the digestion process, the digester is purged of biogas before being emptied and refilled with fresh waste so the digestion cycle can recommence. On any given day there will be two digesters being purged and emptied and refilled with waste. The digestion process for this particular technology occurs under mesophilic conditions at 38-45ºC.

4.2.1.2 AD Technology Process

The nature of the technology process and the waste composition determines the required pre-treatment of the waste. The primary process variables of AD are the methods of feeding the waste into the digester, the moisture content of the mix and the method and degree of aeration of the solid residue (compost). A general description of the AD process is shown in **Figure 4** below. This figure was developed from the information provided through the EOI process and EMRC's research of the technologies and is based on the assumption that the AD process is developed in conjunction with either a two or three bin waste collection system.

A two bin collection system comprises fortnightly collections of comingled recyclables and weekly collections of residue waste, both using MGBs. This system is currently used by the majority of the Member Councils.

A three bin collection system would comprise fortnightly collections of comingled recyclables (as for the two bin system), weekly collections of organic waste and fortnightly collections of dry residue waste, all using MGBs.

The EMRC and its Member Councils are considering implementing a three bin waste collection system if an AD technology is implemented. The organic waste bin would be used to collect source separated food waste and greenwaste for treatment at the RRF. If this system was adopted, less pre-treatment of waste is required prior to digestion, compared to the two bin collection system.

Systems have been introduced by the EMRC to assist residents within its district to separate potentially hazardous materials from the waste stream. Household hazardous waste and battery drop off facilities are provided together with periodic collection programs. These programs assist in reducing the amount of undesirable material within the waste being processed.

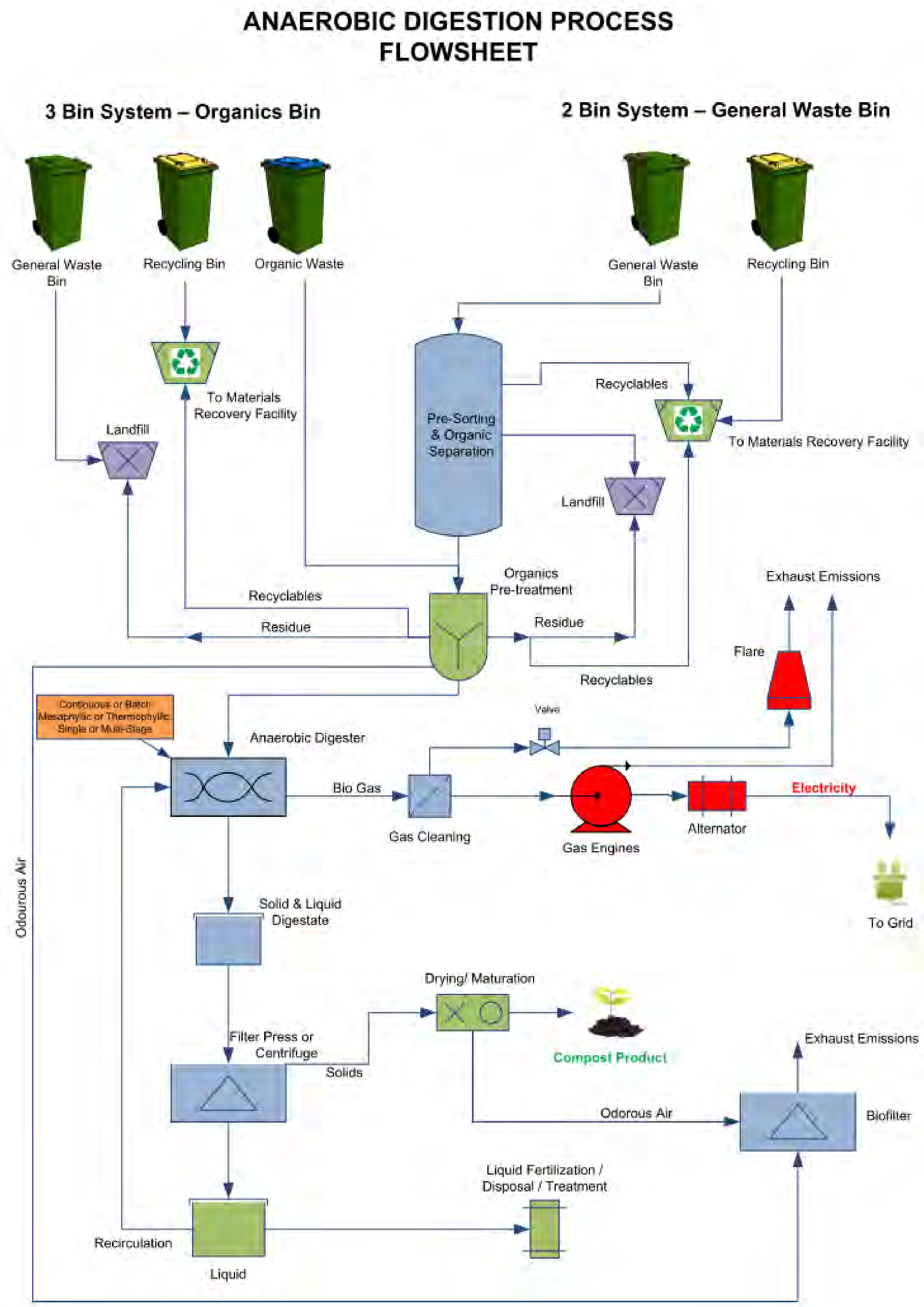

Figure 4 Anaerobic Digestion Process for two and three Bin Systems

In a typical AD facility, MSW is unloaded from the collection trucks into waste pits (bunkers) or onto the floor within a fully enclosed waste receival hall (**Figure** 5). A crane/grapple or front end loader then transfers the waste into a pre-sorting/pre-treatment area. Bulky items and hazardous materials, such as car batteries are removed at this stage, before the waste is sorted and prepared for the biological processes.

Depending on the AD technology chosen for the RRF, utilising a three bin waste collection system, any other contaminants are usually removed after the digestion phase.

For a two bin system, the pre-sorting process typically starts with the removal of bulky items then involves the removal of incompatible and some recyclable materials. Waste goes through a bag opening machine and into a rotating trommel, then magnets, eddy currents and other separators (**Figure 6**) remove the remainder of the recyclable material leaving an organic rich stream which is fed to the pre-treatment process. Products recovered during the mechanical pre-sorting include cardboard, mixed paper, mixed plastics, plastic and glass containers, ferrous and non-ferrous metals, and other inorganic materials.

Preparation of the feedstock for the digester can be undertaken in a number of ways (e.g. shredding, pulping, mixing and screening of the waste) to reduce size and create more homogenous material. The actual mechanical pre-treatment process depends on the digester requirements, the process design and the waste composition.

The pre-treated organic materials are fed into the digesters to undergo anaerobic digestion (**Figure 7**). Naturally occurring anaerobic bacteria break down the organic material through a number of phases (hydrolysis, acetogenesis and methanogenesis) to produce biogas and semi-solid residue referred to as digestate. The RRF digestion process will involve digestion for between 21 to 28 days. The biogas (which contains mainly methane and carbon dioxide with traces of hydrogen sulphide, ammonia, carbon monoxide, water vapour, siloxanes and particulates) can be odorous and the hydrogen sulphide present can cause corrosion in engines. The biogas is therefore cleaned prior to being used as a fuel to reduce air emissions. Typically the biogas cleaning is a two stage process involving cooling of the gas to a temperature of 3-5ºC and dehumidification. The condensate is collected and redirected to the digester percolate tank. After drying, the biogas is compressed and then pumped through a hydrogen sulphide removal process such as an activated carbon filter. Finally it passes through a biogas flow regulator into internal combustion engines where it is used as a fuel to generate electricity. As a safety precaution, a flare system is operable at all times, for use in the event of the gas engines being off-line or during start up and shutdown sequences. In some installations, cleaned biogas is stored in spheres before being used to generate power, for metering into natural gas mains systems or for sale to third parties.

The digestate (the remains of the original feedstock that the microbes cannot break down) is usually dewatered by a filter press (**Figure 8**) or centrifuge, and dried in a biodryer or matured through aerobic composting typically in windrows in an enclosed maturation hall. The compost may be used as a soil conditioner, mulch or blending product for landscape or broad acre farming applications, depending on its final quality and compliance with Australian Standards.

The liquid separated from the digestate is recirculated to the digester and may be used as a liquid fertiliser or disposed of onsite through a wastewater treatment plant. Alternatively it can be incorporated into the existing landfill leachate system detailed in **Section 1.1.1.1**.

Collection and treatment of odorous air is a critical amenity requirement for the RRF design, construction and operation. Odour from each stage of the AD process will be managed through an odour control system. The malodorous air is extracted from the sealed buildings (the waste receival area, sorting area and maturation halls) and pumped into an odour control system located outside the building. It is then filtered and treated before being released into the environment. Types of odour control systems commonly used include biofilters, or a chemical scrubber such as an alkaline oxidation system. When biofilters are used (**Figure 9**) as proposed for the RRF, they are filled with decomposable moistened organic matter such as woodchips or barks. Air flows through the material and micro-organisms in the material decompose harmful substances and eliminate unpleasant odours. Critical design features of biofiltration systems include the humidification of the odorous air leading into the biofilter, inlet air temperature, the distribution of air to the biofilter inlet and the pressure drop over the biofilter.

Fugitive odour emissions will be minimised by the use of rapid opening and closing doors for the waste receival hall. The collection of odorous air will occur as close to source as possible within the enclosed building. In addition, the buildings containing odorous air will be maintained under negative air pressure. Batch digesters will be purged of biogas through the flare system and then aerated prior to being emptied. The digestate that is removed will be retained within an enclosed building with appropriate odour capture and management.

Figure 5 Receival Hall

Figure 6 Removal of Contaminants

Figure 7 Example of a Horizontal Dry System Digester

Figure 8 Screw Press for Dewatering Digestate

Figure 9 Example of a Biofilter

4.2.2 Gasification

4.2.2.1 Gasification Technology Types

Gasification turns waste into an energy-rich fuel gas by heating the waste under controlled conditions. Gasification involves the thermal conversion of organic substances in a limited oxygen environment to produce gases that can be used as feedstock for industrial processes or as a fuel. The process converts the waste into syngas (synthetic gas) at high temperature (850-1000ºC) by carefully controlling the amount of oxygen that is present in the gasifier vessel (known as starved air gasification). Thermal conversion can also be achieved by indirect (external) heating of the waste in a rotary kiln or fluidised bed reactors that are adapted to be operated under gasification conditions. The syngas can be cleaned and used to fuel gas engines or gas turbines for power generation or used as a feedstock for other industrial processes. Often gasification systems are coupled with downstream combustion of the syngas generated. In these systems syngas is fully oxidised to produce mainly carbon dioxide, water vapour and heat and power through the steam cycle, as shown in **Figure 11**.

By-products of gasification are flue gas, fly or filter ash and bottom ash. After the recovery of heat from the flue gas, it is treated through a process that usually involves a combination of individual process units that together provide an overall treatment system for the gaseous emissions. For gasification processes dry flue gas treatment is typically applied. Residues of the flue gas cleaning process are fly ash or filter ash from the bag filter (see **Section 4.2.2.2**).

Bottom ash typically has a relatively low level of organic carbon (TOC <3%). As a consequence of the carefully controlled gasification process, flue gas cleaning requirements are reduced compared to combustion processes.

4.2.2.2 Gasification Process

There are a number of different gasification technologies. The summary below is based on EMRC's research and information from EMRC's Expression of Interest process for resource recovery technologies in 2009.

Generally, there are five stages to the gasification process (see **Figure 10**):

- sorting and waste pre-treatment;
- treatment;
- heat recovery and steam generation;
- flue gas clean-up; and
- ash handling.

A summary of the gasification process is shown in **Figure 11**.

Waste is unloaded from trucks into waste bunkers within a fully enclosed waste receival hall. Fugitive odour emissions will be minimised by the use of rapid opening and closing doors for the waste receival hall, and the collection of odorous air as close to the source as possible within the enclosed building. The waste receival hall will also be maintained under a negative air pressure. Odorous air from the waste receival area will be used in the gasification process thus eliminating any odorous emissions.

The waste is then transferred via an overhead crane into a shredder. When incoming waste is shredded, metals can be removed before gasification to allow recycling. Metal separation can be achieved by using different types of magnets and eddy current separators as illustrated in **Figure 6**. The main objective of the pre-treatment is to remove hazardous materials, ferrous and non-ferrous metals, reduce the size of the waste materials and homogenise the waste in order to improve operation of the gasification chambers.

Systems have been introduced by EMRC to assist residents within its district to separate potentially hazardous materials from the waste stream. Household hazardous waste and battery drop off facilities are provided together with periodic collection programs. These programs will assist in reducing the amount of undesirable material within the waste being processed.

The shredded waste (feedstock) is then conveyed into the gasification reaction chamber through feed hoppers and an airlock to avoid air entering the gasifier and fugitive gases escaping. The gasification process is a two stage thermal process comprising a primary gasification zone followed by a secondary close coupled oxidation zone. The thermal conversion takes place in the primary stage of the gasification chamber – see **Figure 10**. Here the majority of organic material is converted into combustible syngas in a starved air environment at around 900°C. In the secondary chamber of the gasification chamber/reactor, full oxidation takes place at 900-1,000°C by the addition of secondary air and recirculated flue gas. The recirculated flue gas limits the high temperature formation of NOx in the secondary gasification chamber to control the NOx emissions. This is followed by heat recovery, steam generation, flue gas treatment and ash handling.

The heat recovery and steam generation section recovers heat from the hot flue gas downstream of the oxidation chamber and converts this heat into steam for use in a turbine. The heat exchanger detail will vary, depending on the steam pressure required. Typically there will be three connected heat exchangers– a superheater (for increasing the temperature of the steam to around 380°C before it is fed to the steam turbine), a boiler and connected steam drum for generating saturated steam and an economiser to preheat the boiler feed water to around 100°C before it enters the boiler.

The steam turbine is usually a condensing steam turbine designed to convert the energy in the steam to electrical energy by driving the turbine which is connected to an alternating current generator and a transformer to increase to the voltage of the electricity to the required level for use in the plant and for export to the grid system. The exhaust steam from the turbine is condensed back into hot water (known as condensate) which is recycled back to the boiler feed water tank.

Flue gas is the exhaust gas exiting to the atmosphere via a flue and a stack after the heat recovery section. The flue gas has to be cleaned before exiting to the atmosphere which typically involves the addition of lime or bicarbonate and activated carbon (high adsorption materials capable of adsorbing acid gases and toxic elements) to the flue gas followed by filtration through a bag house (fabric) filter. These processes remove particulates (dust particles), acid gases, volatile metals, volatile organic compounds and dioxins. The activated carbon and bag filter plays an important part in the capture of dioxins which may have reformed after destruction in the secondary oxidation stage (achieved by a minimum of 2 seconds residence time at 850ºC) as the gas temperatures drop in the gas cleaning process. The bag filter is followed by the flue gas fan (which provides the driving force to pull the flue gas from the gasification chambers through the heat recovery and gas cleaning systems) and the stack.

A flue gas analyser (continuous emissions monitoring system or CEMS) is installed in the stack to facilitate corrective actions in the event of increases in key emissions. For other parameters that cannot be measured continuously, periodic testing is carried out using stationary source sampling and analysis methodologies.

The ash generated in the primary gasification chamber is known as bottom ash and is the main residue from the gasification process. Ferrous metals are usually recovered from the bottom ash before it is reused in different applications such as road works and earthworks or sent for disposal to landfill. Typically bottom ash would be disposed of to a Class I or Class III landfill. The Red Hill WMF has Class III landfill cells to receive this residue.

The reside from the flue gas cleaning system is known as filter ash or fly ash and requires disposal at an appropriately classified landfill facility. Depending on the concentration of metals in the ash and their potential for leaching, the landfill may need to be a Class IV landfill. The Red Hill WMF has a Class IV landfill cell to receive this waste if necessary. Testing of the fly ash will be undertaken to determine the appropriate method of disposal.

The ratio of bottom ash to fly ash is usually about 3:1 and the ash materials are typically around 20% by weight of the waste feed to the gasification plant.

1. RCV
2. Waste bunker
3. Recycle centre
4. Fuel bunker
5. Manually operated crane
6. Automatic crane
7. Hopper
8. Primary chamber
9. Secondary chamber
10. Heat recovery steam generator
11. Lime and carbon filter
12. Bag house filter
13. Filter residue silo
14. Fuel gas fan
15. Chimney
16. Bottom ash extraction
17. Steam turbine
18. Air cooled condenser

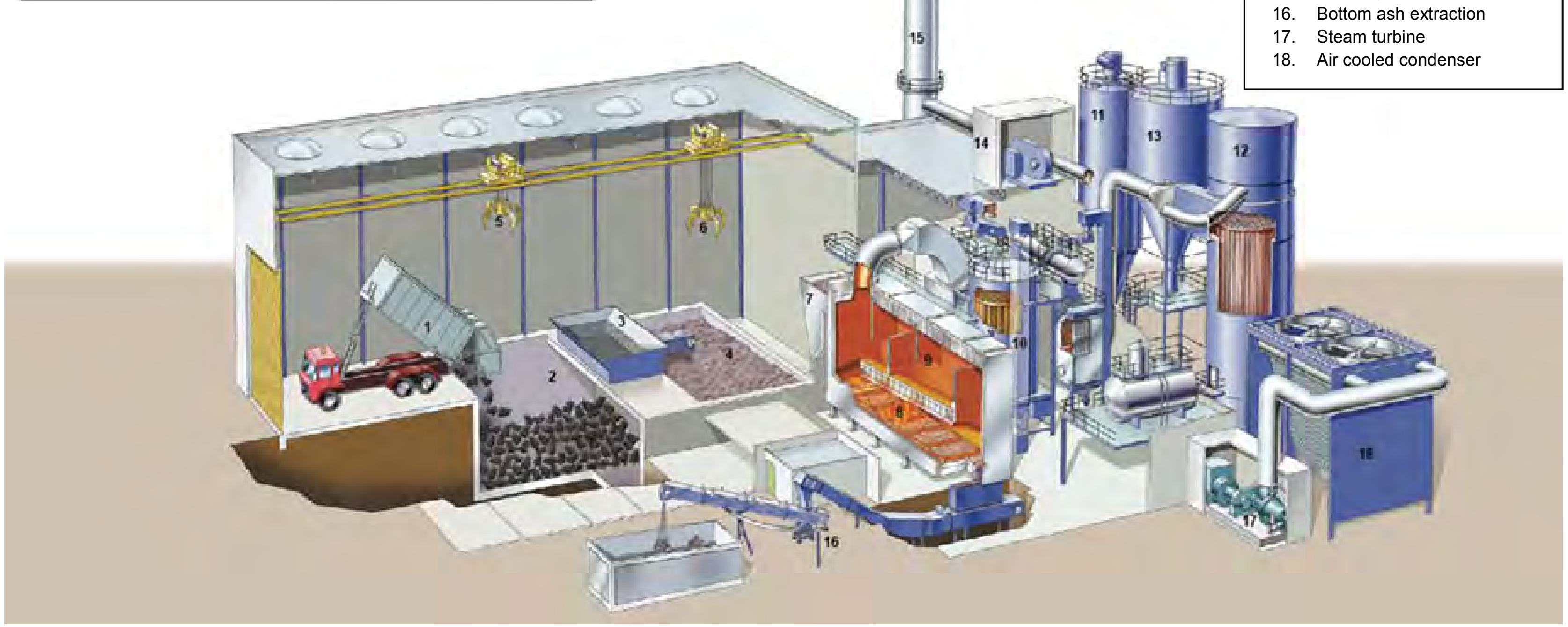

Figure 10 Typical gasification Plant and an Internal View of an Example of a Gasification Plant

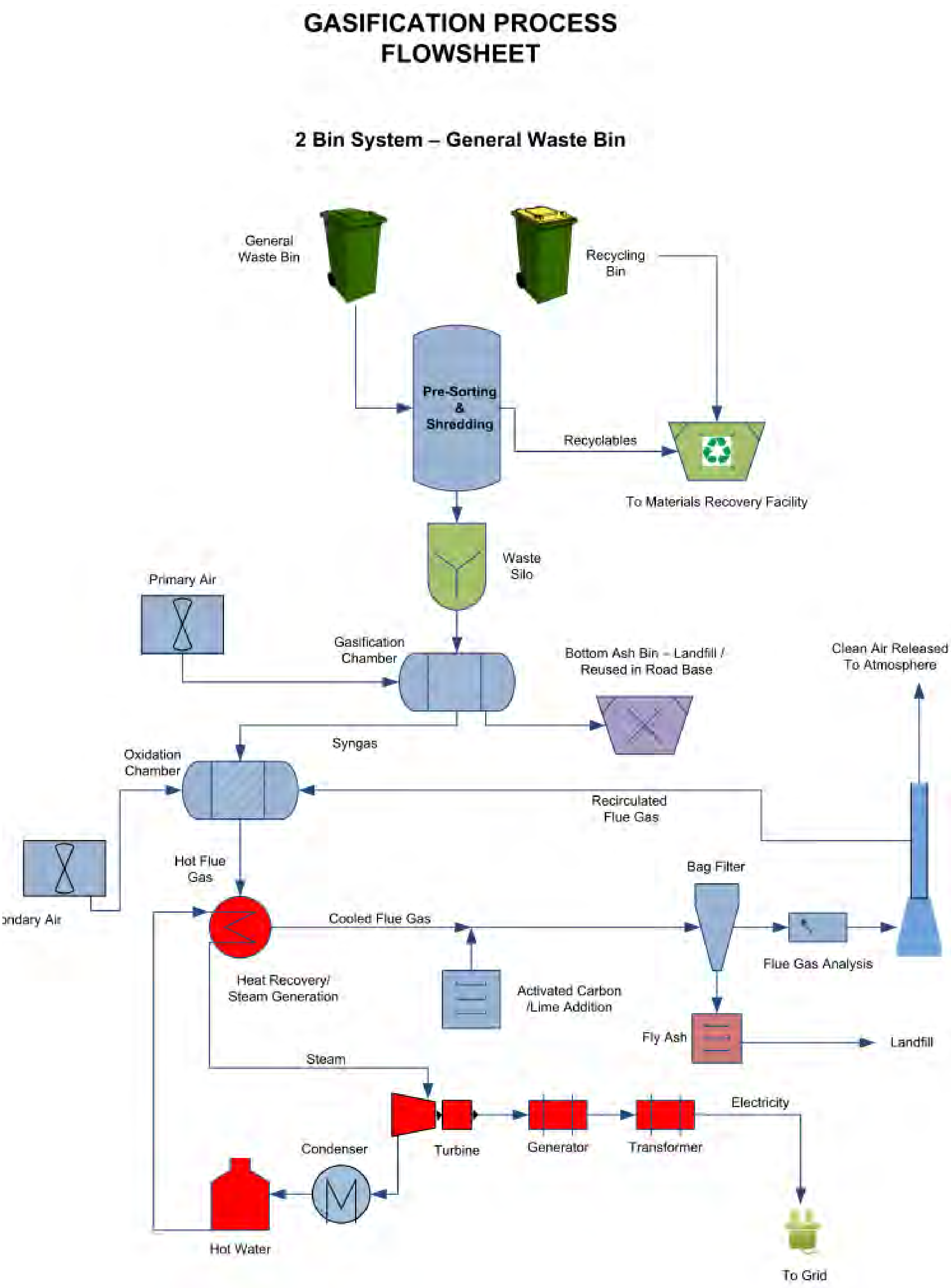

Figure 11 Summary of the Gasification Process

The tight control exercised over the waste gasification and syngas oxidation processes is a key factor in minimising the composition and quantity of flue gas that needs to be cleaned before discharge to the atmosphere. This relates to:

- proprietary mathematical model and computer software to control the process;
- the careful control of airflows to the primary and secondary chambers;
- the feed rate of the waste (via a guillotine);
- the transport of the waste along the grate;
- the design of the duplexer (waste transport mechanism) to control the height of the bed in the gasification zone; and
- use of auxiliary burners to regulate temperatures above 850º C in the secondary chamber during start-ups and shutdowns and as standby burners whilst waste is being processed.

The natural gas or LPG fired auxiliary burners are used during start-up and shutdown and on standby to maintain temperatures in the gasification chamber. When waste is admitted to the gasification chamber (**Figure 12**), auxiliary heating is reduced progressively as the calorific value of the waste is more than sufficient to maintain the design temperatures, i.e. it is a spontaneous rather than an assisted process. By achieving this tight control over the process, the flue gas cleaning is simplified and cost is reduced.

Figure 12 Gasification Chamber

The gasification process achieves the standards set under the European Union Waste Incineration Directive (WID) in regards to gaseous emission control. The WID includes the following definition: *"'incineration plant' means any stationary or mobile technical unit and equipment dedicated to the thermal treatment of wastes with or without recovery of the combustion heat generated*". The process referred to in the PER produces combustible gases (syngas) in the primary chamber, which are then oxidised under tightly controlled conditions in the secondary chamber. Regulators throughout the EU would therefore require this process to meet pollution emission limits set by the WID. Independent measurement data shows that this process meets the WID requirements.

4.2.2.2.1 Emergency shutdown and start-up

In the event of an electrical failure, the emergency shutdown system will close the plant down safely. Such plants have uninterruptable power supply for critical components like:

- The process control system;
- Continuous emission monitoring; and
- Critical elements such as instruments and valves.

The plant will have a standby power generator, which starts automatically with a power failure. This will deliver power to critical components. The flue gas fan has a pony motor driven by the standby power generator. This secures a draught to remove gases from the furnace. The flue gas will continue to go through the bag filter and the adsorbents on the bags will still control the emissions. To secure excess air in the furnace oxidation chamber, valves are kept closed. Air supply to the gasification zone is closed, and an ash layer will quickly form on top of the waste. Within a couple of minutes there is no longer any significant gasification.

As referred to above, the auxiliary burners are used to pre-heat the plant including the flue gas cleaning system before waste is admitted to the gasification chamber and to maintain desired temperatures if this is not achieved from the waste thermal conversion. **Section 9.6.6** describes what would occur in the event of a failure of the bags in the bag filter.

4.3 Key Characteristics – Site of Facility

4.3.1 Site Location and Identification

The Subject Site is located within the Red Hill WMF, which is located on Toodyay Road, approximately 26 km north-east of Perth, WA (**Figure 3**). The Red Hill WMF covers a total area of approximately 305.4ha and covers several cadastral lots within the localities of Red Hill, Gidgegannup and Parkerville as detailed in **Table 4-6**:

Table 4-6 Site Identification Details

Lot / Plan Details	Certificate of Title (Volume / Folio) Details	Street Address	Approximate Size (ha)
Lot 1 on Diagram 15239	Vol.1128 / Folio 23	1094 Toodyay Road, Red Hill	48.4
Lot 2 on Diagram 68630	Vol. 1717 / Folio 585	2 Toodyay Road, Red Hill	21.4
Lot 11 on Diagram 69105	Vol. 1783 / Folio 671	1072 Toodyay Road, Red Hill	25.7
Lot 12 on Plan 26468	Vol. 1672 / Folio 829	1204 Toodyay Road, Gidgegannup	166.4
Lot 81 on Diagram14276	Vol. 1131 / Folio 63	2925 Roland Road, Parkerville	8.7
Lot 501 on Plan 40105	Vol. 2227 / Folio 692	501 Highlands Drive, Parkerville	34.8

The waste management operations are currently located in the western half of the Red Hill WMF predominantly covering Lots 1, 2 and 11, however some operations also extend into the western side of Lot 12. The EMRC has retained bushland in the two southern lots of the Red Hill WMF (Lots 81 and 501) to provide a buffer in excess of 500m from the landfill operations to residences located to the south of the site.

The Subject Site is located within Lot 12 which has a total area of 166.4 ha. The majority of Lot 12 (126.6ha) has been historically cleared for grazing and the remaining 39.8 ha consists of remnant native vegetation. The vegetation on Lot 12 is described further in **Section 8.3.2.3**. The Subject Site is located within the previously cleared north west corner of Lot 12. At present, this area contains unsealed access roads and parking areas and remnant scattered Marri trees. A new landfill cell is located to the east, an unsealed access road to the north and a cleared area located to the west of the Subject Site (**Figure 3**).

4.3.2 Planning Context

The lots located within the Red Hill WMF are situated within the City of Swan (Lots 1, 2, 11 and 12) and the Shire of Mundaring (Lots 81 and 501), and are all owned by the EMRC. However, as the Subject Site is located within the City of Swan, this proposal will only be subject to the City of Swan's town planning requirements. The two lots situated within the Shire of Mundaring are currently not zoned under the Shire of Mundaring's Town Planning Scheme No. 3 (amended March 2010).

Under the City of Swan's Local Planning Scheme No. 17 (amended March 2010) the Subject Site is located within a 'Special Use' zone (**Figure 13**). The 'Special Uses' permitted under the Scheme designated area, include: waste management, receival, recovery, treatment, processing and disposal, as well as extractive industry and radio communications.

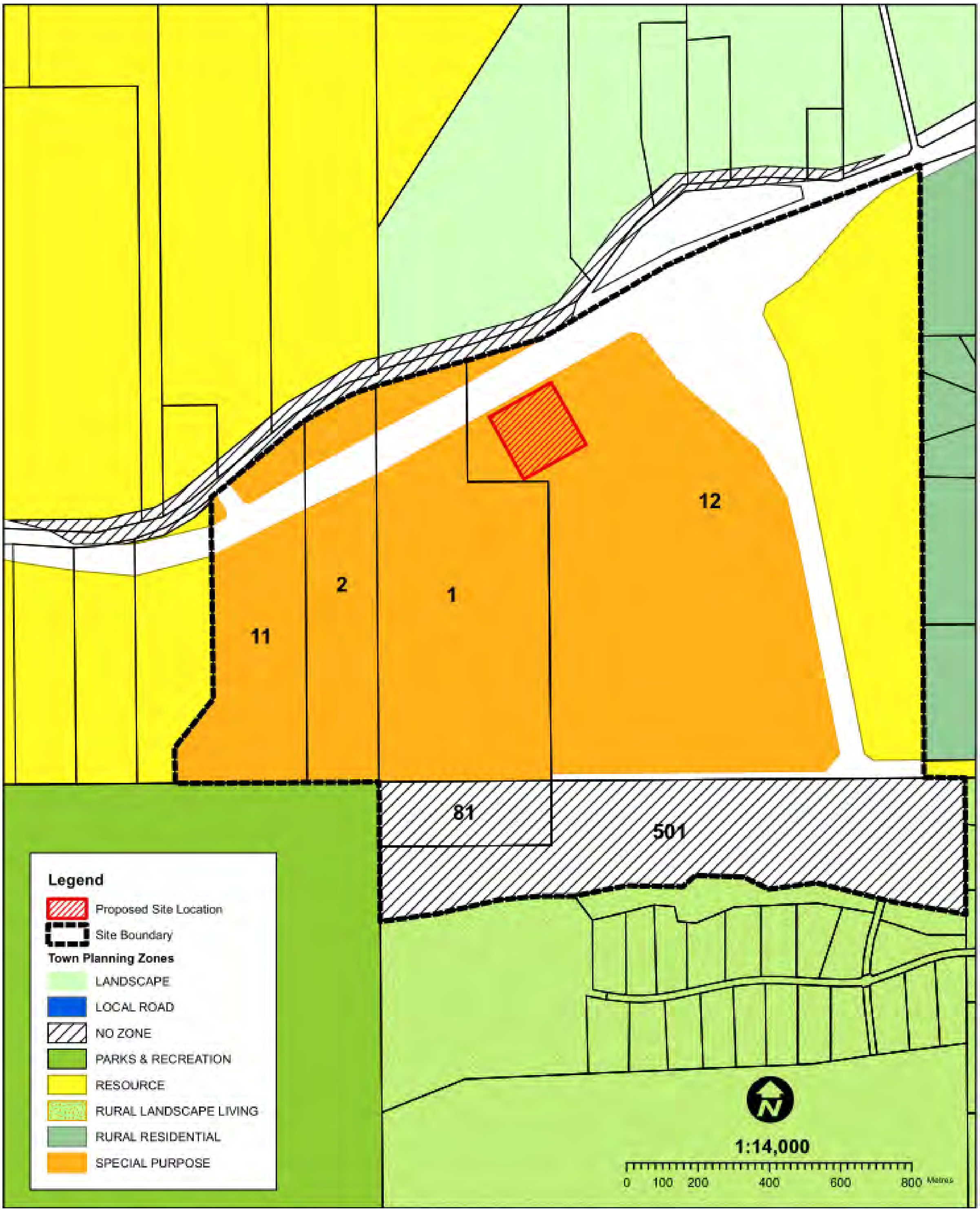

Figure 13 Site Zoning

The Conditions listed in the Local Planning Scheme which relate to the site (Special Use Zone No. 9) indicate that, prior to determining an application for development, the City of Swan shall:

1. *Consult with the Department of Environment, Department of Conservation and Land Management* [now the DEC]*, and Main Roads WA*
2. *Have regard to the interface with John Forrest National Park, surface and groundwater quality, vegetative buffers from surrounding land, existing remnant vegetation on site and fire management.*

The proposed Perth to Adelaide Highway road reserve cuts through the northern portion of the site (through Lots 1, 2, 11 and 12), while the proposed Hills Spine Road runs north to south through Lot 12 to connect the residential areas south of Red Hill to the Perth to Adelaide Highway. These proposed roads are 'Primary Regional Roads' under the Metropolitan Region Scheme. Primary Regional Roads are the most important of the roads of regional significance in the planned road network, and are currently or proposed to be declared under the *Main Roads Act 1930*. The Subject Site will not intrude on these Primary Regional Roads.

The eastern portion of Lot 12 (i.e. east of the proposed Hills Spine Road) is zoned as 'Rural – Resource', while the western portion is zoned as 'Special Use' under the City of Swan's Local Planning Scheme, and as described above.

With the exception of the Primary Regional Roads, the entire Red Hill WMF is zoned as 'Rural' under the Metropolitan Regional Scheme. This zoning includes land in which a range of agricultural, extractive and conservation uses are undertaken (WAPC 2004).

Aside from some permitted developments, uses or advertisements identified in Schedule 5 and Schedule 5A of the City of Swan's Local Planning Scheme, all development on land zoned and reserved under the Scheme requires the prior approval from the City of Swan. A person must not commence or carry out any development without first having applied for and obtained the planning approval of the Local Government. Approval to commence development on the Red Hill WMF is not required from the WA Planning Commission under the Metropolitan Region Scheme (amended November 2007) (WAPC 2007).

To gain approval for the proposed development at the Red Hill WMF, a development application is required to be lodged with the City of Swan for consideration. When considering the application for planning approval the City of Swan may consult with any other statutory, public or planning authority it considers appropriate.

Both the City of Swan and the Shire of Mundaring are aware of the proposed development as both Local Governments are Member Councils of the EMRC and have been involved in the planning phase of the project. Representatives of the EMRC have also made periodic presentations relating to the RRF project to the councils of the local Governments.

4.3.3 Red Hill Waste Management Facility

The EMRC operates the Red Hill WMF in accordance with the environmental and operating conditions outlined in the Licence No. 6833/1997/11 issued by the DEC pursuant to Part V of the EP Act. The licence period commenced on 5 May 2011, and will expire on 4 May 2015. Red Hill WMF is an approved Class III and IV landfill and accepts a range of wastes, including inert waste, putrescible waste, contaminated waste, type 1 and type 2 special wastes, in accordance with the facility Conditions of Licence. The facility also acts as a collection and storage area for dry recyclables and household hazardous waste which are received at the transfer station.

Red Hill WMF accepts waste from various organisations within and outside the region including the general public, commercial operators, and Local, Regional, State and Federal Government organisations. In 2010/2011 the facility accepted approximately 309,300 tonnes of waste, including 126,000 tonnes of Member Council waste plus commercial waste and other wastes (Class IV and greenwaste) (EMRC official records for waste receival 2010/2011).

Prior to the Red Hill WMF development into a waste management facility, the former Department of Main Roads used the land as a borrow pit for the excavation of pisolitic laterite gravel (for use in road construction). Landfilling operations commenced in 1981 in Lot 11, which was filled to capacity in

1992, and subsequently capped and rehabilitated. In total there are 14 completed landfill stages on site. Landfill operations are currently undertaken in Lots 1 and 2 within the active Class III and Class IV cells. Another Class III cell has recently been constructed in the northwest corner of Lot 12 however, landfilling has not yet commenced (EMRC official records for waste receival 2010/2011), however it is expected that filling of this cell will be completed prior to the RRF going online.

The Landfill Gas and Power Pty Ltd (LGP) Station, which extracts and converts the landfill gas produced in Cells 1 to 10 into renewable energy, is located in the northwest corner of the site (within Lot 11) adjacent to Toodyay Road. The LGP facility was upgraded during 2006/2007, increasing the capacity of the plant to 3.65MW. During the upgrade, the latest monitoring and switching equipment were installed, along with replacing the mufflers on the engine exhausts to reduce noise from the plant.

A greenwaste processing facility was developed in 2003, located on Lot 1 of the Red Hill WMF, and includes open windrow composting and mulching of source separated greenwaste. The greenwaste facility recycles greenwaste collected from Council verge collections, greenwaste bins, transfer stations and commercial customers. Australian Standard AS4454 mulches are produced from the composting process and are often made available to residents disposing of waste at the transfer station.

A 6,400L capacity ‘multistore’ dangerous goods unit was also constructed at the Red Hill WMF in 1997, to store low hazard household waste or household hazardous waste. Fitted with a range of safety features, the unit allows different classes of dangerous goods to be stored in individual compartments within the one facility. The unit is located in the northern portion of Lot 11. As the aggregate total of these types of dangerous goods is below the Manifest Quantity threshold (10,000kg or litres), storage of these goods are not required to be covered by a Dangerous Goods Site Licence. The EMRC has a Dangerous Goods Site Licence (No# DGS010844) for the following storage units:

- one 10,000L unleaded petrol underground storage tank; and
- one 25,000L diesel aboveground storage tank.

The Red Hill WMF also has a 5,200L mobile diesel trailer and a 1,300L mobile diesel trailer on site, however these are not required to be licensed.

Other infrastructure on site includes a waste transfer station, weighbridge, administration office, Environmental Education Centre, as well as both sealed and unsealed access roads. The weighbridge, administration office and Environmental Education Centre are located in the northern portion of Lot 11, adjacent to Toodyay Road. The transfer station accepts a range of wastes from residents including: general household waste, recyclable items, greenwaste, car bodies, household hazardous wastes, asbestos, tyres, e-waste and mattresses, and is located across the boundary between Lots 2 and 11.

In accordance with the Conditions of Licence No. 6833/1997/11, Red Hill WMF is enclosed by a 1.8m high mesh-wire security fence. The fence has three-barbed extensions using 40mm galvanised tube posts. Access into the site is through the main gate located along the northern boundary of Lot 11 from Toodyay Road. The site is locked outside of commercial operating hours.

Modern sanitary landfill design and operation techniques are used at the Red Hill WMF, including cell membrane lining systems, leachate collection (**Section 1.1.1.1**) , methane gas capture and power generation.

4.3.3.1 Red Hill Landfill Leachate System

The current system onsite collects leachate from the landfill cells and the greenwaste processing area. Leachate which forms in the landfill cells is a liquid product of the waste being broken down through anaerobic processes. Landfill gas containing methane is generated as a by-product of this process. In the greenwaste processing area, MGB and kerbside collected greenwaste are shredded and formed into windrows which are turned and watered periodically to maintain a desired moisture and oxygen level. Any runoff from these windrows is treated as leachate and so is collected and stored in a leachate pond. The EMRC maintains eight leachate ponds at Red Hill:

- Four ponds to collect leachate from Class II / III cells (stages 1-12);
- One each for the Class IV Stage 1 and 2 cells;
- One large pond constructed to contain runoff from the greenwaste processing area; and
- A leachate pond constructed at the Soil Remediation Area now intended to be used for leachate collection from lime amended bioclay operations.

Class III landfill cells Stages 1-10 use a network of pipes laid in trenches across the cell floor, covered by gravel and a geotextile. Collection pipes are generally constructed of slotted PVC sewer pipes & laid in trenches. The pipes run to manhole structures, constructed of concrete well liners. Leachate is transferred from the well liners by solid PVC sewer pipe under gravity to the leachate ponds.

Landfill cells Stages 11-12 use a network of pipes as per Stages 1-10. Collection pipes are constructed of HDPE pipes with holes drilled in the four quadrants at regular intervals. These collection pipes feed into carrier pipes, which are HDPE pipes with holes drilled in the top half at regular intervals. Each carrier pipe drains into a concrete sump which is placed into the floor of the cell. Leachate is then pumped out using air pumps and transferred to the onsite leachate ponds.

Leachate is currently contained in the leachate ponds, and is managed through evaporation and recirculation back into the landfill cells. No leachate treatment is currently undertaken at Red Hill Landfill. With the introduction of the RRF and the associated diversion of a significant portion of the organic waste from landfill, the quantity of leachate generated within the landfill will reduce from what would be otherwise generated. If anaerobic digestion technology was adopted for the RRF, then some surplus liquid residue from the process may be discharged to the landfill leachate system. However, the quantity is likely to be small with the majority of the liquid residue (around 90%) being recirculated within the AD process and the small amount of surplus liquid residue (10%) will be utilised as a liquid fertiliser (see **Section 12.1.3.2**) or discharged to the landfill leachate system. The current landfill leachate system can be therefore considered sufficient to handle the landfill leachate and the surplus liquid from the AD process. The use of floating covers is also being investigated to minimise the volume of leachate resulting from the rainwater falling directly into the leachate ponds. Collected rainwater would be reused on site for dust suppression.

4.3.4 Future Landfill Expansion

The EMRC currently holds an Approval to Commence Development from the City of Swan in relation to Lots 1 and 2 for the purposes of excavation of lateritic clay and filling of excavation with waste. This approval nominates Lot 11 as the site access, with Lot 12 being the site to contain spoil from the excavation. The approval is valid until 19 October 2016.

A City of Swan Extractive Industry Approval is also current for Lot 12. This is valid until 16 November 2012. The Extractive Industry Approval allows for the excavation and sale of lateritic caprock and clay from a portion of Lots 12.

A substantial part of the development of Lots 1, 2, and 11 for landfill is anticipated to be completed in early 2013. As such, the landfill will need to expand into Lot 12. To accommodate this expansion, the excavation of rock and soil from parts of Lot 12 required for landfill expansion has been undertaken and a liner and leachate system installed for one cell ready for the acceptance of waste. The new landfill cell will be the first stage of landfilling in Lot 12. Provision has been made in its development for future stages to connect to the liner system. A Works Approval W4547 dated 10 November 2009 was issued by the DEC for the establishment of this cell. It is anticipated that landfilling in the cell will commence in 2013 and be completed prior to the commencement of operation of the RRF.

4.3.5 Buffer Zones and Closest Residents

Under the DEC Conditions of Licence (No. 6833/1997/11), an internal buffer of 35m is required between an active landfill cell and the property boundary. In addition, the EPA's Guidance Statement No. 3: Separation Distances between Industrial and Sensitive Land Uses (EPA 2005) indicates that a separation distance of 150m for single residences, and 500m for sensitive uses (subdivision) is suitable for Class II and Class III landfills. Red Hill WMF complies with these recommended distances.

A separation distance between a potential WtE plant and sensitive land uses (such as residential subdivisions) should be 500-1000m depending on the size of the plant and the composition of the waste material to be treated. For anaerobic digestion buffer distances will be decided case by case (EPA 2005). These separation distances are intended to be used as a tool, supplemented by other appropriate scientific investigations. In this PER a full assessment has been undertaken of the impacts of the RRF including modelling of noise, odour and air emissions.

Lots 81 and 501 (located to the south of the Class IV cell, in the Shire of Mundaring) were purchased by the EMRC to secure a buffer from the Hidden Valley Estate. The Hidden Valley Estate is zoned Rural Landscape Living under the Shire of Mundaring's Town Planning Scheme No. 3. An objective of Rural Landscape Living zoning is to preserve the rural landscape and scenic value of the area. It has a low density of residential dwellings and is fully developed across the southern boundary of Lot 501.

Barbarich Estate to the east of Lot 12 is buffered from the active landfill cells by the road reserve that will hold the future Hills Spine Road and the eastern portion of Lot 12. The eastern portion of Lot 12 is zoned Resource under the City of Swan's Local Planning Scheme No. 17 and its future use is affected by the buffer requirements of the landfill and potential RRF. Land within the Barbarich Estate is zoned Rural Residential under Local Planning Scheme No. 17. It has a low density of residential dwellings and is fully developed across the eastern boundary of Lot 12.

The John Forrest National Park provides a buffer to the south and southwest of the active cells, while the adjacent quarry sites provide a buffer to the west and northwest.

A number of residences are located adjacent to the Red Hill WMF. The Subject Site is approximately 400 m from the nearest residence. There are four residences within 1 km of Subject Site. However, these residences are single residences and are not therefore classified as sensitive land uses under the EPA Guidance Statement. Further details on site selection are provided in **Section 5.2.2**.

Current operations at the Red Hill WMF confirm that existing buffers to sensitive landuses are adequate. This has been demonstrated by the monitoring undertaken as part of this assessment of the noise (**Section 10**) and air quality impacts (**Section 9.5**) of the proposed RRF. This is also supported by the odour modelling (**Section 11**). The assessment also found that these buffers are suitable for the RRF. The landuse zonings detailed above confirm no sensitive landuses will be located closer to the Subject Site than currently exists.

4.3.6 Ownership

The Site, comprising the lots as described in **Table 4-6** is owned in freehold title by the EMRC.

4.4 Key Characteristics – Project Logistics and Timetable

The following schedule outlines the anticipated environmental assessment period for the proposal. This schedule allows for the assessment to be undertaken to the full provision of the regulatory process and is contingent on key information being available that enables the EMRC to prepare and submit necessary documentation. Based on these timeframes the EMRC aims to obtain all environmental approvals by January 2013 and commence the operation of the RRF by December 2015 as shown in **Table 4-7**.

Table 4-7 Estimated Project and Assessment Schedule

Task	Details	Commencement	Completion	Target Timeframe
Level of Assessment set		June 2010	September 2010	3 months
Appeal Period and Follow-up on Appeals		September 2010	October 2010	1 month
Environmental Scoping Document		July 2010	March 2011	8 months
EPA Feedback and Review of Scoping Document		April 2011	June 2011	12 weeks
Scoping Document Agreed		June 2011	September 2011	3 months
Draft EIA Report		March 2011	October 2011	8 months
PER Assessment	Submit draft PER to EPA	November 2011	January 2012	6 weeks
	Public Review of PER document	23 July 2012	17 September 2012	8 weeks
	Proponent responds to submissions	24 September 2012	22 October 2012	4 weeks
	EPA assessment	22 October 2012	13 December 2012	7 weeks
	Preparation and finalisation of EPA Report	13 December 2012	28 January 2013	5 weeks
Appeals	Appeals Period	January 2013	February 2013	2 weeks
Minister	Minister Consideration	February 2013	May 2013	3 months
Total Assessment Timeframe				28 months
Complete tender process, finalise RRF contract and procure approvals required		2013	2014	19 months
Complete construction of RRF, obtain operational licence		2015	2016	18 months[1]
Wet commissioning of RRF		2016	2016	3 months
Total Council Approval, Tender Process and Construction Timeframe				40 months

Notes [1] Subject to technology type and tender advice.

5 Justification for the Proposal and Alternative Options Considered

5.1 Justification for the Proposal

Households in the EMRC have generally embraced recycling (of materials such as paper, cardboard, bottles, cans etc.) through yellow top kerbside bins and separate greenwaste collections as accepted community practice. As such, the EMRC is now focussed on recovering more potential resources from the domestic MSW (rubbish bins) stream to further reduce the amount of waste going to landfill. Substantial research into resource recovery has indicated that the successful operation of a RRF will greatly assist in achieving the EMRC's desired outcomes and resource recovery goals, including:

- diverting waste from landfill and increasing the life expectancy of Red Hill WMF;
- reducing the environmental impacts associated with landfilling, including greenhouse gas emissions and potential contamination of soil and groundwater;
- generating a marketable product, such as compost and/or renewable power and recyclables;
- increasing the recovery of resources;
- developing resource recovery options including, timber recycling, used mattress disassembly and other resource recovery options at the EMRC's Recycling Centre in Hazelmere; and
- complying with the Waste Authority's strategies and targets for MSW as detailed in the Western Australian Waste Strategy (2012).

Market research and the EOI process undertaken by the EMRC indicate that there are a number of commercially proven RRF technologies available for the treatment of MSW. The environmental benefits of these technologies are well established and reflected in most waste management hierarchies, including that contained in the Western Australian Waste Strategy (2012). The use of RRFs is also becoming necessary in some parts of the world to meet strict environmental directives such as the European Union Landfill Directive (Council Directive 1999/31/EC). The EMRC has therefore resolved to pursue the environmental approvals for the construction and operation of an RRF as part of an integrated resource recovery strategy for the Eastern Region.

5.2 Alternative Options Considered

The RRF Project forms part of an integrated strategy to provide resource recovery services in the region. Other aspects of this strategy include:

- A comprehensive regional waste education strategy promoting waste avoidance and reduction as well as best practice waste management. The education strategy also forms part of the community engagement associated with the resource recovery project.
- The establishment of a resource recovery park in Hazelmere. This facility currently receives and reprocesses special wastes such as timber and mattresses. Planning has commenced for it to be expanded into a comprehensive, community based resource recovery facility incorporating a reuse centre and the recovery of a range of specific materials.
- Operating the Red Hill WMF as a best practice facility with appropriate leachate management, landfill gas capture, power generation and site rehabilitation.

The EMRC has considered a number of options during the planning process for the RRF for the recovery of resources from the mixed MSW collected by the Member Councils through their weekly kerbside collection systems. In addition to the option of establishing a new RRF, as covered by this Proposal, the following options were considered:

- no change to the current practice of landfill; and

- use of existing resource recovery infrastructure available in Perth.

The 'no change' option has been compared to the option of RRF construction and operation in terms of whole of life environmental and financial implications.

The 'no change' option is considered not to be as environmentally sustainable as the RRF option, as continuing to landfill kerbside MSW at projected landfilling rates:

- does not minimise the amount of waste to landfill;
- decreases the life expectancy of the Red Hill WMF;
- does not maximise gas capture and minimise the risk of other environmental impacts associated with landfilling;
- loses valuable, recoverable resources that may potentially be used instead of virgin products; and
- does not reflect State Government commitments and draft targets to reduce waste going to landfill.

Financial implications are important for the participating Member Councils as the costs for any development will ultimately impact on the ratepayers. Financial modelling suggests that the 'no change' option may well be less financially viable in the longer term, compared to the RRF option. This is attributed to the expected increases to regulatory costs (e.g. the landfill levy) associated with landfilling, as well as increases to market based expenses (e.g. electricity costs and the introduction of carbon trading).

Using local existing resource recovery infrastructure was also considered by the EMRC. While WA is currently leading other states of Australia in terms of commissioning and operating RRFs, there is not capacity available to process the EMRC's MSW tonnage. The other facilities that have been built or are being planned are committed to treat waste from other local and regional governments.

On this basis, the EMRC decided to proceed with the planning to provide its own RRF. A number of project specific options have also been considered by the EMRC during the planning process for the RRF. This process began in 2004, with preliminary assessments made on potential sites, AWT technologies, contract delivery models, and waste (bin) collection systems. In terms of this proposal, site options and technology options are considered relevant and are explained further in the following sections.

5.2.1 Technology Options

Preliminary assessments of potential technologies were undertaken at the beginning of the planning process for the RRF. The evaluation of the technologies used a multi-criteria assessment, with input from members of the public and other stakeholders. Technologies assessed were as follows:

- Bioreactor landfill, that relates to landfilling of waste and the capture of methane;
- Mechanical Biological Treatment – Anaerobic (AD), that produces energy and compost;
- Mechanical Biological Treatment – Aerobic (composting), that produces MSW derived compost;
- EfW technologies including combustion, gasification, pyrolysis.

Bioreactor landfill is a facility that is developed and operated to maximise the rate of generation of landfill gas and to accelerate the stabilisation of the biological processes within the cell. It is similar in many regards to the landfill cells in the RHWMF, however both types of landfills pose potential environmental risks due to the generation of landfill gas and leachate, result in the loss of potentially recoverable resources and sterilisation/alienation of land. Given the strategic nature of the evaluation, the results of the assessment of bioreactor landfill provide a similar outcome to the current RHWMF landfill. Key features of bioreactor landfill which differ from the current RHWMF landfill are:

- Presorting of the waste prior to landfilling; and

- Mining of the cells once the organic waste has stabilised to recover materials for reuse and then the reuse of the cells.

While there are no known examples of bioreactor landfill cells being mined, this option was assessed as the likely future ‘best practice’ landfill method that would be adopted by the EMRC. This was a conservative approach taken for the evaluation of the alternative treatment technologies.

Public workshop participants and community survey participants assisted in developing the assessment criteria which were grouped into four categories (technical, social, economic and environmental).The environmental criteria that were used were:

- Air pollution; the probability and consequence of air contamination, including issues such as particulate matter, chemical toxins such as heavy metals, dioxins and furans and Greenhouse Gas Emissions (GHS).
- Surface water or groundwater pollution; the probability and consequence of surface water/groundwater contamination.
- Noise pollution; the probability and consequence of noise pollution, including noise from the facility and transportation routes.
- Resource conservation; an ability to conserve resources either through energy or material recovery. A net energy balance was calculated for each technology based on energy consumption/ generation by the facility and indirect energy savings through material recovery. The net energy balance was directly related to GHG emissions.
- End product benefits including offsets use of alternatives; the environmental benefits caused by the use of products generated from waste processing over those products being replaced.
- Minimal waste landfilled / maximum recycled and recovered; a quantifiable criterion measuring the percentage of waste diverted from landfill by each technology option.
- Risk of odours generated by the technology causing a nuisance; the probability and consequence of odours generated from the technology.
- Likelihood of obtaining government approval.

In order to assess the impact of GHG emissions, each scenario was modelled to calculate estimates of the Global Warming Units (GWU) produced. The estimate calculations were based on a previous Cardno BSD report (2003).

The average Australian household produces 16 tonnes of GWUs (CO_2 equivalents) per year, **Figure 14** shows the total GHG emission savings for each assessed MSW Treatment Technology scenario in terms of GWU savings when compared to the current situation (i.e. bioreactor landfill).

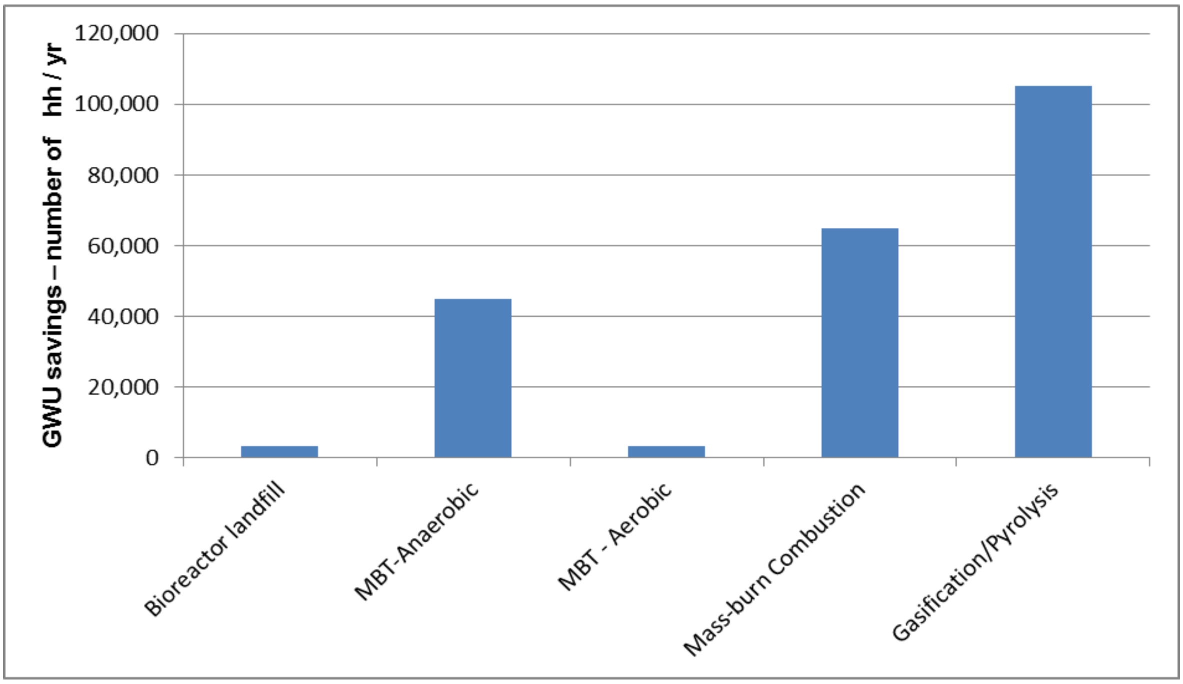

Figure 14 Total GHG Emission Saving Estimates for the MSW Technology Scenarios Assessed.

The results of one of the of the multi-criteria analysis methodologies, an Additive Weighting analysis of the criteria, are summarised in **Figure 15**.

Each of the criterion was given a weighting which were also developed through the consultation process. The additive weightings showed that landfill had the lowest (that is, worst) overall ranking at 43.3, followed by mass burn at 48.9, gasification at 55.4, MBT aerobic at 60.3 and MBT anaerobic preferred at 76.

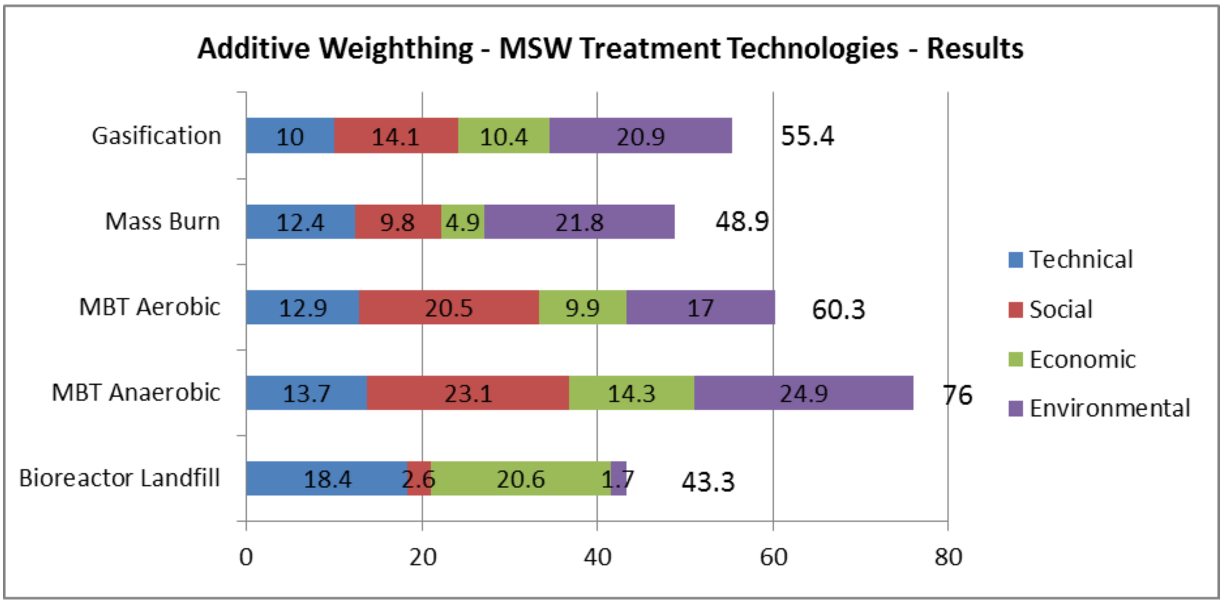

Figure 15 Results of Multi Criteria Analysis of Technology Options

The outcomes from the project planning process led to the resolution by the EMRC to limit the technologies that will be further investigated to AD technology and EfW technologies (combustion, gasification and pyrolysis). Plasma arc gasification was only to be considered if it is proposed to be used as an integral part of one of the other technologies

The EMRC rejected Bioreactor Landfill technology as a viable treatment option for the RRF. Although it had the lowest cost, the recovery of quality organic and recyclable resources from bioreactor landfills has yet to be demonstrated at a commercial scale. It was therefore considered to pose a long term threat to the environment, well after the closure of the facility, due to the risk of landfill gas and leachate leakage from the cells. Without reprocessing of the waste within the landfill cell following stabilisation of the biological processes, material resources will not be recovered and so will be wasted. The site of the landfill cells would also be adversely affected by contamination from the waste, unless rehabilitation is undertaken.

All of the other technology options were considered to be significant improvements on the current disposal method of landfilling in terms of the criteria assessed; most particularly the environmental and social criteria (refer **Figure 5**).

The EMRC also resolved that aerobic composting be excluded from further investigation. This exclusion was primarily based on the inability of the technology to produce energy and its high energy consumption characteristics. Other concerns such as the quality and value of the compost produced from the technology, odour management as well as public perception issues contributed to the decision.

The EMRC has undertaken an extensive information gathering process relating to determining the preferred technology to be used in the RRF. Information was gathered via:

- comprehensive research of available published material related to the technologies;
- national and international tours to inspect facilities and to meet with facility operators and in some cases, regulatory agencies and community representatives;
- attendance at conferences relating to the technologies and meetings with international AWT technology experts;
- request for information from technology suppliers;
- the receipt and evaluation of EOIs in 2009 from companies interested in establishing the RRF for the EMRC; and
- subsequent requests of the Acceptable Tenderers to gather additional technical data relating to these technologies.

The EMRC adopted a set of preliminary recommendations in September 2009 which formed the basis for discussion with the community and Member Councils. In May 2010, Council resolved as follows:

> *"The RRF technology options include anaerobic digestion, gasification, pyrolysis and combustion. Plasma technology will only be considered if it is an integral part of one of these technologies"*

Following this, in August 2011, EMRC considered a further reduction in the number of proposed technologies. The outcome of the council's discussion was to reduce the technologies from four options to two options. The two technologies to be considered within the PER are AD and gasification. Plasma arc is a form of gasification technology that is claimed to improve the emission standards when used in conjunction with other technologies (Gasification Technologies Council, 2011). Consequently, it is proposed that plasma arc not be included in the EIA. In this case the conventional gasification technology emissions are being assessed here which represents the current situation i.e. the worst case options rather than possible future plasma gasification emission scenarios.

The position adopted by the EMRC in adopting AD and gasification is supported by work undertaken by Zaman (2010) and Chaya, and Gheewala (2006).

Zaman analysed three waste treatment disposal options, using a whole of life assessment tool. Sanitary landfill, combustion and gasification-pyrolysis were studied using SimaPro software based on input-output materials flow. The software was used to analyse the environmental burden by different impact categories.

The study found that all technologies are favourable in terms of abiotic and ozone layer depletion due to energy recovery from the waste treatment facilities. Sanitary landfill has a significantly lower environmental impact when compared to other thermal treatment in situations where landfill gases are captured and used for fuel. However, sanitary landfill has significant impact on photochemical oxidation, global warming and acidification. Among the thermal technologies, pyrolysis/gasification is comparatively more favourable to the environment than combustion in terms of global warming, acidification, eutrophication and eco-toxicity categories. While landfill with energy recovery facilities has some environmental advantages, its large land requirement, difficult emission control system and long time span for impacts are disadvantages. As a consequence, restrictions on landfilling are being applied, particularly in more developed countries. Pyrolysis-gasification was found to be a more environmentally friendly option than combustion due to higher energy recovery efficiency (Zaman 2010).

Wirawat Chaya, and Shabbir H. Gheewala undertook a life cycle assessment to evaluate environmental impacts of combustion and AD technologies processing municipal solid waste (MSW) in Thailand. The study found that AD reduced the potential environmental impacts such as global warming, acidification, stratospheric ozone depletion, and photo-oxidant formation due to fertilizer production and to higher net electricity production compared to combustion.

5.2.2 Site Options

Six potential sites were considered for the location of the RRF during preliminary assessments, including:

- **Red Hill**: Lot 12, 1204 Toodyay Road, Red Hill, which is part of the EMRC’s Red Hill WMF
- **Airport**: Perth Airport Development Precinct 3A, bounded by the Great Eastern Highway Bypass, Abernethy Road and Kalamunda Road
- **Lakes Road (Hazelmere):** Lot 100, 77 Lakes Road Hazelmere and Lot 201, 91 Lakes Road (Hazelmere) owned by the EMRC
- **Stratton**: Lot 427, Stratton, located between Roe Highway and Farrell Road
- **Bayswater**: Lot 10, Railway Parade, Bayswater bounded by Tonkin Highway and Railway Parade
- **Roe Highway (Hazelmere)**: Lot 20, Adelaide Street and Lot 196, 196 Adelaide Street (Hazelmere), intercepted by Roe Highway.

These sites are shown below in **Figure 16**.

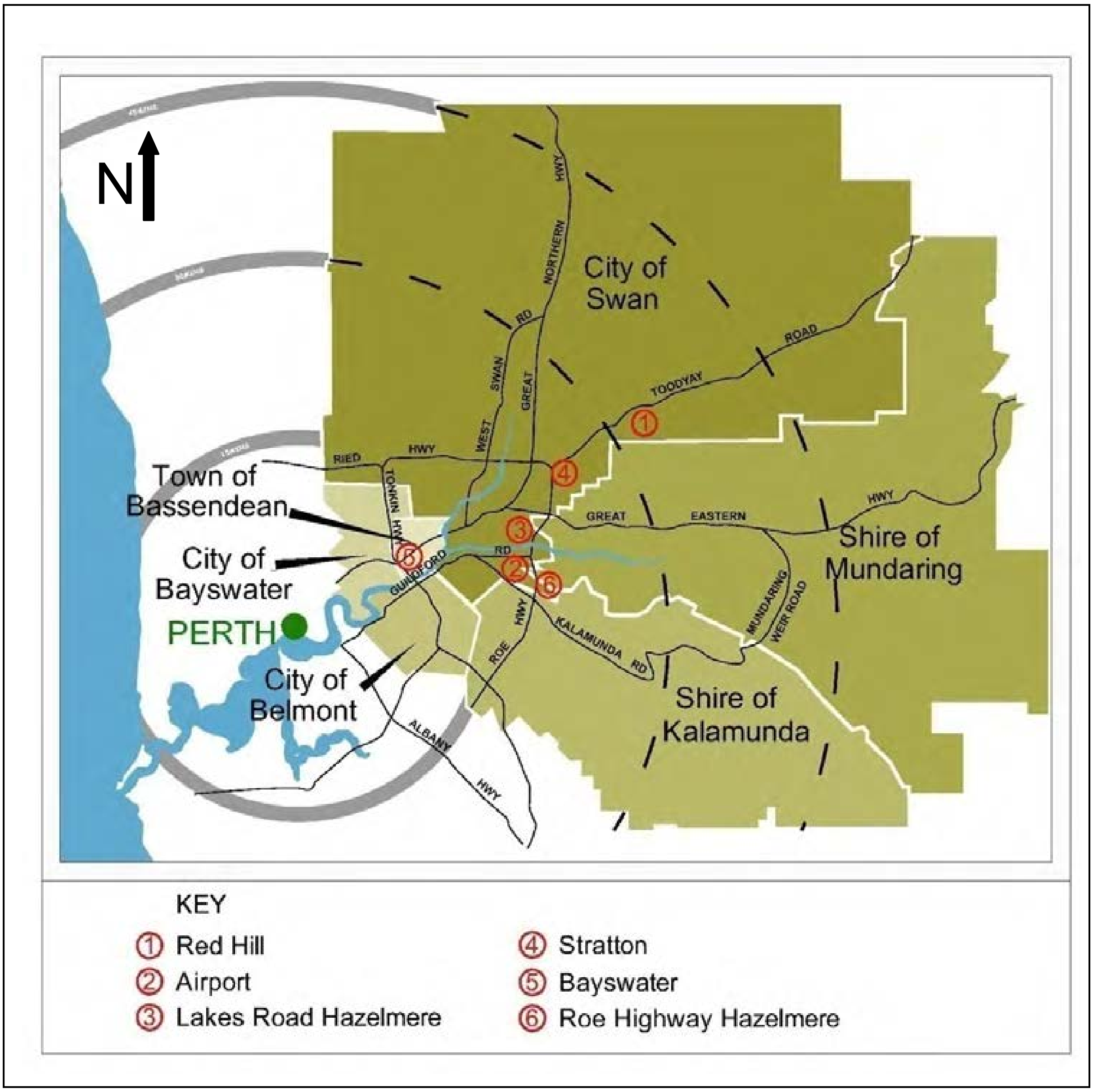

Figure 16 Locations of the Six RRF Site Options in the Eastern Metropolitan Region

As a result of the preliminary assessments the Stratton and Roe Highway (Hazelmere) sites were determined by the EMRC as being unsuitable due to issues such as zoning, proximity to housing and the low likelihood of obtaining Government approvals.

Further investigations of the remaining four sites indicated that the Airport Site and Bayswater Site were no longer viable options for the RRF project. The Bayswater site was proposed to be subdivided into smaller blocks, while the Westralian Airports Corporation was not supportive of the use of the Airport site. The remaining two sites, Red Hill and Lakes Road, Hazelmere, are both owned by the EMRC and were considered to be potentially suitable.

Community consultation and market research indicated that the community supported Red Hill WMF as the preferred site for all RRF technology options, when compared to the Lakes Road, Hazelmere site. The reason for this is primarily due to the Hazelmere site's limited size, buffer zones and proximity to major population centres, while the Red Hill WMF is well buffered and already a waste management facility.

As such, the May 2010 Council Meeting resolved that:

Red Hill Waste Management Facility is the preferred site for the RRF.

A subsequent investigation was then undertaken to determine the preferred location of the RRF within the Red Hill WMF. The EMRC shortlisted five potential sites for the RRF within Red Hill WMF for further investigation including the:

- Red Hill Farm west of the proposed Hills Spine Road in Lot 12 (Site A);
- greenwaste facility footprint in the north east corner of Lot 1 (Site B1);
- north west corner of Lot 12 (Site B2);
- Waste Transfer Station (WTS) within Lot 2 and intruding onto the adjoining completed putrescible landfill cell in Lot 11 (Site C); and
- completed putrescible landfill cell in the south west corner of Lot 11 (Site D).

A qualitative assessment undertaken of the economic, social, environmental, technical, operational and regulatory attributes of each proposed locations suggested that, within the current Red Hill WMF operations, Site B2 (the Subject Site) is the preferred site for the location of the RRF. The location of this Subject Site, within Red Hill WMF, is highlighted in **Figure 3**.

Site B2 was determined to be the preferred location on Red Hill WMF on the following grounds:

- it met the environmental requirements of buffers from sensitive land uses and was likely to be acceptable in terms of the other environmental criteria;
- no additional residential development can occur closer than the current development, i.e. the existing situation is the worst that will ever occur;
- the geotechnical conditions were acceptable and better than the sites that were located wholly or partly over closed landfill cells; and
- it had limited impacts on the future capacity of the landfill cells, whereas other cells had significant impacts. The future airspace loss resulting from some of the other options was valued in many millions of dollars.

The methodology of the site and technology selection process is shown in **Figure 17**. This process involved extensive consultation with the following stakeholders to ensure all issues and concerns relating to resource recovery have been addressed and given due consideration during the selection process:

- Regional community;
- Member Councils; and
- Waste Management Community Reference Group (WMCRG).

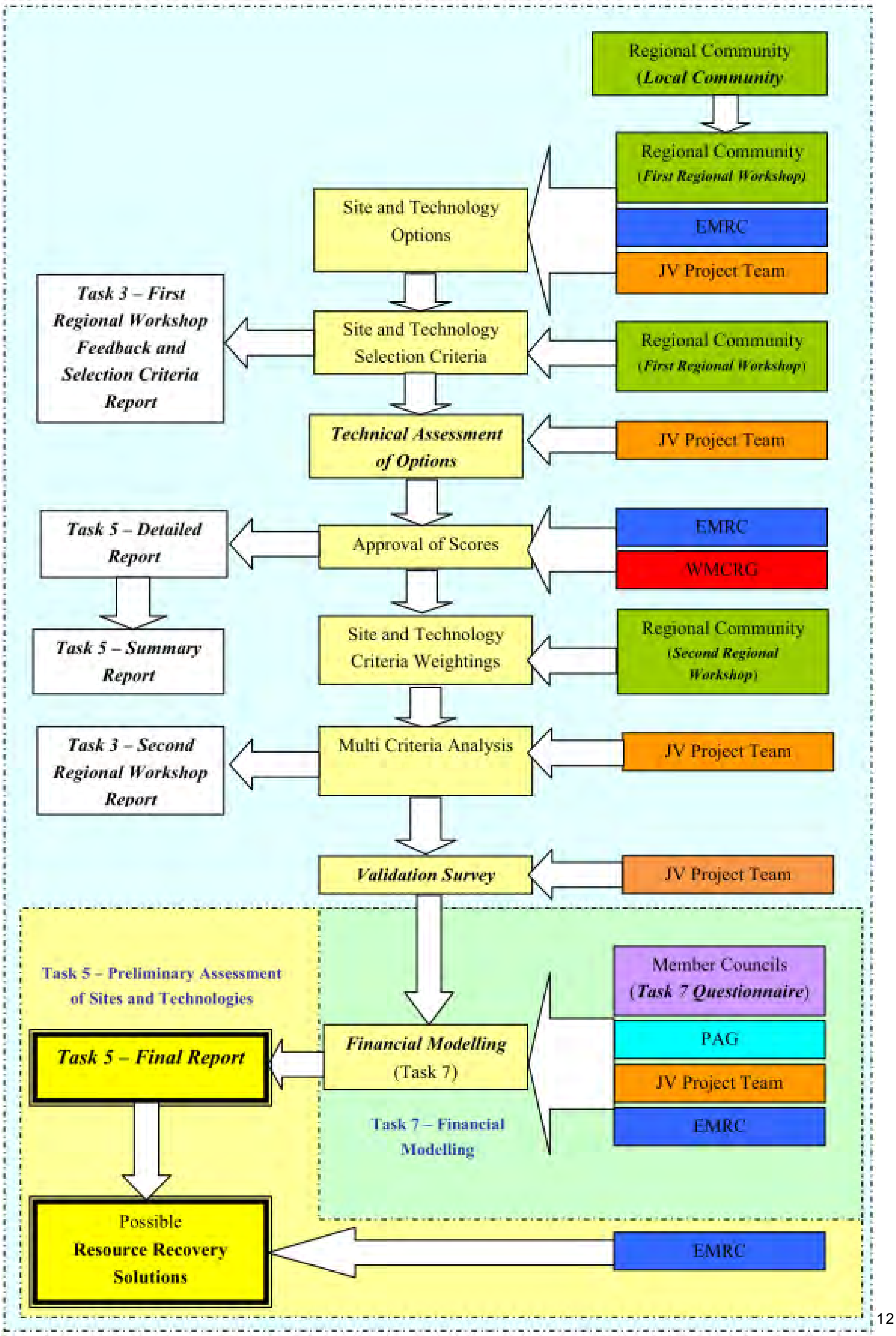

Figure 17 Selection of Sites and Technologies – Decision Making Process (Task 5 Assessment Report)

PAG = Project Advisory Group
JV = Cardno/Meinhardt Joint Venture

6 Community Engagement

6.1 Community Consultation Previously Undertaken

Substantial engagement has taken place with the regional community, community groups and the Member Councils since the commencement of the RRF Project. Community and stakeholder consultation is intended to continue to the end of the project. The following two key phases of the planning process have involved engagement of the community.

6.1.1.1 Preliminary Assessment of Sites and Technologies

The preliminary assessment of potential sites and technologies involved substantial community participation in the form of:

- community information sessions within each of the six Member Councils;
- two regional workshops (on 15 October 2005 and 18 February 2006 respectively);
- follow up telephone validation surveys;
- market research including quantitative and qualitative components in 2009;
- seminar for community stakeholders on EfW with Professor Themelis and Robin Davidov, April 2010;
- community forum September 2010; and
- seminar for community members on AD technology with Gerald Tetchner and Prof. Dongke Zhang.

6.1.1.2 Preferred Resource Recovery Facility Options

A community research programme was run by Patterson Market Research concurrently with the EOI process to ascertain the current community views on the acceptability of technologies and sites. The study involved a structured phone survey and discussions with community focus groups.

Briefings on the RRF Project were also provided to local members of Parliament, the Minister for Local Government, some Federal Members of Parliament, the State Shadow Cabinet and the Waste Authority between June and September 2009 (concurrent to the EOI and EPA processes).

There have been ongoing briefing sessions to the Member Councils and local community groups throughout the planning phase of the project. These briefing sessions will continue until the commissioning of the facility. Community engagement will continue throughout the life of the project.

6.2 Ongoing Engagement

The project's community engagement process has involved a range of activities since the project commenced and now involves three key community groups. Each of these groups' purpose, structure and consultation programme is summarised below in **Table 6-1**.

Table 6-1 Community Groups Consulted for Red Hill WMF RRF

Community Group	Purpose	Structure	Consultation Programme
EMRC Waste Management Community Reference Group (WMCRG)	Formed in 2002, the WMCRG provides informed advice and feedback to the EMRC on a range waste management and waste education issues, including feedback in relation to the resource recovery project.	Currently 14 Reps from across the 6 member Council region. Chaired by one of the members, EMRC record minutes and prepare agendas.	Every 2 months - ongoing
Red Hill Community Liaison Group (RHCLG)	Formed in 2007 to provide advice and feedback on Red Hill landfill operations. The group is also updated by the EMRC on the progress of the RRF project.	This is an open invitation to residents around Red Hill (including Gidgegannup, Stoneville and Parkerville). Agenda and minutes of previous meeting issued beforehand. Chaired by EMRC. Meetings advertised in community newspapers.	Every 2 months - ongoing
EMRC Community Taskforce (CTF)	Formed in July 2010 to assist the EMRC in the development of a Community Partnership Agreement and to comment on the draft Tender Evaluation Criteria for the RRF project.	Eight community members drawn from around Red Hill and across the region plus two EMRC representatives and an independent facilitator.	Every 2-3 months until August 2011 and then as required.

The EMRC will continue to provide an ongoing flow of information to the general EMRC community throughout the life of the project through:

- website information, news and updates;
- community newspaper articles;
- media releases;
- letter box drops; and
- meetings and presentations to local community groups, in particular, those located near to the Red Hill WMF.

As highlighted in **Table 6-1**, the EMRC has now completed an engagement process to develop a Community Partnership Agreement (CPA) with the community within the Region. The CPA identifies project issues of interest or concern to the community and how they will be managed during the construction and operation of the RRF. The CTF was recruited from the regional community to assist the EMRC develop the CPA and provide comment on the tender evaluation criteria.

7 Existing Environment

7.1 Topography, Geology and Soils

Red Hill WMF is located amongst rolling hills east of the Darling Escarpment. The topography of Red Hill WMF is naturally undulating with some considerable height differentials in areas that have been landfilled or used for overburden stockpiles. The highest point of elevation is approximately 305 mAHD located beneath the patch of remnant vegetation in Lot 12. The lowest point of the entire Red Hill WMF is 241 mAHD, also in Lot 12, demonstrating the undulating (and in some cases steep) nature of the site (**Figure 18**)

Geomorphic classification of Red Hill WMF reported in the Perth Metropolitan Area 1:50,000 Geological Mapping Series published by the Department of Mines and Petroleum (DMP 2006) indicates that the Red Hill WMF is predominantly underlain by granites and gravel distributed unevenly throughout the site. The underlying granites are characterised by fine to coarse-grained, occasionally porphyritic rocks of granite, granodiorite and adamellite composition. The gravels are characterised by yellow-brown to reddish brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor recementation; colluvial origin (**Figure 19**).

The EMRC conducted soil borings across the Red Hill WMF in 1994 and 1999 to ascertain the geological profile underlying the site (EMRC 1999). Generally the soil profile is as follows:

- Gravel (0 - 0.5m);
- Lateritic Caprock (0.5 - 1.5m);
- Sand (1.5 – 2m);
- Clays (2m - 10m); and
- Granite Bedrock (10m+).

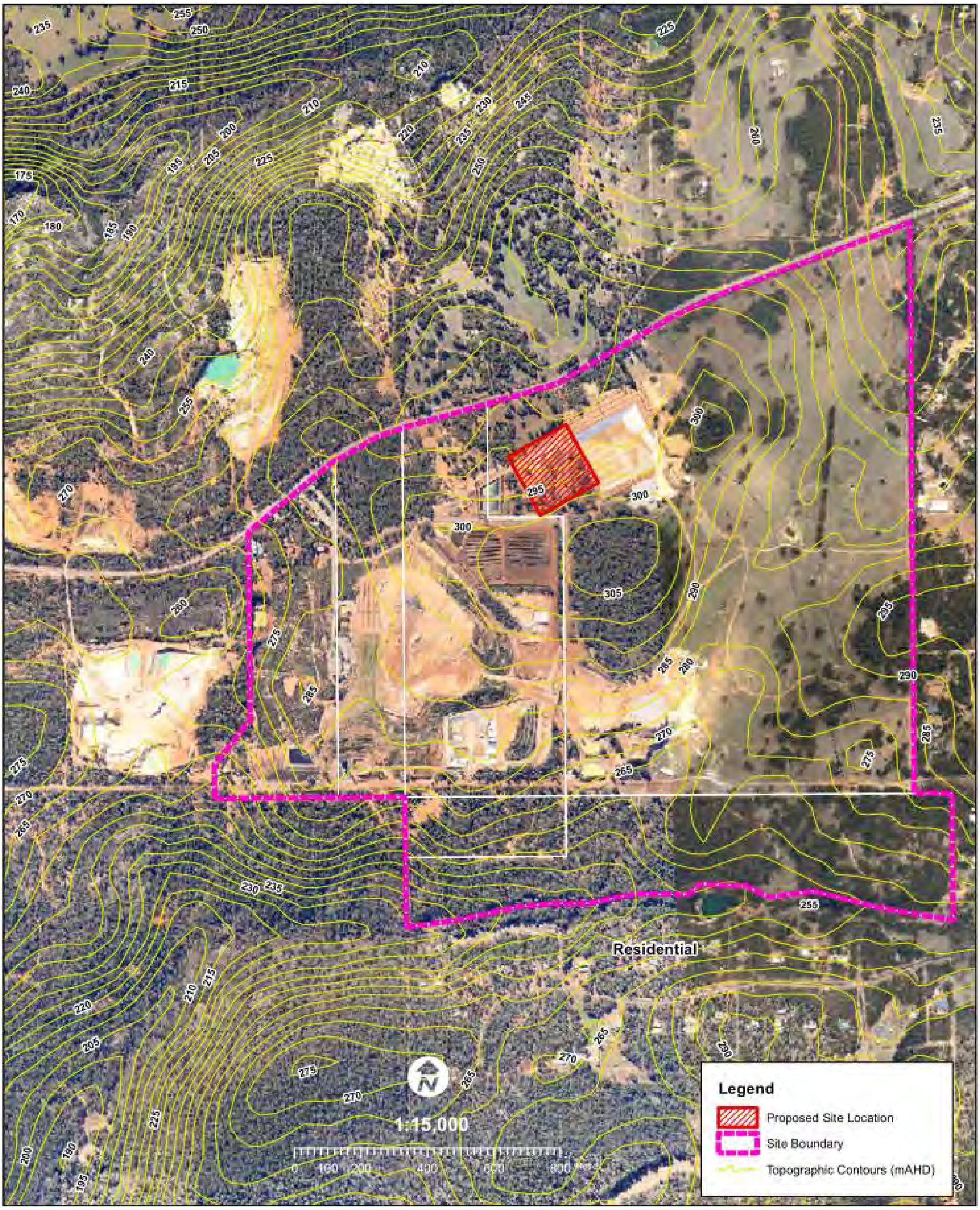

Figure 18 Topography

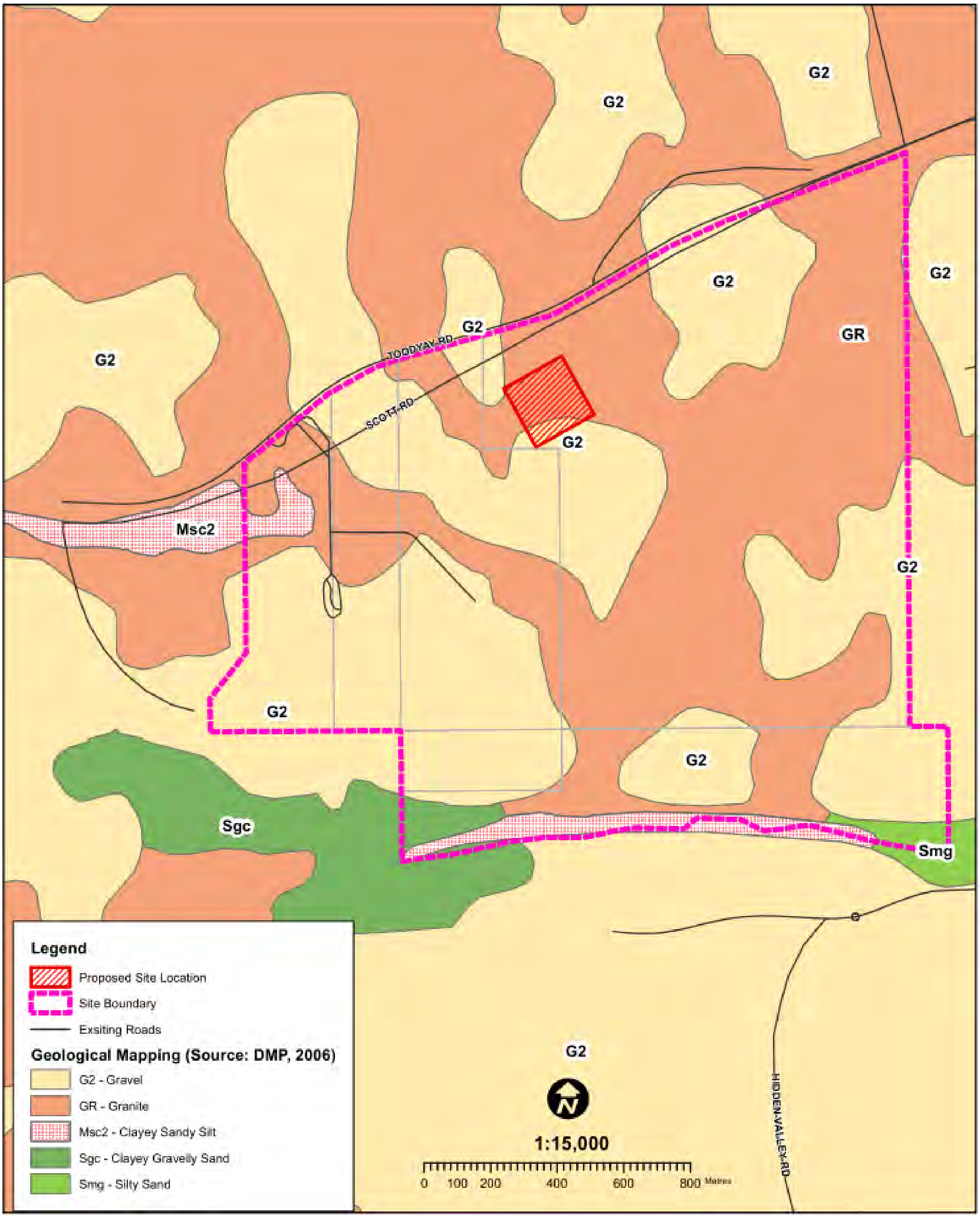

Figure 19 Geology of the Subject Site

7.2 Acid Sulfate Soils

Acid Sulfate Soils (ASS) are naturally occurring soils that contain iron sulfide (iron pyrite) minerals. If disturbed by dewatering, drainage or soil excavation, the pyrite can oxidise thereby releasing acidity and potentially causing environmental impacts, damage to infrastructure and affects to human health. There is no known occurrence of ASS on, or adjacent to, Red Hill WMF (DOW 2010a).

7.3 Climate

The Subject Site is located within the South-West region of WA and experiences a typical Mediterranean climate with warm, dry summers and cool, wet winters.

7.3.1 Rainfall

Red Hill WMF operates a site weather station, however, this station was only established on site in early 2011. While there are a number of weather stations located within the same sub-catchment as the Subject Site, the Mundaring Weather Station (No.009030) is the closest registered station. The Mundaring Weather Station is located within the Jane Brook Catchment approximately 8km southeast of the Subject Site.

Mean monthly rainfall data from the Mundaring Weather Station are summarised in **Table 7-1**.

Table 7-1 Mundaring Mean Monthly Rainfall Data from January 1888 – May 2011

Average Monthly Rainfall (mm)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
12.6	17.0	23.1	51.9	137.1	211.1	215.8	170.5	112.4	69.8	32.7	16.7	1072.4

Source (BOM 2010a)

Monthly rainfall data for the past year is summarised in **Table 7-2**.

Table 7-2 Mundaring Monthly Rainfall from June 2010 – May 2011

Monthly Rainfall (mm)												
Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
61.8	176.4	68.8	46.6	31.4	15.8	24	35.4	0	82.4	37	64.8	990.0

Source (BOM 2010a)

The rainfall data summary indicates that the highest monthly rainfall occurs from May through to September, with approximately 79% of the annual rainfall occurring in these months.

7.3.2 Temperature

Monthly temperature readings have been taken from the Perth Airport Weather Station (No.9021) which is located approximately 17km southwest of the Subject Site. This weather station data has been used due to reliability and completeness of the data. The mean monthly maximum and minimum temperatures are summarised in **Table 7-3** below.

Table 7-3 Perth Airport Mean Monthly Temperature from June 1944 – Dec 2010

Average Monthly Temperature (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max.[1]	31.6	31.9	29.7	25.5	21.7	18.9	17.9	18.4	20.1	22.6	25.8	28.9
Min.[2]	28.2	28.7	26.1	21.2	19.4	16.8	16.2	16.3	18.1	19.7	22.1	24.7

Notes: [1] BOM 2010b
[2] BOM 2010c

7.4 Site Contamination and Pollution Complaints

This section details the results of relevant investigations to ascertain if the Red Hill WMF has any registered historical contamination or pollution complaints.

7.4.1 DEC Contaminated Sites Database

According to a search of the DEC's Contaminated Sites Database, the Red Hill WMF is not registered as a contaminated site under the *Contaminated Sites Act 2003*. The database also indicates that no other sites in the vicinity of the Red Hill WMF have been reported to the DEC and considered as a contaminated site.

7.4.2 DEC Reported Sites Register

A request for a Basic Summary of Records Search for the Red Hill WMF was submitted to the DEC in August 2009. The DEC's records indicate that a memorial has been registered against Lots 1, 2, 11 and 12 of the Red Hill WMF with a site classification of "*12/12/2008 - Possibly contaminated - investigation required*".

The reason for this classification is stated as being due to the Red Hill WMF use as a putrescible and secure landfill site (since 1981), a land use that has the potential to cause contamination. It is further noted that at the time of classification (December 2008), the latest monitoring report indicated that hydrocarbons, metals and nutrients were present in groundwater at concentrations exceeding Australian Drinking Water Guidelines, Irrigation Guidelines and Freshwater Aquatic Ecosystem Guidelines. At that time no soil sampling had been undertaken to determine the extent of contamination in the soil profile, and the contaminated groundwater plume has not been fully delineated. Further investigation was noted as being required to determine the extent of groundwater contamination. It is understood that this statement relates to the leachate contamination from Lot 11 as referred to in **Section 12.4.3.1.** An accredited DEC Contaminated Site Auditor has been appointed to review and audit the EMRC investigation and remediation works associated with the groundwater plume beneath Lot 11.

7.4.3 EMRC Complaints Register

The EMRC maintains a register of complaints in relation to the current operations of the Red Hill WMF, as required by the DEC under the Red Hill WMF Landfill Licence. Since January 2006, 41 registered complaints have been received from local community members, particularly in relation to odour from the Red Hill WMF and litter along Toodyay Road. Of the 26 odour complaints, six complaints were confirmed as related to landfill activities and 20 complaints were unconfirmed, but may have been due to the site operations. Complaints were made mainly by four residents, mostly from two locations; Persoonia Close and Karrak Court, east of the facility. The EMRC responds to each complaint to firstly verify that the landfill operations are the cause of the complaint and then with advice on what action is being taken on the reported issue, where applicable.

Table 7-4 summarises the complaints received at the site since 2006.

Table 7-4 Registered Complaints regarding Operations at the Red Hill WMF Since 2005

Issue	Complaint (date and issue)	EMRC Response
Odour	16 April 2012 - odour complaint from Persoonia Close, Gidgegannup	Source unconfirmed

Issue	Complaint (date and issue)	EMRC Response
	1 March 2012 - offensive odour detected along Toodyay Road	Source unconfirmed
	2 February 2012 - offensive odour detected along Toodyay Road	Source unconfirmed
	16 January 2012 - odour complaint from Persoonia Close, Gidgegannup	The Alliance Demolition Creosote Remediation Project, confirmed
	6 January 2012 - odour complaint from Persoonia Close, Gidgegannup	Landfill Gas and Power drilling methane extraction wells on the side of the Class III Stage 12 landfill cell, confirmed
	3 January 2012 - offensive odour detected along Toodyay Road	Source unconfirmed
	30 November 2011 - offensive odour detected along Toodyay Road	Source unconfirmed
	18 October 2011 - odour complaint from Karrak Court, Gidgegannup	Source unconfirmed
	13 October 2011 – odour complaint from Persoonia Close, Gidgegannup	Excavating hardstand to extend tip face at Class III cell, confirmed
	28 September 2011 – odour complaint from Persoonia Close, Gidgegannup	Source unconfirmed
	26 September 2011 – odour complaint from Karrak Court, Gidgegannup	Source unconfirmed
	16 September 2011- odour complaint from Persoonia Close, Gidgegannup	Quarantine Burial, confirmed
	23 August 2011 - odour complaint from Karrak Court, Gidgegannup	Source unconfirmed
	5 April 2011 - odour complaint from Karrak Court, Gidgegannup	Source unconfirmed
	1 December 2010 - odour complaint from Persoonia Close, Gidgegannup	Source unconfirmed
	27 October 2010 - odour complaint from Karrak Court, Gidgegannup	Old waste exposed, confirmed
	13 October 2010 - odour complaint from Persoonia Close, Gidgegannup	Old waste exposed, confirmed
	1 October 2010 - odour complaint from Persoonia Close, Gidgegannup	Source unconfirmed
	28 January 2010 – offensive odour detected along Toodyay Road (due west)	Source unconfirmed
	25 January 2010 – offensive odour detected along Toodyay Road	Source unconfirmed
	15 December 2009 – offensive odour reported from eastern boundary neighbour	Source unconfirmed
	11 March 2009 – offensive odour detected along Toodyay Road	Source unconfirmed
	10 April 2008 – offensive odour detected along Toodyay Road in the evening	Source unconfirmed
	30 July 2007 – offensive odour detected along Toodyay Road particularly in the evening	Source unconfirmed
	29 November 2006 – offensive odour detected by neighbour	Source unconfirmed
	20 November 2006 – offensive odour detected by local resident	Source unconfirmed

Issue	Complaint (date and issue)	EMRC Response
Litter	2 June 2010 – litter along Toodyay Road	EMRC liaised with Main Roads regarding litter clean up.
	11 July 2008 – litter along Toodyay Road	EMRC liaised with Main Roads regarding litter clean up.
	12 February 2008 – litter along Toodyay Road	EMRC liaised with Main Roads regarding litter clean up.
	14 August 2007 – litter along Toodyay Road	EMRC liaised with Main Roads regarding litter clean up.
Noise	7 April 2011 - noise emanating from the landfill cell	Possibly the height of the landfill cell
	4 August - noise emanating from landfill operations	Noise from landfill cells
	2 June 2010 – reversing beepers on heavy machinery	Landfill operations
	8 August 2007 – noise emanating from LGP Station during the evening	LGP Station
Other	23 June 2011 – resident found dead turtles near Christmas Tree Creek dam	Unrelated to the operations at RDWMF
	28 January 2010 – dust from clay stockpile blowing off site onto neighbouring properties	
	30 November 2009 – debris falling out of empty collection truck	Driver had left rear door open
	23 October 2008 – visual amenity issue in relation to clay stockpile	
	28 October 2008 – objection to installation of security fence along Lot 12	
	2 February 2007 – concern in relation to proposed blasting (vibrations) on site	

Source: EMRC Complaints Register 2005 – present

A ground truthing campaign has been carried out recently by Emission Testing Consultants (ETC) in order to try and relate community odour complaints to site operations. The results of the campaign are detailed in the **Section 11.3.1**.

7.4.4 City of Swan Freedom of Information Search

A Freedom of Information (FOI) request was submitted to the City of Swan on 13 August 2010 to request documents relating to soil/groundwater contamination (confirmed, under investigation or previously investigated), pollution complaints, notices or any other document relating to contamination or pollution of the environment within the Red Hill WMF. The City of Swan's records indicate that there are no documents or reports regarding contamination issues on the Red Hill WMF.

7.4.5 Department of Environment and Conservation Freedom of Information Search

A FOI request was submitted to the DEC on 13 August 2010 to search for documents relating to soil/groundwater contamination (confirmed, under investigation or previously investigated), pollution complaints, notices or any other document relating to complaints, contamination or pollution of the environment within the Red Hill WMF. Due to the volume of information in regards to the Red Hill WMF, it was agreed that only information not currently in possession of the EMRC be sourced. The following information was sourced from the DEC:

- Incident Report (dying trees) (April 2010): Dieback suspected;
- Concern with current Red Hill WMF operational practices (January 2009): The DEC noted (from EMRC monitoring results) that there is low level contamination (elevated nutrients) of ground and surface water, but the levels are not considered to pose a risk to the local environment or community. The EMRC have since undertaken a number of measures to prevent contamination offsite. The DEC also confirmed that the site was operating to best practice guidelines;
- Class IV load with no tracking form (June 2006): Was investigated and source found; and
- Noise Complaint (June 2005): Was investigated and source found. Management measures implemented by LGP.

There has been open communication between the DEC and the EMRC in regard to all groundwater contamination issues onsite, in relation the Class IV landfill and in proximity to the Class III and IV leachate ponds. Management and remediation measures have been implemented by the EMRC and extensive monitoring is ongoing. The DEC has been kept informed during this process.

7.4.6 Department of Mines and Petroleum Freedom of Information Search

A FOI request was submitted to the Department of Mines and Petroleum on 13 August 2010 to request documents from the past five years (2005 – 2010) relating to licenses to store flammable liquids/dangerous goods/liquefied petroleum gas, underground tanks, fuel pumps, inspection/testing reports, contamination/pollution or spills that have occurred on site, or any notices that have been issued to the EMRC in relation to the Red Hill WMF.

The Department of Mines and Petroleum only provided a confirmation letter that explosives, dangerous goods and tanks had been removed from the Red Hill WMF in 2007. The current dangerous good infrastructure on site is outlined in **Section 4.3.2**.

7.4.7 Department of Water Freedom of Information Search

A FOI request was submitted to the Department of Water (DoW) on 13 August 2010 to request documents for the past five years (2005 to 2010) relating to details of any pollution complaints received, any pollution/contamination that has been reported on site, and/or any Notices issued to the EMRC by the DoW.

The DoW communicated that they transferred the request to the DEC.

7.4.8 Department of Commerce Freedom of Information Search

A FOI request was submitted to the Department of Commerce (the Consumer Protection Division) on 13 August 2010 to request documents for the last five years (2005 to 2010) relating to complaints received, incidents that have occurred, or any notices that have been issued to the EMRC in relation to the Red Hill WMF.

The search of the Consumer Protection Division’s records resulted in a number of work safe investigations and enquiries. The investigations and enquires mostly revolved around minor incidents at the community drop off transfer station, appropriate management of asbestos and general operational procedures at the Red Hill WMF and other Waste Transfer Stations (WTS) operated by the EMRC in the region.

8 Risk Assessment of Possible Environmental Impacts

8.1 Pollution Management

8.1.1 Air Quality

Air emissions can impact human health, flora and fauna, ecosystems, water quality, the built environment (through chemical erosion). Air emissions will be generated as a result of the processes involved in the operation of the RRF. The types of gases and constituents of particulates will depend on the technology chosen as well as the composition of the waste processed.

In order to understand the current ambient air concentrations, the existing emissions generated from the Red Hill WMF and the predicted air emissions and plume dispersion, the EMRC engaged qualified consultants Synergetics Environmental Engineering to undertake a baseline air quality monitoring study and modelling of the proposed RRF emission scenarios. The emissions data and plant layouts used in the modelling were sourced from the acceptable tenderers from the EMRC EOI process. The results of the monitoring and modelling were compared to the current air quality standards to determine compliance of the AD and gasification technologies with these standards and to develop appropriate management strategies where necessary.

Details of the air quality impact assessment, including applicable air quality standards, potential environmental impacts and required management measures are presented in **Section** 9.

8.1.2 Noise Emissions

Noise is defined as a *"*vibration of any frequency, whether transmitted through air or any other physical medium*"* (EP Act 1986). Noise at frequencies below the audible frequency range is referred to as infrasound and above the audible frequency range as ultrasound. The most common problem associated with noise however is often from audible noise (EPA 2007). Audible noise may contain annoying characteristics that may increase its impact, such as tonality ("humming", "whining"), modulation (regular changes in level or pitch, e.g. a siren), or impulsiveness ("hammering") (EPA 2007).

Noise will be generated through the construction and operation of the RRF therefore, the EMRC engaged consultants Lloyd George Acoustics to undertake noise monitoring to understand the current noise levels produced at the Red Hill WMF and modelling to predict the noise levels that may be generated from the RRF (Lloyd George, May 2011). The results were assessed to ensure that the current and predicted noise levels will be compliant with the *Environmental Protection (Noise) Regulations 1997*.

Noise has the potential to be a risk to the environment at this site with the chosen technologies and as such further investigation, including applicable standards, potential environmental impacts and required management measures are presented in **Section 10**.

8.2 Social Surroundings

8.2.1 Odour

Odour is perceived by the human brain in response to chemicals present in the air that is breathed. Even in very low concentrations, humans can detect odour due to their sensitive sense of smell. An individual's response to odour is often subjective and depends on the strength of the odour, what it smells like, how often and when it occurs and in what context (SEPA 2010).

The main issue associated with odour is its ability to be 'objectionable' or 'offensive' which can result in annoyance, nuisance or actual harm. Objectionable or offensive effects can occur when an odour compound is present in very low concentrations or in high concentrations (SEPA 2010).

Toxic or offensive odours can often cause nuisance resulting in community complaints, create a poor perception of the operational activities and damage a facility's relations with the community (QLD EPA 2004).

The RRF has the potential to emit odours due to the nature of the waste received and processes involved. Therefore, the EMRC engaged a qualified consultant, SLR Consulting Australia Pty Ltd (SLR), to undertake an odour assessment to determine the current baseline odour levels present at the Red Hill WMF and to undertake dispersion modelling to predict the likely odour impacts from the operation of the RRF.

Odour has the potential to be a risk to amenity of surrounding communities and as such further investigation, including applicable standards, potential environmental impacts and required management measures are presented in **Section 11**.

8.2.2 Traffic

The potential impacts arising from increased traffic movements as well as the interaction between vehicles and employees onsite requires assessment and management to protect the health of people and the surrounding environment. To understand the current number of trucks entering and leaving the Red Hill WMF, the expected increase in trucks and the potential impacts, the EMRC engaged qualified consultants, Cardno Eppell Olsen, to undertake a traffic assessment. The outcomes of the traffic assessment are detailed in **Section 13.3.10**.

8.2.3 Aboriginal Heritage

8.2.3.1 EPA Objective

To maintain the Aboriginal heritage and cultural values associated with nearby sites of significance.

8.2.3.2 Regional Context

An online search for relevant Aboriginal Heritage information was performed using the Department of Indigenous Affairs (DIA) Aboriginal Heritage Inquiry System (DIA 2010). The online inquiry system incorporates both the Heritage Site Register and the Heritage Survey Database. The Heritage Site Register is held pursuant to Section 38 of the *Aboriginal Heritage Act 1972* and contains information on over 22,000 Aboriginal sites throughout WA. The Heritage Survey Database is a catalogue of the heritage survey reports held by the DIA. It holds a description of each survey, its boundaries, proponent and participants. **Table 8-1** summarises the registered Aboriginal sites (**Figure 20** confirms that the proposed site location is remote from registered sites) and survey reports in the immediate vicinity of the site as identified from the Aboriginal Heritage Inquiry System search results (DIA 2010).

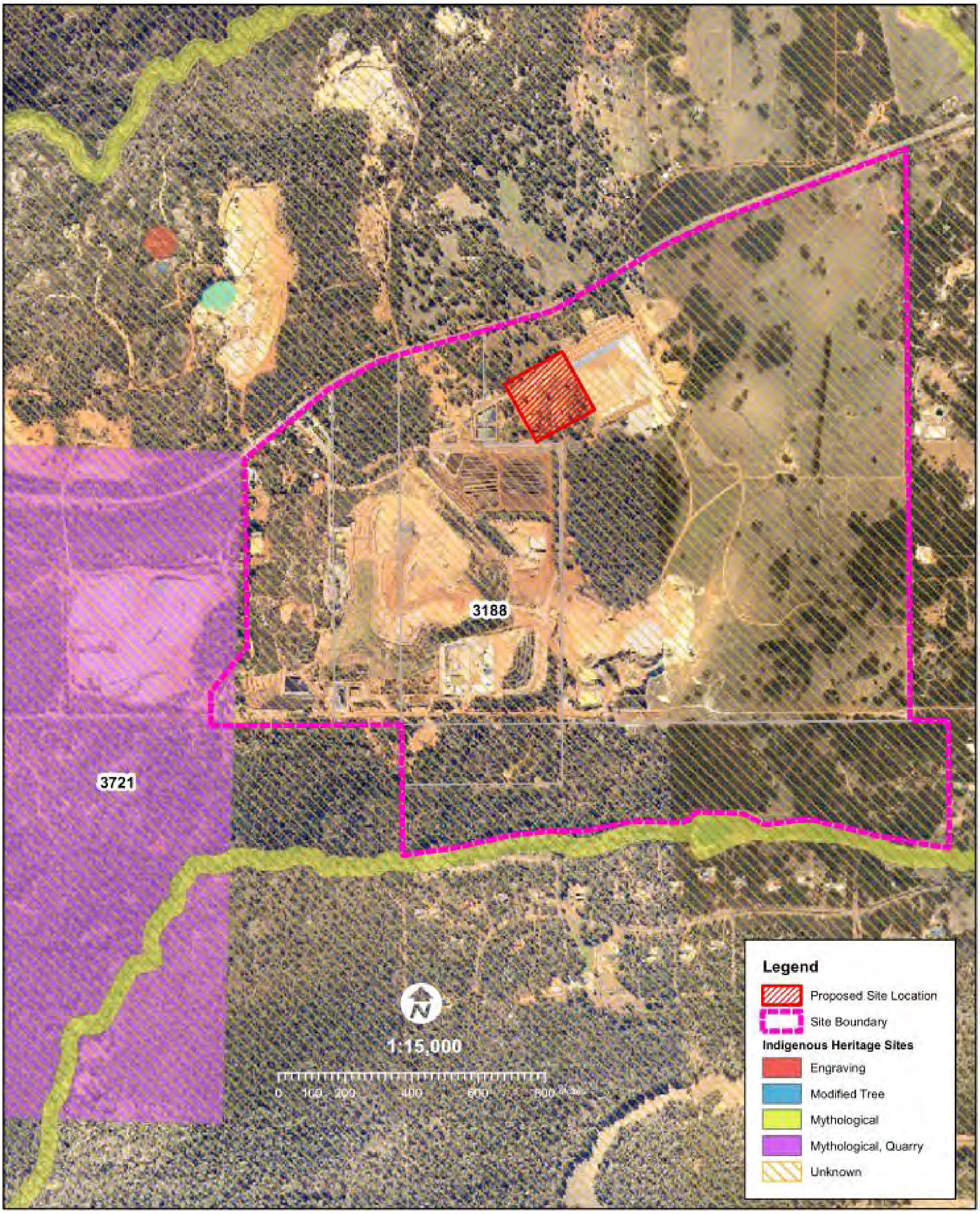

Figure 20 Aboriginal Heritage Sites

Table 8-1 Previously Recorded Sites in the Vicinity of the Red Hill WMF

Site ID	Site No.	Name	Status/Access/ Restriction	Type	Location and Extent
640	S02890	Susannah Brook (whole extent mythological)	P / O / N	Mythological	414334E 6478836N
3656	S02278	Susannah Brook Waugal	P / C / N	Mythological	Not available for Closed Sites
3721	S02221	Red Hill	P / C / N	Mythological Quarry	Not available for Closed Sites
3188	S00546	Darling Range	Not a site	Not a site	415137E 6475750N
17696		Red Hill #1	P / O / N	Artefacts/ scatter	413957E 6477364N
17697		Red Hill#2	P / O / N	Artefacts/ scatter	413606E 6477559N
21077		Gidgegannup Petroglyph	P / O / N	Engraving	414487E 6478709N
21078		Gidgegannup Scarred Tree	P / O / N	Modified Tree	414495E 6478573N
21079		Gidgegannup Rockshelter	Interim / O / N	Rockshelter	414626E 6478498N
21080		Gidgegannup Gnamma Hole	P / O / N	Water source	414572E 6478709N
3433	S02735	Herne Hill Ochre	P / O / N	Mythological	413019E 6477779N
21170		Red/01	P / O / N	Engraving	414460E 6478575N
24883		Wirdarchi Sleeping Spot	L / O / N	Mythological	414128E 6478410N

Notes: Status – Lodged (L), Permanent (P)
Interim Access – Open (O), Closed (C)
Restriction – No restrictions (N)

None of the recorded sites are located on the Red Hill WMF.

8.2.4 Native Title

The Government of WA Office of Native Title was established in 2002 with the primary objective to:

- to resolve native title determination applications and native title compensation applications by agreement;
- to resolve native title matters in accordance with the requirements of the Native Title Act 1993 (Cth) and relevant case law;
- to ensure valid ‘future acts’, that minimise the extinguishment or impairment of native title and minimise the State’s exposure to compensation liability;
- to develop, implement and monitor policies, procedures and practices across Government that ensure native title matters are administered efficiently and consistently;

- to conclude agreements that deal in a comprehensive way with the determination of native title, compensation and arrangements for future acts; and
- to negotiate and participate in the implementation of project agreements.

Currently, there are 10 native title claims in the South West of WA, nine of which are represented by the South West Aboriginal Land and Sea Council (SWALSC). There has been one native title determination in this area, which involved the determination that the Perth Airport is not subject to native title. There are two claims under active management in this region, the Single Noongar Claim (SNC) (Area 1) and Gnaala Karla Booja. The SNC was created to represent the interests of all the native title claimants in the South West region (Office of Native Title 2010).

The Metropolitan portion of the SNC was heard as a separate proceeding in 2006, and was ruled that, except for extinguishment, native title exists in relation to the whole of the Perth Metropolitan Area and that native title is held by the Noongar People (Office of Native Title 2010).

8.2.4.1 Local Context

Australian Interaction Consultants (AIC 2008) were contracted by the EMRC to facilitate an archaeological and ethnographic survey of the proposed expansion of the Red Hill WMF in 2008. Along with AIC consultants, the ethnographic survey involved a number of members of the Combined Swan River and Swan Coastal Plain Working Group, which includes the Swan Valley Noongar Community, the Independent Aboriginal Environment Group, Bibbulmun, Ballaruk and Jacobs Family. The archaeological survey was under taken by AIC archaeologists. The lots inspected included Lots 12, 82 and 501.

AIC concluded that no new sites were identified from the surveys and the proposed expansion of the landfill will not impact any registered sites and the archaeological potential for subsurface materials to be uncovered is minimal. AIC also recommended that further archaeological and ethnographic research of Lots 12, 82 and 501 is not required.

8.2.4.2 Site – Specific Context

Red Hill WMF is freehold land owned by the EMRC, and therefore is not subject to native title claims.

8.2.4.3 Summary

Given there are no Aboriginal heritage sites recorded within the Subject Site no specific management measures are proposed. All contractors operating onsite however must comply with the *Aboriginal Heritage Act 1972*. In the unlikelihood that any Aboriginal artefacts are discovered, they will be immediately reported to the DIA. Given the above, the EPA objective (**Section 8.2.3.1**) will be satisfied.

8.2.5 European Heritage

8.2.5.1 EPA Objective

To maintain the European heritage and cultural values associated with nearby sites of significance.

8.2.5.2 Australian Heritage

In order to determine the actual or potential presence of sites or features of European Heritage significance in the vicinity of Red Hill WMF, a search of the Australian Heritage Database (DSEWPC 2010b) was undertaken. The Australian Heritage Database contains information about more than 20,000 natural, historic and indigenous places throughout Australia and includes:

- World Heritage Sites;
- National Heritage Sites;
- Commonwealth Heritage Sites; and
- sites listed on the Register of the National Estate.

The search indicated that there are no sites listed on the Australian Heritage Database on, or within the vicinity of Red Hill WMF.

8.2.5.3 Local Government Heritage

An online search for places considered to have cultural heritage significance within the City of Swan and Shire of Mundaring was performed using the Heritage Council of Western Australia's (HCWA's) database (Heritage Council of WA 2010). The online system incorporates The State Register of Heritage Places which recognises places of value and importance to WA, and also includes places listed in The State Register, Local Government Municipal Inventory, Commonwealth Register of National Estate and The National Trust List of Classified Places.

The search indicated that no sites of cultural significant are located within the boundary of Red Hill WMF. However one listed site on the HCWA's database, Twelve Mile Well (Place No. 14459), was identified 700m east of Red Hill WMF (Lot 12) at 1352 Toodyay Rd, Gidgegannup. Further information sought from the City of Swan in relation to this site indicated it was not listed on the City's Local Government Inventory as a heritage site. Anecdotal information suggests that the well was covered over during a reconstruction of Toodyay Road.

8.2.5.4 Summary

No European Heritage sites are known to occur within the subject site therefore, no specific management measures will be developed. As such the EPA objective (**Section 8.2.5.1**) is considered to be satisfied.

8.2.6 Visual Amenity

The location, design and construction of the RRF have the potential to impact on visual amenity. Further investigation has been undertaken to ensure suitable mitigation measures are in place. This is detailed in **Section 12.3**.

8.3 Biophysical Factors

8.3.1 Groundwater and Surface Water

8.3.1.1 EPA Objective

To maintain the quality of surface and groundwater so that existing and potential environmental values are protected.

8.3.1.2 Regional Context

8.3.1.2.1 Surface Water Catchments

Red Hill WMF is located on the divide of three surface water sub-catchments in Jane Brook, Susannah Brook, and Strelley Brook. It should be noted that the Strelley Brook Catchment is recognised by the Swan River Trust as being part of the wider Jane Brook Catchment, and is therefore described in this section as part of the Jane Brook Catchment. The sub-catchments form part of the greater Southwest Catchment, which in turn is located within the Swan Coastal Basin (DOW 2010b). **Figure 21** provides the sub-catchment locations.

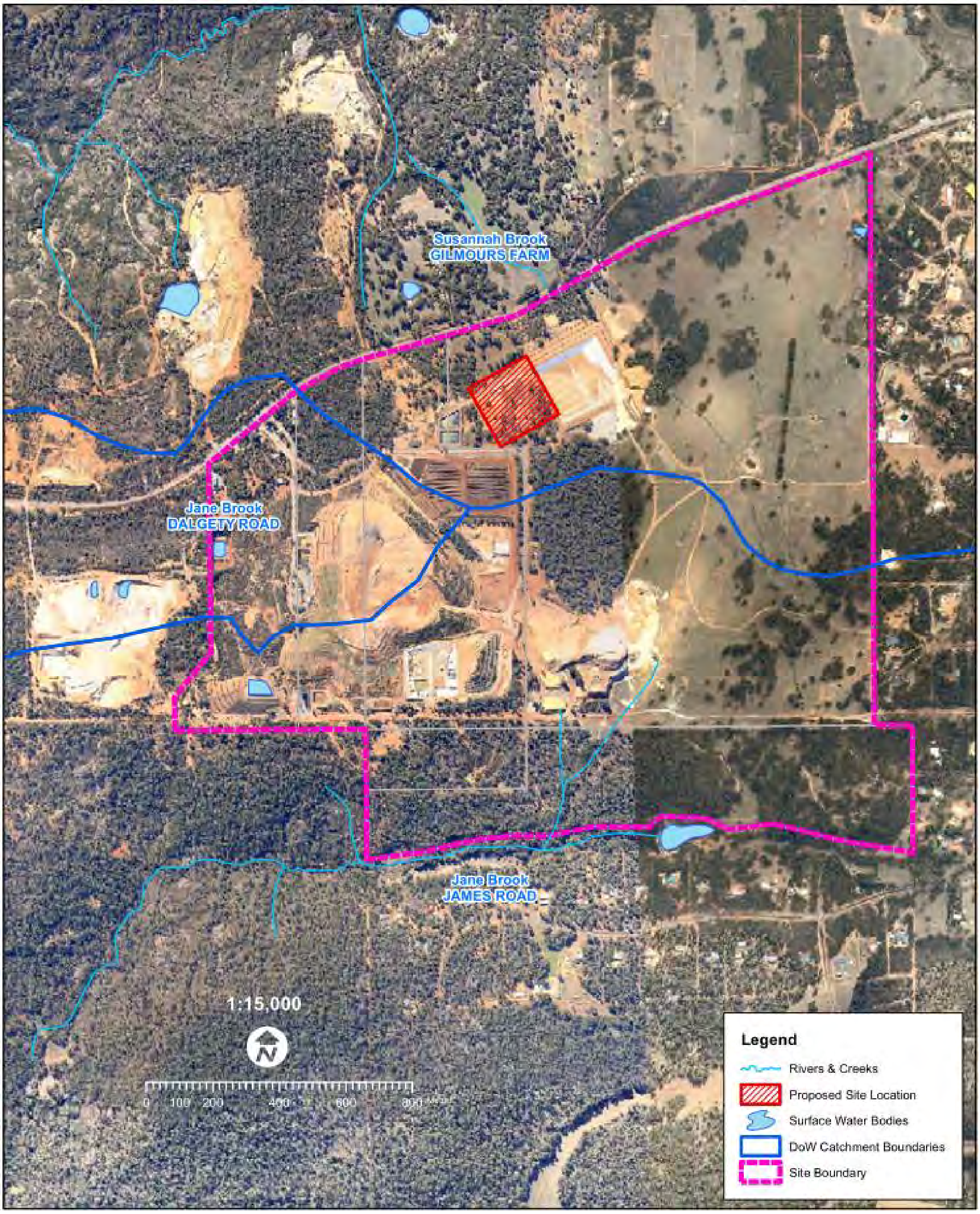

Figure 21 Surface Water and Catchment Areas

Susannah Brook Catchment covers approximately 55 km^2 in area, with agriculture (including broad acre farming, viticulture and grazing) being the dominant land use. Remnant vegetation exists in the centre of the sub-catchment, however extensive clearing of native vegetation has occurred in the upper catchment, and in the lower coastal plain section of the catchment (SRT 2007a).

Susannah Brook is an ephemeral stream (in flow between June and November) that drains from the Darling Scarp, and flows in a westerly direction into the upper Swan River. It is relatively unmodified with the exception of a few small dams located in upper reaches of the stream (SRT 2007a). At its closest point Susannah Brook is located 400 metres north of Red Hill WMF (from the northern boundary of Lot 12).

Jane Brook Catchment covers a total area of approximately 137 km^2 with agriculture being the dominant land use in the catchment. The upper catchment is generally used for grazing, while the lower catchment principally supports viticulture and poultry farming. Native bushland, including the northern section of John Forrest National Park, exists in the middle of the catchment, with patchy areas of bushland also remaining amongst the rural and urban land uses in the upper catchment above the Darling Scarp. Few areas of native vegetation remain in the lower catchment below the scarp due to the expansion of new housing developments (SRT 2007b).

Similarly to Susannah Brook, Jane Brook is an ephemeral water body (in flow June to December) that drains from the Darling Scarp across the coastal plain before converging with the upper Swan River (SRT 2007b). Christmas Tree Creek, a tributary of Jane Brook, flows in a westerly direction adjacent to the southern boundary of the site (below Lot 501), before flowing in a south-westerly direction into Jane Brook. Strelley Brook, a small tributary of Jane Brook, flows in a southwest direction through the coastal plain of the catchment into Jane Brook.

8.3.1.2.2 Proclaimed Surface Water Areas

Under the *Rights in Water and Irrigation Act 1914* (RIWI Act) it is illegal to take water from a watercourse in proclaimed surface water areas without a licence. There are 22 surface water management areas proclaimed under the RIWI Act in WA. New licenses are only issued by the DOW when the allocation limit has not been reached to ensure the protection of the interests of existing users and the environment. Conditions are also placed on the licence to define how and when water may be taken and to specify obligations the licence holder must meet when using the water (DOW 2010b).

A search of the DOW's database has indicated that the Subject Site is not located in a proclaimed surface water area under the RIWI Act.

8.3.1.2.3 Proclaimed Groundwater Areas

Under the RIWI Act it is illegal to take water from a groundwater aquifer in proclaimed groundwater areas without a licence. RIWI licensing is active in all proclaimed areas and for all artesian groundwater wells throughout the State. There are currently 45 groundwater management areas proclaimed under the RIWI Act (DOW 2010c). A search of the DOW's database (DOW 2010a) has indicated that the Red Hill WMF is not located in a proclaimed groundwater area under the RIWI Act.

8.3.1.3 Local Context

8.3.1.3.1 Public Drinking Water Source Area

To protect the State's drinking water resources the DOW has defined certain areas of the State as Public Drinking Water Source Areas (PDWSAs). These areas are given one of the following classifications:

- Priority 1 – managed with the principle of risk avoidance to ensure there is no degradation of the water resource. They cover land where the prime land use value is providing the highest quality drinking water.
- Priority 2 – managed with the principle of risk minimisation to ensure that there is no increase in the risk of pollution to the resource. They are declared over land where low intensity development (such as rural development) already exists.

- Priority 3 – managed to limit the risk of pollution to the water source. They are declared over land where water supply sources need to co-exist with other land uses.

There are no PDWSAs within 5 km of the site (DoW 2010a). A Priority 3 site which forms part of the Middle Helena Catchment Area is the geographically closest PDWSA, located approximately 7.5 km south of the site (at the closet point).

8.3.1.3.2 Hydrogeology

Previous groundwater and soil boring investigations at Red Hill WMF have indicated that the location and extent of groundwater beneath Red Hill WMF is extremely variable. This variation is attributed to the site's elevated location in the catchment and the lack of any defined groundwater aquifer. There are however two prevalent water tables identified beneath the site, including a perched aquifer in the upper or ferruginous zone above a relatively impermeable layer of kaolinitic clays, and a deep aquifer in the saprolitic zone (EMRC 2010).

The depth to the perched aquifer under the Subject Site is approximately 10 metres. Overall, groundwater at the Red Hill WMF flows in a south westerly direction.

There are currently 37 monitoring wells installed across Red Hill WMF. Quarterly groundwater monitoring is undertaken in accordance with Environmental Conditions imposed by the Minster for the Environment and Conservation's, and the requirements of the landfill site's Conditions of Licence (DEC license number 6833/1997/11).

8.3.1.4 Site – Specific Context

8.3.1.4.1 Surface Water Monitoring

Several siltation ponds are located within Red Hill WMF. These ponds are designed to trap and settle out suspended solids and sediment from roads and active working areas. During storm events, the siltation ponds may overflow, discharging water to the surrounding environment. Christmas Tree Creek and Strelley Brook are the two main receiving surface water bodies, and as such, these two environments are monitored quarterly to identify any impact from activities at the Red Hill WMF (EMRC 2009).

8.3.1.4.2 Potential Groundwater Receptors

A search of the DOW Registered Groundwater Bore database identified one registered bore (#23020548) located within the boundary of the Red Hill WMF (along the eastern boundary of Lot 12). The search also identified an additional 24 registered bores located within a 2 km radius from the centre of the Red Hill WMF. These bores are predominantly located in adjacent properties to the north and east of Lot 12.

Six bores, located in the rural/residential property to the north of Lot 12, are identified as being used for domestic, garden irrigation and/or livestock watering purposes, while an additional bore, located to the southeast of the Subject Site, is identified as a livestock watering well. Two project bores, owned by the Waters and Rivers Commission are located to the northeast of the site, while the uses of the remaining 15 bores are not provided in the search data (likely residential personal use).

8.3.1.4.3 Six Year Environmental Performance Review 2004 – 2009 (June 2010)

A Six Year Performance Review was prepared by the EMRC in accordance with the conditions stated in *Ministerial Statement 462 Condition 7-1* and reports on the environmental performance of the Red Hill WMF for the period 2004 to 2009.

Surface water monitoring data collected quarterly over the reporting period does not indicate any decline in downstream surface water quality. Nutrient concentrations at the point of stormwater discharge have improved since the establishment of a nutrient stripping pond. Nitrogen concentrations monitored in Christmas Tree Creek downstream of the facility were below guideline levels. Biological monitoring of surface water systems surrounding the facility indicates that the biological integrity and ecological health of these systems has been maintained.

Groundwater monitoring data have shown that background monitoring bores (located up-gradient of the landfill) have maintained background concentrations for all parameters throughout the reporting period.

DEC accredited auditors, OTEK, were engaged by the EMRC in August 2008 to conduct an independent review of all groundwater investigations and remediation works conducted at the Red Hill WMF.

Groundwater monitoring detected contamination in two locations down-gradient from the facility. These occurred in bores surrounding the Class IV landfill cell and bores along the southern boundary of Lot 11. In response, the EMRC engaged groundwater consultants ATA Environmental to conduct extensive hydrogeological investigations to determine the extent of the leachate impacted groundwater. Subsequent remediation efforts were concentrated on the Lot 11 area due to the limited extent and localised nature of the Class IV contamination. The EMRC engaged Crisalis International to prepare and design specifications for the placement of a 'pump and treat' system to recover contaminated groundwater across the Lot 11 area. This system was installed in October 2009 and recovery operations commenced in December 2009.

Revegetation of former landfill cells has been conducted progressively at the Red Hill WMF since landfilling began in 1981. Rehabilitation of completed landfill cells at the WMF has evolved overtime with a more formal approach being adopted through the development of the Landfill Rehabilitation Program in 2002. A total area of 70ha has been rehabilitated using species endemic to the eastern region. The Class IV, Stage 1 cell was filled and capped in 2007 and direct seeded in 2008.

The Red Hill WMF Environmental Management System (EMS) has been developed and implemented in accordance with International Standards for Environmental Management Systems - ISO 14001. The Red Hill Environmental Policy was amended and upgraded in 2009 to better reflect the growing activities, products and services of the Red Hill WMF operations. The EMRC decided to further progress the EMS and seek certification to the ISO 14001 standard in 2010.

8.3.1.5 Summary

The establishment of the RRF has the potential to cause soil, groundwater and surface water contamination as a consequence of a significant discharge of process liquid or exceedances of air quality standards. Further assessment of the potential risk to groundwater and surface water emanating from these discharges of exceedances has been assessed to be required. This is provided in **Section 12.4**.

8.3.2 Terrestrial Vegetation and Flora

8.3.2.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

8.3.2.2 Vegetation Mapping

Havel, Heddle and Loneragan (1978) mapped the vegetation of the Darling System in WA at a vegetation complex level, which are broad vegetation units based on landform units and landform mapping. The vegetation complex mapping was at a scale of 1:250,000 and the vegetation complexes for the Red Hill WMF are shown on the 'Perth 1:250,000 sheet' (Havel *et al.* 1978). The Red Hill WMF corresponds with three vegetation complexes:

- Dwellingup complex in medium to high rainfall (Darling Plateau): open forest of *Eucalyptus (E.) marginata–E. calophylla*
- Murray and Bindoon complex in low to medium rainfall (Darling Plateau): vegetation ranges from open forest of *E. marginata–Corymbia calophylla* to woodland of *E. rudis* and *E. patens* on the valley floors
- Yarragil complex (Minimum Development Swamps) in medium to high rainfall (Darling Plateau): open forest of *E. marginata – Corymbia calophylla* on upper slopes with mixtures of *E. patens* and *E. megacarpa* on valley floors.

The Red Hill WMF predominantly lies within the Dwellingup complex, with some northern sections of the site (in Lots 1, 2 and 12), and southern sections (in Lots 81 and 501) mapped within the Murray and Bindoon complex. A section of Lot 501 is also mapped within the Yarragil complex. **Figure 22** illustrates the vegetation complex mapping across the site and its surrounds.

Broad mapping for the Interim Biogeographic Regionalisation for Australia (IBRA) programme placed the site within the Northern Jarrah Forest Subregion of the Bioregion 2 (Jarrah Forest) (DSEWPC 2005).

8.3.2.3 Site Vegetation

Patches of native remnant vegetation exist across parts of the Red Hill WMF, while southern 'buffer' Lots 81 and 501 remain covered by native vegetation. Completed landfill cells across Lots 1, 2 and 11 have been capped and revegetated with species endemic to the eastern region.

According to a recent Flora and Vegetation assessment undertaken by Helena Holdings WA Pty Ltd, the condition of the 39.8 ha fragment of remnant bushland in Lot 12 varies from Good (i.e. vegetation structure significantly altered by very obvious signs of multiple disturbances) to Degraded (i.e. basic vegetation structure severely impacted to disturbances) (Helena Holdings 2010). The remaining area (126.6 ha) within Lot 12 consists of grazing pasture with isolated or scattered groups of predominantly *Corymbia calophylla* (Marri) trees. Results of this survey and other assessments are summarised in **Section 8.3.2.8.1**.

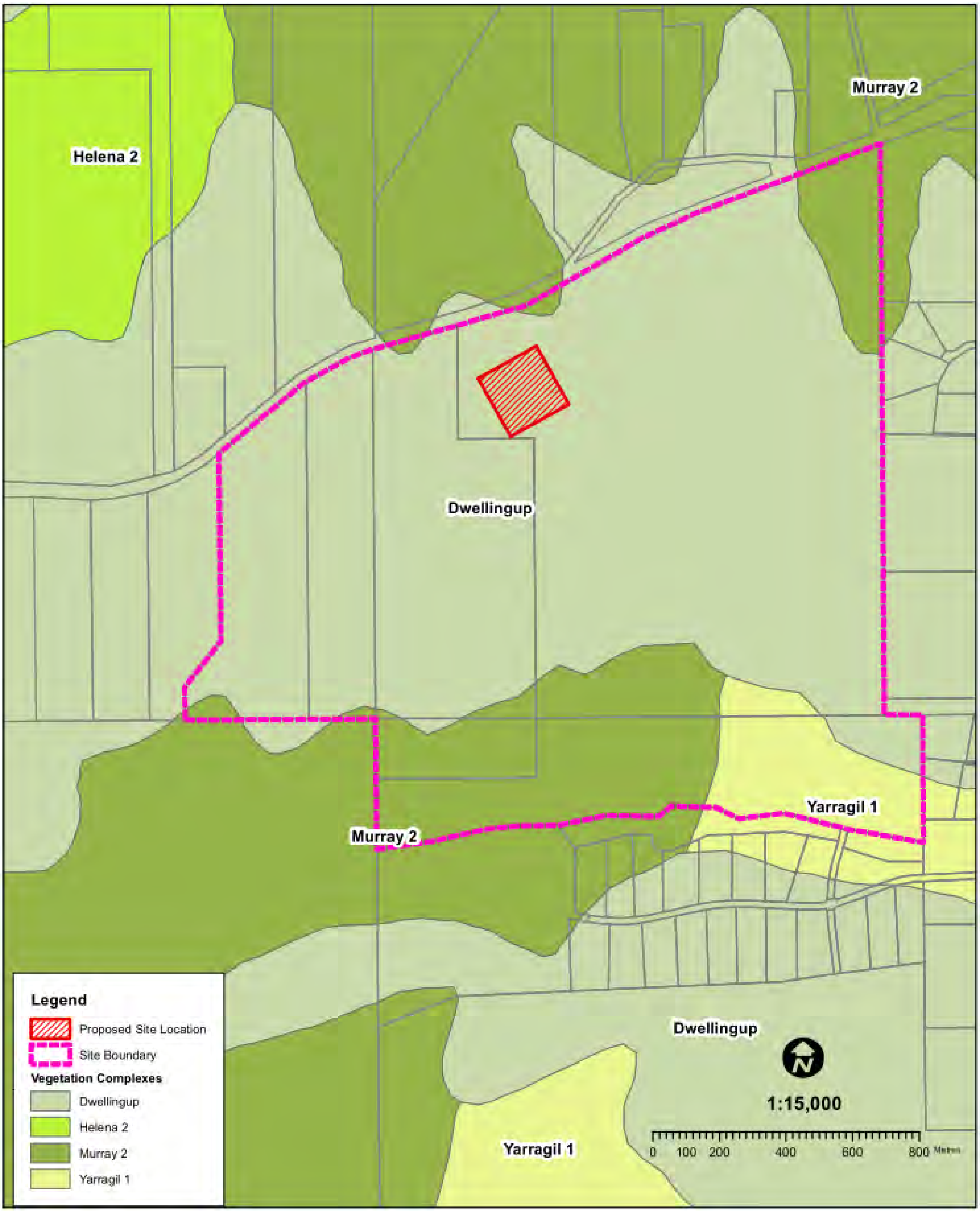

Figure 22 Vegetation

8.3.2.4 Threatened or Priority Ecological Communities

Ecological Communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (DEP 2000). Threatened ecological communities (TECs) are those that have been assessed and assigned to one of four categories related to the status of the threat to the community, with the categories being:

- 'Presumed Totally Destroyed';
- 'Critically Endangered';
- 'Endangered'; and
- 'Vulnerable'.

Priority Ecological Communities (PECs), Priorities 1, 2 and 3, include 'Possible threatened ecological communities that do not meet survey criteria or are not adequately defined' (DEC unpublished). Priority 4 PEC's include 'Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list'. Conservation Dependent ecological communities are placed in Priority 5 PEC's (DEC unpublished).

A search of the DEC's TEC and PEC database found that there are no known occurrences of TEC or PEC's within the boundary of the Red Hill WMF. However there are occurrences of the following ecological communities within approximately 5 km of the Red Hill WMF:

- **'Critically Endangered' TEC**: 'Eucalyptus Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands' (Swan Coastal Plain Community Type 3c)
- **'Critically Endangered' TEC**: 'Shrublands and woodlands of the eastern side of the Swan Coastal Plain' (Swan Coastal Plain Community Type 20c)
- **'Priority 4' ecological community**: 'Central Granite Shrublands.'

8.3.2.5 Declared Rare and Priority Flora (DRF)

A search of the DEC's Threatened (Declared Rare) Flora database, the WA Herbarium Specimen database and the DEC's Declared Rare and Priority Flora List was undertaken for the site and the surrounding area. The database records showed that 13 species of Declared Rare and Priority Flora have been identified within a 5 km radius of the Red Hill WMF. These species, their conservation codes and registered source are listed in **Table 8-2** below.

Table 8-2 Declared Rare and Priority Flora Identified within 5km of the Subject Site

Species	Conservation Code	Source
Acacia oncinophylla subsp. *oncinophylla*	3	WAHERB
Anthocercis gracilis	R	WAHERB
Calothamnus rupestris	4	WAHERB, DEFL
Darwinia pimelioides	4	WAHERB, DEFL
Diplolaena andrewsii	R	WAHERB, DEFL
Grevillea pimeleoides	4	WAHERB
Halgania corymbosa	3	WAHERB, DEFL
Lepyrodia heleocharoides	3	DP List
Pithocarpa corymbulosa	3	WAHERB, DEFL
Tetratheca pilifera	3	WAHERB, DEFL
Templetonia drummondii	4	WAHERB
Thysanotus anceps	3	WAHERB
Verticordia lindleyi subsp. *lindleyi*	4	WAHERB

Source**:** WA Herbarium Specimen Database (WAHERB), DEC Threatened (Declared Rare) Flora database (DEFL), and DEC Declared Rate and Priority Flora List (DP List).

Populations of two Declared Rare Flora species, *Anthocercis gracilis* and *Diplolaena andrewsii*, have been identified approximately 4.5 to 5 km southwest of the Red Hill WMF within John Forrest National Park. All other species have been identified as Priority 3 (Poorly Known Taxa) or Priority 4 (Rare Taxa) species. Priority 3 species are taxa which are known from several populations, and the taxa are not believed to be under immediate threat, though are in need of further survey. Priority 4 species are taxa which are considered to have been adequately surveyed and which, whilst being rare are not currently threatened by any identifiable factors.

8.3.2.6 Bush Forever

Bush Forever is a WA Government initiative that identifies regionally significant bushland to be retained and protected forever. The land that has been nominated for Bush Forever sites covers a wide range of different tenures and land use types. Following guidelines set by the World Conservation Union, Bush Forever aims to protect a target figure of at least 10% of the 26 original vegetation complexes within the Swan Coastal Plain portion of metropolitan Perth, and to conserve threatened ecological communities. Bush Forever sites have been nominated as part of an overall planning process that was undertaken over many years and is now overseen by the WAPC.

A search of the DEC's Native Vegetation Map Viewer found that the proposal is not located within or adjacent to a known Bush Forever site (DEC 2010) (**Figure 23**).

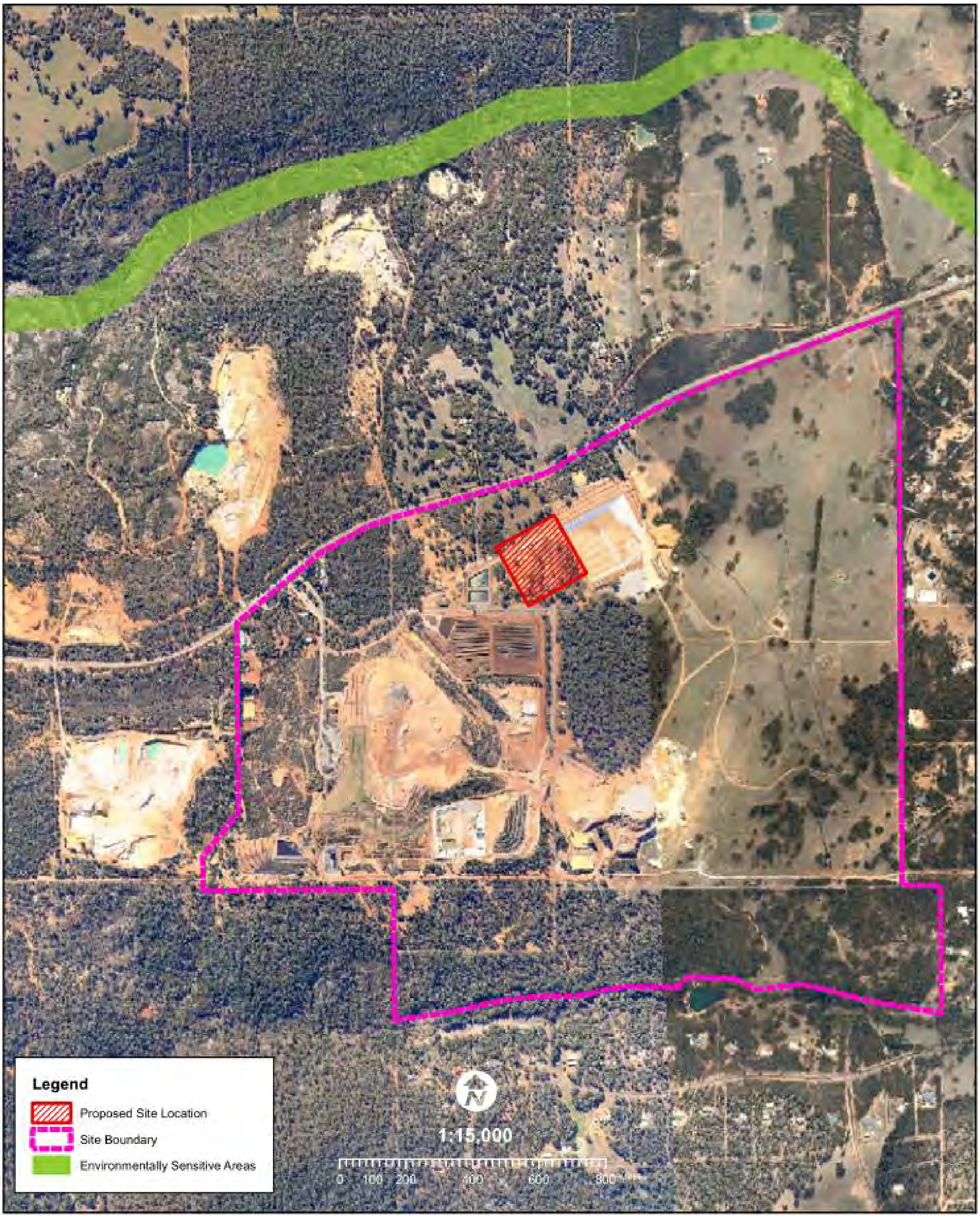

Figure 23 Bush Forever and Environmentally Sensitive Areas

8.3.2.7 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are areas prescribed and regulated under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. These areas have been identified in order to protect the native vegetation values of areas surrounding significant, threatened or scheduled ecosystems or communities. Where a clearing permit is required for an area that is situated within an ESA, then none of the exemptions pursuant to the Regulations apply.

A search of the DEC's Native Vegetation Map Viewer found that the proposal is not located within or immediately adjacent to an ESA. The closest ESA, which covers riparian vegetation for Susannah Brook, is located approximately 400 m north of the Red Hill WMF (at the nearest point from Lot 12) (DEC 2010a) (**Figure 23**).

8.3.2.8 Nationally Threatened Flora Species

The EPBC Act also provides a listing of nationally threatened native species and ecological communities. Listed threatened species and ecological communities are recognized as a matter of national environmental significance. Therefore in the event that the proposal is likely to have a significant impact on listed threatened species and ecological communities, the proposal must be referred to the Federal Environmental Minister under the EPBC Act and undergo an environmental assessment and approval process.

As noted in **Section 3.2**, a search of the EPBC Protected Matters Search Tool indicated that one flora species, *Thelymitra stellata* (Star Sun-orchid), listed under Federal Legislation as a Threatened Species may potentially occur within a 1 km radius of the Red Hill WMF.

8.3.2.8.1 Flora and Vegetation Assessment (May 2010)

Helena Holdings Pty Ltd was engaged by the EMRC to conduct a Level 1 flora and vegetation assessment within Lot 12 of Red Hill WMF. The survey was undertaken as a requirement for a clearing permit being sought by the EMRC in order to expand its current landfill operations. The survey area comprised of two parts; Area 1 (39.8 ha area of existing remnant vegetation) and Area 2 (126.6 ha of grazing pasture with isolated or scattered groups of predominantly *Corymbia calophylla* (Marri trees)).

The results of the Level 1 survey undertaken in October 2009 are summarised below:

- the survey area has been subject to major disturbance (clearing, logging, grazing etc.), resulting in the remnant native vegetation becoming fragmented from the northern boundary of John Forrest National Park;
- a total of 72 taxa were recorded in the project area (including 39 native taxa from 18 Families and 33 weed taxa from 17 Families);
- the vegetation community occurring in Area 1 with minimal variation was Forest to Woodland of *Corymbiacalophylla, Eucalyptus marginata* and *Allocasuarina fraseriana* over Thicket of *Banksia sessilis* var. *sessilis* over occasional shrubs and herbs on fine to medium grained sandy gravel with scattered to numerous laterite outcropping;
- two occurrences of *Templetonia drummondii*, a Priority 4 plant, were recorded within Area 1, although the potential for clearing to adversely impact on the conservation status was determined to be low;
- two of the weed species are listed under the *Agriculture and Related Resources Protection Act 1976*, as a Declared Plant or a Pest Plant. *Echium plantagineum* (Paterson's curse) is a Declared Plant, and *Citrullus lanatus* (Pie Melon) is a Pest Plant;
- no TEC were recorded during the survey;
- the regional impact of the proposed clearing on the vegetation type is considered low;
- modification of all plant strata has occurred though the vegetation within the central portion of Area 1 was determined to be in good condition with evidence of the ability to regenerate;
- the condition of Area 2 is considered to be completely degraded;
- no expression of *Phytophthora* spp. induced dieback was evident; and

- habitat and food sources for the endangered *Calyptorhynchus latirostris* (Carnaby's Black Cockatoo) and vulnerable *Calyptorhynchus Baudinii* (Baudin's Black Cockatoo) may potentially be reduced if one or more of the following species are cleared:
  - *Banksia sessilis var. sessilis* (Parrot bush) - identified within the remnant vegetation of Area 1 in mostly good condition;
  - *Corymbia calophylla* (Marri) – large Marri trees were identified in Area 1 and in isolated or scattered groups in Area 2; and
  - *Banksia grandis* and *Allocasuarina fraseriana* – both identified in the survey area.

8.3.2.8.2 Vegetation Monitoring Programme (November 2009)

All rehabilitated landfill cells are monitored during spring of each year by consulting botanists to ensure the following:

- that the revegetation program is providing a self-sustaining vegetation community (i.e. there is sufficient species diversity, minimal infestation of weeds, species are self propagating),
- vegetation cover is providing effective erosion control,
- there is no deep rooted tree or large shrub species which have the potential to comprise the integrity of the landfill cap,
- provide valuable information on the success of certain revegetation for future planning.

Permanent transects and monitoring quadrants were established during 2007 and are monitored annually. These areas include:

- Class III Stages 6, 7, 8
- Class III Stages 4 and 5
- Class III Stage 9
- Class III Stages 1 and 2
- Class IV Stage 1
- Class III Stage 7, 8 (top portions)
- Class III Stage 10 and 11
- Class III Stage 12

These areas consist of completed landfill cells which have been revegetated and are in varying stages of establishment. The monitoring plots and transects were chosen to reflect a cross section of varied site conditions in each area.

Overall results indicate that native vegetation cover is improving as projected foliage cover increases which is related to successional processes as plants grow, cover develops and weaker germinates die. The overall health of the plants is good with most areas progressing towards a self-sustaining, successful long term habitat.

8.3.2.8.3 Clearing Permits

According to the DEC's Native Vegetation Map Viewer tool, two applications for Clearing Permits have been applied for by the EMRC for two separate areas of vegetation. Works in accordance with expired Clearing Permit No. 2277/1 were undertaken in 2008 for the construction of the new cell in Lot 12. Clearing Permit No. 1516/1 was withdrawn by the EMRC, in 2007, as it was discovered that clearing permits had already been obtained for Lots 1 and 2.

8.3.3 Terrestrial Fauna

8.3.3.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

8.3.3.2 Fauna

Searches of the DEC's Threatened and Priority Fauna Database, the DEC's NatureMap database and the EPBC Protected Matters were undertaken to identify conservation significant fauna species that potentially occur within the survey area. The search results are summarized in **Table 8-3** below.

Table 8-3 Significant Fauna Species Identified within a 5km Radius of the Subject Site

Species	Conservation Code	Source
Apus pacificus (Fork-tailed Swift)	Migratory / Listed - overfly marine area	EPBC
Ardea alba (Great Egret, White Egret)	Migratory / Listed - overfly marine area	EPBC
Ardea ibis (Cattle Egret)	Migratory / Listed - overfly marine area	EPBC
Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo)	Vulnerable / Schedule 1	EPBC, DEC TPFD
Calyptorhynchus baudinii (Baudin's Black-Cockatoo, Long-billed Black-Cockatoo)	Vulnerable / Schedule 1 / T	EPBC, DEC TPFD, NatureMap
Calyptorhynchus latirostris (Carnaby's Black Cockatoo, Short-billed Black-Cockatoo)	Endangered / Schedule 1	EPBC, DEC TPFD
Calyptorhynchus sp (White-tailed Black Cockatoo)	Schedule 1	DEC TPFD
Dasyurus geoffroii (Chuditch, Western Quoll)	Vulnerable / Schedule 1 / T	EPBC, DEC TPFD, NatureMap
Falco peregrinus (Peregrine Falcon)	Schedule 1	NatureMap
Haliaeetus leucogaster (White-bellied Sea-Eagle)	Migratory / Listed - overfly marine area	EPBC
*Isoodon obesulus fuscivente*r (Quenda)	Priority Five	DEC TPFD
Macropus irma (Western Brush Wallaby)	Priority Four	DEC TPFD
Merops ornatus (Rainbow Bee-eater)	Migratory / Listed - overfly marine area	EPBC

Source**:** EPBC Protected Matters Search (EPBC), DEC Threatened and Priority Fauna Database (DEC TPFD), and DEC NatureMap Species Report (NatureMap).

8.3.3.3 Fauna Assessment

The EMRC commissioned Bamford Consulting Ecologists (BCE) (2010) to conduct a fauna assessment within the bushland of Lot 12 within Red Hill WMF, south of the proposed RRF site. The Subject Site was not included in the study. The survey was undertaken in November 2009, to determine the fauna values of the site and identify the likely impacts of the potential clearing required for the expansion of the current landfill operations.

The study area has a total area of 50ha, with the majority historically cleared for grazing when Lot 12 operated as a farm. There is one area of bushland remaining: a patch of approximately 13.5ha. This patch of bushland is degraded and generally lacking an understorey.

BCE concluded that the Red Hill project area is largely disturbed, but may support some fauna of conservation significance. The proposed development will lead to the localized loss of some fauna habitat. However, there is extensive intact habitat to the south-east (John Forrest National Park) and north of the project area, supporting similar fauna and fauna habitats in a landscape that is generally in good condition. The overall conservation significance of the project area can be therefore considered as low.

8.3.4 Aquatic Flora and Fauna

Aquatic flora plays a vital role in enhancing water quality. Freshwater fauna contribute significantly to Australia's biodiversity and are integral components of freshwater ecosystems. As detailed in **Section 8.3.1.2.1** the nearest surface water bodies are located in the in Jane Brook and Susannah Brook Catchments. Susannah Brook is an ephemeral stream that drains from the Darling Scarp, and flows in a westerly direction into the upper Swan River. At its closest point Susannah Brook is located 400 m north of Red Hill WMF.

Jane Brook is an ephemeral water body that drains from the Darling Scarp across the coastal plain before converging with the Upper Swan River (SRT 2007b). Christmas Tree Creek, a tributary of Jane Brook, flows in a westerly direction adjacent to the southern boundary of the site (below Lot 501), before flowing in a south westerly direction into Jane Brook. Strelley Brook, a small tributary of Jane Brook, flows in a south west direction through the coastal plain of the catchment into Jane Brook.

The EMRC initiated an annual aquatic fauna study in 2008, which is conducted by consultant ecologists to assess the ecological condition of the surface water systems within the surrounding John Forrest National Park and to determine any potential impacts the Red Hill landfill operations may have on these surrounding systems.

Overall, results to date suggest that surface water systems within the John Forrest National Park, whilst showing signs of mild to moderate disturbance from anthropogenic activities (e.g. urbanisation), have retained their level of significant ecological and conservation value with no adverse impacts from activities of the Red Hill WMF.

As noted in **Section 8.3.1.5** the establishment of the RRF has the potential to cause soil, groundwater and surface water contamination if a significant discharge of process liquid or exceedances of air quality standards were to occur. As such there is the potential for aquatic flora and fauna to be impacted. Further investigation into the assessment of this risk and appropriate management measures developed to ensure the operation of the RRF will not impact on aquatic flora and fauna are presented in **Section 8.3.4** and **Section 12.8** respectively.

8.4 Human Health

Human health may be affected by the establishment of facilities such as the RRF through exposure to air pollution, contamination of food chain, water contamination, noise and increased risks of injury. Developments such as these may also impact on the social and emotional status of individuals and communities. Members of the community more susceptible to both the physical and social impacts are often children and the elderly.

The results of the assessments of the environmental risks from the RRF were examined to determine the level of impact these factors may have on human health. The EMRC has considered the potential health impacts on both occupational health and public health. The potential health impacts assessed include exposure to emissions (noise, air and odour) and by-products generated from the RRF such as light, traffic, the social environment and sustainability of ecosystems.

The long term emissions of air toxics have been considered in the modelling and impact assessment study. An assessment of the potential for bioaccumulation of emissions is not necessary in this case, since the air quality standards for persistent pollutants are considered protective of whole of life exposures, i.e. the permitted air emissions are sufficiently low that they will not cause adverse health effects if individual are exposed to them on regular basis. Advice from Department of Health, 2012 is that "*DOH is satisfied the substances modelling using a combination of measured data and emission limits data for the proposed technologies are unlikely to cause health effects provided the emission remain consistently below the recommended air quality health based references for the life of the facility.*" This advice also considers secondary routes of exposure to pollutants which can arise as a consequence of bioaccumulation and ingestion of foods grown on nearby properties.

In order to protect to the health of the community and employees, the EMRC has developed a number of suitable management measures which are detailed in **Section 13**.

8.4.1 Artificial Light Pollution

Artificial light emanating from facilities can impact on the amenity of surrounding residents, attract pests, impact flora and fauna, intrude on airspace and create human health issues. The Red Hill WMF operates during day light hours therefore, only minimal security lighting is currently utilised at night.

The waste processing technologies being considered for the RRF will be continuous processes. However there will be minimal outdoor activities occurring outside of the current hour of operation of the Red Hill WMF. The establishment of the RRF will cause some increase in the lighting provided on the Red Hill WMF, due to the requirement for security lighting outside operational hours and the need to light various aspects of the process plant and equipment for operational and safety requirements. As a consequence the EMRC has developed a number of management measures to ensure any lighting installed does not impact on health, flora and fauna and does not intrude into prescribed airspace. These are detailed in **Section 12.2**.

9 Environment Assessment – Air Quality

Synergetics were commissioned to undertake ambient air monitoring to determine the current ambient air concentrations of key pollutants, which includes impacts from the existing emissions generated from the Red Hill WMF. In addition, predicted ambient air concentrations of air emissions from the AD and gasification technologies were determined from plume dispersion modelling. The results of the monitoring and modelling were compared to relevant air quality standards to assess compliance of these technologies with these standards and to develop appropriate management practices where necessary to ensure compliance.

The EPA objective, applicable air quality standards, potential environmental impacts and the management measures for control of air emissions are discussed below.

9.1 EPA Objective

To maintain the environmental values, health, welfare and amenity of nearby land uses, and the wider Perth airshed by meeting the statutory requirements of air emissions, including dust emissions.

9.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 12 – Minimising Greenhouse Gas Emissions
- EPA Guidance Statement No.18 – Prevention of Air Quality Impacts from Land Development Sites
- EPA Guidance Statement No. 3 – Separation Distances between Industrial and Sensitive Land Uses
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process
- State Planning Policy No. 2 - Environment and Natural Resources Policy
- State Planning Policy No. 4.1 - State Industrial Buffer Policy
- City of Swan Local Planning Strategy

9.3 Air Quality Standards and Impact Assessment Criteria

In WA, air quality is regulated by the DEC. Specific air quality assessment criteria for WA are being developed by the DEC but have not been finalised at the time of the air quality assessment. However, an interim approach to the adoption of air quality guidelines was recommended in 2004 by the then Department of Environment (DEC, 2004). This approach has been followed in this assessment.

Ambient air quality guidelines are defined as the concentration of a pollutant in ambient air which it is desirable not to exceed in order to ensure that human health, amenity and environmental values are protected. Compliance with guidelines may or may not be required under legislation, depending on site specific circumstances.

As part of the interim approach to the selection of air quality guidelines for the assessment of air quality impacts, WA DEC recommended the use of a hierarchical selection process as follows:

- National Environment Protection Measure (NEPM) standards will be preferentially used as guidelines.
- World Health Organisation (WHO) guidelines for air quality will be employed in the absence of a NEPM standard.

- Criteria from other jurisdictions can be adopted for other pollutants not covered by NEPM and WHO guidelines, once assessed and deemed to be applicable to the WA context.

The Australian, State and Territory Governments and the National Environment Protection Council, agreed to a NEPM for Ambient Air Quality on 26 June 1998. The air quality standards are legally binding on each level of government. The standards relate to six main air pollutants:

- carbon monoxide;
- nitrogen dioxide;
- photochemical oxidants;
- sulfur dioxide;
- lead; and
- particles.

In addition to the recommendations listed above a draft State Environment (Ambient Air) Policy (SEAAP) for WA has been released for public and stakeholder comment (WA Government, 2009). This policy has not yet been set into law and therefore does not directly apply to the present assessment. It is, however, an indication of likely future regulation in WA.

Relevant assessment criteria were compiled according to the available guidance; in particular the species covered by the emission limits presented in the EU Waste Incineration Directive (WID) were included to ensure that the major air emission species generated by the thermal treatment of waste (gasification) were considered in the impact assessment (EU, 2000).[3] These include total particulates (dust), SO_2, NO_X, CO, heavy metals (defined as the total of Antimony, Arsenic, Lead, Chromium, Cobalt, Cooper, Manganese, Nickel, Vanadium), Mercury, Cadmium, Thallium, polychlorodibenzo-*p*-dioxins and polychlorodibenzofurans (“dioxins and furans”), TOC, HCl and HF.

Emission limits from the UK Environment Agency (EA) for landfill gas operations (UK EA 2010) provide the basis for selection of substances (air emissions) of interest from the AD technologies. These include SO_2, NO_X, CO and non-methane VOCs (NMVOCs). Another substance (formaldehyde) was reported by one of the AD technology suppliers as a significant component in emission from that facility and this has also been included in the assessment. The relatively small number of substances of interest from AD technologies does not indicate that there are no emissions of other substances. However the inclusion of the listed substances in the UK EA regulations may be indicative that other substances emitted from combustion of landfill gas are below a level that can lead to significant impacts on the local air quality. Further details regarding the standards detailed above are provided within **Appendix A Section A1**.

[3] The EU WID defines ‘incineration plant’ as meaning *any stationary or mobile technical unit and equipment dedicated to the thermal treatment of wastes with or without recovery of the combustion heat generated. This includes the incineration by oxidation of waste as well as other thermal treatment processes such as pyrolysis, gasification or plasma processes in so far as the substances resulting from the treatment are subsequently incinerated* (EU, 2000). As the syngas produced by gasification is oxidised to produce energy, it is considered that gasification is covered by this directive.

9.4 Existing Environment

9.4.1 Previous Monitoring

As far as can be ascertained, comprehensive air quality monitoring has not previously been conducted at the Red Hill WMF. A meteorological station was installed onsite in early 2011 to provide measurements of a range of meteorological parameters including wind speed and direction, temperature and relative humidity (see blue diamond in **Figure 24** for location of the meteorological station).

9.4.2 Scope of Monitoring Campaign at Red Hill

The monitoring programme involved the operation of two Air Quality Monitoring Stations (AQMS) for the continuous measurement of CO, NO, NO_2, NO_X, SO_2, PM_{10} and $PM_{2.5}$. The AQMS were located at a neighbouring property off Toodyay Rd and near the eastern boundary of the EMRC Red Hill WMF. In addition to this continuous monitoring, campaign based sampling was conducted for PAHs, dioxins, TSP, PM_{10}, metals, HCl, HF, H_2S, volatile organic compounds (VOCs) and carbonyls at the above locations plus an additional location in Hidden Valley (as illustrated in **Figure 24**).

The continuous monitoring was conducted for a four month period (April and July), with three campaigns of discrete monitoring carried out at each monitoring location and an additional two campaigns at the EMRC site only. As far as possible, these campaigns were conducted at regular intervals over the available timeframe. The duration of the monitoring program enabled the collection of samples across the change of season from the very hot and dry conditions that were experienced in April, to the cooler, wet conditions in July. In addition, this covered a period when local vegetation burning off occurred as well as a cooler period where increased use of wood burning heaters was expected, thereby contributing to higher levels of ambient pollution (in particular ambient levels of particulates).

The purpose of the monitoring program was to obtain site and receptor specific data on ambient air concentrations of key pollutants and to use this to provide a conservative estimation of background concentrations for a cumulative impact assessment. The data are considered to provide a satisfactory level of conservatism in the values used for the cumulative assessment. The 95th percentile concentrations of the continuously monitored substances (for the relevant time averages) and the maximum concentrations of the substances measured in the campaign monitoring were used as typical background concentrations for the entire year of modelling, which provides for a conservative (but not excessively conservative) outcome.

A comparison of hourly average NO_2 concentrations at the DEC's Rolling Green site with EMRC Lot 12 and Toodyay Rd stations was made to assess the representativeness of the four months of Red Hill measurements against the longer term data from Rolling Green.

Results of the campaign monitoring are detailed in **Section 9.4.4.** Details of the methodology and all results from the monitoring programme have been reported elsewhere (Synergetics 2011).

9.4.3 Selection of Sampling Locations

The three sites selected in the vicinity of the Red Hill WMF for monitoring were chosen to provide direct coverage of neighbouring residential areas. These are located to the north-east, east and south of the subject site (refer to **Figure 24**). Further details on the methodology for selection of the sampling sites are provided within **Appendix A Section A2.1**.

Figure 24 Monitoring Locations Around the Red Hill WMF Locality

9.4.4 Sampling Program Methodology and Results

As detailed in **Section 9.4.2**, the baseline air quality assessment comprised both continuous and campaign based monitoring.

9.4.4.1 Continuous Monitoring

The continuously monitored species included PM_{10}, $PM_{2.5}$, CO, NO_X (NO and NO_2) and SO_2. Details of the measurement methodologies are presented in **Appendix A Section A2.2.1**.

A summary of the maximum concentrations obtained from the continuous monitoring of CO, NO, NO_2, SO_2, PM_{10} and $PM_{2.5}$ are presented alongside the corresponding NEPM limit for that averaging period in

Table 9-1.

All maximum concentrations were found to be well below the corresponding NEPM limits.

Table 9-1 Summary of Continuous Background Data – Maximum Concentrations

Species	Units	Average Time	NEPM	ERMC Lot 12				Toodyay Rd			
				April	May	June	July	April	May	June	July
NO_2	ppb	1 h	120	17	11	13	15	26	23	19	23
CO	ppm	8 h	9	0.7	0.3	0.4	0.2	0.3	0.5	0.5	0.5
SO_2	ppb	1 h	200	26	18	14	4	4	9	4	5
		24 h	80	4	6	19	3	3	3	3	3
PM_{10}	µg/m³	24 h	50	27	19	21	20	30	26	19	20
$PM_{2.5}$	µg/m³	24 h	25	2	2	12	8	5	8	8	8

9.4.4.2 Campaign Based Monitoring

Details of the pollutants and measurement methodologies for the campaign based monitoring are presented in **Appendix A Section A2.2.2.**

The results from the three sampling campaigns at the Toodyay Rd and Hidden Valley sites and the five campaigns conducted at the Red Hill Lot 12 site are summarised in **Appendix A Table A 4** for the various parameters. These show the ranges of concentrations observed from the monitoring. These concentrations have not been adjusted for the amounts of the substances in the sampling blanks. The results from the blank samples are included to facilitate interpretation of the significance of the results from the samples.

9.4.4.3 Comparison of Red Hill and Rolling Green NOx data

A comparison of the NOx concentration data from the two Red Hill monitoring stations and the DEC Rolling Green station was carried out to assess the suitability of the Red Hill data for predictions of air quality on a long term basis. The results of the comparison are presented in **Table 9-2**.

Table 9-2 Comparison of Red Hill and Rolling Green NO_2 concentrations

Statistic	April 2011			May 2011			June 2011			July 2011		
	EMRC Lot 12	Toodyay Rd	Rolling Green	EMRC Lot 12	Toodyay Rd	Rolling Green	EMRC Lot 12	Toodyay Rd	Rolling Green	EMRC Lot 12	Toodyay Rd	Rolling Green
Maximum	17.0	26.3	19.0	11.4	23.1	21.0	12.8	19.4	15.0	14.9	23.0	14.0
Minimum	0.0	1.7	1.0	0.0	1.0	2.0	0.0	1.0	0.0	0.0	0.8	1.0
Average	1.7	6.3	3.1	1.2	5.4	5.0	1.3	3.9	3.7	0.8	3.9	2.4
95%ile	6.7	15.2	9.0	3.8	15.4	12.0	4.4	12.9	8.0	3.9	12.8	6.0

The comparison shows that that NO_2 data from the Red Hill stations were generally consistent with Rolling Green data. Importantly, the comparison indicates that the Toodyay Rd 95th percentile concentrations are likely to provide a more conservative outcome compared with the Rolling Green NO_2 data, which is a desirable situation for this assessment.

9.4.4.4 Conclusion

Air quality data were obtained from the monitoring programme at locations surrounding the proposed RRF at the Red Hill facility, for assessment of cumulative impacts from the RRF as well as providing a baseline against which the air quality impacts of changing operations at the Red Hill WMF or at neighbouring facilities can be evaluated.

9.5 Environmental Impact Assessment - Air Emissions

9.5.1 Approach

The assessment of environmental impacts from air emissions from the proposed RRF was carried out using emissions data provided by the technology suppliers and dispersion modelling to predict ground level concentrations (GLCs) for comparison with air quality standards and guidelines. A cumulative assessment was also conducted whereby the background concentrations of pollutants were combined with the predicted GLCs for comparison with the standards and guidelines. This provides a conservative approach in that the assessment considers the incremental impact of the proposed RRF on the existing air quality at locations surrounding the Red Hill WMF.

9.5.2 Sources of Emissions from the RRF

The gasification technology discharges waste gases to atmosphere via a tall stack, which presents the most significant source of air emissions for assessment.

The AD technology discharges waste gases to atmosphere via the exhausts from the gas engines, flares and waste gas burner, which have been considered in this assessment.

9.5.3 Existing Emissions Sources

The impact of air emissions from the existing sources, both onsite and offsite the Red Hill WMF, have been characterised by the baseline monitoring study. This was considered in the cumulative assessment where concentrations of pollutants in ambient air were combined with model predictions of ambient air concentrations from dispersion of emissions from the respective technologies. As a consequence, discrete modelling of existing emissions sources was not required.

9.5.4 Modelling of Air Emissions

Synergetics was commissioned by the EMRC to undertake air dispersion modelling to assess the potential impacts on air quality from the proposed RRF at the Red Hill WMF.

The air dispersion modelling was conducted using CALPUFF to predict the GLCs of emissions from the proposed RRF. Those predicted GLCs were then compared with air quality guidelines and standards to assess the potential impact of air emissions at sensitive receptors nearby to the subject site (further details of this modelling are provided in **Appendix A, Section A3**).

9.5.4.1 Emission Sources and Emissions Rates

Details of the emissions sources and emission rates of key pollutants used in the modelling are presented in the relevant sections below for the assessment of gasification and AD technologies.

These emission rates were derived from data provided by the technology suppliers for smaller operating facilities (information from larger operations was not sufficiently detailed), adjusted for a 200,000 tpa waste throughput for the gasification facility and a 150,000 tpa waste throughput for the AD facility. Details of the derivation of the emission rate estimates used for the modelling are presented in the modelling report from Synergetics (2011).

9.5.5 Meteorological Modelling

The CALMET meteorological model was used to generate the hourly 3D gridded wind and temperature fields along with the associated micro-meteorological variables (mixing height, stability class, etc.). Generally, CALMET uses prognostic data that is supplemented with observational meteorology (comprising of surface and/or upper air) to generate the initial gridded fields, and subsequently makes use of terrain and land-use data for incorporating the influence of topography, and ultimately resulting in the final gridded fields.

For this assessment, the prognostic meteorological data was sourced from the TAPM (v4.0.4) meteorological module while the EMRC meteorological monitoring station provided the observational data. Details of the station are presented in **Table 9-3**. TAPM was used to generate the prognostic data.

Table 9-3 Details of ERMC meteorological monitoring station

Parameter	Value
Station location (UTM)	416572 mE, 6477888 mS
Station height (m)	10
Monitored period	22/01/2011 to 21/03/2012
Monitored variables and frequency	• 5-min wind speed and wind direction • Hourly precipitation, air temperature and relative humidity

Topographical data from the terrain STRM 3 (90 m 3 s arc) and land use data (~1000 m, 30 s arc) that are available from the United States Geological Survey (USGS) were used.

Details of the parameters for the TAPM and CALMET meteorological modelling are provided in **Appendix A Section A3.3** and a detailed description is presented in the Synergetics report (2012). Note that modelling was also carried out using Perth Airport meteorological data prior to the availability of data from the EMRC station and the results of that modelling have been compared with the current modelling for a consistency check. Full details of the initial modelling are reported in Synergetics (2011), which should be read in conjunction with the Synergetics (2012) report on the modelling using EMRC meteorological data.

9.5.6 Receptor Locations

A grid of 2091 receptors spaced 250 m apart across a modelled domain of 10 km by 12.5 km was used for the initial dispersion modelling and a grid of 2304 receptors in a domain of 12 km x 12 km used for the revised modelling conducted using Red Hill meteorological data. The population of interest in the impact assessment were the nearby residents, therefore discrete receptors were also identified including the nearest residences to the proposed facility (R1 to R9, see **Figure 25**) and a school located approximately 3.8 km from the south east corner of the site. No other specific sensitive receptors were identified in the area (i.e. no day care centres, retirement homes, hospitals, etc.). The locations of the discrete receptors (and monitoring stations) are illustrated in **Figure 25**.

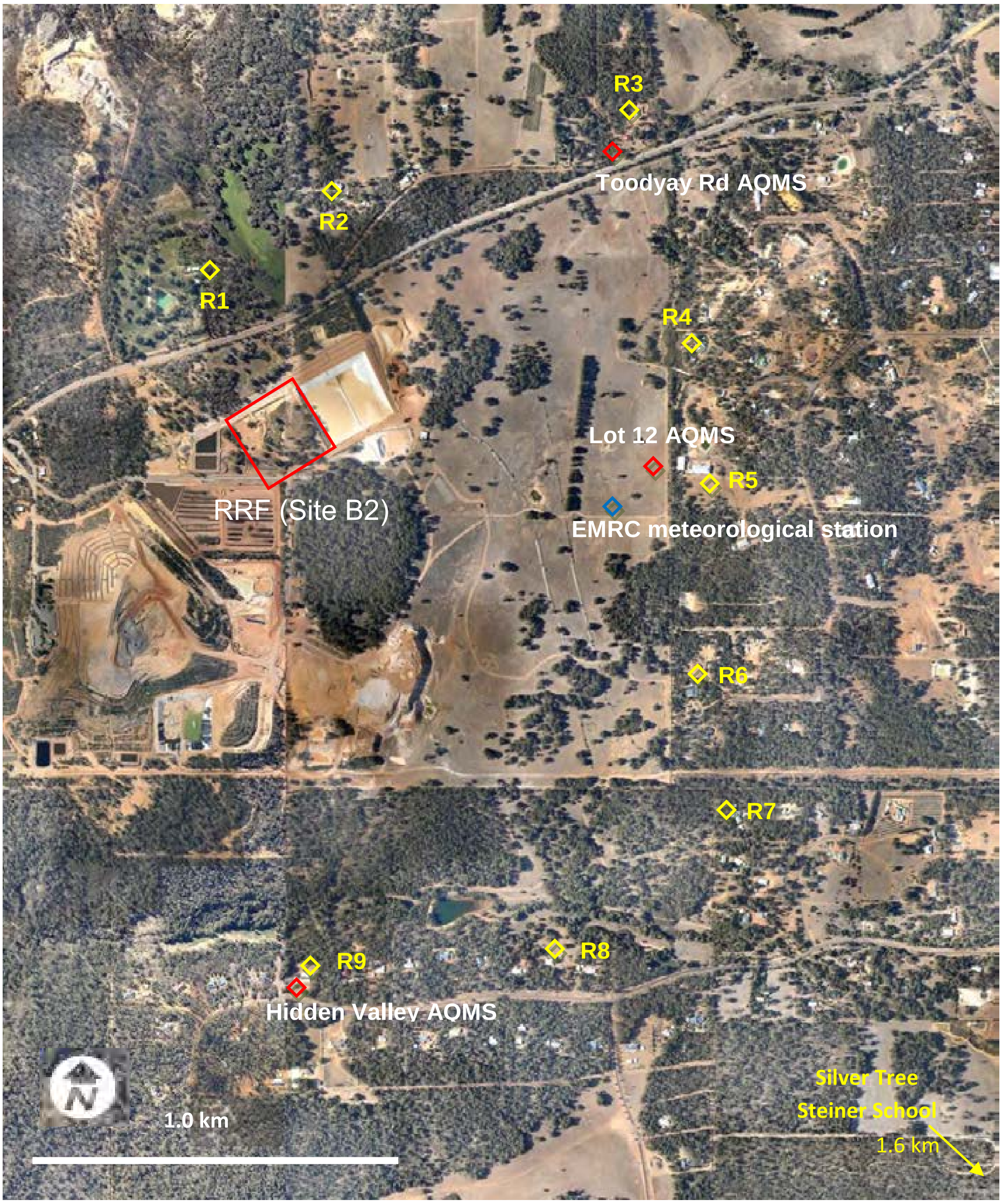

Figure 25 Locations of Receptors for the Dispersion Modelling Assessment

The modelling also provides predictions of GLCs within the Red Hill WMF. These GLCs have been compared with ambient air quality standards and guidelines to assist in the interpretation of the impacts predicted for offsite receptors. Assessment of potential health impacts at onsite receptors should be conducted using occupational health objectives (since the exposures are limited to business hours) and not ambient air standards, which are protective for non-occupational exposures that may occur at all times.

9.5.7 Impact Assessments

Two types of assessments have been made in this study. The first is where predictions of GLCs from the respective technologies have been compared against the appropriate standards and guidelines. The second is where the background ambient air concentrations were added to the predicted GLCs from the proposed RRF to determine the cumulative impact of the emissions substances from all sources (see **Appendix A Section A2 & A5**).

The assessment criteria and background concentrations of pollutants of interest used for the impact assessment are presented in **Table 9-4**. The background concentrations of all of these substances are below the associated criteria, with the most significant substances (relative to the criteria) being dioxins (48% of 24 hour criterion for maximum middle bound total TEQ concentration) and PM_{10} (40% of 24 hour criterion for the 95th percentile PM_{10} concentrations).

Table 9-4 Assessment Criteria and Background Concentrations for Impact Assessment

Pollutant	Assessment Criteria Averaging Period	Assessment Criteria (µg/m^3)	WA Relevant Guideline	Background Measurement Averaging Period	Background Concentration for Impact Assessment (µg/m^3)	Percentage of Assessment Criteria (%)	Data Used to Derive Background
CO	15 min	100000	WHO guidelines for air quality (WHO 2000)	15 min	480	0.5	95th percentile from Toodyay Rd AQMS
CO	30 min	60000	WHO guidelines for air quality (WHO 2000)	30 min	460	1	95th percentile from Toodyay Rd AQMS
CO	1 hour	30000	WHO guidelines for air quality (WHO 2000)	1 hour	460	2	95th percentile from Toodyay Rd AQMS
CO	8 hour	11249	AAQ NEPM (NEPC 2003)	8 hour	380	3	95th percentile from Toodyay Rd AQMS
NO_2	1 hour	246	AAQ NEPM (NEPC 2003)	1 hour	30	12	95th percentile from Toodyay Rd AQMS
NO_2	Annual	61.6	AAQ NEPM (NEPC 2003)	-	2	4	
TSP	24 hour	90	Kwinana Environmental Protection Policy 1992 (TSP Area C)	24 hour	32	36	Maximum detected
PM_{10}	24 hour	50	AAQ NEPM (NEPC 2003), WHO AQ guidelines global update (WHO 2005)	24 hour	20	40	95th percentile
$PM_{2.5}$	24 hour	25	AAQ NEPM (NEPC 2003), WHO AQ guidelines global update (WHO 2005)	24 hour	6	26	95th percentile from Toodyay Rd AQMS
$PM_{2.5}$	Annual	8	AAQ NEPM (NEPC 2003)	-	1	16	
SO_2	10 min	500	WHO guidelines for air quality (WHO 2000), WHO AQ guidelines global update (WHO 2005)	10 min	18	4	95th percentile from Red Hill AQMS
SO_2	1 hour	571.8	AAQ NEPM (NEPC 2003)	1 hour	18	3	
SO_2	24 h	228.7	AAQ NEPM (NEPC 2003)	24 hour	19	8	
SO_2	Annual	57.2	AAQ NEPM (NEPC 2003)	-	1	3	
Benzene	1 hour	29	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	14 day	0.7	2	Maximum from campaign data
Formaldehyde	1h	20	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	7 day	4.3	21	Maximum from campaign data
Benzo(a)pyrene	1 hour	0.4	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	24 hour	0.0003	0.1	0.5 of LOR for campaign data
Benzo(a)pyrene	Annual	0.0003	SEP (Ambient Air) Draft Policy (WA EPA 2009)		0.00002	7	
Dioxins (TEQ)	1 hour	0.000001	Air guideline values for selected substances (Toxikos 2010)	24 hour	0.00000048	48	Maximum middle bound from campaign data
Arsenic	1 hour	0.09	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	24 hour	0.01	14	0.5 of LOR for campaign data
Arsenic	Annual	0.003	Air guideline values for selected substances (Toxikos 2010)		0.001	33	
Cadmium	1 hour	0.018	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	24 hour	0.006	35	0.5 of LOR for campaign data
Cadmium	Annual	0.005	WHO guidelines for air quality (WHO 2000)		0.0005	10	0.5 of LOR for campaign data
Cobalt	24 hour	0.1	Ontario's Ambient Air Quality Criteria (Ontario MOE 2008)	24 hour	0.01	10	0.5 of LOR for campaign data
Chromium (VI)	Annual	0.0002	Air guideline values for selected substances (Toxikos 2010)	24 hour	0.00007	35	5% of maximum campaign total Cr data
Chromium (III)	1 hour	10	Air guideline values for selected substances (Toxikos 2010)	24 hour	0.02	0.2	Maximum from campaign total Cr data
Copper	24 hour	1	Air guideline values for selected substances (Toxikos 2010)	24 hour	0.008	0.8	Maximum from campaign data
Mercury	1 hour	1.8	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	24 hour	0.001	0.1	0.5 of LOR for campaign data
Mercury	Annual	1	WHO guidelines for air quality (WHO 2000)		0.0001	0.01	
Manganese	1 hour	18	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	24 hour	0.04	0.2	Maximum campaign data
Manganese	Annual	0.15	WHO guidelines for air quality (WHO 2000), Air guideline values for selected substances (Toxikos 2010)		0.003	2	
Nickel	1 hour	0.18	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	24 hour	0.01	7	0.5 LOR campaign data
Nickel	Annual	0.003	Esperance Ni annual guideline (WA DoH 2007)		0.001	33	
Lead	Annual	0.5	AAQ NEPM (NEPC 2003), WHO guidelines for air quality (WHO 2000)	24 hour	0.02	4	Maximum campaign data
Antimony	1 hour	9	Approved methods for the assessment of air pollutants in NSW (DEC NSW 2005)	24 hour	0.01	0.1	0.5 LOR campaign data
Thallium	1 hour	1	TCEQ Effect Screening Levels (TCEQ 2011)	24 hour	0.01	1	0.5 LOR campaign data
Thallium	Annual	0.1	TCEQ Effect Screening Levels (TCEQ 2011)	-	0.001	1	
Vanadium	24 hour	1	WHO guidelines for air quality (WHO 2000)	24 hour	0.008	0.8	Maximum campaign data

9.6 Assessment of Emissions from Proposed Gasification Facility

Modelling of the gasification technology was carried out to assess impacts of emissions from the Subject Site to the north and north east of the current operating areas at the Red Hill WMF. For the purposes of the modelling, the elevation at the Subject Site was assumed to be 298.5mAHD. The actual elevations would depend on final design of site works for the construction of the RRF.

9.6.1 Technology Description

A typical gasification technology is comprised of essentially five processes for conversion of waste into energy (see **Section 4.2.2**). These are:

- fuel (waste) bunker and transport system;
- thermal conversion unit;
  - primary gasification chamber to convert waste to synthesis gas (syngas); and
  - secondary chamber for syngas combustion;
- heat recovery steam generator (HRSG);
- power generation system; and
- flue gas cleaning system.

Due to the circumstances specific to this assessment emissions discharged to atmosphere via a tall stack after treatment in the flue gas cleaning system will be investigated further below.

9.6.2 Facility Layout

The layout of the buildings used to model the thermal treatment option was taken from information provided in the EOI process. The main plant buildings and main stack were considered in the modelling as illustrated in **Figure 26**. It is likely that there would also be some utility buildings in the area. These have not been included since the details are unknown at this time.

Figure 26 Layout of Buildings for Modelling of Gasification Facility and Flue Gas Treatment at the Subject Site

The emissions source characteristics are presented in **Table 9-5**.

Table 9-5 Thermal Processing Facility Emission Source Parameters

Parameter	Value
X coordinates (UTM km)	415.719
Y coordinates (UTM km)	6478.044
Stack height (m)	42
Effective stack diameter (m)	1.6
Exit velocity (m/s)	13.9
Exit temperature (K)	431

9.6.3 Emissions Inventory

Emissions data from an existing 30,000 tpa facility processing various wastes (operating at greater than 80% capacity during measurement) were provided through the EOI process. This data was scaled to estimate emissions from the 200,000 tpa facility (see **Table 9-6**) proposed for the RRF. By taking the maximum measured emission rates after the flue gas cleaning system, this data was scaled to 50,000 tpa for a unit and the use of four units to provide the total 200,000 tpa waste feed rate proposed for the project. The existing facility data was therefore scaled up by using a factor of 1.67 and assuming the following: efficiencies in emissions controls observed for the operating facility are maintained when scaled up to a 50,000 tpa unit.

Table 9-6 Emission Rates used for Evaluation of Gasification Facility

Emission Substance	Emission rate Estimate for 200,000 tpa Gasification (g/s)
Total dust (TSP)	0.045
TOC	0.11
HCl	0.31
HF	0.0032
SO_2	1.8
NO_X	4.2
CO	1.9
Cadmium	3.0×10^{-6}
Thallium	7.4×10^{-7}
Mercury	1.7×10^{-4}
Antimony	6.9×10^{-6}
Arsenic	2.8×10^{-6}
Lead	3.5×10^{-4}
Chromium	9.9×10^{-6}
Cobalt	1.7×10^{-6}
Copper	9.8×10^{-5}
Manganese	2.0×10^{-5}
Nickel	6.7×10^{-6}
Vanadium	3.7×10^{-6}
Dioxins (TEQ)	1.3×10^{-9}
Benzo(a)pyrene	3.7×10^{-7}

The facility would run continuously for the full year and the pollutants would be discharged at the maximum estimated rates for that period.

The emissions data used was provided by a technology vendor for a gasification facility processing waste. This data may include periods when syngas supply is reduced and supplementary fuel is burned in the auxiliary burners. The start-up operations when only the auxiliary burners were in operation to pre-heat the gasification chamber showed that the frequency of shut-downs and associated start-ups is low. If a conservative assumption is made, it equates to 96 hours per year of operation on the auxiliary burners for a typical plant and 48 hours per year for a fully optimised plant. The emissions from the auxiliary burners are equivalent to a gas fired boiler and are insignificant compared with the emissions from the combustion of syngas during the remainder of the year. . This is a conservative approach in that it is unlikely that emissions would be continually discharged at the maximum rates and also that each of the four lines of the plant would need planned shutdowns for maintenance, thereby reducing the average emission rates across the year. Hence modelling of start-up operations was considered unnecessary.

There is no overall design efficiency for the gasification emission control system. However, typical scrubbing and filtration efficiencies for some of the air emissions provided by the gasification technology provider are outlined in **Table 9-7.**

Table 9-7 Gasification Scrubber and Filter Efficiency

Air emission	Gasification scrubber and Filter Efficiency
HCl	99 – 99.9%
HF	99 – 99.9%
SO_2	85 – 95%
Dioxin	99 – 99.9%
Dust	99.9 – 99.99%
Hg	90 – 95%
Heavy metals (excl. Hg)	99.5 – 99.9%

9.6.4 Results from Dispersion Modelling

The results derived from modelling of emissions from a 200,000 tpa gasification facility are presented in **Appendix A Section A4.1** for the direct impact of the facility, and **Table 9-8** which details the cumulative results (the sum of the existing emissions and the emissions from the RRF).

The results show the predicted maximum concentration for the indicated pollutant and time averaging period at discrete offsite receptors and also at any location in the modelling domain. A comparison is included with the respective assessment criteria to indicate the potential health impact. None of the pollutant GLCs derived from direct dispersion of emissions from the gasification facility (i.e., no contribution from background) are predicted to exceed the air quality assessment criteria (refer to **Table A 7** and **Appendix A Section A4.1**). The most significant impact is predicted to be from hourly average NOx emissions (as NO_2), with maximum predicted GLCs at 8.6% of the assessment criteria for the discrete receptors and 16% of the criteria at a non-sensitive location in the modelling domain.

The results from the cumulative assessment also show no exceedances of the assessment criteria for all parameters (**Table 9-8**), indicating that operation of a gasification thermal facility at 200,000 tpa throughput would be highly unlikely to give rise to unacceptable health impacts, even in the presence of existing air pollutants from other sources.

Table 9-8 Impact Assessment of the Maximum Offsite Cumulative Concentrations for the Modelled Gasification Facility

Pollutant	Assessment Criteria (µg/m³)	Average Period	Predicted Maximum Concentration (µg/m³)		Assessment Criteria (%)	
			At Discrete Receptor	Anywhere on Grid	At Discrete Receptor	Anywhere on Grid
Arsenic	0.09	1h	0.013	0.013	14%	14%
	0.003	Annual	0.001	0.001	33%	33%
Benzo(a)pyrene	0.4	1h	0.00027	0.00027	0.07%	0.07%
	0.0003	Annual	0.00002	0.00002	6.7%	6.8%
Benzene (1)	29	1h	0.703	1.022	2.4%	3.5%
Cadmium	0.018	1h	0.006	0.006	35%	35%
	0.005	Annual	0.001	0.001	10%	10%
CO	100000	15 min	492	566	0.5%	0.6%
	60000	30 min	470	535	0.8%	0.9%
	30000	1h	469	525	1.6%	1.8%
	11249	8h	387	393	3.4%	3.5%
Cobalt	0.1	24h	0.010	0.010	10%	10%
Cr^{III} (2)	10	1h	0.018	0.018	0.2%	0.2%
Cr^{VI} (3)	0.0002	Annual	0.0001	0.0001	35%	35%
Copper	1	24h	0.008	0.009	0.8%	0.9%
Dioxins (TEQ)	1.0×10^{-6}	1h	4.9×10^{-7}	4.9×10^{-7}	49%	49%
HCl	100	1h	32	40	32%	41%
HF	100	1h	5.02	5.11	5.0%	5.1%
Mercury	1.8	1h	0.002	0.007	0.1%	0.4%
	1	Annual	0.0001	0.0002	0.01%	0.02%
Manganese	18	1h	0.040	0.041	0.2%	0.2%
	0.15	Annual	0.003	0.003	2.1%	2.1%
Nickel	0.18	1h	0.013	0.013	7.0%	7.1%
	0.003	Annual	0.001	0.001	33%	34%
NO_2 (4)	61.6	Annual	2.7	5.7	4.5%	9.3%
	246.4	1h	51	70	21%	28%
Lead	0.5	Annual	0.020	0.020	4.0%	4.1%
$PM_{2.5}$ (5)	8	Annual	1.3	1.3	16%	16%
	25	24h	6.5	6.7	26%	27%
PM_{10} (6)	50	24h	20	20	40%	41%
Antimony	9	1h	0.01	0.01	0.1%	0.1%
SO_2	500	10 min	27	86	5.6%	17%
	571.8	1h	27	81	4.7%	14%
	57.2	Annual	1.7	2.8	3.0%	5.0%
	228.7	24h	22	28	9.7%	13%
Thallium	1	1h	0.01	0.01	1.3%	1.3%
	0.1	Annual	0.001	0.001	1.0%	1.0%
TSP	90	24h	32	32	35%	35%
Vanadium	1	24h	0.008	0.008	0.8%	0.8%

Notes
[1] Assumed TOC is 100% benzene
[2] Assumed total Cr emissions comprises 90% Cr^{III}
[3] Assumed total Cr emissions comprises 10% Cr^{VI}
[4] Assumed NO_X emissions comprised 100% NO_2
[5] Assumed $PM_{2.5}$ is 100% of TSP emissions
[6] Assumed PM_{10} is 100% of TSP emissions

Considerably higher maximum concentrations were predicted for some substances in the cumulative assessment, which reflect the contributions from the background concentrations in comparison to the small incremental contributions predicted for the proposed facility. Examples where the background contributions dominate the assessment include As, Cd, Cr^{VI}, dioxins, HCl, Ni, $PM_{2.5}$, PM_{10} and TSP. Dioxins provide the most significant cumulative impact, where predicted maximum dioxins GLCs from the cumulative assessment are 49% of the assessment criterion.[4] In contrast, the predicted NO_X (as NO_2) concentrations at non-sensitive receptors increase from 16% of the assessment criteria for direct impacts from the proposed facility to only 28% with inclusion of the background NO_2 concentration, highlighting that NO_X emissions from the proposed gasification facility are predicted to be of greatest significance.

Contour plots of the maximum predicted 1 hour NO_X concentrations for the gasification facility (for the direct and cumulative impacts) are presented in **Figure 27** and **Figure 28**, respectively. These illustrate the extent of dispersion of the emissions in relation to the locations of the discrete receptors. The red triangle indicates the location of the RRF emission source and the orange diamonds indicate locations of the discrete receptors.

[4] This does not imply that existing dioxin concentrations at Red Hill are significant and pose a health risk. The ambient air dioxins concentration used for cumulative assessment is the maximum middle bound total TEQ concentration observed for the various sampling events. This middle bound TEQ concentration includes contributions from congeners that were not detected in the measurement. Studies carried out as part of the National Dioxins Programme using non-standard but more sensitive measurements methodology suggest ambient air dioxins concentrations are lower than determined in this programme. Hence the true dioxins concentrations at the Red Hill area are likely to be lower than the concentration used for the cumulative assessment, consistent with the conservative approach adopted for assessment of air quality impacts from the RRF.

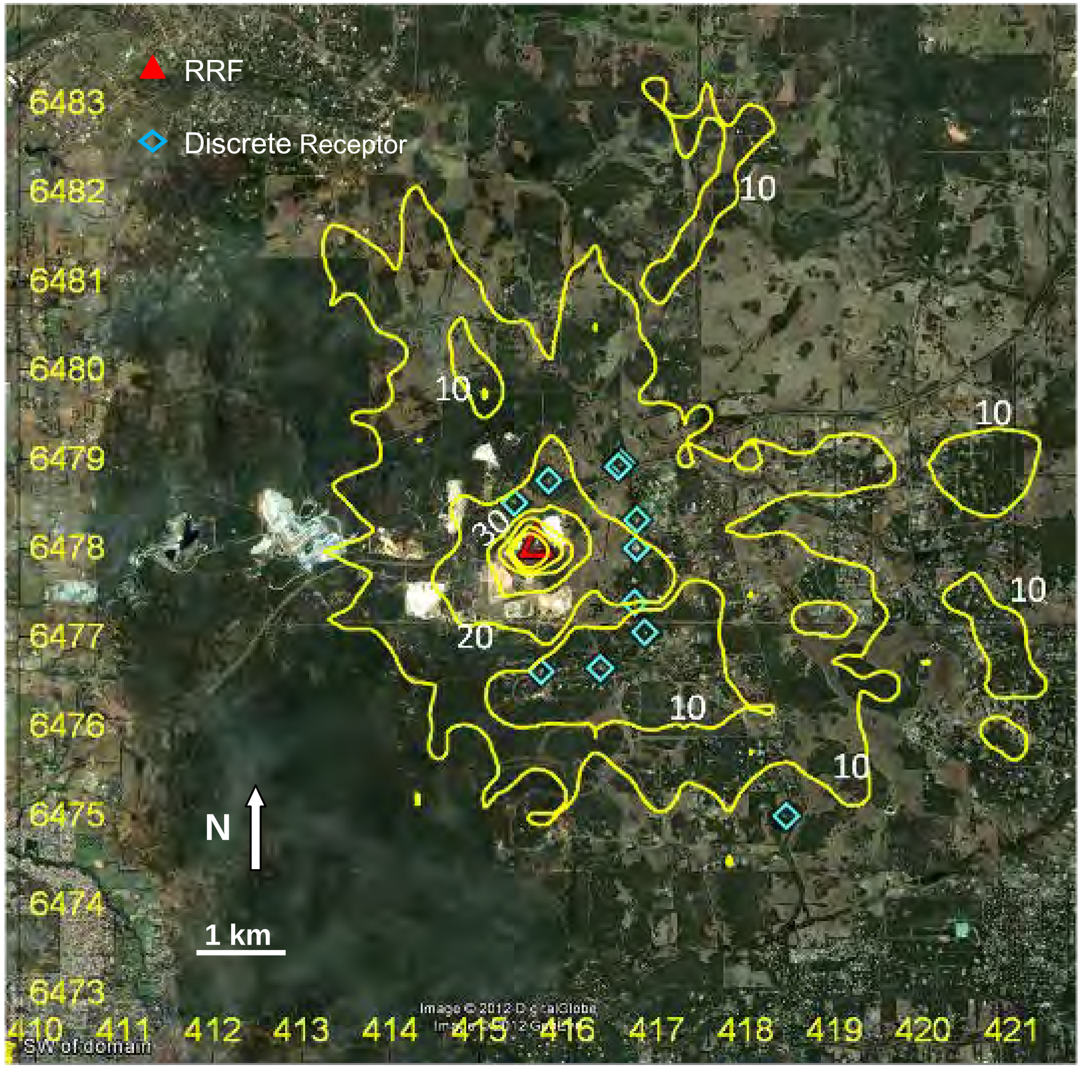

Figure 27 Maximum 1hr NOx Concentrations (μg/m^3) from Gasification Facility (Direct Assessment)

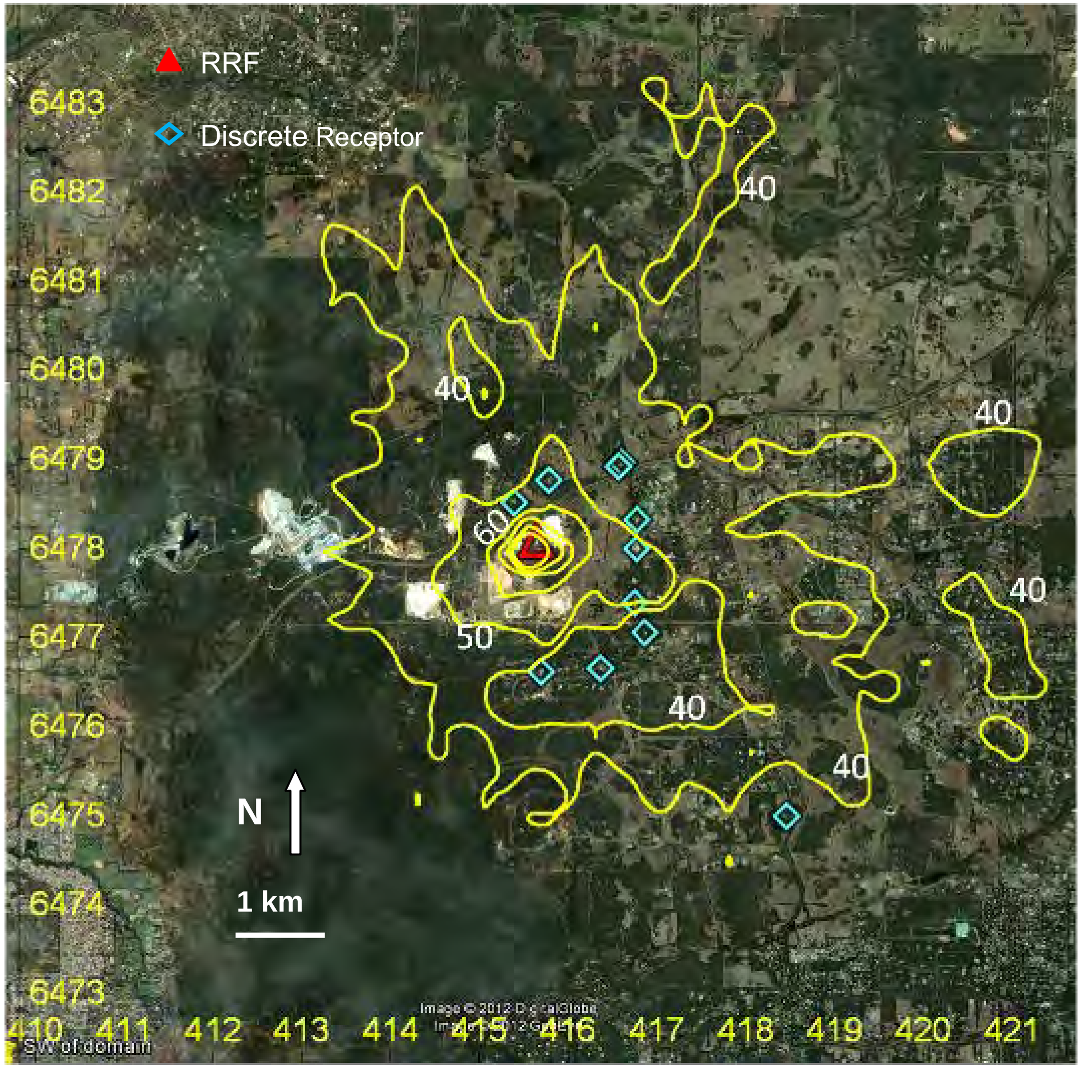

Figure 28 Maximum 1hr NOx Concentrations (µg/m3) from Gasification Facility (Cumulative Assessment) (Assessment criteria concentration 246.2 µg/m^3)

9.6.5 Emissions from start-up and Shutdown

9.6.5.1 Start-Up

The following start-up procedure ensures that emissions during start-up are not significantly different to emissions during normal operation:

1. Heat the thermal conversion unit using auxiliary burners (natural gas fired) to an operating temperature greater than 850°C. This will ensure the baghouse filters are pre-heated to prevent condensation of moisture and possible blinding of the bags.

2. Pre-coat the bags in the bag house with acid gas adsorbent and activated carbon (for metals and dioxins control) by stopping the automatic pulse cleaning, injecting the absorbent and running the flue gas fan for approximately 2 hours. Pre-coating and pre-heating would be completed before syngas is fed to the thermal conversion unit.

During start-up of the thermal conversion unit, operating of the auxiliary burners is fully automatic, controlled by temperature measurements. Emissions from combustion of the first syngas into the thermal conversion unit will report to the pre-conditioned baghouse filters, where particulates, acid gases, metals and dioxins will be captured as in normal plant operation. Hence the levels of emissions are not expected to exceed those obtained during normal operation and modelling of air emissions from start-up conditions was not required.

9.6.5.2 Shutdown

To commence plant shutdown waste feed is stopped entering the gasification chamber and the inlet to the chamber is sealed. The remaining waste is transported through the gasification chamber until all combustible contents are gasified.

Only after all the combustible contents are gasified can the temperature drop below 850 °C, prior to this the auxiliary burners will automatically start operating if the temperature in the thermal conversion unit drops below 850°C. The thermal conversion unit is then allowed to cool to ambient temperature, when the fans and adsorbent dosing are shutdown.

Careful control of the temperatures will ensure that the emissions will decrease as the levels of waste are depleted during shutdown. Hence modelling of air emissions from shutdown conditions was not required.

9.6.5.3 Maintenance Shutdown

The frequency and extent of shutdown periods are site specific, however, typical requirements for the first year is to shut each line down four times (for a week at a time) to monitor the conditions within the system and carry out planned maintenance. It is expected that the number of shutdowns for planned maintenance will be decreased when the operation pattern is established.

The one week shutdown duration allows for thorough cleaning of internal systems but does not include time required for cool down and start-up.

9.6.6 Plant Failure/Operational Failure

9.6.6.1 Plant Failure

Different levels of response are employed depending on the type of failure.

In defined process situations an independent Emergency Shutdown system automatically performs a safe shutdown of the plant in order to secure life, health of the environment and integrity of the facility. This shutdown is immediate, focusing on prevention of a larger problem.

In lower risk situations a controlled shutdown can be instigated by the Process Control System or the operator. This would be equivalent to a normal shutdown (see **Section 9.6.5.2**).

9.6.6.2 Operational Failure

A process alarm will sound when any online emission measurements register above the set alarm level (as determined by the licence conditions). After the problem has been identified it can either be resolved online or the plant will be shutdown to complete remedial actions. If any one of the emissions remains high for a significant period of time then an automatic plant shutdown will be initiated by the Process Control System.

9.6.6.3 Anticipated Downtime

The anticipated availability of the RRF is 7800 hours per year. The anticipated maintenance downtime is four planned shutdowns per line per year, with each one week in duration, or 672 hours (**Section 9.6.5.3**). Assuming that the contingency is equal to unplanned, then the allowance for unplanned shutdown/contingency will be 288 hours. The modelling conservatively assumed that the gasification facility would run continuously for 365 days (8760 hours) per year at maximum estimated rates, which provides a conservative position in the assessment.

9.6.6.4 Emissions Control System Failure

There will be a scrubbing system on each gasification furnace line of 50,000 tpa, i.e., there will be four independent flue gas filtration systems for a 200,000 tpa RRF each comprising an acid gas adsorbent and activated carbon dosing system, a baghouse filtration system, flue gas fan, flue gas analyser and flue gas stack. There is very little likelihood that the entire emissions control system will fail resulting in uncontrolled emissions that exceed emission limits. A controlled shutdown of the process can be implemented in the event of failure of adsorbent dosing system, with the adsorbents already coating the bags providing sufficient capacity to capture acid gases, metals and dioxins that will decrease as the shutdown progresses. For the baghouse, it is normal for a small number (say 1-5%) of filter bags out of a total in excess of 500 bags in the baghouse to fail (rupture) over an operational period, causing an increase in the emissions of particulate matter and associated adsorbed compounds commensurate with the loss of effective surface area for the ruptured bags. The pressure drop across the baghouse and the emissions are monitored closely and if they remain at acceptable levels then the plant will continue to operate until the next planned shutdown.

If the bag house performance declines and the dust levels in emissions increases, then the affected line would be shut down, the bag filter inspected and faulty bags replaced. Current bag filter technology is robust and reliable and the likelihood of serious failures is very low. Also, the CEMS operation will alert operations well before emissions limits are exceeded and remedial action implemented in a timely manner. That may require that the plant be shut down in a controlled manner by using the PSD (process shut down) function in the control system rather than the Emergency Shutdown (ESD) function.

Dispersion modelling of emissions failure conditions was not carried out since the likelihood of exceedances of emission limits is very low due to the controls and remedial actions available to plant operators.

9.7 Assessment of Emissions from Proposed AD Facility

Modelling of the AD technology was carried out to assess impacts of emissions at the same receptors considered in the modelling of the gasification technology. Two AD technologies have been assessed that represent commercially available technologies considered appropriate for the RRF. The differences in these technologies are primarily with the handling of waste in the digestion phase of the process, with AD Option 1 operating continuously and AD Option 2 on a batch basis. Both technologies generate biogas.

- AD Option 1 uses a biogas burner to generate heat to operate the process and to dry the residual solid digestate. Any excess biogas produced can be used to generate electricity for internal use and export to the grid. It also has a flare to burn surplus biogas when the gas engines are off-line or for routine safety procedures.

- AD Option 2 produces biogas within the process which can be used to generate electricity for internal use and export to the grid. Waste gas, produced primarily from purging of digesters during changeover, will be disposed of via the flare.

The modelling predicted that neither technology option would produce exceedances of the ambient air assessment criteria at discrete receptors or any other location in the modelling domain for the various emissions parameters, for both the direct impact and when background concentrations of the parameters are considered.

The following sections provide a summary of the findings relative to both of the AD technology options. Details of the assessment of both of the AD technology options are shown in **Appendix A Section A4**.

9.7.1 Technology Description

A typical AD process is comprised of the following key processes:

- waste preparation;
- anaerobic digestion of the waste;
- recovery of biogas;
- biogas cleaning and combustion in spark ignition engines;
- generation of electricity;
- residual organics separation and percolate recycling;
- composting and refining of residual organics; and
- odour management.

This assessment considers the impacts of air emissions discharged from the exhausts of the engines, the flare and biogas burner (for the biodryer).

9.7.2 Facility Layout

The layouts of the buildings used to model the AD processes were taken from the facility description provided for the EOI processes. The emissions sources and the main plant buildings and structures modelled for both AD options are illustrated at the Subject Site in **Figure A 1** and **Figure A 2 Appendix A**. It is likely that there would also be some utility buildings located in the area but the details are unknown at this time and these have not been included in the modelling. Those buildings are expected to be relatively small compared with the main plant building and as a consequence would have a negligible impact on the modelling outcomes.

The characteristics of the emissions sources associated with AD were used for input into the CALPUFF model (see **Appendix A4**).

9.7.3 Emissions Data

Both AD processes (operating at 150,000 tpa) were modelled using emissions information provided by the technology suppliers and operating facilities. The majority of emissions of the AD Option 1 were referenced to the limits provided by the UK EA for landfill gas operations (UK EA 2010) while other information was provided by the technology supplier based on experience with operating existing AD Plants. AD Option 2 was modelled using emission rate data from the biogas engines at an operating facility in Germany which was reported to process between 10,000-12,000 tpa of waste using the technology. The data were scaled to estimate emissions from a 150,000 tpa facility for the RRF with biogas being directed to two biogas engines. The emission rates for the enclosed flare were derived from the UK guidance and the SO_2 emission limit was calculated from a biogas H_2S concentration of 14 ppm reported by the supplier, assuming all sulphur was emitted as SO_2.

A relatively small number of substances were reported by the technology supplier (compared with the gasification technology), which indicates that these are the more significant emission parameters from AD technology and as a consequence, are the focus of regulatory requirements from the UK EA. The emissions information and the sources of the information are listed in **Table 9-9** and **Table 9-10**.

Table 9-9 Emissions Data for the AD Option 1 Facility

Emissions source	Emission substance	Emission limit (mg/Nm³ 5% @O_2)[1]	Emission Rate (g/s)	Reference for data[2]
Gas engines	CO	1400	2.4	UK EA
	NMVOC [3]	75	0.1	UK EA
	Formaldehyde	Not provided	0.12	Bekon
	SO_2	31	0.05	Expected operational steady state
	NO_X	500	0.9	UK EA
Biogas burner	CO	1400	0.2	HMfUR
	NMVOC	75	0.09	Technology Supplier
	SO_2	31	0.06	Technology Supplier
	NO_X	500	0.35	Technology Supplier
Flare[4]	CO	50	0.08	UK EA
	NMVOC	5	0.008	UK EA
	SO_2	469	0.7	Calculated by supplier
	NO_X	150	0.2	UK EA

Notes:

[1] Conditions as per UK EA 2010

[2] Data supplied with annotation by the technology supplier

[3] The EA guidance provide an emissions limit for NMVOC and VOC where VOC includes unburnt methane, the NMVOC limit was omitted in the most recent guidance (UK EA 2010). For the purposes of the AQ assessment the limit was taken from the previous version of the guidance published in 2004.

[4] Emission limit conditions mg/Nm³ 3% @O_2 as per UK EA 2002.

Details of the composition of the NMVOC emissions were not provided, so these were assumed to be 100% benzene to provide a conservative approach for the impact assessment.

Table 9-10 Emissions Data for the AD Option 2 Facility

Emissions source	Emissions Parameter	Emission Rate (g/s)	Source of Data
Gas engines	CO	1.13	Measured data, scaled up for 150,000 tpa facility
	NMVOC	0.1	AMEC
	Formaldehyde	0.12	Measured data, scaled up for 150,000 tpa facility
	SO_2	0.09	Measured data, scaled up for 150,000 tpa facility
	NO_X	1.72	Measured data, scaled up for 150,000 tpa facility
Flare	CO	0.08	UK EA, scaled for 150,000 tpa facility
	NMVOC	0.008	UK EA, scaled for 150,000 tpa facility
	SO_2	0.013	Calculated from existing facility biogas H_2S concentration, scaled for 150,000 tpa facility
	NO_X	0.2	UK EA, scaled for 150,000 tpa facility

Formaldehyde emissions were not provided for AD Option 1, presumably because it is not a specified determinant under the UK legislation. However, formaldehyde is expected to be present in the gas engine exhaust emissions from this technology option, hence the emission rate from AD Option 2 gas engines has been used for the modelling of AD Option 1 technology. Similarly, NMVOC data was not provided for Option 2 gas engines, so the data from Option 1 was used for modelling of AD Option 2 technology (factored for 2 gas engines in Option 2).

As discussed for the assessment of the gasification technology, a conservative assumption was made that NO_X emissions are comprised of 100% NO_2.

9.7.4 Dispersion Modelling Results for the AD Facility

A conservative assumption was made for the modelling in that the two gas engines would operate continuously for the entire year. This is an unlikely scenario as the technology supplier has advised that the gas engines will run for 98% of the time. However, this approach ensures that the emissions impacts during the worst case dispersion conditions in the modelled year will be captured in the modelling. For AD Option 2 it was also assumed that the two digester changeovers would occur concurrently each day of the year over a 3 hour period from 11 am to 2 pm (to coincide with the middle of the working day), which determines the rate of biogas feed to the flare.

The flare, the gas burner and the gas engines were modelled independently (following advice from the technology supplier that each of these sources can only operate at maximum rates when the other sources are not operating). The simulation option was run across the entire year to provide a conservative assessment of the potential impact of the flare and the biogas burners, which the technology supplier advised would operate for approximately 5% of the year. In this case the worst case dispersion conditions were captured, which ensured that the short term impacts were not underestimated but does result in a large overestimation of the annual concentrations.

The results of the modelling are presented in **Appendix** A**, Table A 9** and **Table A 11** for direct impact of the emission sources and in **Table 9-11** and **Table 9-12** for the cumulative assessment. The contour plot for NO_x GLCs for the cumulative assessment of the gas engine emissions from AD Option 1 is presented in **Figure 29** and the contour plot for NO_x GLCs from AD Option 2 for the cumulative assessment is presented in Figure **30**.

A more realistic approach to the modelling, where the emission rates for each source were apportioned based on estimates of biogas consumption rates for each hour in the modelling year would have been appropriate in the event that this highly conservative approach had predicted exceedances of the GLC assessment criteria. This was not the case, in that the model results show no exceedances of the ambient air assessment criteria are predicted at discrete receptors or any other location in the modelling domain for the various emissions parameters for both the direct impact and when background concentrations of the parameters are considered. This suggests that that operation of this type of AD facility at 150,000 tpa throughput would be highly unlikely to give rise to unacceptable health impacts, even in the presence of existing air pollutants from other sources.

Table 9-11 Maximum Predicted GLCs from Modelling of AD Option 1 Emissions (Cumulative Impacts)

Pollutant	Standard concentration (µg/m³)	Averaging period	Predicted maximum (µg/m³)						% of standard					
			At discrete receptor			Anywhere on grid			At discrete receptor			Anywhere on grid		
			Gas engines	Biogas burner	Flare	Gas engines	Biogas burner	Flare	Gas engines	Biogas burner	Flare	Gas engines	Biogas burner	Flare
CO	100000	15 min	838	615	609	1060	638	609	0.8	0.6	0.6	1.1	0.6	0.6
	60000	30 min	729	535	530	923	556	531	1.2	0.9	0.8	1.5	0.9	0.9
	30000	1h	635	466	462	803	484	462	2.1	1.5	1.5	2.7	1.6	1.5
	11249	8h	477	383	381	623	384	381	4.2	3.4	3.4	5.5	3.4	3.4
NMVOC (as benzene)	29	1h	10	3.7	0.8	19	12.5	0.8	34	12	2.8	65	43	2.9
Formaldehyde	100	30 min	9.1	N/A	N/A	14	N/A	N/A	9.1	N/A	N/A	14	N/A	N/A
	20	1h	8.5	N/A	N/A	12	N/A	N/A	42	N/A	N/A	60	N/A	N/A
NO_2	61.6	Annual	4.4	2.7	2.5	14	4.4	3.2	7.1	4.4	4.1	22	7.1	5.1
	246.4	1h	92	42	35	153	77	36	37	17	14	61	31	14
SO_2	500	10 min	24	22	35	28	29	39	4.7	4.3	7.1	5.5	5.8	7.7
	571.8	1h	22	20	33	26	26	36	3.8	3.5	5.7	4.5	4.6	6.2
	57.2	Annual	1.6	1.5	1.8	2.1	1.8	3.8	2.7	2.6	3.0	3.7	3.1	6.6
	228.7	24h	20	20	23	22	20	23	8.5	8.5	10	9.4	8.7	10

N/A = not assessed. Formaldehyde is not a significant emission for this source

Table 9-12: Maximum Predicted GLCs from Modelling of AD Option 2 Emissions (Cumulative Impacts)

Pollutant	Standard Concentration (µg/m^3)	Averaging Period	Predicted maximum (µg/m^3)				% of Standard			
			At Discrete Receptor		Anywhere on Grid		At Discrete Receptor		Anywhere on Grid	
			Gas Engines	Flare	Gas Engines	Flare	Gas Engines	Flare	Gas Engines	Flare
CO	100000	15 min	701	607	761	613	0.7	0.6	0.7	0.6
	60000	30 min	611	529	662	534	1.0	0.8	1.1	0.9
	30000	1h	532	460	576	464	1.7	1.5	1.9	1.5
	11249	8h	410	380	449	381	3.6	3.3	4.0	3.3
NMVOC (as benzene)	29	1h	9.1	0.73	15	1.2	33	2.5	50	4.0
Formaldehyde	100	30 min	14	N/A	19	N/A	13	N/A	19	N/A
	20	1h	12	N/A	16	N/A	59	N/A	83	N/A
NO_2	61.6	Annual	5.3	2.4	10	2.5	8.5	3.9	16	4.1
	246.4	1h	139	31	207	42	56	12	84	17
SO_2	500	10 min	26	19	30	20	5.2	3.9	6.0	4.0
	571.8	1h	24	18	27	18	4.2	3.1	4.8	3.2
	57.2	Annual	1.6	1.4	1.8	1.5	2.8	2.5	3.3	2.5
	228.7	24h	20	19	21	19	8.9	8.3	9.5	8.3

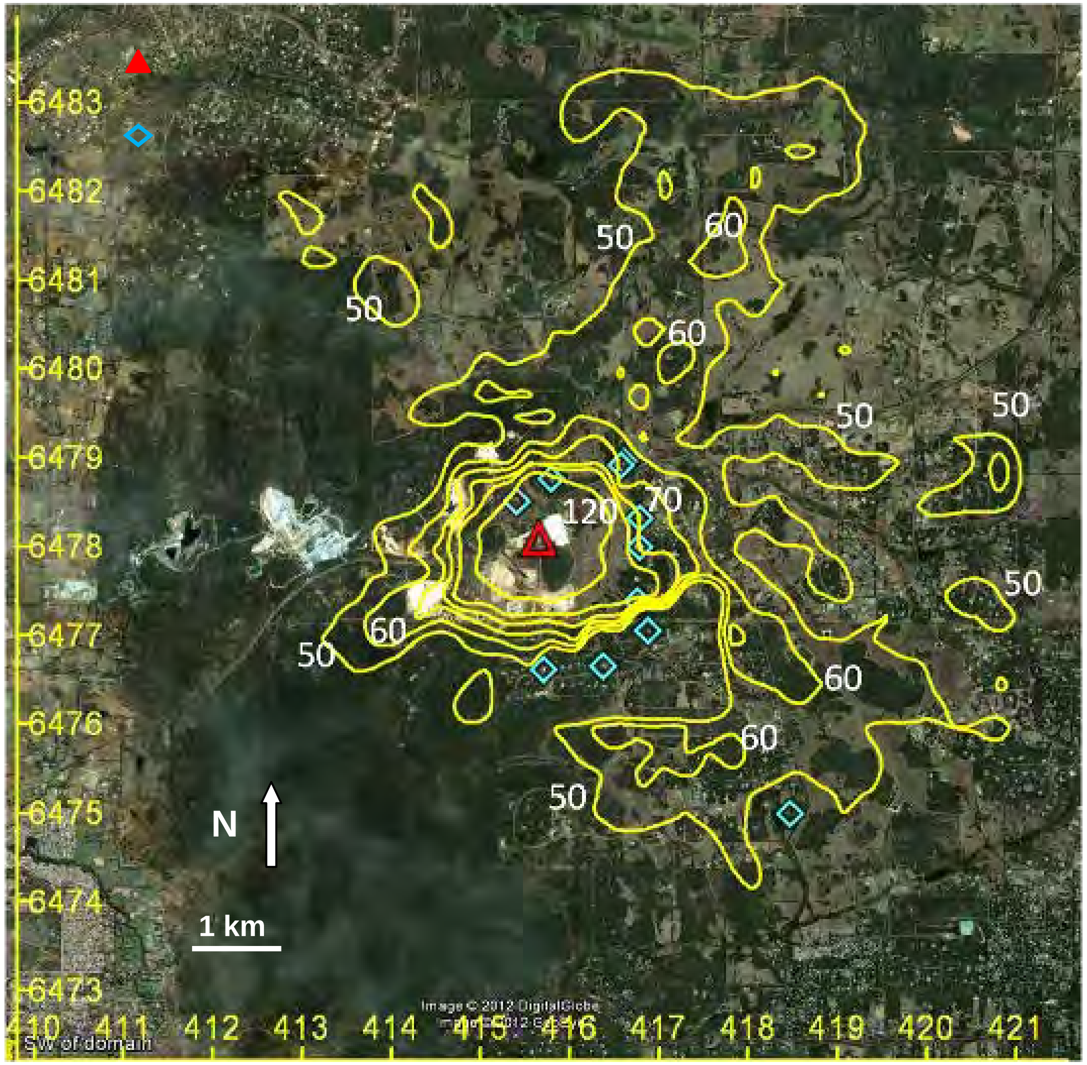

Figure 29 Maximum 1hr NO_X Concentration Contours ($\mu g/m^3$) for AD Option 1 Gas Engines Emissions (Cumulative Assessment)

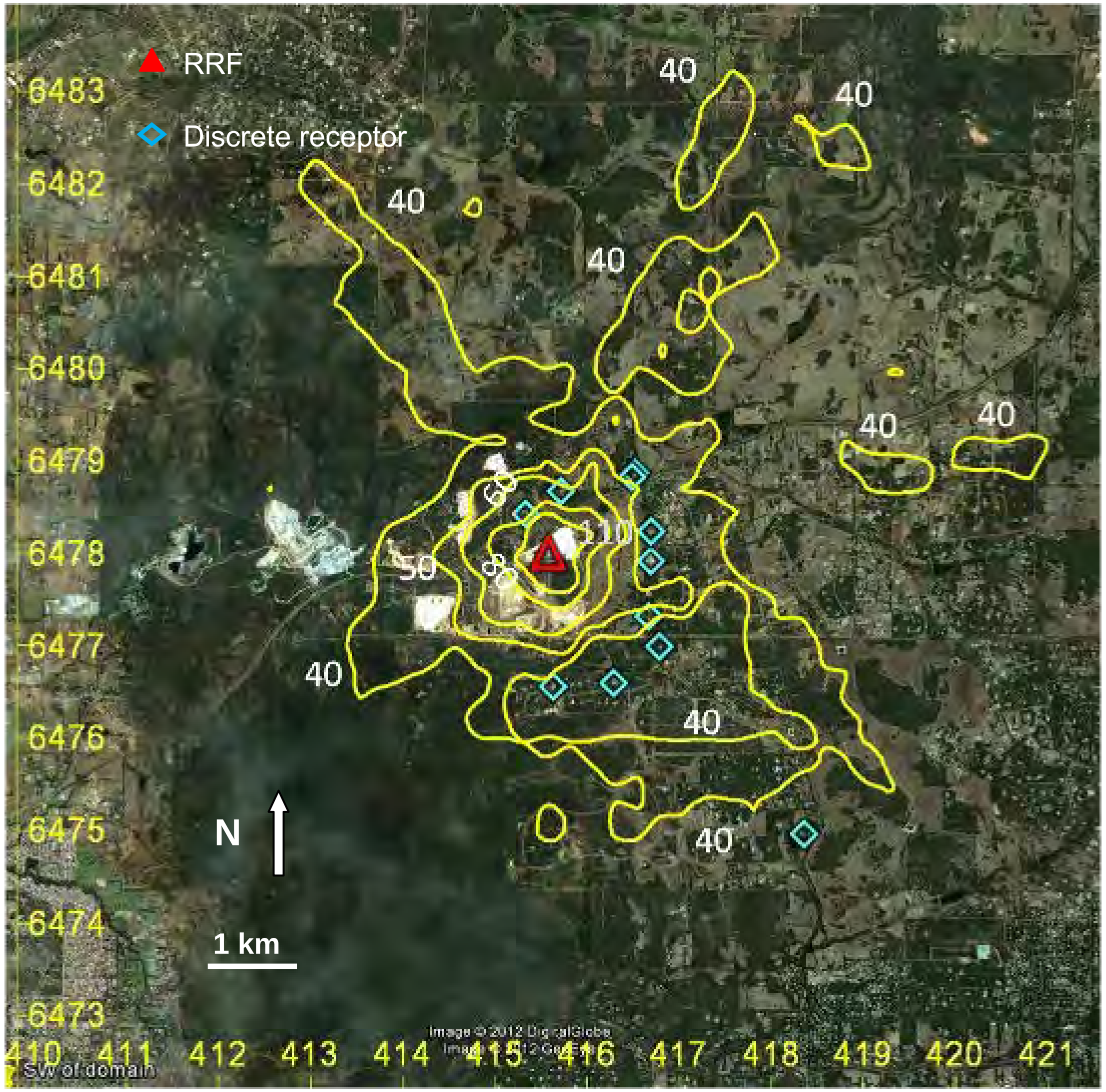

Figure 30 Maximum 1hr NO_X Concentration Contours (µg/m^3) of AD Option 2 for Emissions from Engines (Cumulative Assessment) (Assessment criteria concentration 246.2 µg/m^3)

9.7.5 Start-up and Shutdown

Bi-annual major service shutdowns of three days (i.e. 6 days per year) on the generators are required during which time there will be reduced power production (assuming there is more than 1 generator). During this time approximately half the biogas will be flared. A single unplanned shutdown of three days in which all of the biogas is flared has also been allowed for. For periods when the flare is unavailable or the electricity generator sets are off line feeding the digesters would be halted reducing the production of biogas as detailed in **Section 9.7.6.1**.

The emissions impacts of these shutdown scenarios have not been modelled since they are captured in the modelling carried for normal operation, in that the flare is assumed to operate continuously for the whole year of modelling.

9.7.6 Plant Failure/Operational Failure

9.7.6.1 Plant Failure

Should the gas engines or generators fail, then all biogas produced would be diverted to the flare for combustion. Biogas production will reduce because waste feed to the digesters would be halted immediately. After two to three days of shutdown biogas production will have dropped to approximately 25% of design, continuing to reduce if the failure had not been rectified.

The flare will be maintained in a constant state of readiness to operate with a pilot light fuelled by LPG burning at all times to combust the biogas when it is diverted to the flare in a scheduled or unscheduled circumstance. Monitoring and testing of the pilot light and back-up systems will ensure that it remains available at all times. If monitoring of the pilot light shows that it has extinguished, action will be taken for it to be reignited.

During start-up and shutdown or plant failure modes of operation, biogas gas is directed to the flare as part of the safe operation of the plant. In these circumstances, when combustion can no longer be sustained, the flare is extinguished and exhaust gases are directed through the exhaust chimney.

The emissions impacts of these scenarios have not been modelled since they are captured in the modelling carried for normal operation of the flare.

9.7.6.2 Operational Failure

If the digesters suffer a biological kill from over-temperature or a pH surge then the AD system will be shut down, digestate tanks emptied and the contents disposed of to a waste water treatment facility.

9.8 Plume Rise Assessment

Plume rise assessments were carried out to provide information in the event that the proposed RRF is deemed to be a controlled activity by Western Australia Airports Corporation and a formal assessment of the impact of the proposed RRF on Perth airport flight paths is therefore required.[5]

[5] If a WAC assessment finds that a further study is deemed necessary, then that study would have to be conducted in accordance with *CASA guidelines (Advisory Circular AC 139-05(0))* which requires assessment of 5 years of meteorology using TAPM.

The assessment showed that the initial emission vertical velocity of 13.9 m/s for the main stack of the thermal processing facility rapidly declines to the required 4.3 m/s by a height of 349 m (50 m above ground level).

The flare from the AD option 1 facility had the highest emission vertical velocity of 9.1 m/s at 1 m above the top of that emissions source but that velocity rapidly declines to below 4.3 m/s by the height of 312 m (14 m above ground level). The velocities from the other emissions sources were even lower than the flare emissions at the same height.

The gas engine exhaust emissions for the AD option 2 facility had a lower initial velocity (13 m/s) compared to the flare (15 m/s initial velocity). The emission velocity for the gas engine declined to below 4.3 m/s at 312 m (14 m above ground level) whereas the velocity for the flare declined to below 4.3 m/s at 310 m (16 m above ground level).

9.9 Summary of Modelling Outcomes

Key outcomes from the modelling of emissions from gasification and two AD technologies are as follows:

- no exceedances of ambient air quality standards and guidelines are predicted at nearby sensitive receptors for all emissions parameters associated with the respective technologies. This includes the direct impact of emissions or from a cumulative assessment whereby background concentrations of pollutants are considered in the assessment along with predicted GLCs from the RRF;
- the modelling was conducted using a conservative approach, in that:
  - estimates of emissions rates were based on maximum rates observed from operating gasification facilities or UK guideline concentrations for AD facilities;
  - background emissions concentrations were based on either the maximum or 95th percentile concentrations obtained from the background monitoring programme;
  - emissions sources were assumed to operate 100% of the time; and
  - Maximum predicted GLCs were compared with assessment criteria (ambient air quality standards and guidelines) to determine the potential for health impacts.
- hence, it is considered unlikely that adverse community health impacts would arise from the operation of an RRF using either gasification or AD technologies.

9.10 Environmental Management

9.10.1 Point Source Emissions

To mitigate and manage the risk of point source air emissions, the EMRC will:

- comply with best practice measures as outlined in the EPA Guidance Statements 3, 12 and 18;
- select a contractor and associated technology that has a proven, satisfactory track record in a number of other facilities;
- ensure the technology design will produce air emissions that meet licence conditions;
- employ cleaning, filtering and scrubbing devices to treat outputs from flue gases and odour control systems;
- design and build appropriately engineered enclosed buildings to house odorous materials and processes and maintain negative air pressures in those buildings to control odour emissions;
- undertake regular monitoring of air emissions for the life of the project and make this information publicly available; and
- prepare and implement an Air Quality Management Plan (AQMP) detailing all management measures. The AQMP will include but not be limited to:

- continuous emissions monitoring of NOx stack emissions from the gasification option[6];
- development of standard operating procedures that deliver low emission outcomes;
- regular maintenance of all equipment to ensure compliance with license conditions;
- a Contingency Plan to be implemented during upset or maintenance conditions;
- staff training to ensure awareness of air quality related standard operating procedures;
- procedure to be followed should complaints be received; and
- regular review of management plan.

NOx impacts are predicted to be well below Air Quality (AQ) standards. NOx emission instrumentation will be compliant with the requirements of the WA DEC CEMS code (DEC, 2006).

In addition, emissions testing for other parameters will be carried out as per the environmental license. A detailed emissions management and monitoring plan will be developed as part of a Works Approval, since the exact form of that plan will be dependent on the design of the facility.

Further details regarding point source emissions can be found in **Appendix A Section A5.1**.

9.10.1.1 Fugitive Emissions

To mitigate and manage the risk of fugitive air emissions, the EMRC will

- select a contractor and associated technology that has a proven satisfactory track record in a number of other facilities and meets the applicable regulatory standards in these applications;
- prepare and implement an AQMP detailing all management measures (**Section 9.10.1**); and
- undertake regular equipment monitoring and testing for contaminated air leaks and repair equipment/buildings immediately if leaks are detected.

Further details regarding fugitive emissions can be found in **Section 4.2.1.2, Section 4.2.2.2** and **Appendix A Section A5.2**.

9.10.2 Summary

Given the current air quality at Red Hill WMF (**Section 9.4.4**), the results of the air emissions modelling (**Section 9.6.4** and **Section 9.7.4)** and the management measures outlined in **Section 9.10.1**, the EPA objective is satisfied.

9.11 Environmental Impact Assessment - Greenhouse Gases

The level of greenhouse gas (GHG) in the atmosphere is increasing due to anthropogenic causes. CO_2 has increased by about 31% and methane (CH_4) by 151% over the past 200 years. CO_2 is the main gas produced as a result of human activity (WA EPA 2002). Therefore, the impact of GHG emissions from gasification and AD technologies is an important factor to be considered when selecting a preferred technology.

The six GHG's covered by the Kyoto Protocol are CO_2, CH_4, perfluorocarbons (CF_x), hydrofluorocarbons (HFCs) sulphur hexafluoride (SF_6) and nitrous oxide (N_2O). GHG's which are not specifically covered by the Kyoto Protocol include water vapour (H_2O), chlorofluorocarbons (CFCs), O_3, NO_x, CO, NMVOC and SO_2 (WA EPA 2002).

[6] NOx is predicted to provide the greatest potential for direct environmental impacts for the gasification plant option

As GHGs will be generated from the proposed technologies, the EMRC engaged qualified consultants to model the predicted levels of GHG emissions which will be reduced by introducing either an AD or gasification RRF to process the waste rather than disposing of it to landfill.

The EPA objective for GHGs, the environmental impacts and the management measures are provided below.

9.11.1 EPA Objective

To reduce greenhouse gas emissions to a level which is as low as is practicable for the chosen technology.

9.11.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 12 – Minimising Greenhouse Gas Emissions.
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process
- Western Australian Planning Commission Statement of Planning Policy No. 2 Environment and Natural Resources Policy.

9.11.3 Environmental Impact

Modelling was undertaken by Cardno utilising Hyder CPRS model from Office of Climate Change) in order to assess the impact of GHG emissions for each technology option. Each scenario was evaluated to calculate equivalent tonnes per annum CO_2 produced.

AD technologies emit GHG through the production and burning of biogas (CO_2 emissions and a small amount of CH_4) and burning of Liquefied Propane Gas (LPG) for process heat. The flue gases produced from gasification contain CO_2, NO_x, H_2O and SO_2. Petrol, diesel and LPG powered vehicles required for the operation of the RRF will also produce small quantities of GHGs.

The estimates consider the GHG emissions from each facility, the power generation offsets (for the RRF that produces energy as a product) and the energy saving from using recycled materials rather than virgin materials (i.e. the impact of recycling materials via a MRF or via separation at the RRF).

Power generation offsets relate to the savings in GHG emissions which would have been produced from a conventional power station in generating the power produced by the chosen technologies. The GHG emissions from the scenarios using energy producing technologies should thus be offset by the GHG emissions produced by a conventional power station producing the same power output. The emissions offset will thus depend on the degree of power generated in the technology options.

The offsets will also depend on the type of conventional power station assumed, as coal-fired, gas-fired and oil-fired power stations all produce different levels of emissions. Advice from Synergy is that 70% of electricity in the South-western Australia is derived from coal-fired power stations and 30% is from the gas-fired stations. This ratio has been used to evaluate the level of GHG emission offsets.

The savings in GHG emissions associated with the energy savings of recycling material is linked to net savings in energy consumption when comparing the energy used in the production of packaging (e.g. glass and plastic bottles, aluminium and steel cans) from raw materials compared to recycled materials (Cardno BSD, 2003). This energy saving corresponds to a saving in GHG emissions, thus the GHG emissions of all of the technology option scenarios are offset to varying degrees depending on the amount of recyclables recovered.

Table 9-13 shows the breakdown of the estimates for each component of the GHG emissions for the two technology scenarios (Cardno BSD, 2003).

Table 9-13 GHG Emission Estimates for the Proposed Technology Options Table from a 200,000 tpa WtE facility and a 150,000 tpa AD facility

Technology	Gross emissions CO_2 eq tonnes / annum	Direct emissions (from biogenic material) CO_2 eq tonnes / annum	Emissions Reduction after considering renewable energy offsets CO_2 eq tonnes / annum	Net Emissions CO_2 eq tonnes / annum
Landfill (40% Gas)	113,975	8,021	10,112	95,842
Anaerobic Digestion	22,979	21,087	19,939	-18,047
Gasification	100,000	70,000	78,120	-48,120

Both RRF technologies under consideration will, if implemented, have a net reduction in CO_2 or CO_2 equivalent emissions in comparison to landfill. This is due to the offsetting of fossil fuel powered electricity and preventing the generation of landfill gas (CH_4) through landfill diversion.

9.11.4 Environmental Management

To manage the level of GHG emissions, the EMRC will:

- undertake regular GHG accounting in accordance with the National Carbon Accounting System and make this information publicly available.

9.11.5 Summary

Given the results of GHG emissions modelling (see **Section 9.11.3**) and the management measures outlined in **Section 9.11.4**, the EPA objective (**Section 9.11.1**) is considered to be satisfied.

9.12 Environmental Impact Assessment - Dust Emissions

Dust can arise from a variety of natural and artificial sources. Depending on the particle size it may cause acute and chronic health effects, nuisance or visibility impacts, with the chemical composition depending on the nature of the source material (DEC, 2011). Dust will be generated as a result of the construction and operation of the RRF, therefore a number of management measures have been developed to ensure the potential impacts are minimised. The human health impacts associated with dust are detailed further in **Section 13.3.3.1**.

The EPA objective regarding dust, the applicable standards, the potential environmental impacts and management measures are outlined below.

9.12.1 EPA Objective

To maintain the environmental values, health, welfare and amenity of nearby land uses, and the wider Perth airshed by meeting the statutory requirements for dust emissions.

9.12.2 Applicable Standards and Guidelines

- National Environmental Protection Measure for Ambient Air Quality (NPEC, 1998).
- EPA Guidance Statement No.18 – Prevention of Air Quality Impacts from Land Development Sites.
- EPA Guidance Statement No. 3 – Separation Distances between Industrial and Sensitive Land Uses.
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
- Western Australian Planning Commission Statement of Planning Policy No. 2 Environment and Natural Resources Policy.
- City of Swan Local Planning Strategy.

9.12.3 Environmental Impact

The impact of dust is influenced by the size of the particle, the chemical composition and dust concentration. Total suspended particulates (TSP) are particles with an aerodynamic diameter less than 50µm and are generally associated with adverse aesthetic effects rather than health effects (DEC 2011). TSP however, can become trapped in the upper respiratory tract (just behind the nose and mouth) when inhaled. These inhalable particles or nuisance dust can settle on surfaces, causing soiling and discolouration and may also cause irritation of the mucosal membranes (eyes, nose and throat). If contaminated they may pose an increased health risk through ingestion (DEC 2011).

Human health effects of dust tend to be related to PM_{10} or less as these particles remain suspended in the air for longer periods and can penetrate into the lungs (DEC 2011). Details regarding dust particles 10µm or less are discussed in **Section 13.3.4** which confirms that the Subject Site conforms to NEPM standards.

During the construction phase of the RRF, dust levels may increase as a result of clearing and site levelling, earthmoving activities, truck movements, unloading and wind action on cleared areas. Dust emitted from these activities may potentially cause:

- human and fauna health problems from direct exposure (e.g. respiratory issues, skin or eye irritations, and dust allergies);
- deterioration of the health of surface water ecosystems, due to dust settling on the surface water, causing:
  - decrease in water quality;
  - sedimentation and eutrophication; and
  - loss of aquatic plants and animals.
- reduction in the condition of terrestrial vegetation due to:
  - shading of leaves reducing photosynthesis;
  - plant performance; and
  - encouraging the growth of epiphylls on leaves.
- amenity and nuisance issues associated with dust deposits on neighbouring properties and passing vehicles.

It anticipated that any dust generated during the construction phase of the project will be minimal and managed by the measures outlined in **Section 9.12.4** below. A detailed analysis of the PM_{10} and $PM_{2.5}$ data from the four months of monitoring conducted at Lot 12 on the EMRC site and the residence at Toodyay Road suggests that the current dust management practices effectively control particulate emissions from the landfill operations (Synergetics 2011). Very low levels of dust are expected from the stack in the case of gasification or from the biogas combustion in the case of AD. Modelling of the emissions from both technology options (**Sections 9.6** and **9.6.5**) has shown that particulate emissions directly from the processes are predicted to be within acceptable standards.

Areas associated with, but outside the RRF, such as access roads to the facility will be sealed. Therefore, it is unlikely that the NEPM standards for particulates will be exceeded as a consequence of the RRF and throughout the life of the project, considering the outcomes described in **Sections 9.6** and **9.6.5**.

9.12.4 Environmental Management

To minimise to production of dust generation from the construction and operation of the RRF, the EMRC will:

- seal roads for high traffic areas onsite (where possible) to avoid dust creation;
- continue to use dust management practices on Red Hill WMF particularly during the construction period;
- ensure all trucks utilise appropriate measures to cover/seal loads when entering and exiting the facility;
- prepare and implement a Dust Management Plan (DMP) aligned with EPA Guidance Statement No.18 which will include but not be limited to:
  - monitoring of dust generation activities onsite;
  - regular maintenance of all equipment to ensure compliance with standards is maintained;
  - staff training to ensure awareness of dust related standard operating procedures;
  - a Contingency Plan to be implemented during maintenance conditions;
  - procedure to be followed should complaints be received; and
  - regular review of management plan.
- comply with all relevant standards and guidelines during the construction and operation of the RRF.

9.12.5 Summary

By adopting the management measures outlined in **Section 9.12.4** and taking into account that both the AD and gasification technologies utilise closed systems, therefore little to no dust will be produced as a result of the operation and the EPA objective outlined in **Section 9.12.1** will be satisfied.

10 Environmental Impact - Noise

10.1.1 EPA Objective

To maintain the environmental values, health, welfare and amenity of nearby land uses by meeting the statutory requirements of noise emissions.

10.1.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 8 – Environmental Noise (Draft);
- EPA Guidance Statement No. 3 – Separation Distances between Industrial and Sensitive Land Uses;
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process;
- State Planning Policy No. 2 - Environment and Natural Resources Policy;
- State Planning Policy No. 4.1 - State Industrial Buffer Policy; and
- City of Swan Local Planning Strategy
- Austroads Guide to Traffic Management Part 3 – Traffic Studies and Analysis

10.1.3 Existing Environment

The EMRC commissioned Lloyd George Acoustics Pty Ltd (LGA) to conduct a baseline noise emission study of the current operations at the Red Hill WMF. The study measured the noise levels of equipment on site and used computer modelling to predict these levels to the nearest residences of the Red Hill WMF (Lloyd George, May 2011).

Onsite measurements were carried out on 25 November 2010 between 10.30am and 12.30pm. The measurements were undertaken in compliance with the *Environmental Protection (Noise) Regulations 1997* (the Regulations). Noise levels were measured by certified hand-held sound level meter within reasonable proximity (1 m to 20 m) to the noise sources so that ground and meteorological affects would have minimal influence and the noise source being quantified was dominant above other background noises.

Computer modelling using *SoundPLAN 7.0* was used to support the hand-held measurements. Further details on the model input data is provided within **Appendix B Section B2.1**.

10.1.3.1 Noise Assessment Criteria

Environmental noise in WA is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 7 defines the prescribed standard for noise emissions as:

"7. (1) Noise emitted from any premises or public place when received at other premises

(a) Must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) Must be free of:

i. Tonality;

ii. Impulsiveness; and

iii. Modulation".

A "…noise emission is taken to significantly contribute to a level of noise if the noise emission exceeds a value which is 5 dB below the assigned level..."

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

(a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) The noise emission complies with the standard after the adjustments of **Table 10-1** are made to the noise emission as measured at the point of reception.

Table 10-1 Adjustments for Intrusive Characteristics

Tonality	Modulation	Impulsiveness
+ 5 dB	+ 5 dB	+10 dB

Note: The above are cumulative to a maximum of 15dB.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown in **Table 10-2**.

Table 10-2 Baseline Assigned Noise Levels

Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise Sensitive	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor

Figure 31 shows the layout of the Red Hill WMF, the location of the Subject Site and the location of the nearest residences.

At residence R01, the influencing factor has been calculated as 2 dB, due to the adjoining land used as a quarry. For the remaining residences, the influencing factor has been assumed to be 0 and therefore the baseline assigned noise levels of **Table 10-2** are applicable. It could be argued that some residences have an influencing factor, since land within 450 m is owned by EMRC. However, as this nearest land is currently not used for landfill, the influencing factor has not been applied.

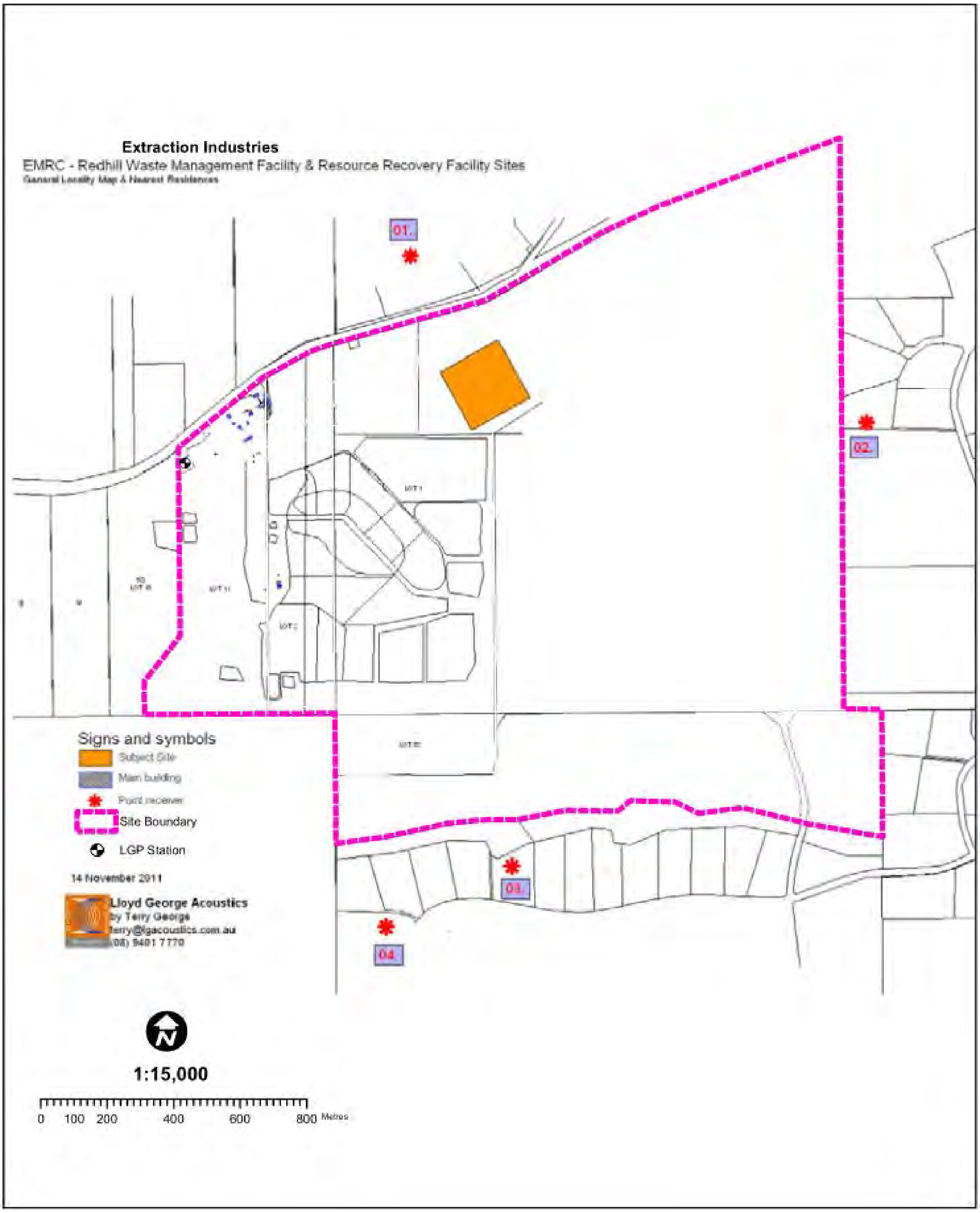

Figure 31 Red Hill WMF - Nearest Residences

The RRF plant is assumed to operate 24 hours a day and be relatively constant in operation so the L_{A10} night time assigned noise level will determine compliance or otherwise. These assigned noise levels are:

- R01 is 37 dB L_{A10} during the night;
- R02 to R04 is 35 dB L_{A10} during the night.

As the Landfill Gas and Power plant also operates during the night, the design goal is for the RRF to be 5 dB less than the assigned noise levels. This allows for the RRF to then not be considered a significantly contributing noise source. Even if the Landfill Gas and Power Station did not exist, a level 5 dB less than the assigned noise level would still be the goal to allow for potential tonality from the RRF plant.

10.1.3.2 Existing Noise Emissions

The modelling results of the predicted existing baseline noise levels at the nearest residences were assessed against the assigned noise levels of the Regulations. Modelling results are summarised in **Table 10-3.** The assessment results from the noise level measurements conducted in November 2010 indicated that there was up to a 9 dB exceedance during the night and a 1 dB exceedance during the day at the nearest residences of the Red Hill WMF.

Table 10-3 Assessment of Predicted Baseline Noise Levels

Location	Predicted Noise Level, dB		Tonality Adjustment, dB		Assigned Level, dB		Exceedance, dB	
	Night-time	Daytime	Night-time	Daytime	Night-time	Daytime	Night-time	Daytime
R01	41	48	+5		37	47	9	1
R02	30	38	+5	+5	35	45	-	-
R03	22	40	+5	+5	35	45	-	-
R04	36	39	+5	+5	35	45	6	-

The exceedance during the day is not considered to warrant any mandatory actions as the exceedance of 1dB only occurs under worst-case weather conditions and traffic noise is the dominant source during the day at the nearest residential location. However, it is recommended that noise control options to the bulldozers/waste compacters onsite be investigated for newer and quieter models or for noise control kits (e.g. exhaust silencer) to be fitted to existing machines to reduce the noise emission level.

During the night, the predicted exceedances are more significant based on the modelling results, which have been attributed to the noise from the operations at the nearby Landfill Gas and Power (LGP) Power Station, which is located in the north west corner of the EMRC Red Hill site on leased land. This is consistent with the conclusions of the previous noise monitoring at the site. This matter has been referred to LGP as the occupier and operator of the power station and action is underway to address the issue.

The EMRC has constructed a new Class III landfill cell immediately to the east of the Subject Site. It is anticipated that the current Class III landfill cell will be closed and filling of the new cell commenced in early 2013. The impact of this move will not affect the night time noise levels as the landfill cell is only operated during the day. Day time noise levels will be assessed once this new cell is operational.

As noted above, the operation of the RRF is designed to achieve night-time compliance. Noise associated with the landfill cells has no impact on the night time noise levels.

10.1.4 Environmental Impact

The amenity of residents living in close proximity to the RRF may be impacted if audible noise levels exceed regulatory guidelines during construction and operation of the facility. Incoming and outgoing traffic to the site, noise from electricity generators and machinery onsite (including reversing beepers etc.) may also cause intrusive noise. Employees may be exposed to excessive noise during operational hours.

Reversing warnings which are not beepers (e.g. clackers) have been trialled and shown to be ineffective at providing warnings of dangers to employees at Red Hill WMF. Investigations into alternatives are continuing.

Population growth in the region is expected to result in gradual increases in the amount of waste collected from the kerbside, and therefore increases in collection truck traffic to / from Red Hill WMF can be expected over the life of the project. Development of an RRF is not expected to increase the number of kerbside collection trucks above the number that would enter Red Hill WMF without the RRF, as the waste would be otherwise be disposed to landfill on the site. However, as RRF technologies will be producing marketable products there will be an increase in the number of trucks entering and leaving Red Hill WMF. This is likely to be limited for EfW technologies and involve the transport of recovered recyclables. The number of truck movements would be greater with an AD technology which generates relatively large volumes of compost. This will, however, result in only a minor increase in the traffic volumes on Toodyay Road (Refer **Section 13.3.10**).

The development of the Perth - Adelaide Highway, and the Hills Spine Road, will significantly change traffic flows, and increase traffic through Red Hill and Gidgegannup. It is not known when these roads will be constructed by Main Roads; however it is not expected to be within the next 10 years. Access from Red Hill WMF will need to be reassessed during the design of the Perth – Adelaide Highway. Therefore, this development should not impact on the assessment of this proposal.

In summary, the potential vehicle traffic impacts from establishment and operation of the RRF are:

- A minor increase in traffic along Toodyay Road; and
- A corresponding minor increase in traffic related noise.

People's reaction to noise is often a stress response in which the person may either ignore or tolerate or may lead to feelings of anger or defeat, especially if the noise is perceived to be out of the hearer's control (WA EPA 2007).

Prolonged exposure to excessive noise levels may lead to human health issues, for example hearing loss, increased stress levels and hypertension, aggression, sleep disturbances and depression. Faunal behaviours, including migration, breeding, feeding and general communication, may also be disrupted by excessive noise levels. The impacts associated with human health are discussed further in **Section 13.3.5**.

The limited studies on the impacts of noise on terrestrial animals indicate that animal populations appear to either habituate to or avoid man-made noise. It should be noted that there may be less-obvious impacts that research has not revealed to date (WA EPA 2007).

LGA were commissioned by the EMRC to use the computer model developed from the baseline noise emission study (refer to **Section 10.1.3**) to determine the predicted noise levels resulting from the operation of the RRF. The assessment of predicted noise levels included all aspects of the plant operation including power generation. Details of the noise assessment are specified in the noise impact report (Lloyd George, September 2011).

The following are summaries of the outcomes of the assessments undertaken applicable to each of the technology options.

10.1.4.1 Anaerobic Digestion Technology

Table 10-4 provides the predicted noise levels associated with a typical (worse-case) AD plant with a capacity of 150,000 tpa, with the plant located at the Subject Site. Also considered is the orientation of the RRF on the site. A noise contour plot for this option, with the digester tanks located to the south west of the facility, is shown in **Figure 32** (Lloyd George, September 2011).

Table 10-4 Predicted Noise Levels for Anaerobic Digestion Technology

Site Orientation	Receiver Location		
	Toodyay Road (R01)	Persoonia Cl (R02)	Hidden Valley (R03 & R04)
Digester Tanks Northeast	38	27	16
Digester Tanks Northwest	41	22	18
Digester Tanks Southwest	33	26	18
Digester Tanks Southeast	32	30	17

The noise assessment has found that there will be marginal exceedances during the night relative to the assigned noise levels of the Regulations at R01, making allowance of +5 dB for tonality. However the worst case AD option was modelled (e.g. housing the AD Plant within a corrugated metal clad shed with no attempt at managing noise). With appropriate design, the AD facility would achieve compliance with the assigned noise levels at all times at the subject site.

10.1.4.2 Gasification Technology

Table 10-5 provides the results of the noise modelling associated with the gasification plant to the surrounding residences, for the preferred Site B2.

Table 10-5 Predicted Noise Levels for Gasification Technology

Site Location	Receiver Location		
	Toodyay Road (01)	Persoonia Cl (02)	Hidden Valley (03 & 04)
B2	30	26	14

A L_{A10} noise contour plot for the gasification technology is shown in **Figure 33** (Lloyd George, September, 2011). These results demonstrate that a gasification facility would achieve compliance with the assigned noise levels at all times at the subject site.

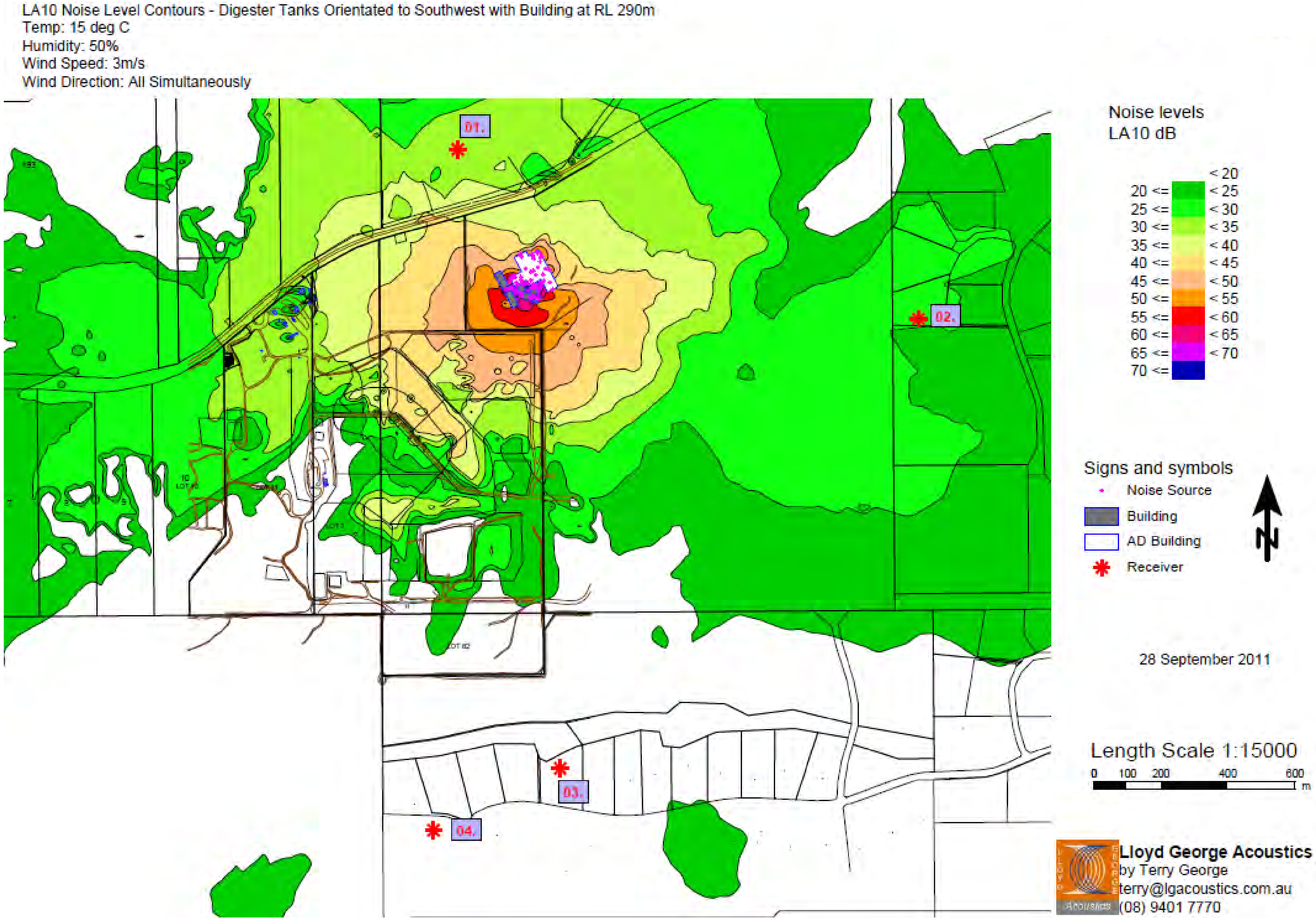

Figure 32 L_{A10} Noise Level Contours - Anaerobic Digestion

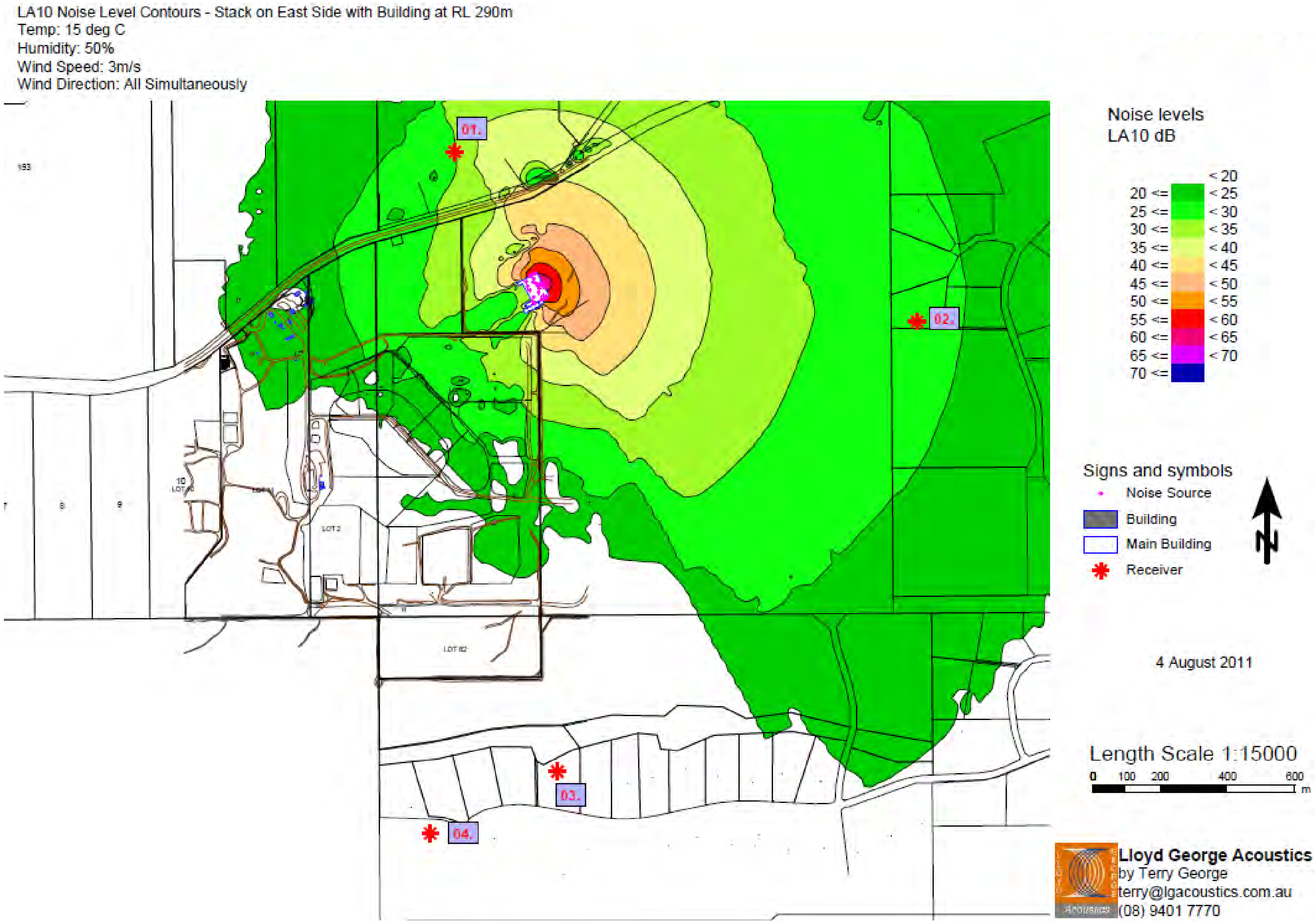

Figure 33 L_{A10} Noise Level Contours - Gasification

10.1.5 Environmental Management

It will be a condition of contract that the Contractor must ensure that the facility complies with the *Environmental Protection (Noise) Regulations 1997* at all times. During wet commissioning, noise measurements will be undertaken and any required rectification works will be completed prior to commencement of full operation.

The Contractor will be required to prepare and implement a Noise Management Plan (NMP) detailing all management measures during construction and operation. This will include but not be limited to:

- compliance with all noise related conditions to work;
- regular maintenance of all equipment to ensure compliance with standards is maintained;
- staff training to ensure awareness of noise related standard operating procedures;
- a Contingency Plan to be implemented during upset or maintenance conditions;
- procedure to be followed should complaints be received;
- continue to monitor traffic entering and leaving the site; and
- regular review of the management plan.

10.1.6 Summary

The assessment of the impacts of noise from the RRF has found that the current baseline noise levels exceed the assigned night noise levels for R01 and R04, predominantly due to the noise emanating from the LGP Power Station. The issue has been referred to LPG for attention and action is underway to address the issue.

The modelling of the RRF using the two technology options being considered by the EMRC has found that with appropriate design and resolution of the above issues relating to current operations the facility would achieve compliance with the assigned noise levels at the nearby residences if it were located at the Subject Site. Once a technology and provider are selected, it is expected that detailed design works would incorporate a comprehensive review of equipment noise levels to ensure compliance with the Regulations. As such, the EPA objective as detailed in **Section 10.1.1** has been considered as attainable.

11 Environmental Assessment – Odour

11.1 EPA Objective

To maintain the amenity of nearby land uses by meeting the statutory requirements for odour emissions.

11.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 3 – Separation Distances between Industrial and Sensitive Land Uses.
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
- Department of Environmental Protection Odour Methodology Guideline.
- Western Australian Planning Commission Statement of Planning Policy No. 2 Environment and Natural Resources Policy.
- City of Swan Local Planning Strategy.

11.3 Existing Environment

The EMRC commissioned SLR Consulting Australia Pty Ltd (SLR Consulting) to undertake a baseline odour monitoring of a range of odour sources at the existing Red Hill WMF. The monitoring results were used within a dispersion modelling exercise to determine offsite impacts from current operations and several proposed locations of the RRF.

An odour monitoring campaign was performed at the Red Hill WMF in January 2011 by SLR (SLR Consulting 2011a, 2011b).

The WA Department of Environmental Protection '*Odour Methodology Guideline'* (March 2002) states in Section 4.1 that "*Determination of odour emission rates for point and non-point sources should be undertaken with reference to the Dutch or CEN Standards, or the equivalent Australian Standard.* For non-point sources, *Australian/New Zealand Standard (AS/NZS) (4323.4:2009) requires the use of an enclosure device of a design such as the USEPA emission isolation flux chamber.*" Therefore all area source odour samples were taken using an Isolation Flux Hood (IFH) and carried out according to the method described in *AS/NZS (4323.4:2009) "Stationary source emissions Method 4: Area source sampling – Flux chamber technique*" and the US EPA technical report "*EPA/60068-86/008 – Measurement of Gaseous Emission Rates from Land Surfaces using an Emission Isolation Flux Chamber – User's Guide*".

Sampling of point sources (stacks and volumes) was performed using *Australian/New Zealand Standard (AS/NZS) (4323.3:2001) "Determination of Odour Concentration by Dynamic Olfactometry".* The odorous sample is drawn through a Teflon tube, into a single use, odour-free Nalophan sample bag secured inside a drum kept under vacuum using a pump.

All odour samples were tested by Emissions Testing Consultants (ETC) based in Jandakot, Perth. ETC laboratory is NATA accredited for *Australian Standard AS/NZS 4323.3:2001 "Determination of Odour Concentration by Dynamic Olfactometry*". As required, all samples were analysed within 30 hours of sampling.

The odour sources sampled (both solid waste and liquid waste sources) during the campaign include:

- landfill gas engine exhaust;

- inside landfill gas engine house area;
- vents from landfill gas engine house area;
- transfer station;
- landfill leachate inspection liners;
- covered ponds;
- leachate ponds;
- alternative daily cover; and
- greenwaste windrows (both fresh MGB greenwaste and greenwaste mulch).

A layout of the site detailing locations of current operations and the current odour sources is presented in **Figure 34**.

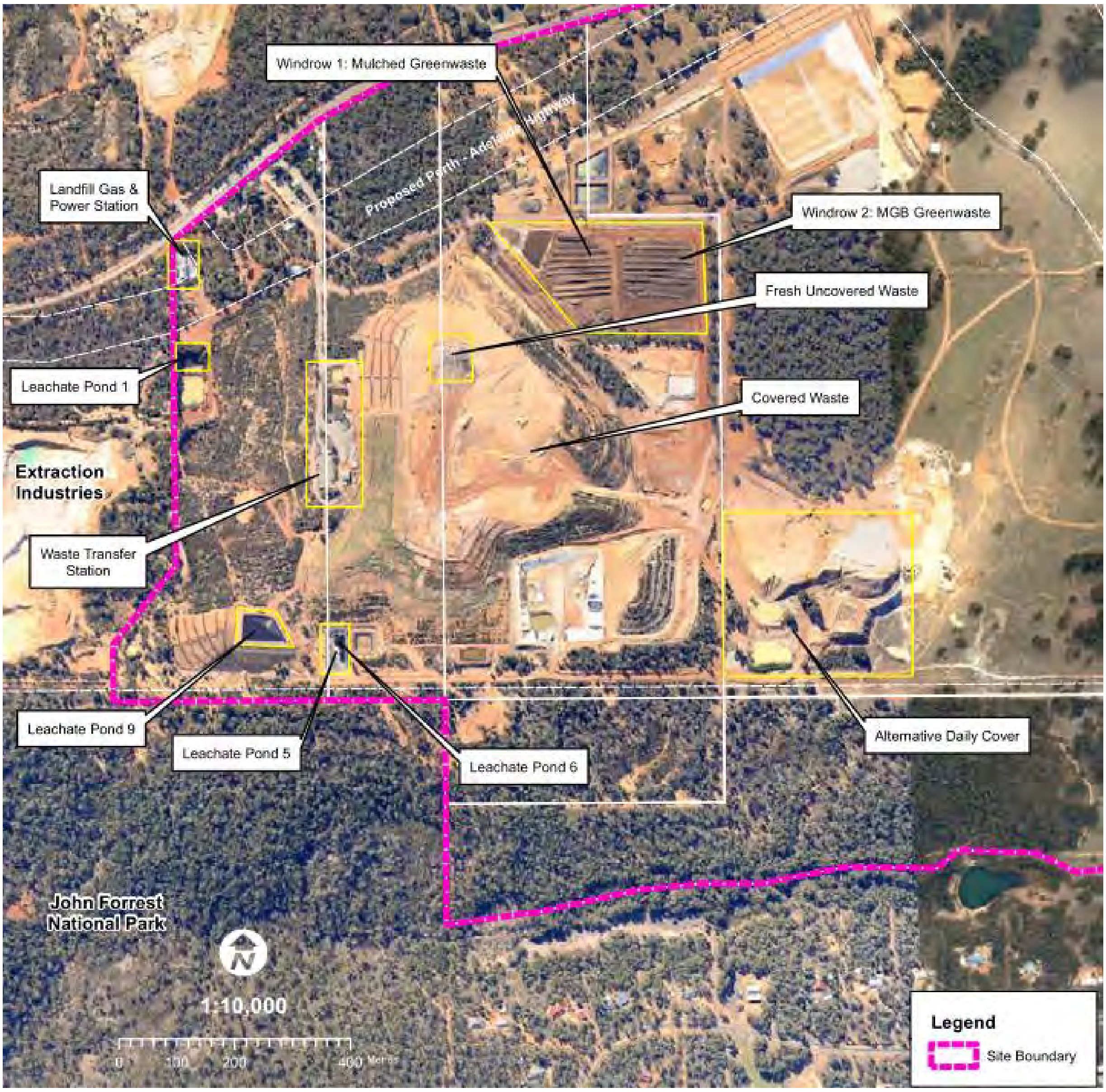

Figure 34 EMRC Red Hill WMF – Current operations and Odour Sources

Based on the site specific monitoring, specific odour emission rates have been calculated for each source. As triplicate samples were taken of each source, the highest value, also taking into account analysis uncertainty has been taken forward for modelling. A summary of the odour emission rates is presented in **Table 11-1**.

Table 11-1 Specific Odour Emission Rates

Source	Odour Emission Rate
Solid Waste Sources	**$OU.m^3/m^2/s$**
Fresh Uncovered Waste	0.97
Covered Waste	0.04
Alternative Daily Cover	0.05
Windrow 1 (fresh MGB greenwaste)	2.65
Windrow 2 (mulched greenwaste)	0.14
Liquid Waste Sources	**$OU.m^3/m^2/s$**
Leachate Pond 9	0.02
Leachate Pond 6	0.02
Leachate Pond 5	0.97
Leachate Pond 1	1.03
Volume Sources	**$OU.m^3/s$**
In Engine Power Station	30
Waste Transfer Station	2989
Point Sources	**$OU.m^3/s$**
Landfill Liner (Concrete Pipe)	0.8
Landfill Gas Engine Roof Vent	213
Landfill Gas Engine Exhaust	9356

11.3.1 Dispersion Modelling Validation

A ground truthing campaign has been carried out by Emission Testing Consultants (ETC) in order to try and relate community odour complaints to site operations. The results so far have been used to validate the dispersion modelling results conducted by SLR Consulting. Modelling results were compared against field observations on and off the Red Hill Waste Management Facility site to identify whether the January 2011 odour monitoring results and the subsequent dispersion modelling exercise has resulted in under predictions of odour emissions.

Ground truthing odour monitoring was carried out by ETC on 19th of March (Day 1), 3rd (Day 2) and 4th (Day 3) of April 2012. The survey locations were selected on survey days to capture the maximum downwind odour impact from the Red Hill Waste Management Facility and were based around the locations of previous complainants, working back towards the landfill operation. The ground truthing surveys were conducted by three surveyors using the survey technique based on the VDI 3940 method (as per Australian/New Zealand (AS/NZ) Standard AS4323.3 – "*Determination of Odour Concentration by Dynamic Olfactometry*". At each observation location, each of three observers noted odour intensity, hedonic tone and character of the odour experienced.

For the purpose of comparing modelling results against the ground truthing monitoring, the survey locations were mapped on the dispersion modelling grid and the nearest gridded receptors were chosen to be reflective to the survey locations. The ground truthing results were presented in the form of odour intensity values and converted to odour concentrations using the Weber-Fechner Law as recommended in *the Odour Methodology Guideline (2002)* issued by Department of Environmental Protection, WA. This conversion was performed to enable the respective observations made during the ground-truthing campaign to be compared against the predicted odour concentrations.

The ground truthing odour observations were compared against the modeled odour concentrations under similar conditions as experienced during the survey days, such as the wind conditions, time of a day and the season. This was performed to determine the variation and understand the significance of odour dispersion according to those varying considerations. In order to assess the statistical relationship between the monitored odour intensities and the corresponding modelled odour concentrations at the survey locations, a covariance analysis was performed. Overall, based upon the limited data set available, it can be concluded that the odour modelling study tends to compare well when compared against the comparable odour intensity observations. However, the following limitations should be considered when interpreting those results and trying to draw a conclusion from the comparison:

- The ‘calculation’ of odour concentration from intensity observations is a simplistic one using a range of standardised factors which are applied to a range of odour sources of significantly different characteristics;
- The calculation of odour concentration from intensity observations is a logarithmic one. Minor changes in the observed values therefore have an increasingly significant change in the calculated odour concentration value;
- The odour observations are compared against the corresponding nearest Cartesian receptor point, which is noted to fall between 42 m and 116 m from the intensity survey observation point. This may introduce positive and negative bias to the subsequent comparison;
- The variability between the monitored odour and that predicted is at the bottom end of the scale. Both values have a precision of 1 OU, and therefore the relative difference between the two values is statistically difficult to estimate.
- The modelled odour concentrations represent mean 1-hour odour concentrations which are not a true reflection of the 1-second human response to the odour. To account for this, a Peak-to-Mean correction factor has been applied, as derived from NSW OEH guidance.

Given the above, the dispersion modelling validation can be regarded as providing sufficient correlation between the odour modelling study and the odour intensity observations. Moreover, the verification exercise provides evidence that the odour observations and predictions are comparable, and therefore it is reasonable to conclude that the measurement of odour emissions though isolation flux chamber techniques provides a reliable source of data compared to that observed.

Detailed description of the methodology, odour observations and results are provided in the SLR Consulting Report (2012a).

11.3.2 Site Odour Emissions

Based on the site specific monitoring data, total odour emissions per second from each odour source have been calculated and are presented in **Table 11-2**. This table shows that the top two odour sources in terms of total odour emission (OU.m3/s) are the landfill gas engines (contribute up to 74%) and fresh MGB greenwaste windrows (contribute up to 16%). It should be noted that this is an assessment of odour emissions only. The physical characteristics of the emission source, and dispersion meteorology will have a large impact on which source contributes most to the offsite odour impacts experienced.

Table 11-2 Calculated Odour Emission by Source

Source	Odour Emission Rate (OU.m^3/s)		
	Maximum	Mean	Minimum
Solid Waste Sources			
Fresh Uncovered Waste	3140	2512	1926
Covered Waste	3682	2586	1907
Alternative Daily Cover	68	47	31
Windrow 1 (fresh MGB greenwaste)	60968	42628	28254
Windrow 2 (mulched greenwaste)	2234	1252	766
Liquid Waste Sources			
Leachate Pond 9	52	52	52
Leachate Pond 6	17	17	17
Leachate Pond 5	2672	1936	1247
Leachate Pond 1	1229	921	668
Volume Sources			
In Engine Power Station			
Waste Transfer Station	2989	912	142
Point Sources			
Landfill Leachate Inspection Liner (Assumed 10)	136	47	7.9
Landfill Gas Engine Roof Vent (Assumed 3)	638	504	441
Landfill Gas Engine Side Vent (Assumed 8)	240	189	145
Landfill Gas Engine Exhaust	37422	36613	25438

The results of the odour monitoring have been used to determine the offsite impacts from the current operations and the proposed RRF technology options.

11.4 Environmental Impact

The data referred to in **Section 11.3** was used for dispersion modelling to assess the odour impacts of the RRF technologies under consideration by the EMRC. A suite of computer modelling programmes (CALMET, CALPUFF and CALPOST) were used for this purpose. Further details of these models have been provided in **Appendix C Section C2.5**.

11.4.1 Odour Modelling

Three dispersion modelling scenarios have been assessed as part of this Project:

Scenario 1: utilises the odour emissions data from the site specific monitoring campaign outlined in **Section 11.3** and assesses the current impact of the Red Hill WMF on the surrounding environment.

Scenario 2a: uses the odour emissions data from Scenario 1 and assesses the impact of an AD facility option as part of the RRF.

Scenario 2b: uses the odour emissions data from Scenario 1 and assesses the impact of a gasification facility option as part of the RRF.

11.4.1.1 Scenario 1 -Existing Red Hill WMF Odour Scenario

Scenario 1 has been constructed to assess the current impact of the Red Hill WMF. Emission rates calculated for the sources identified in **Table 11-1** have been used in dispersion modelling. The areas of each source (refer **Table 11-3**) have been estimated from aerial photography.

Table 11-3 Source Areas used in Dispersion Modelling

Source	Area (m^2)
Leachate Pond 1	1,187
Leachate Pond 5	2,754
Leachate Pond 6	872
Leachate Pond 9	2,663
Windrow 1(fresh MGB greenwaste)	22,988
Windrow 2 (mulched greenwaste)	16,449
Fresh Waste	3,236
Covered Waste	101,652
Total	**151,801**

The emission rate for alternative daily cover (ADC) has been used for all covered waste and alternative daily cover sources due to the uncertainty in the spatial distribution of ADC/covered waste on a day-to-day basis. Given that the emission rate for ADC is higher than the emission rate for covered waste, it is considered that this is a conservative assumption.

The assumed or measured source parameters for sources including the LGP Station (exhaust stacks, roof and side vents), landfill liners and the WTS are presented in **Table 11-4**.

Table 11-4 Source Parameters used in Dispersion Modelling

Parameter	Value
Landfill Gas Engine Exhausts (4)	
Stack Height	10.5 m
Stack Diameter	0.35 m
Exit Velocity	37.4 m/s
Exit Temperature	623 K
Landfill Gas Engine Room Roof Vents (3)	
Stack Height	10.5 m
Stack Diameter	0.81 m
Exit Velocity	9.7 m/s
Exit Temperature	303 K
Landfill Leachate Inspection Liners (10)	
Stack Height	1.5 m
Stack Diameter	1 m
Exit Velocity	0.1 m/s
Exit Temperature	303 K
Landfill Gas Engine Room Side Vents	
Effective Height	5 m
Length of side	27 m
Sigma Y	6.3 m
Sigma Z	3.7 m
Waste Transfer Station	
Effective Height	2 m
Length of side	153 m
Sigma Y	35.5 m
Sigma Z	0.9 m

Information for the LGP Station was collected by measurement. Sources located on the roof of the facility have been represented in the dispersion modelling exercise as point sources. Given the large area of the side vents, and the low exit velocity experienced whilst on site, this source has been represented in the dispersion modelling exercise as a volume source, with side length equal to 27 m, representing the length of the LGP Station.

11.4.1.2 Scenario 2a – AD

Details on the AD option have been sourced from the Acceptable Tenderers. Essentially, the process will involve the delivery of 150,000 tpa, which will be deposited within a building through a roller door located on the north eastern side of the building. The waste will then be sorted into streams, including recyclables, which will then be baled and stored, organics which will be taken to the digesters or fermenters and residual for disposal to landfill.

The process is to be operated within a sealed building, operated under negative pressure to avoid odour egress. All air and odour will be passed through a large biofilter, to be located on the south eastern side of the building.

During site opening hours of between 7 am to 4 pm, Monday to Friday for member Council waste, the potential exists for odour to escape the building when roller doors are opened. It is unknown how often these roller doors will be opened, but the SITA Neerabup Waste Composting Facility operate similar quick acting roller doors (Mindarie Regional Council, pers. comm.) and it is estimated that, per truck, entry and exit results in the doors being open for approximately 60 seconds (30 seconds entry, 30 seconds exit). Each truck carries approximately 8.5 tonnes of waste, and therefore, 17,647 trucks would enter the Red Hill RRF delivering 150,000 tpa. Based on a nine hour operating day five days per week, the total number of trucks visiting per hour would be on average, 7.5. Based on the assumption that each truck visit will result in the roller doors being open for 60 seconds, a total roller door opening time each hour of 7.5 minutes has been calculated.

Odour emissions presented below have been adjusted to account for the roller door opening time by calculating a time weighted average emission rate. This is calculated by multiplying the emission rate by 0.125 (7.5/60).

For the purposes of calculating the odour emission through the roller doors, the following assumptions have been made:

- A total of 150,000 tpa is delivered to the AD facility, equating to approximately 576 tonnes per day;
- The density of waste has been assumed to be 0.85 tonnes/m^3 ;
- The resulting 677 m^3 of waste is divided into four stockpiles:
    - Waste Receival;
    - Feedstock Preparation;
    - Fermenter Unloading; and
    - Finished compost product.
- The stockpiles have been assumed to be 8 m high, and calculated to be 45 m in diameter at 37 degrees repose;
- Digester residue is composted inside the building;
- The calculated surface area of each stockpile is 3,329 $m^{2;}$
- Odour emission rates for Fresh Waste, as measured onsite (**Table 11-1**) have been applied to the Waste Receival and Feedstock Preparation stockpiles, Fermenter Loading and Unloading and Finished compost product stockpiles;
- Total odour emissions are therefore calculated to be 3,794 OU.m^3/s for each of the Waste Receival and Feedstock Preparation, Fermenter Loading and Unloading and Finished Product stockpiles;
- In total, a potential odour emission rate of 15,178 OU.m^3/s is calculated to be potentially emitted through the roller doors; and
- Application of the time weighted factor of 0.125 results in an emission rate (applied over each hour of operation) of 1,897 OU m^3/s.

AD technology providers have provided odour emissions data for the biofilter. These values have been provided as 500 OU.m^3/m^3 and 321 OU.m^3/m^3. The highest of the emission rates provided has been selected for use in dispersion modelling. This is considered to represent a reasonable and conservative assumption for the biofilter odour emission rate since the mean odour load (OU/m^3) measured from six locations across the biofilter in an AD facility in Oensigen, Austria was 181±45 (Personal communication Evergreen Energy on behalf of Kompogas, 2011).

The size of the biofilter associated with the selected biofilter emission rate is 2,158 m^2 equating to 2 biofilter beds approximately 47 m x 22 M. The flux of air exiting the biofilter has been provided as 100 m^3/m^2/hr, or 0.03 m^3/m^2/s. This flux rate, together with the odour emission concentration of 500 $OU.m^3/m^3$ produces an odour emission flux through the biofilters of 13.9 $OU.m^3/m^2$/s.

No odour emissions have been assessed from biogas flaring as it is assumed that the high temperatures within the flare will result in the oxidation of all odorous constituents. In the dispersion modelling exercise, the biofilters have been represented as area sources, with dimensions of 47 m x 22 m with an odour emission rate of 13.9 $OU.m^3/m^2$/s.

Emissions of odour through the roller doors have been represented in the dispersion modelling exercise as a volume source, with a height of 8 m and length of 17 m, representing the actual size of the roller door opening. Initial Sigma Y has been assumed to be 3.95 m and Sigma Z 1.86 m.

11.4.1.3 Scenario 2b – Gasification

For the purposes of this assessment, the gasification RRF option is assumed not to include a biofilter. It is assumed that all emissions within the building will be routed to the gasification process. Therefore, the only source of odour would be the emissions through the roller doors as described for Scenario 2a. The same odour emission rate has been applied through the roller doors as described for Scenario 2a.

11.5 Plant Failure

In the event of a failure of the biofilter and associated exhaust fans the plant would be shut down and all the doors including main access doors kept closed at all times until the failure mode is diagnosed and the biofilter is completely refurbished. At this point isolation of the relevant duct work to the biofilter bed can be undertaken and the biofilter can be restored.

The biofilters for the RRF will be compartmentalised with built-in redundancy capacity. This will enable individual cells of the biofilters to be by-passed while maintenance and repairs are effected without impinging on the effectiveness of the biofilters as a whole. If a single cell fails then the same procedures that would be followed for scheduled maintenance would be followed and the RRF would be able to continue to operate at capacity. However, if a more general failure of the biofilter was to occur than the RRF would be shut down as described above.

To minimise potential for operational failure of biofilters, key operating parameters such as the exhaust air temperature and the back pressure will be checked on a regular basis to ensure the optimal conditions for the micro-organisms in the filter media. The biofilter will be constructed to allow a fast, even airflow with minimal pressure drop of exhaust air. The filter media will be removed and replaced when it starts to disintegrate and affects airflow. High porosity of the biofilter material (80 – 90 %), the humidity of the exhaust air (60 – 70 %), pH, temperature and the contact time with micro-organisms need to be controlled for good biofilter performance. The humidity in the biofilter can be maintained with a special watering system or by humidifying the exhaust air to be purified before it passes through the biofilter. Conditioning processes of the exhaust air are discussed further in the **Section 4.2.1.2**.

The odour generated from the RRF predominantly originates from the vehicle access door to the waste receival hall and from the biofilters. In the event of a failure of the biofilters that would require a plant shut down, the doors would remain close and the biofilters turned off. In this situation to total amount of odour emitted from the RRF is likely to be below that of normal operations, making normal operations the worst case. Therefore specific modelling of the shutdown of the biofilters and the RRF was not modelled.

11.6 Odour Impact Assessment

The application of the highest of the discrete odour concentrations measured for each source has been used in the modelling assessment. This approach is commonly applied to provide a reasonable level of conservatism to the subsequent assessment, and the demonstration of the impact based upon maximum concentrations allows confidence that the operational impacts are likely to be less than those predicted. Given the degree of uncertainty regarding odour sampling, measurement, and modelling, this level of conservatism is necessary to allow the conclusions of the study to be used with confidence. In regard to this sensitivity test, the conservatism of using the determined maximum values in lieu of the determined mean is regarded as high, and may potentially account for an aggregated margin of around 146% (SLR Consulting, 2012b).

Summary of odour emission rates and their average conservatism (i.e. ratio between $OU_{(max)}$ and $OU_{(mean)}$) is summarised in **Table 11-5**.

Table 11-5 Summary of Odour Emission Rates Using Maximum Odour Emission Rates and Represented by Mean Odour Emission Rates

Source	$OU_{(max)}/S$	$OU_{(max)}/S$ (as % of total)	$OU_{(mean)}/S$	$OU_{(mean)}/S$ (as % of total)	Ratio $OU_{(max)}/S/OU_{(mean)}/S$
Leachate Pond 1	1230	1%	920	1%	133%
Leachate Pond 5	2670	2%	1940	3%	138%
Leachate Pond 6	17	<1%	17	<1%	100%
Leachate Pond 9	52	<1%	52	<1%	100%
Fresh Uncovered Waste	3140	3%	2510	3%	125%
Covered Waste	3680	3%	2590	3%	142%
Alternative Daily Cover	88	<1%	60	<1%	147%
Windrow 1 (fresh MGB greenwaste)	60970	55%	42630	56%	143%
Windrow 2 (mulched greenwaste)	2230	2%	1250	2%	178%
Waste Transfer Station	2990	3%	940	1%	318%
Landfill Leachate Inspection Liner (Assumed 10)	136	<1%	46	<1%	295%
Landfill Gas Engine Roof Vent (Assumed 3)	640	1%	480	1%	133%
Landfill Gas Engine Side Vent (Assumed 8)	240	<1%	190	<1%	129%
Landfill Gas Engine Exhaust (Assumed 4)	37420	34%	25910	34%	144%
Total	111607	100%	76670	100%	146%

Table 11-6 presents the maximum, 99.9th percentile (9th highest) and 99.5th percentile (44th highest) 1 hour average odour concentrations at the surrounding sensitive receptor locations, as predicted by CALPUFF using an entire year of spatially varying meteorology, for current (base case) and proposed (RRF) operations at the Subject Site using the emission rates discussed in **Section 11.3**.

Also presented are the two part criteria used by the WA DEC, 99.9th percentile 1 hour average and 99.5th percentile 1 hour average odour concentrations.

The odour criteria are applicable to the 99.9th percentile (8 OU) and 99.5th percentile (2.5 OU) outputs only. These criteria mean that the odour concentration at the point of interest has to be <8 OU on a 1 hour averaging time for all but 9 hours per year (0.1%) and <2.5 OU on a 1 hour averaging time for all but 44 hours per year (0.5%). The maximum predicted 1 hour odour concentration at each receptor is provided for information purposes only. All predicted values are reported as OU with those highlighted red indicating where relevant criteria have been exceeded.

Table 11-6 Dispersion Modelling Predictions for Existing Red Hill WMF Operations and RRF Options – 1hr Predictions

Receptor	Scenario 1 (Existing Red Hill WMF Operations) (OU)			Scenario 2a (AD) (OU)			Scenario 2b (Gasification) (OU)		
	Max	99.9th	99.5th	Max	99.9th	99.5th	Max	99.9th	99.5th
Criterion	none	8.0	2.5	none	8.0	2.5	none	8.0	2.5
1	6.1	3.4	2.3	8.0	4.3	2.8*	6.1	3.4	2.3
2	5.0	3.1	1.9	11.1	5.8	3.7	5.0	3.1	1.9
3	3.2	2.2	1.3	7.4	3.6	2.5	3.2	2.2	1.3
4	3.1	1.8	1.1	5.4	3.2	1.9	3.2	1.8	1.1
5	2.6	1.4	0.8	4.4	2.2	1.3	2.6	1.4	0.8
6	2.4	1.4	0.7	3.6	2.0	1.0	2.4	1.4	0.7
7	2.8	1.5	0.8	5.6	2.8	1.3	2.8	1.5	0.8
8	4.4	2.3	1.0	4.8	2.6	1.4	4.4	2.3	1.0
9	2.9	1.7	1.0	4.6	2.5	1.5	2.9	1.7	1.0
10	4.7	2.1	1.3	7.3	3.3	1.8	4.7	2.1	1.3
11	5.8	2.7	1.3	5.8	3.3	1.9	5.8	2.7	1.3
12	4.2	3.3	1.4	4.2	3.6	1.7	4.2	3.3	1.4
13	6.7	1.9	0.8	10.5	3.0	1.2	6.7	1.9	0.8
14	2.8	1.8	0.6	4.1	2.7	0.9	2.8	1.8	0.6
15	2.3	1.4	0.6	3.2	1.8	0.8	2.3	1.4	0.6
16	2.5	1.4	0.6	3.1	1.9	0.8	2.5	1.4	0.6
17	3.5	1.6	0.6	5.0	2.1	0.8	3.5	1.6	0.6
18	4.1	1.5	0.7	7.2	1.8	0.9	4.1	1.5	0.7
19	4.6	1.4	0.7	6.6	2.0	1.0	4.6	1.4	0.7
20	3.6	1.5	0.8	3.9	2.3	1.0	3.6	1.5	0.8
21	3.5	1.6	0.8	4.3	2.2	1.0	3.5	1.6	0.8
22	3.4	1.9	0.8	5.2	2.6	1.1	3.4	1.9	0.8
23	3.8	1.6	0.8	5.2	2.5	1.2	3.8	1.6	0.8
24	5.4	2.3	0.8	7.2	3.1	1.1	5.4	2.3	0.8
25	4.1	1.6	0.8	5.1	2.6	1.0	4.1	1.6	0.8
26	3.2	1.2	0.6	3.7	1.9	0.8	3.2	1.2	0.6
27	3.1	1.3	0.6	4.3	2.1	0.8	3.1	1.3	0.6

*Figures highlighted in red are indicating where relevant criteria have been exceeded.

Dispersion modelling predictions of 99.9th and 99.5th percentile 1-hour odour concentrations indicate that, compared to the existing Red Hill WMF operations, the gasification option will have no additional impacts. The operation of the AD option is predicted to result in minor (<0.5 OU) to more significant (>1 OU) exceedances of the 99.5th percentile odour criterion at Receptors 1, 2 and 3, located on Toodyay Road to the northeast of the RRF.

Contour plots showing the spatial distribution of odour for each Scenario and odour criterion are provided in **Appendix C Section A1**.

Figure 35 Location of Sensitive Receptors Surrounding the Red Hill WMF

As may be inferred from **Table 11-6**, for the existing Red Hill WMF operations scenario (Scenario 1), the maximum odour concentrations are predicted at the residences to the north and east of the Red Hill WMF (refer **Figure 35** above). The highest concentrations of odour predicted under Scenario 1 operations are 6.7 OU (maximum) at Receptor 13 on Tomallan Ct, 3.4 OU (99.9th percentile) and 2.3 OU (99.5th percentile) at Receptor 1 on Toodyay Road. None of these predicted concentrations exceed the respective odour impact assessment criteria.

Scenario 2a examined the impact of the Anaerobic Digestion (AD) option for the RRF, using the assumptions outlined in **Section 11.4.1.2**. Odour concentrations under this scenario are predicted to increase at all receptors, however at all but 3 receptors (Receptors 1, 2 and 3 on Toodyay Road) the odour criteria are satisfied. Concentrations of odour at Receptors 1, 2 and 3 are predicted to be

2.8 OU, 3.7 OU and 2.5 OU as a 99.5th percentile respectively. The 99.9th percentile odour criterion is satisfied at all receptors. The magnitude of these exceedances can be viewed as minor for Receptors 1 and 3. At Receptor 3 the odour concentrations are at the criterion level and at Receptor 1 odour concentrations are less than 0.5 OU (20%) above the criterion. At Receptor 2, the exceedance may be viewed as more significant, given that the exceedance is predicted to be 1.2 OU (48%) above the criterion.

Scenario 2b examined the impact of the gasification option for the RRF, using the assumptions outlined in **Section 11.4.1.3**. Odour concentrations under this scenario are predicted to be the same as for Scenario 1. At all receptors the odour criteria are predicted to be satisfied.

The similarity between the predicted odour concentrations of Scenario 1 and Scenario 3 is explained by the minor odour impact resulting from the operation of the roller doors on the gasification plant. Examination of the odour concentrations resulting from this source at Receptor 1 indicates that the maximum, 99.9th and 99.5th percentile 1-hour concentrations are 0.2 OU, 0.1 OU and 0.0 OU, respectively. It is noted that these odour concentrations are calculated by the dispersion model as the maximum concentration from that source, in the absence of all other sources.

Given that the emissions of odour through the roller doors have been assumed to be identical between Scenario 2 and Scenario 3, the increases in predicted odour concentrations resulting from the operation of the AD plant can therefore be traced to the operation of the biofilter. Examination of the odour concentrations resulting from the biofilter at Receptor 1 indicates that the maximum (1st highest), 99.9th (9th highest) and 99.5th percentile (44th highest) 1-hour concentrations are 4.1 OU, 2.2 OU and 1.3 OU, respectively. The predicted odour concentrations relating to the biofilter operation have been extracted from dispersion modelling files run for biofilter operation only. Concentrations relating to each discrete Project element are not shown within this report, as it is the cumulative impact of all sources which is of concern. Please note that as the odour emission rate of each source represented within the different scenarios may vary with time and the resultant impact from each source may also vary with the dispersion of those emissions. The maximum impact associated with each discrete source may therefore occur at different times and the resultant cumulative impact from all sources may not be equal to the aggregate of the maximum of each source. The major predicted contributor to odour at the Receptors to the north and east of the Red Hill WMF during existing operations is Windrow 2, containing MGB greenwaste. At Receptor 1, it is predicted that the maximum, 99.9th and 99.5th percentile odour concentrations resulting from this source only are 5.9 OU, 3.4 OU and 2.3 OU, respectively.

It is noted that whilst the emission rates for Scenario 1 have been quantified by site-specific measurements, the assumptions for Scenario 2a and Scenario 2b are based upon a range of assumed conditions based upon performance specifications. Often these specifications are provided by equipment providers as “worst case” conditions, representing the performance limit ratherAn than typically achieved odour concentrations, and as such these data may represent an over-estimation of odour emissions from these technologies.

Similarly, the odour concentrations used are representative of total odour emissions without any consideration as to its potential offensiveness, and emissions from biofilters are often noted as having low potential for offense due to their neutral and earthy odour characteristics.

Based on the results of the dispersion modelling exercise, it is predicted that the Red Hill WMF currently operates within WA DEC odour guidelines. Operation of the Gasification plant is not predicted to change this situation. However, operation of the AD option may pose problems at 3 Receptors to the north and east of the Red Hill WMF, on Toodyay Road. Investigation into the ability or otherwise to further reduce odour emissions from the biofilters or the MGB greenwaste windrows will be investigated during the detailed design stage to ensure that odour emissions standards and ambient odour concentration criteria are met.

11.7 Environmental Management

To mitigate and manage the risk of nuisance odour emissions, the EMRC will:

- Reduce odour emissions from the MGB greenwaste windrows by either relocating them to make way for landfill stage 14 or reducing its size by conducting some of the activities, elsewhere on-site or off-site;
- RRF operation within sealed buildings during waste receival and pre-treatment of waste;
- maintain negative pressure conditions in the odorous areas of the RRF building;
- design sealed digesters for AD processes that are robust and pose little risk of breach or failure;
- install one, or a number (as required), of odour control systems, such as covered or fully enclosed biofilters which extract odorous air from the sealed process areas before being treated and released to the environment through a stack. Modelling has shown that this will remove any potential non-compliance issues at the nearest receptors;
- monitor critical biofilter performance parameters including inlet air temperature and relative humidity;
- respond to odour complaints immediately by undertaking steps to investigate and manage the issue; and
- prepare and implement an Odour Management Plan (OMP) will include but not be limited to:
  - regular maintenance of all equipment to ensure compliance with standards is maintained;
  - staff training to ensure awareness of odour related standard operating procedures particularly in relation to biofilter management;
  - a Contingency Plan to be implemented during upset or maintenance conditions;
  - procedure to be followed should complaints be received;
  - conduct periodic field odour assessment surveys; and
  - regular review of management plan.

Performance requirements for the odour management for the AD plant will be included in the tender specification for the facility.

11.8 Summary

Dispersion modelling of odour from the proposed RRF technologies has indicated that the EPA objective outlined in Section **11.1** will be satisfied by adopting the management measures outlined above.

12 Other Priority Factors

12.1 Residual Solid and Liquids

12.1.1 EPA Objective

To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

12.1.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
- Australian Standards for Compost, Soils Conditioners and Mulches AS-4454-2003

12.1.3 Environmental Impact

12.1.3.1 Gasification

As discussed in **Section 4.2.2**, the gasification process results in the creation of both bottom ash and fly ash. The composition of both is dependent on the constituents of the fuel and the air emissions cleaning system, however ash generated from gasification is expected to contain heavy metals and other hazardous materials. Given this, the two stage gasification/combustion process is extremely efficient in removing the organic species from the residual waste and therefore, bottom ash may contain very low residual organic carbon content of 0.1-1% (JCS 2009).

The bottom ash produced from the gasification chamber is removed by a conveyor to a bin. The fly ash generated from the flue gas cleaning process is separated in a fabric filter and conveyed to a filter dust storage silo by compressed air.

The composition of both the fly ash and bottom ash is dependent on the type of fuel used within the process, in this case MSW. Information from solid waste incineration (which includes MSW and MSW and commercial and industrial waste) confirms that concentration limits for total and leachable concentrations of determinants tested meet the requirements for Class III waste disposal as detailed in DEC 2009.

The results illustrate that the ash is likely to be suitable for disposal in a Class I to IV landfill, such as exists at the Red Hill WMF.

If the gasification technology were selected, EMRC would follow its waste acceptance criteria to determine the class of waste for both the bottom ash and the fly ash. This involves characterisation of waste and where required leaching testing to determine suitability for reuse.

Incorrect disposal of these ashes may result in contamination of surrounding soil, surface waters and groundwater. The unsafe handling of fly ash and bottom ash may also have potential human health impacts. These impacts are discussed in **Sections 12.4** and **12.4**.

12.1.3.2 Anaerobic Digestion

Residual solid or digestate is produces by the AD processes and is separated from the residual liquid by a filter press or centrifuge and matured through aerobic composting. The liquid is recirculated to the digester, used as a liquid fertiliser, treated in a waste water treatment plant or disposed of onsite (i.e. in the landfill leachate system). The incorrect disposal of the residual liquid may cause contamination of surrounding soil, surface water or groundwater.

Compositional data of compost and liquid residue that are typically produced by an AD system processing MSW are shown in **Table 12-1**. This data shows that the residue produced as a result of the AD process is high in organic solids, nitrogen and potassium with medium levels of phosphorous. As such it is proposed this by-product could be sold as a liquid fertiliser.

Table 12-1 Compost and Liquid Residue Composition from a Typical AD System

Parameter	Unit	Average	Low	Medium	High
Total Solids	%TS	13.4		✓	
Total Organic Solids	%TS	45.7			✓
Total Nitrogen	kg/t TS	35.2			✓
Minimum N (nutrient balance)	kg/t TS	17.2			✓
Phosphate (P_2O_5)	kg/t TS	13.9		✓	
Potassium (K_2O)	kg/t TS	33.8			✓
Calcium (Ca)	kg/t TS	37.4		✓	
Magnesium (Mg)	kg/t TS	9.4		✓	
Sulfur as sulfate (SO_4)	kg/t TS	7.6		✓	
Conductivity	mS/cm	6.4			✓

If the anaerobic digestion technology was to be selected, EMRC would ensure that AD derived compost quality meets *the Australian Standards for Compost, Soils Conditioners and Mulches AS-4454-2003*.

The human health impacts associated with the residual liquids are discussed in **Section 13.3.2**.

12.1.4 Management

To mitigate the potential environmental impacts associated with the generation, handling and disposal of solid and liquid residual wastes the EMRC will:

- implement safe handling and correct disposal methods for residual solid and liquid wastes;
- dispose residual bottom ash and fly ash in the appropriate class of landfill located at the Red Hill WMF;
- dispose of the residual liquid waste (from AD) in a waste water treatment plant or pass it through the leachate management system of the landfill cells; and
- ensure that the residual digestate solid meets an appropriate standard such as AS-4454-2003 Australian Standards for Compost, Soils Conditioners and Mulches, depending on the use of that material.

12.1.5 Summary

Given the management measures outlined in **Section 12.1.4** it is believed that the EPA objectives (**Section 12.1.1**) have been met.

12.2 Artificial Light Pollution

Artificial light emanating from facilities can impact on the amenity of surrounding residents, attract pests, impact flora and fauna, intrude on airspace and create human health issues. As the RRF will require security lighting outside operational hours, the EMRC have developed a number of management measures to ensure any lighting installed does not impact on health, flora and fauna and does not intrude into prescribed airspace.

The EPA objective in regards to light, the applicable standards, potential environmental impacts and the management measures to be adopted are outlined below.

12.2.1 EPA Objective

To maintain the environmental values, health, welfare and amenity of nearby land uses by meeting the statutory requirements for artificial light pollution.

12.2.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
- Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting.
- State Planning Policy No. 4.1 State Industrial Buffer Policy.

12.2.3 Existing Environment

The Red Hill WMF operates during day light hours therefore, only minimal security lighting is currently utilised at night.

12.2.4 Environmental Impact

It is almost impossible to contain all light within the boundaries of the property utilising outdoor lighting systems as some light will unavoidably spill outside the property boundaries, either directly or by reflection. Potential adverse impacts associated with excessive artificial light generated from the RRF at night may include:

- human health issues from light spillage into neighbouring homes, e.g. residents suffering fatigue, stress, headaches;
- reduced amenity from light spillage onto a neighbour’s property;
- impacts on flora and fauna physiology and local ecosystems, e.g. by confusing faunal navigation (in particular migratory birds), and confusing natural diurnal patterns of light and dark;
- increasing occurrence of pests that are attracted to light;
- blinding or confusing pilots of aircraft operating in the prescribed airspace; and
- wasting energy due to instances of unnecessary lighting.

12.2.5 Environmental Management

To mitigate and manage impacts arising from artificial light pollution, the EMRC will:

- install lighting that complies with Australian Standard AS 4282-1997;
- use minimum intensity light sources necessary to accomplish the lighting requirements and still uphold Occupation Health and Safety requirements for the site;
- install light motion sensors or timers in appropriate areas of the facility and train staff to manually switch off lights when not needed;
- ensure light fixtures direct light to where it is required to reduce light spillage effects;

- design the facility and landscape to help protect neighbouring properties from light spillages; and
- design and install lighting on the stack which meets WAC criteria and does not intrude on prescribed airspace.

12.2.6 Summary

By adopting the management measures outlined in **Section 12.2.5** the EPA objective (**Section 12.2.1**) will be satisfied.

12.3 Visual Amenity

12.3.1 EPA Objective

To maintain the aesthetic amenity of nearby land uses by meeting the community's expectations of the current land use.

12.3.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
- Western Australian Planning Commission Statement Of Planning Policy No. 2 Environment and Natural Resources Policy
- Visual Landscape Planning in Western Australia – A Manual For Evaluation, Assessment, Siting And Design.

12.3.3 Environmental Impact

There is potential for the RRF to impact the local residents' visual amenity, however considering that the Subject Site is within Red Hill WMF, visual amenity of the site is already low. The location of the RRF is shown in **Figure 3**. Traffic passing along Toodyay Rd and some isolated rural properties north of the Subject Site will be able to see the RRF. The height and layout of the RRF will be dependent on the technology chosen. The landfill cell located north east of the Subject Site will eventually provide limited screening of the RRF as the cell is filled.

The EMRC has established a Community Task Force to assist in developing a Community Partnership Agreement which addresses how issues of concern to the community relating to the establishment and operation of the RRF will be addressed. The aesthetics of the RRF was addressed by The Community Task Force in preparing the Community Partnership Agreement. Objective 6.1 is to "*Provide a functional and visually acceptable landscaped facility"* (CPA, 2011). Discussion by the Task Force around this item acknowledged that the RRF would need to be a fit for purpose building of an industrial type, and that suitable landscaping should be provided using appropriate local native flora species.

12.3.4 Environmental Management

To mitigate and manage the visual amenity issues arising from construction of the facility, the EMRC will:

- liaise with the community as detailed in the EMRC Community Partnership Agreement (**Appendix F**);
- consider the community's requirements in relation to visual amenity and implement their recommendations if practicable; and
- landscape the area surrounding the RRF using appropriate local native flora species.

12.3.5 Summary

By adopting the above management measure and taking into account the location of the RRF within the existing WMF the EPA objective (**Section 12.3.1**) is considered to be satisfied.

12.4 Groundwater and Surface Water Quality

Groundwater is a critically important resource as it supplies much of the water we need for irrigation, drinking and other uses (DoW, n.d.). Surface water bodies can have ecological, cultural, aesthetic, recreational and economic values which require protection and management. Therefore the potential impacts from the operation of the RRF require consideration and management to ensure these important water sources are protected.

The EPA objective in relation to groundwater and surface water, the applicable standards and guidelines, the potential environmental impacts and the management measures to be employed are outlined in the subs sections below.

12.4.1 EPA Objective

To maintain the quality of surface and groundwater so that existing and potential environmental values are protected.

12.4.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 3 – Separation Distances between Industrial and Sensitive Land Uses
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000,
- Western Australian Planning Commission Statement Of Planning Policy No. 2 Environment And Natural Resources Policy

12.4.3 Existing Environment

12.4.3.1 Surface water

As detailed in **Section 8.3.1.4** the nearest surface water bodies to the Subject Site are Christmas Tree Creek and Strelley Brook. Results from ongoing monitoring at these locations indicate no decline in downstream water quality from the current operations at Red Hill WMF. The six year Environmental Performance Review for 2004-2009 revealed the following:

- nutrient concentrations at the point of stormwater discharge has improved;
- nitrogen levels in Christmas Tree Creek were below guideline levels; and
- the biological integrity and ecological health of surrounding surface water systems has been maintained.

12.4.3.2 Groundwater

Previous groundwater and soil boring investigations at Red Hill WMF have indicated that the location and extent of groundwater beneath Red Hill WMF is extremely variable. There are two prevalent water tables identified beneath the site which include a perched aquifer and a deep aquifer. The depth to the perched aquifer under the Subject Site is approximately 10 m. Overall, groundwater at the Red Hill WMF flows in a south westerly direction.

Ongoing quarterly groundwater monitoring data gathered from background monitoring bores (located up gradient of the landfill) have maintained consistent background concentrations for all water quality parameters. However, groundwater monitoring undertaken at two locations down gradient from the

Class IV landfill cell, and also the southern boundary of Lot 11 detected contamination. The contamination is localised around Lot 11 however is not fully delineated from Lot 11. Monitoring and remediation is currently being undertaken to manage the contamination (EMRC 2010). This investigation is detailed further in **Section 8.3.1.4**.

12.4.4 Environmental Impact

The potential impacts from a significant breach of liquid (such as from firewater and digester liquid) include soil, groundwater and surface water contamination. This has follow-on effects to the aquatic ecosystems, as well as downstream or down gradient effects. Soil, groundwater and surface water contamination may occur from the following events:

- ruptures or breaches of the digester of an AD facility may cause leachate or contaminated liquid to be released into the surrounding environment;
- flooding or a fire within the waste receival facility of any of the technology options may also cause an uncontrolled contaminated liquids flow;
- gasification technologies will have boiler water and cooling water blow down discharges; and
- all technologies will have wash down water discharges from time to time depending on housekeeping requirements.

Should these events result in a breach leaving the site limits the impacts may cause the following:

- human/livestock/native fauna health impacts from exposure to contaminated water;
- degraded aquatic ecosystem quality;
- soil contamination from movement of contaminated groundwater through soil profile; and
- decrease in water quality.

The assessment of the air quality (refer **Section** 9) has determined that no exceedances of ambient air quality standards and guidelines are predicted within or near the Red Hill WMF for all emissions parameters associated with the respective technologies. Therefore it is highly unlikely that there will be adverse effects on the quality of surface water or ground water from air borne pollutants from the RRF.

12.4.5 Environmental Management

To mitigate and manage the risk of fugitive liquid emissions, the EMRC will:

- select the successful tenderer based on evidence that the technology and design is proven and meets the regulatory standards;
- design the facility to minimise and contain liquid leakages;
- undertake regular equipment monitoring and testing for leaks and repair equipment immediately if leaks are detected;
- make spill kits available onsite and train staff to manage site spills in emergencies;
- undertake remediation of contaminated areas if spills occur; and
- continue to undertake groundwater and surface water monitoring and sampling.

12.4.6 Summary

By adopting the management measures outlined above and taking into consideration that all roads and hardstand areas will be sealed (therefore minimising the potential for any spills to contaminate soil, surface water or groundwater) the EPA objective (**Section 12.4.1**) will be satisfied.

12.5 Terrestrial Vegetation and Flora

The DSEWPC (2010c) states that Australia's native vegetation is one of the richest and most important elements of our natural heritage. Native vegetation binds and nourishes soils, provides habitat, shelter and sustains native fauna, protects streams, wetlands, estuaries, coastlines and absorbs carbon dioxide and emits oxygen through photosynthesis. The destruction of vegetation is the primary source for land degradation, salinity, declining water quality and one of the main causes for a loss in biodiversity (DSEWPC 2010b).

In order to protect native vegetation from any impacts arising from the construction and operation of the RRF the EMRC has undertaken steps to assess these potential impacts and develop appropriate management strategies.

The EPA objective in relation to terrestrial vegetation and flora, the applicable standards and guidelines, the potential impacts and the management strategies to be implemented are outlined below.

12.5.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

12.5.2 Applicable Standards and Guidelines

- Environmental Protection Act 1986
- Wildlife Conservation Act 1950
- Environmental Protection and Biodiversity Conservation Act 1999
- EPA Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia
- EPA Guidance Statement No. 19 – Environmental Offsets – Biodiversity
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
- Western Australian Planning Commission Statement Of Planning Policy No. 2 Environment And Natural Resources Policy

12.5.3 Existing Environment

The Subject Site currently consists of unsealed access roads and parking areas and scattered remnant Marri trees. Further details regarding terrestrial flora and vegetation are detailed in **Section 8.3.2**. From previous studies undertaken it was determined that the Subject Site does not contain any of the following:

- TECs;
- PECs;
- Bush Forever sites;
- ESAs; and
- DRFs.

12.5.4 Environmental Impact

The establishment of the RRF will require minimal to no clearing of remnant vegetation as the Subject Site has been historically cleared for grazing purposes. A few scattered Marri trees (*Corymbia calophylla*) remain within the Subject Site.

WHO Guidelines (2000) address the ecological effects of some major air pollutants. The guidelines focus on the ecological effects of sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and other nitrogen compounds, and ozone (O_3). A number of other atmospheric contaminants such as metals and persistent organic pollutants are known to have ecological effects, but methods linking soil contamination or bioaccumulation to atmospheric concentrations have not yet been developed.

Moreover, ambient air quality goals have been set by the ANZECC (1990) for the protection of both commercially valuable plants sensitive to fluoride (HF) and plant species generally. The ambient air goals for fluoride are intended for areas of commercial or conservation value and are not intended for comparison with airborne or foliar fluoride levels within industrial areas or buffer zones associated with fluoride emitting industries.

The goals set for General Land Use (including residential) are designed to protect most of the sensitive species in the natural environment. The goals set for Specialised Land Use apply when commercially valuable plants, which are demonstrated to be very sensitive to fluoride are being considered. However, it is acknowledged that despite the observation of effects of fluoride on Australian native plants species is not definitive, the goals should protect the majority of species under most conditions.

It should be noted that no Threatened or Priority Ecological Communities or Threatened (Declared Rare) flora occur within the vicinity of the RRF. Two occurrences of the Priority four species *Templetionia drummondii* were recorded in native vegetation outside the site. Priority four taxa are taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years (DEC, 2010). Therefore any impact to these individuals would not be considered significant in terms of conservation of this species.

Applicable guidelines are summarized in the **Table 12-2** together with the maximum predicted air emission from gasification and AD options 1 and 2.

Table 12-2 demonstrates that no exceedances of ecological guidelines are predicted at nearby the RRF for SO2 and NOx associated with the respective technologies. No guidelines for the 1 h average HF emissions are set by the ANZECC, therefore no direct comparison between the guidelines and predicted maximum HF emissions can be made. However, it is unlikely that exceedances of 12 hour average HF emissions will occur and there will be adverse effects on the terrestrial vegetation and flora from air borne pollutants from the RRF.

While potential impacts to flora and vegetation may occur as a result of air emissions, it is unlikely that such impacts will be significant in terms of biodiversity conservation as no Threatened flora, TECs' or PECs have been recorded within the vicinity of the RRF. Should impacts to significant fauna habitat species, particularly Black Cockatoo habitat species, then the proponent will establish a program to monitor the impacts to determine if they are the result of environmental changes and threatening process such as drought, *Phytophthora* Dieback or *Armillaria leutenobia* or the result of air emissions.

Table 12-2 Comparison of ecological guidelines and the maximum predicted emissions from gasification and AD

Emission	Guideline (ug/m3)	Average Period	Reference	Maximum Predicted Emission (ug/m3)					
				Gasification		AD Option 1		AD Option 2	
				Discrete Receptor	Anywhere on Grid	Discrete Receptor	Anywhere on Grid	Discrete Receptor	Anywhere on Grid
SO_2	20	Annual	WHO, 2000	1.7	2.8	1[1]	3.8[1]	1.6[2]	1.8[2]
NO_x	30	Annual	WHO, 2000	2.7	5.7	4.4[2]	14[2]	5.3[2]	10[2]
HF, General landuse	3.7 2.9	12 h 24 h	ANZECC, 1990	5.02[3]	5.11[3]	N/A	N/A	N/A	N/A
HF, Special landuse	1.8 1.5	12 h 24 h	ANZECC, 1990	-	-	N/A	N/A	N/A	N/A

[1] From the flare
[2] From the gas engines
[3] Time period of 1 hour

12.5.5 Environmental Management

Minimal to no clearing will be required to establish the RRF in the Subject Site however, to mitigate and manage impacts arising from any clearing of remnant vegetation onsite, the EMRC will:

- maintain, where possible, any Black Cockatoo habitat trees or food resources (i.e. *Banksia sessilis var. sessilis, Corymbia calophylla, Allocasuarina fraseriana* and *Banksia grandis*);
- re-establish fauna habitat if necessary;
- recycle the cleared vegetation through the onsite greenwaste processing facility;
- undertake weed management, in particular implement appropriate management measures for the *Echium plantagineum** and *Citrullus lanatus**; and
- If impacts to significant fauna species exist, the proponent will establish a monitoring program.

12.5.6 Summary

The EPA objective (**Section 12.5.1**) will be satisfied by adopting the above management measures and considering the following:

- the majority of the Lot 12 (Area 2), in which the Subject Site is located, has been historically cleared for grazing purposes and is determined to be 'completely degraded';
- potential impacts on Priority 4 species *Templetonia drummondii* is considered 'low'. This species however, is not located within the Subject Site;
- no TECs or PECs are located within the Subject Site;
- no Bush Forever sites are located within the Subject Site;
- no ESAs are located within the Subject Site; and
- the regional impacts from any clearing onsite is determined to be 'low'.

Based on these findings it is not necessary to refer this proposal to the Federal Environment Minister under the EPBC Act.

12.6 Terrestrial Fauna

Fauna play an integral part in the functioning of ecosystems, biodiversity and possess their own intrinsic value. Fauna can also be of great spiritual and cultural significance. The potential impacts on fauna from the development of the RRF have been considered by the EMRC and appropriate management measures developed.

The EPA objective in relation to fauna, the applicable standards and guidelines, the potential environmental impacts and the management measures to be employed are outlined below.

12.6.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

12.6.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 56 - Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia;
- EPA Guidance Statement No. 19 - Environmental Offsets – Biodiversity;
- EPA Position Statement No. 3 - Terrestrial Biological Surveys as an Element of Biodiversity Protection;

- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process; and
- Western Australian Planning Commission Statement of Planning Policy No. 2 Environment And Natural Resources Policy.

12.6.3 Existing Environment

The fauna assessment undertaken in February 2010 concluded that 57 fauna species of conservation significance could occur within the remnant vegetation in Lot 12. The Subject Site however, is not located within this vegetation. Only a few remnant Marri Trees are located within the Subject Site. Further details on this assessment are provided in **Section 8.3.2.8.1**.

12.6.4 Environmental Impact

The potential impacts on fauna, if native vegetation requires clearing for the construction and operation of the RRF, or is adversely affected by air emissions from the RRF include:

- loss of habitat and foraging extent for native fauna;
- further reduction in the total wildlife corridor area, which exists between the Jane Brook and Susannah Brook sub-catchments;
- disruption of faunal behaviour, for example, migration, breeding and feeding habits and/or causing fauna injury or deaths;
- decrease in health of fauna species due to pollution; and
- bioaccumulation and/or biomagnification of contaminants.

The comparison of the ecological guidelines and predicted air emissions from different technology options (**Section 12.5.4**) demonstrated that no exceedances of guidelines are predicted at nearby sensitive receptors for selected emissions parameters associated with the respective technologies. Therefore it is highly unlikely that there will be adverse effects on the terrestrial fauna from air borne pollutants from the RRF.

12.6.5 Environmental Management

If clearing is required for the establishment of the RRF, the following management measures will be adopted by the EMRC to minimize impacts on any fauna present in the area:

- Maintain, where practicable, any Black Cockatoo habitat trees or food resources (i.e. *Banksia sessilis var. sessilis, Corymbia calophylla, Allocasuarina fraseriana* and *Banksia grandis*);
- Red Hill WMF already has Pest and Fauna Management Plans in place for the landfill. These plans will be extended to cover the RRF should they become necessary.
- Re-establish fauna habitat if necessary; and
- Comply with the Conditions of DEC Licence 6833/1997/11.

12.6.6 Summary

By adopting the above management measures and considering the following:

- the Subject Site is located within a previously cleared area and is in a ‘completely degraded condition’;
- the Fauna Assessment (February 2010) determined that the impact from any clearing of the remaining vegetation was considered to be low or low to moderate and unlikely to further fragment fauna populations in the area; and
- it is highly unlikely that there will be adverse effects on the fauna habitat from air borne pollutants from the RRF,

the EPA objective (**Section 12.6.1**) will be satisfied.

Based on these findings it is not necessary to refer this proposal to the Federal Environment Minister under the EPBC Act.

12.7 Aquatic Flora

Aquatic flora plays a vital role in enhancing water quality (McMahon 2001) by:

- removing nutrients from the water and sediments and competing for nutrients with algae that form problematic blooms;
- reducing erosion by reducing river flows, by trapping suspended sediment and by stabilising the banks and beds of rivers;
- providing food sources directly or indirectly to aquatic and terrestrial animals such as fish, shrimp, freshwater crayfish, turtles and birds; and
- providing a habitat for shelter and breeding to aquatic and terrestrial animals.

Given the importance of aquatic flora, the potential impacts from the operation of the RRF on aquatic flora were assessed and appropriate management measures developed. The EPA objective in relation to aquatic flora, the applicable standards and guidelines, the potential environmental impacts and the management measures to be employed are outlined below.

12.7.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

12.7.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 19 – Environmental Offsets – Biodiversity;
- EPA Guidance Statement No. 3 – Separation Distances between Industrial and Sensitive Land Uses; and
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.

12.7.3 Existing Environment

As detailed in **Section 8.3.1** the nearest surface water bodies are located in the Jane Brook and Susannah Brook Catchments. Christmas Tree Creek, a tributary of Jane Brook, flows in a westerly direction adjacent to the southern boundary of the site (below Lot 501), before flowing in a south westerly direction into Jane Brook. Strelley Brook, a small tributary of Jane Brook, flows in a south west direction through the coastal plain of the catchment into Jane Brook.

12.7.4 Environmental Impact

The potential environmental impacts on Jane Brook and Susannah Brook resulting from the operation of the RRF include:

- change in aquatic flora composition;
- decrease in dissolved oxygen (DO) levels; and
- excessive dust deposition.

Investigations carried out on air quality projected from the development of the proposed RRF have confirmed that priority emissions fall below the ecological guidelines as detailed in **Section 12.5.4.** Therefore it is highly unlikely that there will be adverse effects on the quality of aquatic flora from air borne pollutants from the RRF. Further investigation relating to dust suppression onsite has also confirmed that through appropriate mitigation dust can be managed appropriately.

12.7.5 Environmental Management

To manage any of the potential impacts arising from the operation of the RRF the EMRC will:

- continue to undertake surface water monitoring and sampling within Christmas Tree Creek and Strelley Brook for the life of the project;
- if the results indicate an increase in algal growth, decrease in DO levels, increases in invasive species or dust deposition, further investigation will be required to determine if these impacts are a result of the operation of the RRF; and
- if the impacts are confirmed to be a result of the operation of the RRF, appropriate management measures and increased monitoring and sampling will be implemented.

12.7.6 Summary

By adopting the above management measures and taking into consideration the dust and air quality results confirming levels to be below required standards the EPA objective (**Section 12.7.1**) has been satisfied.

12.8 Aquatic Fauna

12.8.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of aquatic fauna and ecosystems through the avoidance or management of adverse impacts and improvement in knowledge.

12.8.2 Applicable Standards and Guidelines

- EPA Guidance Statement No. 19 – Environmental Offsets – Biodiversity;
- EPA Guidance Statement No. 3 – Separation Distances between Industrial and Sensitive Land Uses; and
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.

12.8.3 Environmental Impact

The potential impacts on fauna resulting from the operation of the RRF include:

- change in aquatic vertebrate composition;
- change in biomass;
- excessive dust deposition;
- degraded habitat; and
- reduced water quality.

12.8.4 Environmental Management

To manage any potential impacts on fauna resulting from the operation of the RRF the EMRC will:

- continue to undertake surface water monitoring and sampling within Christmas Tree Creek and Strelley Brook for the life of the project;
- if the results show signs of the impacts outlined above, further investigation will be required to determine if these impacts are occurring as a result of the operation of the RRF. If the impacts are attributed to the RRF, appropriate management measures and increased monitoring and sampling will be implemented; and
- prepare and implement a NPM (see **Section 10.1.5**).

12.8.5 Summary

By adopting the above management measures and taking into consideration the dust and air quality results confirming levels to be below required standards the EPA objective (**Section 12.8.1**) has been satisfied.

13 Human Health

To assist in assessing the potential health impacts of establishing the RRF, the EMRC engaged qualified consultants to undertake monitoring and modelling of factors such as air and noise emissions. The data used for the modelling was sourced from currently operational AD and gasification plants. Although not considered a health impact within this PER, if odour was to become a persistent issue then it may potentially affect health. Hence odour monitoring and modelling was also undertaken.

An air quality assessment was undertaken to determine the existing ambient concentrations within the Red Hill WMF, the existing emissions from the landfill operations and the predicted emissions and plume dispersion resulting from the operation of the RRF. The result of this assessment is discussed in **Section 9**.

A noise impact assessment was undertaken to determine the current noise levels and to model the potential noise levels associated with the RRF. The results of this assessment are discussed in **Section 10**.

An odour impact assessment was undertaken to determine the current level of nuisance odours and to predict the likely impact of the operation of the RRF on these baseline odour levels. The results of this assessment are discussed in **Section 11.**

13.1 EPA Objective

To protect neighbouring residents and workers from any adverse health impacts associated with the proposed RRF.

13.2 Applicable Standards and Guidelines

- Occupational Health and Safety Regulations 1996;
- EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process;
- Codes of Practice; and
- National Exposure Standards (NES) (SWA, 2011).

See **Section 9.2** applicable standards and guidelines for ambient air emissions, **Section 9.12.2** for dust, **Section 10.1.2** for noise and **Section 12.2.2** for light.

13.2.1 Air Emissions Standards (Public Health)

As outlined previously in **Section 9.3**, air quality standards from NEPM, WHO and other jurisdictions have been utilised for assessment of air emissions impacts from the proposed RRF. The NEPM standards are shown in **Appendix A Table A 1** and the WHO guidelines (2005) are shown in **Appendix A Table A 2**. These air quality standards are applicable for assessment of community exposure to air emissions generated from the RRF and other emission sources in the area. The EMRC is committed to minimising the contributions of emissions from the RRF to the ambient air by operating the RRF in full compliance with air emissions limits that will be set by the regulatory agencies and included in the environmental license for the facility. It is understood that those limits will be protective of human health in the neighbouring communities.

13.2.2 Air Emission Standards (Occupational Health)

National Emissions Standards (NES) declared by the National Commission under s.38(1) of the *National Occupational Health and Safety Commission Act 1985,* developed standards for airborne concentrations of individual chemicals to prevent occupational deaths, injuries and diseases. These occupational exposure standards are guides only and are not to be used as a definitive line between safe and dangerous concentrations of chemicals. These standards are not a measure of relative toxicity and should not be applied in the control of community air pollution (NOHSC 2001).

The occupational exposure standards for airborne contaminants are expressed as a time-weighted average (TWA) concentration of that substance over an eight-hour working day, for a five day working week. Short term exposure limits (STELs) are concentrations of airborne substances averaged over a period of 15 minutes. This short term TWA concentration should not be exceeded at any time during a normal eight hour working day (NOHSC 2001). Further guidance on interpreting NES is provided in NOHSC 2001.

The NES for some key air emissions relevant to the RRF are outlined in **Table 13-1** below. These standards are recommended guidelines only and only applicable to employees working in the RRF. Air emission standards for ambient air relevant to the general public are outlined in **Section** 9. It should be noted that STELs are recommended for those substances only when there is evidence either from human or animal studies that adverse health effects can be caused by high short term exposure (NOHSC 2001).

A NES has not been developed for methane as it is not appropriate to recommend an exposure standard for an asphyxiant, instead sufficient oxygen concentration should be maintained (SWA November 2011).

Table 13-1 NES for Key Air Emissions from Gasification

Emission	TWA (ppm)	TWA (mg/m^3)	STEL (ppm)	STEL (mg/m^3)
Carbon Dioxide	5000	9000	30000	54000
Nitrogen Dioxide	3	5.6	5	9.4
Sulfur Dioxide	2	5.2	5	13
Hydrogen Chloride	5	7.5 Peak limitation	-	-
Hydrogen Fluoride	3	2.6 Peak limitation	-	-
Lead, inorganic dusts and fumes (as Pb)	-	0.15	-	-
Arsenic and soluble compounds (as As)	-	0.05	-	-

Note: No NES has been developed for methane, dioxins, furans, Pbs and VOCs.

13.3 Human Health Impacts

The potential health impacts associated with the proposed technologies include indirect and direct exposure to air emissions, odour, dust, noise, light and traffic. These impacts may cause physiological and/or psychological impacts due to:

- direct or indirect exposure to air emissions;
- physical/dermal contact with waste or compost;

- exposure to contaminated soil, groundwater or surface water;
- prolonged and excessive noise emissions;
- excessive dust emissions;
- artificial light spill into neighbouring properties; and
- increased traffic levels.

Employees may be exposed to pollutants directly through handling and storage of waste or compost, through inhalation when handling ash, compost, or via gas and/or particulate emissions. People living in close proximity to facilities may be exposed indirectly through deposition of pollutants to soil, vegetation and surface water.

The following potential factors affecting public health that are discussed in the subsections below are:

- gas emissions;
- residual solids and liquids;
- particulates;
- dust;
- noise;
- light;
- odour;
- traffic;
- contaminated soil, surface water and groundwater;
- rainwater quality;
- working conditions; and
- community wellbeing.

13.3.1 Gas emissions

13.3.1.1 AD

The key constituents of the biogas produced from AD are CO_2 and CH_4 together with small quantities of moisture (H_2O) and hydrogen sulfide (H_2S).

Methane is a colourless, odourless gas that is extremely flammable. High concentrations may cause asphyxiation and loss of mobility/consciousness. Low concentrations may cause narcotic effects with symptoms such as dizziness, headache, nausea and loss of co-ordination. There are no known toxicological effects from exposure to methane (ALAL 2010).

The biogas produced will be cleaned prior to being utilised for fuel for gas engines/or will be sold to the natural gas grid. As biogas production and handling is undertaken in a closed system and is not released direct to air under normal operating conditions, the potential health impacts from the biogas generated from the AD process is negligible.

The predicted air emission concentration levels from combustion of biogas are provided in **Section 9.5**. These gas emissions are predicted to meet the NEPM and WHO air quality standards within the studied area, therefore no adverse health impacts are likely to occur.

13.3.1.2 Gasification

The key potential health impacts arising from gasification are associated with air emissions from the RRF stack. Refer **Section 4.2.2.** The majority of emission material released to the atmosphere comprises CO_2 and H_2O vapour with small amounts of PM, metals associated with the PM and gaseous pollutants. The composition of the air emissions produced is partly due to the composition of the feedstock (NRC 2000).

The potential health effects associated with the key gas emissions are provided in **Appendix** D **Section D2.** The current air emissions at the Red Hill WMF are discussed in

Table 9-1 and predicted air emission levels for these gases are provided in **Table 9-8**. All key gas emissions will meet NEPM and WHO air quality standards.

Thermal treatment technologies of waste are sometimes seen as controversial because of perceived health risks from air pollution, especially dioxins. Historically such fears were defendable because of relatively inferior performance of technologies of the day. However, the decisions to be considered now concern current generation technologies, which provide superior emissions performance that readily satisfy stringent regulations such as those from EU WID, to ensure NEPM and WHO air quality standards can be achieved. As a result of the new limit values and more efficient flue gas cleaning, emissions to air from thermal treatment of MSW have reduced considerably between 1990 and the present day (DEFRA 2004). Emissions from modern gasification facilities can be considered almost negligible relative to other background activities such as emissions from traffic and wood fires. Currently there are numerous WtE plants operating within or adjacent to major cities and population centres, such as Paris, Tokyo and London with no identified health risks.

Details of two international studies into the possible human health impacts on the proposed RRF technologies are presented in **Appendix D Section D1** and **Section D2** These studies, from the Department for Environment, Food and Rural Affairs (DEFRA) (DEFRA 2004) and AECOM (2007) confirmed the findings from this study that human health from stack emissions is not at significant risk for either technology proposed. Moreover, during the preparation work of *European Union Reference Document on the Best Available Techniques for Waste Incineration* (2006), the emissions data from a survey of 142 European non-hazardous waste incineration plants was collected. Due to efficient flue gas cleaning the air emissions of the different installations covered in this survey met the emission standards of Directive 2000/76/EC on incineration of waste all parameters except CO, where some exceedances were measured (European Commission 2006). The assessment of the gasification technology option for the RRF has indicated CO would not exceed air quality standards.

The EMRC has developed a number of management measures to ensure the health and safety of the RRF employees and the surrounding residents are maintained. These management measures are outlined in **Section 13.4**. Potential human health impacts from the gasification of MSW have been considered in the modelling and impact assessment study. In particular, the cumulative assessment (where the background concentrations of pollutants are combined with predictions of the contribution from the proposed RRF project) demonstrates that the impact of the RRF project on air quality is negligible. Conservative emission rates were used in the assessment and those emission rates were assumed to remain consistent from year to year since the modelling was conducted for maximum waste throughput.

An assessment of the potential for bioaccumulation of emissions is not necessary, since the air quality standards for persistent pollutants are protective of whole of life exposures. Advice from Department of Health (2012) is that "*DOH is satisfied the substances modelling using a combination of measured data and emission limits data for the proposed technologies are unlikely to cause health effects provided the emission remain consistently below the recommended air quality health based references for the life of the facility*." This advice is taken to consider secondary routes of exposure to pollutants which can arise as a consequence of bioaccumulation and ingestion of foods grown at nearby properties.

13.3.2 Residual Liquids and Solids

13.3.2.1 AD

The AD process generates both residual solid and liquid materials. The AD process is discussed in detail in **Section 4.2.1.** Due to the nature of the process and the constituents of the waste, these residual materials will have a predominantly biological composition. These may include pathogens as well as trace elements, inorganic salts, and synthetic chemicals such as pesticides and naturally occurring organics. The potential impacts associated with these contaminants are discussed in the following subsections. The EMRC has developed a number of management measures to ensure the health and safety of the RRF employees and the surroundings residents are maintained. These management measures are outlined in **Section 13.4.2**.

13.3.2.2 Gasification

As discussed previously in **Section 4.2.2,** the gasification process produces bottom ash in the gasification chamber and fly ash from the air emissions cleaning system. The composition of these ashes differs and are dependent on the composition of the waste fuel and the exact type of adsorbents used in the flue gas cleaning system. The residual ashes are likely to contain heavy metals, primarily as their oxides.

Employee exposure to these ashes may occur by inhalation during incorrect handling and disposal. Due to the potential hazardous nature of the residual ashes appropriate management will be implemented to ensure the health and safety of all employees is maintained. These management measures are outlined in **Section 13.4.2**. With these management measures in place, it is unlikely that residual ashes will present any health impacts on RRF employees or the general public.

The only residual liquids produced in the gasification process are blow down from the cooling tower and boiler systems during normal operation and any maintenance cleaning. Appropriate measures are outlined in **Section 13.4.2** to suitably manage these liquids.

13.3.3 Particulates

According to NOHSC (2001) there are four factors which determine the degree of hazard associated with a specific airborne particulate, these are:

- the type of particulate involved and its biological effect;
- the concentration of airborne particulates in the breathing zone of the employee;
- the size of particles present in the breathing zone; and
- the duration of the exposure.

The chemical composition and physical characteristics of the particulate determine the biological effect of the substance. The biological effects associated with airborne particulates may include:

- systemic toxic effects caused by the absorption of the toxic material into the blood (e.g. lead, manganese, cadmium and zinc);
- allergic and hypersensitivity reactions caused by the inhalation of dusts from materials such as flour, grains, some woods and some organic and inorganic chemicals;
- bacterial and fungal infections associated with the inhalation of dusts containing viable organisms and/or spores;
- fibrogenic reactions in the gas exchange regions of the lung due to the presence of materials such as asbestos and quartz; and
- carcinogenic response due to the presence of, for example, chromates and asbestos; and

- irritation of the mucous membranes of the nose and throat caused by acid, alkali or other irritating particulates, especially mists.

Potential health impacts may occur from inhalation of particulates or direct contact (dermal) with waste and/or compost. Exposure to these contaminants from AD may occur during the pre-sorting, digestion or composting processes. Exposure to particulates from gasification may occur during waste handling/receival, handling of ash and/or via flue gas emissions. The constituents of particulates that may present a health risk to employees during the handling of waste and/or compost may include:

- Pathogens;
- Bioaerosols;
    - Nematodes
    - Bacteria
    - Fungi
    - Endotoxins
- VOCs;
- Trace elements and heavy metals; and
- Pesticides.

Further details of the assessment of risks associated with all these constituents are presented in **Appendix D Section D2** and **D3**. This assessment concludes that both AD and gasification technologies do not produce end products with constituents at levels which result in a risk to human health.

13.3.3.1 Dust

As mentioned previously in **Section 9.12.1**, the health impacts associated with dust are influenced by particle size, chemical composition and concentration. $PM_{10\text{-}2.5}$ or thoracic particles can be inhaled into the upper part of the airways and lung. $PM_{2.5}$ (fine particles or respirable dust) are more problematic as they can be inhaled deep into the lungs and lodge in the gas exchange region (alveolar region). If these fine particles are contaminated, they may pose a further health risk through the risk of absorption of chemicals in the blood stream (DEC 2008). **Table 9-8** shows cumulative concentrations of PM_{10} and $PM_{2.5}$ to be below the assessment criteria. The health effects associated with thoracic particles and respirable dust were discussed previously in **Section 9.12.3**.

TSPs are usually associated more with nuisance, skin or eye irritations and exacerbation of dust allergies. TSPs may be generated through the construction of the RRF however, any dust produced onsite is likely to be minimal and will be managed by measures outlined in the DMP. The management measures to be implemented are discussed in **Section 9.12.4**.

13.3.4 Nanoparticles

Nanoparticles or nanoparticulates are particles with a diameter under 100 nanometres (nm) (BSI 2005). Nanoparticles can be present as an aerosol (mostly solid or liquid phase in air), a suspension (mostly solid in liquids) or an emulsion (two liquid phases). Nanoparticles occur through the natural or anthropogenic disintegration of larger structures or by controlled assembly processes (SCENIHR 2005).

Nanoparticles can absorb onto the surface of living cells and enter the tissues and fluids of the body. The characteristic of nanoparticles that influence their potential health impacts are their size, chemical composition and surface characteristics and shape (EU accessed November 2011) The key factors which influence the interaction with living structures include nanoparticle dose, the ability of nanoparticles to spread within the body and their solubility.

Given this, there is still little known on the interaction of nanoparticles in ambient air and biological systems. More research is required into the response of living organisms to the presence of nanoparticles of varying size, shape, chemical composition and surface characteristics in order to understand and categorize the toxicity of nanoparticles (EU accessed November 2011).

At present, epidemiological studies on ambient air pollution have failed to provide consistent evidence that nanoparticles are more hazardous to human health than larger particles. Epidemiological studies do not currently have the capacity to demonstrate differences between the toxicity of the various components of PM. Exposure:Dose relationships depend predominantly on time and location, and epidemiological studies are limited by the lack of appropriate measurement (SCENIHR 2005).

Stanmore (unpublished 2011) undertook a literature review of the emissions of nanoparticles from thermal treatment of MSW and concluded as follows:

The small (nano-size) airborne particles released into the atmosphere grow during their lifetime by a dynamic process of accretion, mostly by inorganic salts such as nitrates. The origin of the original nuclei is overwhelmingly from combustion processes. Nanoparticles stay in suspension for long periods, and are transported over intercontinental distances. Organic compounds and metals are found to some extent in all samples of ambient air. The species which are responsible for health impacts are present in material from all sources. Motor vehicles produce most fine particles and dominate the generation of urban pollution. Uncontrolled emissions are also a significant contributor to poor air quality. Because the particulate emissions from a well-designed waste-to-energy (WtE) plant before release into the atmosphere are of the same order as in the ambient air above a modern city site, they will have a negligible addition to the overall sum of particulates in an urban environment (Stanmore unpublished).

Advice was sought from WA Department of Health toxicologists in respect of local regulatory requirements for assessment of nanoparticles from the RRF facility. That advice concluded that the immature status of health impact knowledge and absence of regulatory regime precludes an assessment. Procedures and benchmarks for measurement in stack emissions and environmental and human health risk assessment have not been established. EMRC will continue to monitor developments in nanoparticle measurement and risk assessment to ensure future regulatory requirements can be addressed for the RRF project.

13.3.5 Noise

During the construction and operation of the RRF there is the potential for noise exceedances to occur. Prolonged exposure to excessive noise levels may lead to human health issues such as hearing loss, increased stress levels and hypertension, aggression, sleep disturbances and depression. Details on the current noise levels at Red Hill WMF and the predicted noise levels are detailed in **Sections 10.1.3** and **10.1.4,** respectively. The management measures to be implemented are shown in **Section 10.1.5**.

13.3.6 Light

Lighting required for security at the RRF may result in light spillage. The potential health risks associated with excessive light spillage include fatigue, stress and headaches. The management measures to be implemented are outlined in **Section 12.2.5**.

13.3.7 Odour

Odour has not been considered as a health impact within this PER, instead it has been addressed as an amenity issue. However, in the unlikely event of persistent excessive odour, then the associate loss of amenity may lead to health issues. Background odour levels, predicted odour levels and management measures are outlined in **Section 11.7.**

13.3.8 Soil, Groundwater and Surface water

Public health may be indirectly impacted through the contamination of soils, groundwater and surface water from deposition of particulate emissions generated from the RRF. The predicted particulate emissions are shown in **Table 9-6** and **Table 9-8** and indicate that these emissions will fall below the NEPM air standard of 50 µg/m³ averaged over a 24 hour period for PM_{10} and 25 µg/m³ over a one day period or 8 µg/m³ annually for $PM_{2.5}$. It is therefore unlikely that significant contamination of soil, groundwater and surface water will occur and cause health impacts as a result of the RRF. The management measures to be implemented by the EMRC are shown in **Section 13.4.7**.

13.3.9 Rainwater Water Quality

Potential health impacts associated with drinking water quality may occur through rainwater tank contamination from particulate emissions. The factors influencing the potential health effects from contaminated water are dependent on the distance to the source of emissions, the accumulation of particulates, and the constituents of particulates. As previously outlined in **Section 9**, particulate emissions fall below NEPM standard of 50 µg/m³ averaged over a 24 hour period for PM_{10} and 25 µg/m³ over a one day period or 8 µg/m³ annually for $PM_{2.5}$. Never the less, the EMRC encourages a number of measures to ensure rainwater quality is maintained. These management measures will also assist in protecting drinking water from other potential sources of contamination not associated with the RRF and prevent potential breeding grounds for mosquitoes. The recommended management measures are outlined in **Section 13.4.8**.

13.3.10 Traffic

Employees may be harmed through vehicle movements onsite or during waste discharge operations. The potential health risks associated with traffic movement onsite are injury and/or death. In addition to onsite traffic impacts, public exposure to increased traffic may occur due to the additional trucks required for the operation of the RRF. The outcomes of the traffic study undertaken by Cardno in 2011 are outlined below.

13.3.10.1 Existing Traffic

Toodyay Road is a sealed two lane carriageway of approximately 8.1m width which carries approximately 7,000 vehicles per day (vpd). The speed limit of Toodyay Road is 100km/hr and the road is classified as a Primary Distributor.

Access to Red Hill WMF is currently achieved by an unsignalled T-intersection with Toodyay Road with a channelized right turn and auxiliary left turn arrangement. This intersection layout is shown in **Figure 36.**

Figure 36 Intersection of Toodyay Road and Red Hill WMF Access

Traffic volumes for Toodyay Road have been obtained from Main Roads WA for the period July 2010-July 2011. The existing volumes along Toodyay Road are detailed in **Table 13-2**.

Table 13-2 Existing Two-Way Traffic Volumes – Toodyay Road

Daily	AM Peak Hour	PM Peak Hour
6,885	668	567

These volumes are within the existing environmental capacity of Toodyay Road as a two-lane rural road on a high speed alignment. Existing traffic volumes accessing the site has been estimated by EMRC as approximately 300vpd.

These vehicles consist of employee vehicles, waste collection trucks and public vehicles. A breakdown of the existing traffic volumes accessing the site is detailed in **Table 13-3**.

Table 13-3 Existing Traffic Volumes – Site Access

User Type	Daily Volume			AM Peak Hour			PM Peak Hour		
	Total	In	Out	Total	In	Out	Total	In	Out
Trucks	285	143	143	32	16	16	32	16	16
Office Staff	30	15	15	15	15	0	15	0	15
Public/Other	285	142	142	32	16	16	32	16	16
Total	**600**	**300**	**300**	**79**	**47**	**32**	**79**	**32**	**47**

The existing intersection arrangement adequately caters for present traffic volumes, with turning vehicles able to use deceleration lanes reducing the slowing of general through traffic.

13.3.10.2 Future Development Traffic – No RRF Scenario

EMRC have provided forecasts of future tonnages of waste which will be transported to the site. These forecasts do not include outgoing tonnages as a result of the development of the RRF.

In order to estimate the corresponding increases in the number of vehicles accessing the site, an estimate of the average present tonnage per truck was undertaken and then applied to the forecast future tonnages. This method presents a worst case scenario, as it does not factor in any future efficiency improvements such as off-site consolidation into large trucks or improved handling practices.

The estimated future traffic volumes are detailed in **Table 13-4**.

Table 13-4 Future Development Traffic – No RRF Scenario

User Type	Daily Volume			AM Peak Hour			PM Peak Hour		
	Total	In	Out	Total	In	Out	Total	In	Out
Trucks	412	206	206	44	22	22	44	22	22
Office Staff	30	15	15	15	15	0	15	0	15
Public/Other	284	142	142	32	16	16	32	16	16
Total	**726**	**363**	**363**	**91**	**53**	**38**	**91**	**38**	**53**

Comparing **Table 13-3** and **Table 13-4**, the estimates of future traffic show a marginal increase of 12 extra vehicles in the peak hour. This additional volume does not require any changes to the intersection arrangement, as it represents less than 1% increase in flow at the intersection. The existing intersection arrangement adequately caters for this marginal increase in traffic.

13.3.10.3 Future Development Traffic – With RRF Scenario

The RRF will generate additional vehicle trips to and from the site, transporting the compost product to various sites around Perth. These vehicles will generally arrive empty at the site and leave full.

Estimates of the future tonnages of compost to be transported were provided by EMRC and these have been used to estimate the likely truck numbers required for transportation. The estimated truck numbers are detailed in **Table 13-5**. The truck movements have been assumed to be spread fairly evenly across the day.

Table 13-5 Total Trip Generation – with RRF Scenario

User Type	Daily Volume			AM Peak Hour			PM Peak Hour		
	Total	In	Out	Total	In	Out	Total	In	Out
Trucks	412	206	206	44	22	22	44	22	22
RRF Trucks	36	18	18	2	2	0	2	0	2
Office Staff	30	15	15	15	15	0	15	0	15
Public/Other	284	142	142	32	16	16	32	16	16
Total	**762**	**381**	**381**	**93**	**55**	**38**	**93**	**38**	**55**

Comparing **Table 13-4** and **Table 13-5**, the estimates of future traffic show a marginal increase of 2 extra vehicles in the peak hour. This additional volume does not require any changes to the intersection arrangement, as it represents a negligible increase in flow at the intersection. The existing intersection arrangement adequately caters for this marginal increase in traffic.

13.3.10.4 Future Background Traffic Growth

Forecasts of future traffic volumes on Toodyay Road were requested from Main Roads and these are shown in **Table 13-6**.

Table 13-6 Future Traffic Volumes – Toodyay Road

Year	Daily	AM Peak Hour	PM Peak Hour
2021	20,000	1,940*	1,640*
2031	45,000	4,365*	3,690*

* Only daily volumes were provided by Main Roads. AM and PM Peak Hour volumes were estimated using the same hourly distribution model as current traffic volumes.

These volumes are significantly in excess of current traffic volumes and will necessitate the upgrading or improvement of Toodyay Road to a four-lane divided road standard.

A new, dual carriageway route for the Perth-Adelaide National Highway, known as the Orange Route, has been planned for many years and the most recent redevelopment of the Red Hill WMF site was designed so as to be compatible with its construction.

The intention of the Orange Route is to provide an alternative route for through traffic currently using Great Eastern Highway through Greenmount and Mundaring, as well as serving future urban development of the land to the south of Toodyay Road and at Gidgegannup. In conjunction with the Orange Route, a new east-west route known as the Hills Spine Road is also proposed and will intersect with the Orange Route near the Red Hill WMF site.

The construction of the Orange Route and Hills Spine Road will significantly alter road access in the area. Following discussions with Main Roads, the Red Hill WMF site has been developed to be compatible with a future access from the Hills Spine Road, to the east of the site. When these road upgrades occur, the intersections will be constructed to adequately cater for all traffic movements.

13.3.10.5 Internal Site Configuration

A preliminary assessment of the internal site configuration has been undertaken. There are no constraints which will prevent the internal road network being constructed to Australian Standards.

As there is not currently a proposed site layout for the RRF the following recommendations are made for the design of access roads to ensure that the expected vehicles are accommodated:

- one-way circulatory systems should be promoted to minimise vehicle conflicts;
- two-way roads should be at least 7m wide;
- one-way roads should be at least 3.5m wide;
- an AutoTurn assessment should be undertaken at the Concept Design stage to ensure that the swept paths of large vehicles will be accommodated;
- the number of 4-way intersections should be minimised; and
- parking bays should be a minimum of 2.5m wide.

13.3.11 Working Environment

Employees may be exposed to potential health impacts through air emissions, direct contact with waste and onsite traffic movements. The EMRC considers the health and safety of employees operating the RRF a high priority and therefore, to ensure this is maintained, appropriate occupational health and safety codes and management procedures will be implemented throughout the life of the RRF. The assessment of working environment and worker safety is the responsibility of the WorkSafe. Exposure to air emissions is discussed in **Section 9.5**, direct contact with waste and compost in **Section 13.3.2** and traffic impacts and management in **Section 13.3.10**.

13.3.12 Ecosystems and Natural Environments

The health of ecosystems and the environment are intrinsically linked to the health of human beings. The health impacts from the contamination, damage or destruction of the environment can cause both physiological and psychological effects. Physical effects may occur from the contamination of air, water and food resources. Psychological needs and benefits associated with natural environments that may be affected include identity formation, restoration, recreation, connection, inspiration, stress reduction, spirituality and personal connection with a logical and meaningful world. Concern, anxiety, guilt, anger, helplessness, dread, and pessimism may result from the perception and/or direct experience of environmental degradation (Reser 2007).

To ensure that the sustainability of nearby ecosystems and surrounding environments are protected, the EMRC will implement a number of measures (**Table 14-1**) to avoid, minimise and manage any environmental impacts associated with the operation of the RRF.

13.3.13 Future Generations

The health of future generations may be impacted from the contamination, damage or destruction of ecosystems or through exposure of current generations to pollutants. The potential impacts may vary greatly and include both physiological and psychological impacts. Potential indirect health impacts on future generations from current generation exposure to pollutants may include congenital effects.

The health of future generations will be protected as far as practicable given that; air emissions will fall below the current NEPM and other relevant air quality standards, the implementation of management measures outlined in **Section 9.11.4** and the RRF will utilise modern technology and best practice.

13.4 Environmental Management

To minimise the potential of human health impacts arising from the construction and operation of the RRF, the EMRC will implement the following measures listed in the subsections below.

13.4.1 Air Emissions (Gases and Particulates)

To manage potential health risks associated with indirect and direct air emissions the EMRC will:

- comply with environmental (discharge) licence conditions;
- utilise cleaning, filtering and scrubbing devices within buildings;
- comply with Occupational Health and Safety Regulations;
- implement relevant Occupational Health and Safety codes and management systems; and
- develop and implement an AQMP and OMP.

Further details regarding air emissions are detailed in **Section 9**.

13.4.2 Residual Liquids and Solids

To manage residual liquid and solid wastes produced from the RRF the EMRC will:

- implement appropriate safe handling and disposal processes;
- dispose all ashes in the appropriate landfill cells located at the Red Hill WMF;
- dispose of the residual liquid waste onsite (i.e. to the landfill leachate system) or a wastewater treatment plant; and
- ensure AD derived compost quality meets the Australian Standards for Compost, Soils Conditioners and Mulches AS-4454-2003.

13.4.3 Dust

To manage any dust generated onsite during construction of the RRF the EMRC will:

- seal roads for high traffic areas onsite (where possible) to avoid dust creation;
- continue to use dust management practices at the Red Hill WMF particularly during the construction period;
- ensure all trucks utilise appropriate measures to cover/seal loads when entering and existing the facility;
- prepare and implement a DMP align with EPA Guidance Statement No.18; and
- comply with all relevant standards and guidelines during the construction and operation of the RRF.

13.4.4 Noise

13.4.4.1.1 Construction Noise

Under Regulation 13 of the *Environmental Protection (Noise) Regulations 1997*, noise generated from construction is not required to meet the assigned levels provided certain conditions are met. Construction noise is to be managed to comply with the assigned levels where practicable (EPA 2007).

13.4.4.1.2 Operational Noise

In order to manage noise generated from the operation of the RRF the EMRC will:

- utilise equipment that meets requirements of the *Environmental Protection (Noise) Regulations 1997*;
- continue to undertake noise monitoring;
- comply with existing Red Hill WMF complaint response procedure; and
- develop and implement a NMP.

Details on the current noise emission levels and predicated levels are provided in **Section 10** and **Appendix B Section B2.1**.

13.4.5 Light

To manage potential light pollution the EMRC will:

- install minimal security lighting that meets Australian Standard AS 4282-1997;
- design and install lighting that will avoid light spillage effects; and
- install stack lighting which meets WAC criteria and does not intrude on prescribed airspace.

Light Pollution is further detailed in **Section 8.4.1**.

13.4.6 Odour

The following measures will be implemented to ensure odour generated from the RRF is managed:

- construct and operate within sealed buildings during waste receival and pre-treatment of waste;
- maintain negative pressure conditions within the buildings;
- design sealed digesters for AD processes that are robust and pose little risk of breach or failure;
- install one, or a number (as required), odour control systems, such as covered or enclosed biofilters which extract odorous air from the sealed process areas before being filtered, treated and released to the environment;

- respond to and investigate odour complaints immediately to manage and/or mitigate the issue; and
- prepare and implement an OMP detailing all management measures.

Details on current odour levels and predicted levels are provided in **Section 11** and **Appendix C.**

13.4.7 Soil, Groundwater and Surface Water Quality

Soil, groundwater and surface water quality will be managed by implementing the following measures:

- air emissions levels will meet licence conditions;
- facility will be designed to minimise and contain liquid leakages;
- regular equipment monitoring and testing for leaks and repair equipment immediately if leaks are detected;
- spills kits to be available onsite and staff trained to manage site spills in emergencies;
- remediation of contaminated areas if spills occur; and
- ongoing groundwater and surface water monitoring and sampling.

13.4.8 Rainwater Quality

The EMRC encourages the individuals and the community to adopt the following management measures recommended by the Department of Health (DoH) for rainwater tank systems:

- installation of filters;
- gutter guards or screen mesh to reduce the quantity of debris entering the tank; and
- first flush devices.

Further management measures recommended by the DoH are outlined in the brochure *Urban Rainwater Collection* (DoH 2003).

13.4.9 Traffic

The following management objective is considered relevant to the proposal:

To ensure the traffic network can safely accommodate the projected traffic numbers and vehicle types, and that the increase in traffic does not adversely impact on the amenity of social surroundings.

To mitigate and manage potential health impacts arising from increased traffic inside and outside of the site, the EMRC will:

- ensure that the site access roads and associated intersections are designed to safely accommodate the expected traffic volumes and turning movements of vehicles;
- appropriately upgrade roads;
- design the facility layout to avoid any potential traffic associated risks to employees;
- utilise lines, signs and flashing lights onsite to control traffic movements; and
- continue to monitor traffic entering and leaving the site.

13.4.10 Working Environment

To ensure the health and safety of the RRF employees are maintained the EMRC will implement the following management measures:

- occupational health and safety codes;
- occupational health and safety management system;

- training for all employees on the operation of the RRF, identification of hazards and risks;
- Personnel Protective Equipment (PPE) to be worn (if required);
- incident report system;
- emergency response system.

13.4.11 Ecosystems and Natural Environments

In order to avoid, minimise and manage the potential impacts on the surrounding environment and ecosystems the EMRC will implement the management measures summarised in this report.

13.4.12 Mosquito-borne Diseases

Measures to inhibit nuisance mosquito breeding within the development site will be incorporated into the design of the facility and will be carried out as part of ongoing operations. The primary means of inhibiting nuisance mosquito populations is the elimination of standing water bodies through the incorporation of water sensitive design. Any stormwater runoff generated by roofing and hardstanding within the site will be disposed of via the existing approved drainage network, and will not be permitted to stand for periods sufficient to enable the maturation of mosquito larvae. Similarly, measures will be undertaken that any vessels within the site will not be permitted to accumulate standing water conducive to mosquito breeding. Such vessels will be overturned regularly to dispose of collected stormwater or stored or disposed of appropriately.

13.4.13 Future Generations

To mitigate any potential health impacts on future generations the EMRC will implement the management measures summarised in this report.

13.4.14 Summary

A summary of all the health determinants, potential health impacts and the management measures to be implemented by the EMRC is provided in this report.

14 Summary and Conclusions

Table 14-1 summarises all management measures proposed at the site to ensure that sufficient mitigation is in place to allow all risks to be manageable.

Table 14-1 Key Environmental Factors, Impacts and Management

No.	Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Predicted Impacts	Management
			1 Pollution			
1.1	Air quality	Surrounding area	To maintain the environmental values, health, welfare and amenity of nearby land uses, and the wider Perth airshed by meeting the statutory requirements of air emissions, including dust emissions. To comply with EPA Guidance Statement No.18 – *Prevention of Air Quality Impacts from Land Development Sites,* Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses* and Statement No. 12 – *Minimising Greenhouse Gas Emissions.*	Human and faunal health issues due to exposure Deterioration of nearby terrestrial and aquatic ecosystems Degradation of buildings and structures Increased pollution of the wider Perth air shed Amenity and nuisance issues	AD: No exceedances of the ambient air assessment criteria for the various emissions parameters are produced, for both the direct impact and when background concentrations of the parameters are considered. Gas emissions are predicted to meet the NEPM and WHO air quality standards within the studied area, therefore no adverse health impacts are likely to occur. EfW: None of the pollutant Ground Level Concentrations (GLCs) are predicted to exceed the air quality assessment criteria. Operation of a gasification facility would be highly unlikely to give rise to unacceptable health impacts, even in the presence of existing air pollutants from other sources.	Prepare and implement an Air Quality Management Plan (AQMP) and a Dust Management Plan Employ appropriate pollution control equipment to remove contaminants from flue gases or composting aeration prior to emission into the atmosphere Undertake monitoring in line with requirements of licence Undertake regular Greenhouse Gas (GHG) accounting in accordance with National Carbon Accounting System.
1.2	Noise emissions	Surrounding area	To maintain the environmental values, health, welfare and amenity of nearby land uses by meeting the statutory requirements of noise emissions. To comply with EPA Guidance Statement No. 8 – *Environmental Noise (Draft)* and Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Human health issues and loss of amenity due to exposure Disruption to normal faunal behaviours Minor increase in traffic related noise due to the increase in traffic along Toodyay Road	AD: The noise assessment has found that there will be marginal exceedances during the night relative to the assigned noise levels of the Regulations at one of the receptors (worst case AD option was modelled). This is primarily due to noise from an existing power generation plant on site and corrective action is currently being assessed by its owner. With appropriate design, the AD facility would achieve compliance with the assigned noise levels at all times at the subject site. EfW: Gasification facility would achieve compliance with the assigned noise levels at all times at the subject site.	Prepare and implement a Noise Management Plan (NMP) Design of plant and equipment to comply with the *Environmental Protection (Noise) Regulations 1997* Continue to monitor traffic entering and leaving the site
1.3	Artificial light pollution	Surrounding area including the prescribed airspace of the Perth Airport	To maintain the environmental values, health, welfare and amenity of nearby land uses by meeting the statutory requirements for artificial light pollution.	Human health issues and reduced amenity from light trespassing into neighbouring properties/houses Impacts on flora and fauna physiology and local ecosystems Increased occurrence of pests attracted to light Blinding or confusing pilots of aircraft operating in a prescribed airspace Wasting energy on instances of unnecessary lighting	Facility will utilise outdoor lighting systems and some light will unavoidably spill outside the property boundaries, either directly or by reflection. Facility operates during day light hours therefore, only minimal security lighting is currently utilised at night minimising the impact during the night time.	Design the RRF and landscape in a way to protect receptors from artificial light Obtain approval from Civil Aviation Safety Authority, (CASA)through the Western Airports Corporation (WAC) to ensure lights will not intrude into prescribed airspace
1.4	Solid and liquid residuals	Surrounding area	To protect surrounding residents and workers from any adverse health risks associated with the by-products generated from the RRF; To maintain the quality of soil, surface water and groundwater so that existing and potential environmental values are protected.	Human health issues due to exposure.	AD: Produces digestate and liquid residue with predominantly biological composition that may include pathogens as well as trace elements, inorganic salts, and synthetic chemicals such as pesticides and naturally occurring organics. A number of management measures involving safe handling, containment and disposal have been developed to ensure the health and safety of the RRF employees and the surroundings residents are maintained. EfW: process creates both bottom ash and fly ash. Employee exposure to these ashes may occur by inhalation during incorrect handling and disposal. With appropriate management measures in place, it is unlikely that residual ashes will present any health impacts on RRF employees or the general public.	▪ Implement safe handling and correct disposal methods for residual solid and liquid waste. ▪ Dispose residual bottom ash and fly ash in the appropriate class of landfill located at the Red Hill WMF ▪ Dispose of the residual liquid waste (from AD) to landfill leachate system or to a waste water treatment plant. ▪ Ensure that the residual digestate solid meets an appropriate standard such as AS-4454-2003 Australian Standards for Compost, Soils Conditioners and Mulches, depending on the use of that material.

2 Social Environment						
2.1	Odour emissions	Surrounding area	To maintain the amenity of nearby land uses by meeting the statutory requirements for odour emissions. To comply with EPA Guidance Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Reduced amenity	AD: Odour modelling, based on the assumptions adopted, show that operation may pose problems at 3 Receptors to the north and east of the Red Hill WMF, on Toodyay Road. These can be resolve through appropriate design of the odour management system. EfW: None of the predicted concentrations exceed the respective odour impact assessment criteria.	Prepare and implement Odour Management Plan (OMP) Operate within sealed buildings under negative air pressure, in odorous parts of the facility. Design and install appropriate Odour Control Systems to service the RRF Reduce the size of and therefore the odour emissions from the Mobile Garbage Bins (MGB) greenwaste windrows
2.2	Public Health	Surrounding area	To protect neighbouring residents and workers from any adverse health risks associated with the proposed RRF or increased traffic.	Health impacts, including physiological and/or mental impacts, due to any one of the following causes: Direct or indirect exposure to air emissions at elevated levels Noise emissions at prolonged excessive levels Dust emissions at excessive levels Artificial light 'trespassing' into neighbouring properties Increased traffic levels.	Public Health impacts can be considered minimal when all the management procedures presented in this report are adopted.	Refer to Section 13 for management information
2.3	Aboriginal heritage	Aboriginal heritage sites in proximity of Subject Site	To maintain the Aboriginal heritage and cultural values associated with nearby sites of significance. To comply with EPA Guidance Statement No. 41 – *Assessment of Aboriginal Heritage*.	Changes to the physical and biological proposal may disturb or impact on an Aboriginal heritage site	No Aboriginal heritage sites recorded within the Subject Site.	Comply with *Aboriginal Heritage Act 1972*
2.4	Visual amenity	Surrounding area	To maintain the aesthetic amenity of nearby land uses by meeting the community's expectations of the current land use	Reduced visual amenity of facility on the Subject Site	The Subject Site is located within the existing Red Hill WMF and therefore no changes are predicted as visual amenity of the site is already low.	Design the RRF taking into account the community's recommendations Landscape the area surrounding the RRF with native flora species
3 Biophysical Factors						
3.1	Surface water and groundwater	Jane Brook and Susannah Brook catchments	To maintain the quality of surface and groundwater so that existing and potential environmental values are protected. To comply with EPA Guidance Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*. To comply with Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 where applicable.	Human/livestock/native fauna health impacts from exposure to contaminated water Degraded aquatic ecosystem quality Soil contamination from movement of contaminated groundwater through soil profile Decrease in water quality	Potential for any spills to contaminate surface water or groundwater is minimised due to the sealing of all roads and hardstand areas. No exceedances of ambient air quality standards and guidelines are predicted; therefore it is highly unlikely that adverse effects on surface water or ground water from air borne pollutants will exist.	Continue groundwater and surface water monitoring and sampling Design RRF to minimise and retain leakages of liquids Implement procedures to prevent and contain spills during emergencies
3.2	Terrestrial vegetation/flora	Vegetated areas on and surrounding the site	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge To comply with EPA Guidance Statement No. 51 - *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* and Statement No. 19 – *Environmental Offsets – Biodiversity*	Loss of priority species Weeds Excessive dust emissions Decrease in vegetation quality Fire ignition Reduced colonisation ability.	Minimal to no clearing of remnant vegetation is required as the Subject Site has been historically cleared for grazing purposes. It is unlikely that there will be adverse effects on the terrestrial vegetation and flora from air borne pollutants.	Prepare and implement a Vegetation Clearing Management Plan. Employ best practice clearing methods. Comply with the conditions of the Licence 6833/1997/11 issued by the DEC for the landfill operations at Red Hill WMF
3.3	Terrestrial fauna	Habitat areas on and surrounding the site	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge To comply with EPA Guidance Statement No. 56 - *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* and Statement No. 19 – *Environmental Offsets – Biodiversity.*	Loss of habitat and foraging extent Increase in pests species Fauna deaths or injury during clearing Reduction in wildlife corridor Disruption to faunal behaviours Decrease in health of fauna species due to pollution Bioaccumulation and/or biomagnification of contaminants	The proposed development will lead to the localized loss of some fauna habitat. However, there is extensive intact habitat close to the project area, supporting similar fauna and fauna habitats in a landscape that is generally in good condition. It is unlikely that there will be adverse effects on the terrestrial fauna from air borne pollutants.	Comply with the conditions of the Licence 6833/1997/11 issued by the DEC for the landfill operations at Red Hill WMF

3.4	Aquatic flora	Nearby surface water bodies in Jane Brook and Susannah Brook catchments	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. To comply with EPA Guidance Statement No. 19 – *Environmental Offsets – Biodiversity* and Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Reduce water quality Excessive dust emissions Change in biomass.	Facility is unlikely to have an environmental impact on Jane Brook and Susannah Brook with appropriate management. It is unlikely that there will be adverse effects on the aquatic flora from air borne pollutants. Dust mitigation can be managed appropriately.	Continue surface water monitoring and sampling.
3.5	Aquatic fauna	Nearby surface water bodies in Jane Brook and Susannah Brook catchments	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. To comply with EPA Guidance Statement No. 19 – *Environmental Offsets – Biodiversity* and Statement No. 3 – *Separation Distances between Industrial and Sensitive Land Uses*.	Increase in algae and decrease in oxygen Invasive pest species Excessive dust emissions Degraded habitat Reduced water quality Disruption to normal faunal behaviours	Facility is unlikely to have an environmental impact on Jane Brook and Susannah Brook with appropriate management. It is unlikely that there will be adverse effects on the aquatic fauna from air borne pollutants. Dust mitigation can be managed appropriately.	Continue surface water monitoring and sampling

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Appendix A

Air Quality Modelling

A1. State and International Air Quality Standards

A1.1 NEPM Standards

The main air pollutants and the current national air quality standards are shown in **Table A 1**.

Table A 1 National Ambient Air Quality Standards

Pollutant	Concentration and averaging period
Carbon monoxide (CO)	9.0 ppm (parts per million) measured over an eight hour period
Nitrogen dioxide (NO_2)	0.12 ppm averaged over a one hour period 0.03 ppm averaged over a one year period
Ozone (O_3)	0.10 ppm of ozone measured over a one hour period 0.08 ppm of ozone measured over a four hour period
Sulfur Dioxide (SO_2)	0.20 ppm averaged over a one hour period 0.08 ppm averaged over a 24 hour period 0.02 ppm averaged over a one year period
Lead (Pb)	0.5 µg/m³ (micrograms/m³) averaged over a one year period
Particles as PM_{10}	50 µg/m³ averaged over a 24 hour period
Particles as $PM_{2.5}$	Advisory reporting standard: 25 µg/m³ over a one day period; 8 µg/m³ over a one year period[7]

Source: DSEWPC, 2005d

A1.2 WHO Standards

The WHO Air Quality Guidelines (AQGs) were developed in 2000 to provide global guidance on reducing the health impacts of air pollution. These guidelines were updated in 2005 and are presented below in **Table A 2**.

[7] The WA Department of Health has advised that the annual $PM_{2.5}$ advisory reporting standard is not an acceptable criterion for assessment of air quality impacts in WA (Goetzmann, pers, comm, 2012)

Table A 2 WHO Ambient Air Quality Guidelines

Pollutant	Concentration	Averaging period
Cadmium	5 ng/m^3	annual
Carbon disulfide	100 µg/m^3	24 hour
CO	100 mg/m^3 60 mg/m^3 30 mg/m^3 10 mg/m^3	15 minute 30 minute 1 hour 8 hour
1,2-Dichloroethane	0.7 mg/m^3	24 hour
Dichloromethane	3 mg/m^3 0.45 mg/m^3	24 hour 1 week
Formaldehyde	0.1 mg/m^3	30 minute
Hydrogen sulfide	150 µg/m^3	24 hour
Lead	0.5 µg/m^3	annual
Manganese	0.15 µg/m^3	annual
Mercury	1 µg/m^3	annual
NO_2	40 µg/m^3 200 µg/m^3	annual 1 hour
O_3	100 µg/m^3	8 hour
Particles as PM_{10}	20 µg/m^3 50 µg/m^3	annual 24 hour
Particles as $PM_{2.5}$	10 µg/m^3 25 µg/m^3	annual[8] 24 hour
Styrene	0.26 mg/m^3	1 week
SO_2	20 µg/m^3 500 µg/m^3	24 hour 10 minute
Tetracholorethylene	0.25 mg/m^3	annual
Toluene	0.26 mg/m^3	1 week
Vanadium	1 µg/m^3	24 hour

A1.3 Species Specific Standards

A1.3.1.Total Chromium

A local assessment criterion was not available for total Chromium, however criteria for both trivalent (Cr^{III}) and hexavalent (Cr^{VI}) Chromium were available from the Air Guideline Values document prepared by Toxikos for DEC WA (WA DoH, 2011). Only Total Chromium was measured in the baseline air quality monitoring programme (Synergetics 2011), which did not quantify the respective valence states of the metal. However data from several studies conducted in California was reviewed

[8] The WA Department of Health has advised that the annual $PM_{2.5}$ standard is not an acceptable criterion for assessment of air quality impacts in WA

by the California Air Resources Board. This showed that the Total Chromium in ambient air comprised between 2% and 8% Cr $^{(VI)}$ (CARB, 1986). In the absence of local information, the midpoint of this range (5%) was applied to estimate the background concentration of Cr $^{(VI)}$ from the Total Chromium measured in the baseline monitoring programme.

A1.3.2.Total Organic Carbon

The WID specifies an emission limit for total organic carbon (TOC). TOC is not a single species and therefore does not have a criterion assigned for assessment of potential health impact. A conservative approach was adopted in this assessment so that TOC emissions were assumed to be benzene and the predicted TOC concentrations was assessed against the benzene guideline from NSW (DEC NSW, 2005).

A1.3.3.Benzo(a)pyrene

Benzo(a)pyrene is not in the WID, however it has been considered in this assessment since it is included in the draft SEAAP and an ambient air standard (actually a monitoring investigation level) is available from the Air Toxics NEPM and was adopted by the draft SEAAP. The NEPM value was therefore used for the impact assessment.

A2. Monitoring

A2.1 Selection of Sampling Locations

The three sites selected in the vicinity of the Red Hill WMF for monitoring were chosen to provide direct coverage of neighbouring residential areas to the north east, east and south of the subject site. The prevailing wind direction at various times of the year has the potential to carry any emissions arising from the Red Hill WMF into the neighbouring communities. The areas are zoned rural residential and landscape (City of Swan 2010), therefore the population density is low (compared to a residential area). To the west of the site lies undeveloped land zoned for Resources (an outdoor concert venue has also recently been constructed but there is no accommodation in this area) and two quarry operations (on the north side of Toodyay Rd). The John Forrest National Park adjoins the site to the south west. The nearest residential area to the west is over 4 km away (off the escarpment), as a consequence monitoring in this direction was considered a lower priority than the directions in which the community was located closer to Red Hill WMF.

Site specific meteorological data was not available at the time of planning for the monitoring; therefore the wind roses compiled by BOM from observations at Perth Airport were used to evaluate the prevailing winds. It was found that the winds from the east and south easterly direction were most likely to carry emissions into the community and so the continuous monitoring stations were located accordingly at sites where a suitable power supply and access were available.

The sites were evaluated against the recommendations provided in the Australian Standard 3580.1.1:2007: *Guide to siting air monitoring equipment*. This guide states an AQMS would be ideally located unobstructed by surrounding trees and structures. This criterion was met at the Red Hill Lot 12 and the Hidden Valley residence locations. At the Toodyay Road residence there was vegetation within approximately 5 m of the station to the east, however this location was the best site that could be accessed in the required direction. The station was also in close proximity to the driveway and relatively close to the house, giving useful quantification of the ambient air pollutant levels that residents were likely to actually be exposed to. This would include the impacts of everyday activities such as driving cars in and out of the area and burning fuel in wood burning stoves in the winter months. The Lot 12 site was in a more remote location and therefore would likely see less of the localised impacts caused by resident activities but would be more representative of the air quality in the region.

A2.2 Sampling Programme Methodology

A2.2.1.Continuous Monitoring

The continuously monitored species included PM_{10}, $PM_{2.5}$, CO, NO_X (NO and NO_2) and SO_2. Details of the measurement methodologies are presented in **Table A 3**.

Table A 3 Target Pollutants and Methodology for Continuous Monitoring

Pollutant	Reason for monitoring	Sampling Methodology
Particulates (PM_{10})	Ambient Air Quality NEPM pollutant. Dust emissions possible from proposed RRF.	Continuous sampling using TEOM sampler as per AS3580.9.8-2001
Particulates ($PM_{2.5}$)	Ambient Air Quality NEPM pollutant. Dust emissions possible from proposed RRF.	Continuous sampling using TEOM sampler as per general requirements of AS3580.9.8-2001 (for PM_{10})
Nitrogen Oxide (NO_x)	Ambient Air Quality NEPM pollutant. NO_x emissions expected from on-site diesel powered vehicles, combustion of landfill gas and combustion of biogas or syngas from treatment of waste in RRF.	Continuous monitoring using analyser as per AS3580.5.1-1993.
Carbon monoxide (CO)	Ambient Air Quality NEPM pollutant. CO emissions expected from on-site diesel powered vehicles, combustion of landfill gas and thermal treatment of waste.	Continuous monitoring using analyser as per AS3580.7.1-1992
Sulfur dioxide (SO_2)	Ambient Air Quality NEPM pollutant. SO_2 emissions expected from on-site diesel powered vehicles, combustion of landfill gas and combustion of waste.	Continuous monitoring using analyser as per AS3580.4.1-1990

A2.2.2.Campaign Based Monitoring

Details of the pollutants and measurement methodologies for the campaign based monitoring are presented in **Table A 4**.

Table A 4 Target Pollutants and Methodology for Campaign Monitoring

Pollutant	Reason for monitoring	Sampling methodology	Sampling duration	Analytical method	Laboratory
Particulates (TSP) and metals	To determine baseline dust levels and associated heavy metal content. Dust levels may be elevated by changes in site activities. Existing local mineral extraction may contribute to dust levels.	High volume sampling as per AS3580.9.3-2003. Metals analysed from filters by USEPA methods IO-3.1 and IO-3.5.	24 hour	Nitric acid digestion and analysis by ICP AES and FMS	ALS
Volatile organic compounds (VOCs)	Benzene, toluene, and xylenes are NEPM Air toxics pollutants. Other VOCs can be measured along with these substances. Residual emissions may be possible from thermal treatment/digestion of waste and combustion of landfill gas.	Passive sampling as per EN 13528-2:2002 and EN 13528-3:2003 methods.	14 day	Thermal desorption GC/MS	CCWA
Carbonyls	Aldehydes and ketones including formaldehyde (NEPM Air toxics pollutant), acetaldehyde, acetone, 2-butanone (NPI reporting substances).	Passive sampling as per EN 13528-2:2002 and EN 13528-3:2003 methods.	7 day	Solvent extraction and HPLC	CCWA
Hydrogen sulfide (H_2S)	Emissions possible from proposed AD and may also be minor component in landfill gases.	Passive sampling as per EN 13528-2:2002 and EN 13528-3:2003 methods.	14 day	ZnS precipitation and methylene blue colorimetry.	CCWA
Polycyclic aromatic hydrocarbons (PAHs)	NEPM Air toxics pollutants. Residual emissions may be possible from thermal treatment of waste and combustion of landfill gas.	High volume sampling with quartz filter and PUF adsorbent as per USEPA TO-13A.	24 hour	USEPA SW 846 8270 GC-MS SIM mode	ALS
Polycholor-dibenzo-*p*-dioxins and polychloro-dibenzofurans ('dioxins')	Dioxin and furan emissions may be formed in the thermal treatment processes. Trace levels may be produced from combustion of landfill gas.	High volume sampling with quartz filter and PUF adsorbent as per USEPA TO-9A	24 hour	High resolution GC-MS	ALS
Hydrogen chloride (HCl)	HCl emissions may result from chlorine present in wastes that would report to syngas and be discharged in the	Passive samplers for HCl as per EN 13528-2:2002 and EN 13528-3:2003 methods	7 day	Ion chromatography	CCWA

	combustion waste gas emissions.				
Hydrogen fluoride (HF)	HF emissions may result from fluorine containing materials (e.g. fluoropolymers such as Teflon) that may be present in wastes that would report to syngas and be discharged in the combustion waste gas emissions.	Passive samplers for HF as per EN 13528-2:2002 and EN13528-3:2003 methods.	14 day	Ion selective electrode	CCWA
Particulates (PM_{10})	Monitored only at Hidden Valley on a campaign basis for comparison to other sites.	High volume sampling as per AS3580.9.6-2003	24 hour	Gravimetric analysis of filter as per AS2724.3-1984	ALS

The results from the three sampling campaigns at the Toodyay Rd and Hidden Valley sites and the five campaigns conducted at the Red Hill Lot 12 site are summarised in **Table A 5** below.

Table A 5 Summary of Results from Campaign Monitoring

Parameter	Units	Location			Blank
		Lot 12	Hidden Valley	Toodyay Rd	
HCl	µg/m³	< 5 to 5.7	< 5 to 12	< 5 to 6.7	< 5 to 3.8
HF	µg/m³	<2 to 0.13	<2 to 0.13	< 0.13 to < 2	< 0.13 to < 2
H_2S	µg/m³	< 0.4 to 0.8	0.4 to 0.9	< 0.4 to < 0.8	< 0.4 to < 0.8
PAHs	ng/m³ (BaP)	3.2 to 19.2	1.7 to 7.7	1.4 to 1.6	1.2
Dioxins (lower bound)	pg WHO-TEQ/m³	0 to 0.0002	0 to 0.0005	0 to 0.0002	0.003
Dioxins (middle bound)	pg WHO-TEQ/m³	0.09 to 0.1	0.9	0.9	0.1
Dioxins (upper bound)	pg WHO-TEQ/m³	0.2	0.2	0.2	0.2
TSP	µg/m³	11 to 28	11 to 32	11 to 74	3.8
Antimony	µg/m³	<0.01	<0.01	<0.01	<0.01
Arsenic	µg/m³	<0.01	<0.01	<0.01	<0.01
Barium	µg/m³	<0.1	<0.1	<0.1	<0.1
Beryllium	µg/m³	<0.01	<0.01	<0.01	<0.01
Cadmium	µg/m³	<0.005	<0.005	<0.005	<0.005
Chromium	µg/m³	< 0.01 to 0.004	< 0.01 to 0.004	< 0.01 to 0.004	0.004
Cobalt	µg/m³	<0.01	<0.01	<0.01	<0.01
Copper	µg/m³	< 0.01 to 0.003	< 0.01 to 0.004	0.006	0.007
Manganese	µg/m³	< 0.01 to 0.004	< 0.01 to 0.00	0.004 to 0.016	<0.01
Nickel	µg/m³	<0.01	<0.01	<0.01	<0.01
Thallium	µg/m³	<0.01	<0.01	<0.01	<0.01
Zinc	µg/m³	0.02 to 0.06	0.03	0.02 to 0.06	0.01
Vanadium	µg/m³	<0.01	<0.01	< 0.01 to 0.008	<0.01

Lead	$\mu g/m^3$	<0.010 to 0.01	<0.01	<0.01	<0.01
Mercury	$\mu g/m^3$	<0.001	<0.001	<0.001	<0.001
Benzene	$\mu g/m^3$	0.05-0.26	0.06-0.11	<0.02-0.08	<0.02
Benzene, 1,2,4-trimethyl-	$\mu g/m^3$	<0.02	<0.02-0.03	<0.02-0.03	<0.02
Benzene, ethyl-	$\mu g/m^3$	<0.01-0.03	0.03-0.08	0.01-0.05	<0.01
Butylacetate	$\mu g/m^3$	<0.02-0.07	<0.02-0.16	<LOR	<0.02
Ethene, tetrachloro-	$\mu g/m^3$	<0.1	<0.01-0.02	<0.01-0.01	<0.01
Heptane	$\mu g/m^3$	<0.02-0.18	<0.02-0.09	<0.02-0.09	<0.02
Hexan-1-ol, 2-ethyl-	$\mu g/m^3$	<0.03-0.19	<0.03-0.05	<0.03	<0.03
Hexane	$\mu g/m^3$	<0.02-0.13	0.03-0.21	<0.02-0.13	<0.02
Limonene	$\mu g/m^3$	<0.1-0.4	0.12-0.43	<0.1-0.35	<0.1
Octane	$\mu g/m^3$	<0.03-0.06	<0.03	<0.03	<0.03
Pinene, □	$\mu g/m^3$	<0.1-0.5	0.17-0.86	<0.1-1.5	<0.1
Styrene	$\mu g/m^3$	<0.01-0.02	0.01-0.02	<0.01-0.02	<0.01
Toluene	$\mu g/m^3$	<0.08-0.51	0.23-0.6	0.15-0.49	<0.01
Undecane	$\mu g/m^3$	<0.02-0.07	<0.02-0.05	<0.02-0.06	<0.02
Xylene, m- & p-	$\mu g/m^3$	<0.02-0.14	0.05-0.13	0.01-0.12	<0.02
Xylene, o-	$\mu g/m^3$	<0.01-0.03	0.03-0.08	<0.01-0.06	<0.01
Formaldehyde	$\mu g/m^3$	1 to 1.8	1.3 to 1.5	1.2 to 1.7	0.3 to 0.4
Acetaldehyde	$\mu g/m^3$	< 0.1 to 0.8	< 0.1 to 0.8	< 0.1 to 0.8	< 0.1 to 0.3
Acetone	$\mu g/m^3$	< 0.1 to 0.6	< 0.1 to 0.3	< 0.1 to 0.3	< 0.1 to 0.3
Acrolein	$\mu g/m^3$	< 0.2 to 1.3	< 0.2 to 1.3	< 0.2 to 0.9	0.1 to 3
Propionaldehyde	$\mu g/m^3$	< 0.2 to 0.5	0.1 to 0.3	0.2 to 0.5	< 0.1 to 0.3
Crotonaldehyde	$\mu g/m^3$	< 0.1 to 2.2	0.3 to 1.8	0.2 to 1.7	0.2 to 1.8
Methacrolein	$\mu g/m^3$	< 0.4 to 0.8	0.1 to 0.7	< 0.4 to 0.1	< 0.1 to 0.6
Butyraldehyde	$\mu g/m^3$	< 0.1 to 1.3	< 0.1 to 0.8	< 0.1 to 0.8	< 0.1 to 0.5
2-Butanone	$\mu g/m^3$	< 0.1 to 1.1	< 0.1 to 1	< 0.1 to 1.1	< 0.1 to < 0.4
Benzaldehyde	$\mu g/m^3$	< 0.1 to 0.2	< 0.1 to 0.2	< 0.1 to 0.2	< 0.1 to 0.1
Valeraldehyde	$\mu g/m^3$	< 0.2 to 0.2	0.2 to 1.8	< 0.2 to 0.2	< 0.2 to 0.1
Tolualdehyde	$\mu g/m^3$	< 0.1 to 0.5	< 0.1 to 0.5	< 0.1 to 0.6	< 0.1 to 0.3
Hexaldehyde	$\mu g/m^3$	< 0.1 to 2.8	< 0.1 to 2.7	< 0.1 to 2.5	< 0.2 to 0.3

The AQMS were operated and maintained by Benchmark Monitoring Pty Ltd (Benchmark) and the data generated were subjected to validation by Benchmark. Valid data capture rates of above 90% were achieved for all parameters over the four month period. This indicates the data adequately represents the air quality over that period.

A3. CALPUFF Modelling of Air Emissions

The air dispersion modelling was conducted using CALPUFF to predict the GLCs of emissions from the proposed RRF. Those predicted GLCs were then compared with air quality guidelines and standards to assess the potential impact of air emissions at sensitive receptors near to the Subject Site.

A3.1 CALPUFF model set up

CALPUFF V6.42 was used to conduct the dispersion modelling. The model set up included the following options:-

- computational domain was a 12 km x 12 km grid with gridded receptors at 250 m intervals;
- PRIME algorithms were used to include the effects of building downwash; and
- no chemical transformations or deposition were modelled to give a worst case scenario.

A3.2 Background Air Quality Data Handling

Varying guidance is available on the correct handling of the background air quality data. DEC NSW advocate the use of the 100th percentile from a year of continuous monitoring (DEC NSW, 2005) while EPA Victoria allows the addition of the 70th percentile or maximum background data (VIC EPA, 2001). The use of the 100th percentile is extremely conservative and may lead to overestimation of the highest impacts due to the low probability of these impacts from the proposed RRF coinciding with the highest background concentration because there are multiple, independent sources of the pollutants. A more sophisticated way of handling background data may be to use a probabilistic risk assessment approach where the distribution of the ambient background data is merged with the distribution of the model predictions at a sensitive receptor (Wiebe *et al.*, 2011). However, this type of approach was considered unnecessarily complicated for this stage in the potential emissions impacts assessment.

Some of the results from the discrete monitoring were reported as less than the limit of reporting (LOR). In other words, the true concentration is somewhere between zero and the LOR. This presents an issue with the selection of an appropriate concentration value for the assessment based on a non-detect result. Various approaches can be considered from treatment of left-censored data, i.e., values below the LOR, where the true concentration is not known with quantifiable uncertainty. A number of statistical treatments can be considered, e.g., Maximum Likelihood Estimation and Regression on Order Statistics, however, these generally require a relatively large number of observations to provide adequate statistical power in the treatment. A common approach, that does not consider the underlying distribution of values, is to assign a fraction of the LOR as the concentration for the assessment. This typically involves the use of 100%, 50% or 0% of the LOR, depending on the level of conservatism applied to the assessment.

The averaging times from the discrete monitoring varied with parameter from 24 hours to 14 days. These times did not align with the averages specified in the guidelines and standards used for the impact assessment. Where 24 hour data were available, the USEPA conversion factor of 0.4 was applied to generate the 1 hour averages. In the absence of guidance on methodology to re-average data from background sampling conducted over several days (maximum duration 14 days) to 1 hour averages the factor to convert from 24 hours to 1 hour (as per US EPA guidance) was used to convert the maximum concentration observed during the sampling campaigns, irrespective of the duration. It is not possible to predict if this is an under or over estimate of the actual hourly average concentration, however it provides a conservative outcome compared with simply using the measured concentration from longer averaging periods for assessment of the impacts against a guideline or standard with a shorter averaging period.

A3.3 Meteorological Modelling

CALPUFF requires wind fields generated from the CALMET model. CALMET uses meteorological data in addition to terrain and land-use data to generate wind fields for the modelled period. Terrain and land use data available from the United States Geological Survey were employed.

The parameters of the TAPM and CALMET modelling domains are summarised in **Table A 6**. The domain used for the CALMET modelling was defined from the South Eastern corner with UTM coordinates 415 E 6478 N. The domain extended 12 km to the north and 12 km to the east with a grid spacing of 0.25 km and encompassed the major terrain features of the area.

Table A 6 TAPM and CALMET Parameters for modelling using EMRC meteorological data

Grid Parameter	Value
TAPM (v4.0.4)	
Grid reference origin (UTM)	415686 mE, 6478083 mS
Number of grid nesting (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grid points	25 x 25 x 25
Modelling period	1st January 2011 to 31st Dec 2011
Data assimilation	None
CALMET (v6.1)	
Grid reference origin	409686 mE, 6472083 mS
Grid spacing	0.25 km
Domain size	12 km x 12 km
Number of grid points	48 x 48 x 10
Projection	UTM Zone 50
Hemisphere	S
Number of vertical layers	10
Call face heights	0, 20, 40, 80, 160, 320, 640, 1200, 2000, 3000, 4000
Local time zone	UTC+8
Modelling period	1st January 2011 to 31st Dec 2011
Length of modelling period	8760 h
Geoid ellipsoid	WGS-84
Region	Global (as per WGS-84)
Datum	WGS-84

A3.4 Impact Assessment

Four months of continuous ambient air quality data were collected to facilitate the cumulative assessment. This included concentrations of CO, NO_2, SO_2, PM_{10} and $PM_{2.5}$ at two AQMS located at Lot 12 of the Red Hill WMF and offsite at a nearby residence on Toodyay Road (Synergetics 2011).

The concentrations of NO_X and particulates at the Toodyay Rd AQMS were marginally higher than the Red Hill AQMS; hence the Toodyay Road data were used for the background data for these parameters. SO_2 concentrations were slightly higher at the Red Hill AQMS and therefore this data was used for the SO_2 background in the cumulative assessment.

The four months of available ambient air quality data spanned the change of season therefore providing the two extremes of conditions for generation and dispersion of particulate emissions. In particular the drier months provide greater opportunity for generation of fugitive emissions of crustal particulates, whereas the cooler, wetter months provide greater opportunity for emissions of smoke derived particulates from wood fired heating and forest burn-offs. An estimate of the likely annual concentration of pollutants based on the data obtained over the four months of the monitoring campaign was made using a 0.08 conversion factor from the US EPA for scaling emissions from stationary sources from hourly averages to annual averages (US EPA 1992).

The 95th percentile concentrations for NO_2, SO_2, CO and PM_{10} from continuous data collected at the respective AQMSs were added to the model predictions across the modelled domain for assessments of the cumulative impacts. This provides a reasonable compromise between the use of the excessively conservative 100th percentile observed background concentrations, as advocated by DEC NSW, and the 70th percentiles from EPA Victoria. A high level of conservatism is maintained while not leading to highly unlikely outcomes from use of the maximum values.

Data from discrete monitoring campaigns were also available for VOCs (including aldehydes and ketones), heavy metals, polychlorodibenzo-*p*-dioxins and polychlorodibenzofurans ("dioxins"), PAHs, hydrogen chloride and hydrogen fluoride from three locations in the vicinity of the Red Hill WMF (Synergetics, 2011). Unless otherwise indicated, the maximum measured concentration of each of these substances was used as the respective background value since the relatively small number of samples from the five campaigns (total of 11) precluded generation of a meaningful 95th percentile concentration. This approach provides a conservative approach in the assessment of these substances since the sample concentrations are based on considerably longer sampling durations (many days).

Some substances were not detected in the monitoring programme. Background concentrations for those substances were derived from use of 50% of LOR concentration, which was considered a reasonable compromise between the use of zero concentrations (which provides a low level of conservatism) and use of 100% of the LOR (which provides excessive conservatism).

Similarly, the middle bound total toxic equivalency concentrations for dioxins were used to determine a background concentration for this assessment.

A4. Assessment of Emissions

A4.1 Dispersion Modelling Results for Gasification Facility

The results derived from modelling of emissions from a 200,000 tpa gasification facility are presented in **Table A 7** for the direct impact of the facility.

Table A 7 Impact Assessment of the Maximum Offsite Concentrations for the Modelled Gasification Facility

Emission	Assessment Criteria (µg/m^3)	Average Period	Predicted Maximum Concentration (µg/m^3)		Assessment Criteria (%)	
			At Discrete Receptor	Anywhere on Grid	At Discrete Receptor	Anywhere on Grid
Arsenic	0.09	1h	0.00001	0.00003	0.02%	0.03%
	0.003	Annual	0.0000004	0.000002	0.01%	0.07%
Benzo(a)pyrene	0.4	1h	0.00002	0.00004	0.004%	0.009%
	0.0003	Annual	0.0000006	0.000003	0.2%	1.0%
Benzene (1)	29	1h	0.05	0.1	0.2%	0.3%
Cadmium	0.018	1h	0.00001	0.00003	0.08%	0.2%
	0.005	Annual	0.0000005	0.000002	0.009%	0.05%
CO	100000	15 min	12	23	0.01%	0.02%
	60000	30 min	11	20	0.02%	0.03%
	30000	1h	9.4	17	0.03%	0.06%
	11249	8h	7.5	13	0.07%	0.1%
Cobalt	0.1	24h	0.000003	0.000009	0.003%	0.009%
Chromium^{III} (2)	10	1h	0.00005	0.00009	0.0005%	0.001%
Chromium^{VI} (3)	0.0002	Annual	0.0000002	0.0000008	0.08%	0.4%
Copper	1	24h	0.0002	0.0005	0.02%	0.05%
Dioxins (TEQ)	0.000001	1h	6.5×10^{-9}	1.2×10^{-8}	0.7%	1.2%
HCl	100	1h	1.5	2.9	1.5%	2.9%
HF	100	1h	0.02	0.03	0.02%	0.03%
Mercury	1.8	1h	0.0009	0.002	0.05%	0.09%
	1	Annual	0.00003	0.0001	0.003%	0.01%
Manganese	18	1h	0.00009	0.0002	0.001%	0.004%
	0.15	Annual	0.000003	0.00002	0.002%	0.01%
Nickel	0.18	1h	0.00003	0.00006	0.02%	0.1%
	0.003	Annual	0.000001	0.000005	0.03%	0.2%
NO_2 (4)	61.6	Annual	0.65	3.3	0.6%	5.4%
	246.4	1h	21	40	8.6%	16%
Lead	0.5	Annual	0.00005	0.0003	0.01%	0.05%
$PM_{2.5}$ (5)	8	Annual	0.007	0.04	0.09%	0.4%
	25	24h	0.08	0.3	0.3%	1.0%
PM_{10} (6)	50	24h	0.08	0.3	0.2%	0.5%
Antimony	9	1h	0.00003	0.00007	0.0004%	0.003%
SO_2	500	10 min	9.7	18	2.0%	14%
	571.8	1h	9.0	17	1.6%	11%
	57.2	Annual	0.3	1.4	0.5%	2.5%
	228.7	24h	3.2	10	1.4%	4.4%
Thallium	1	1h	0.000004	0.000007	0.0004%	0.003%
	0.1	Annual	0.0000001	0.0000006	0.0002%	0.001%
TSP	90	24h	0.08	0.3	0.09%	0.3%
Vanadium	1	24h	0.000007	0.00002	0.001%	0.002%

Notes [1] Assumed TOC is 100% benzene
[2] Assumed total Cr emissions comprises 90% Cr^{III}
[3] Assumed total Cr emissions comprises 10% Cr^{VI}
[4] Assumed NO_X emissions comprised 100% NO_2
[5] Assumed $PM_{2.5}$ is 100% of TSP emissions
[6] Assumed PM_{10} is 100% of TSP emissions

A4.2 Dispersion Modelling Results for AD Option 1 (Continuous Process)

A4.2.1.Continuous Technology Description

AD Option 1 involves the following key processes:

- waste preparation;
- addition of percolate from waste handling operations to the waste (to inoculate the waste);
- anaerobic digestion of the waste and percolate;
- recovery of biogas;
- biogas cleaning and combustion in spark ignition engines;
- generation of electricity; and
- residue organics recovery and pelletising.

This assessment considers the impacts of air emissions discharged from the exhausts of the engines as well as biogas burner (for the biodryer) and the flare.

A4.2.2.Facility Layout

The layouts of the buildings used to model the AD processes were taken from the facility description provided for the EOI process. The four emissions sources (S1 to S4) and the main plant buildings and structures modelled are illustrated at the Subject Site in **Figure A 1.**

Figure A 1 Layout of Building for Modelling of AD Option 1 Facility

The characteristics of the four emissions sources associated with AD Option 1 were used for input into the CALPUFF model (see **Table A 8**).

Table A 8 Stack Emission Source Parameters

Parameter	Source 1 (S1)	Source 2 (S2)	Source 3 (S3)	Source 4 (S4)
Name	Biogas burner	Flare[1]	Gas Engine A	Gas Engine B
X coordinates	415.694	415.709	415.746	415.742
Y coordinates	6478.082	6478.124	6478.086	6478.083
Stack height (m)	8	10	8	8
Stack diameter (m)	0.74	1.28	0.51	0.51
Exit velocity (m/s)	15	15	15	15
Exit temperature (K)	523	750	523	523

Notes [1] Source 2 was modelled as an enclosed flare based on the information provided by the technology supplier.

A4.2.3.Dispersion Modelling Results for the AD Option 1

The results derived from modelling of emissions from a 150,000 tpa AD facility are presented in **Table A 9** for direct impact of the emission sources.

The results show that no exceedances of the ambient air assessment criteria are predicted at discrete receptors or any other location in the modelling domain for the various emissions parameters, for both the direct impact and when background concentrations of the parameters are considered. This suggests that operation of this type of AD facility at 150,000 tpa throughput would be highly unlikely to give rise to unacceptable health impacts, even in the presence of existing air pollutants from other sources.

Table A 9 Maximum Predicted GLCs from Modelling of AD Option 1 Emissions

Pollutant	Standard concentration (µg/m³)	Averaging period	Predicted maximum (µg/m³)						% of standard					
			At discrete receptor			Anywhere on grid			At discrete receptor			Anywhere on grid		
			Gas engines	Biogas burner	Flare	Gas engines	Biogas burner	Flare	Gas engines	Biogas burner	Flare	Gas engines	Biogas burner	Flare
CO	100000	15 min	231	8.0	2.1	453	31	8.2	0.2	0.01	0.002	0.5	0.03	0.008
	60000	30 min	201	7.0	1.8	394	27	7.2	0.3	0.01	0.003	0.7	0.05	0.01
	30000	1h	175	6.1	1.6	343	24	6.2	0.6	0.02	0.005	1.1	0.08	0.02
	11249	8h	97	3.2	0.5	243	15	3.8	0.9	0.03	0.005	2.2	0.13	0.03
NMVOC (as benzene)	29	1h	9.4	3.0	0.2	18	12	0.6	32	10	0.5	63	40	2.2
Formaldehyde	100	30 min	4.8	N/A	N/A	9.4	N/A	N/A	4.8	N/A	N/A	9.4	N/A	N/A
	20	1h	4.2	N/A	N/A	8.2	N/A	N/A	21	N/A	N/A	41	N/A	N/A
NOx (as NO_2)	61.6	Annual	2.0	0.34	0.1	11	2.0	0.8	3.2	0.6	0.2	18	3.2	1.2
	246.4	1h	62	12	4.7	123	47	19	25	4.9	1.9	50	19	7.6
SO_2	500	10 min	4.2	2.4	16	8.2	9.2	63	0.8	0.5	3.2	1.6	1.8	13
	571.8	1h	3.9	2.2	15	7.6	8.5	59	0.7	0.4	2.6	1.3	1.5	10
	57.2	Annual	0.12	0.06	0.3	0.7	0.36	2.4	0.2	0.1	0.5	1.2	0.6	4.1
	228.7	24h	1.0	0.6	3.8	2.7	2.6	19.5	0.4	0.2	1.7	1.2	1.1	8.5

N/A = not assessed. Formaldehyde is not a significant emission for this source

A4.3 Dispersion modelling results for AD Option 2 (Batch Technology)

A4.3.1.AD Option 2 (Batch Technology) Description

AD Option 2 involves the following key processes:

- waste preparation and mixing;
- inoculation of waste;
  - addition of digestate and percolate to fresh waste; and
  - loading of inoculated waste into digesters.
- anaerobic digestion of the waste;
- recovery of biogas;
- biogas conditioning and combustion in spark ignition engines;
- generation of electricity;
- unloading of digesters, residue composting and maturation; and
- recovery and export of matured compost.

This assessment considers the impacts of air emissions discharged from the exhausts of the engines and the flare.

A4.3.2.Facility Layout

The layout of the buildings to model AD Option 2 was derived from the specifications provided during the EOI process. Three emission sources are indicated, namely two gas engines and the flare. The layout of the major structures at Site B2 is illustrated below in **Figure A 2**.

Figure A 2 Layout of Building for the AD (Option 2) Modelling

The stack characteristics were provided by the technology supplier, however the details of the flare were not available at the EOI stage of the project since the design specification is dependent on the final design of the AD process which would occur at the time of tendering for the project. For the purposes of this assessment, it was assumed that the flare would be an enclosed flare similar to that detailed for the AD Option 1 process. The technology supplier has advised that the flare would operate only during periods of digester change-over, which would occur twice a day. A flaring period of 2 to 2.5 hours would result for each change-over with approximately 43 m^3/h biogas being flared per digester. Therefore, if two digesters were being changed at the same time then a biogas feed rate to the flare of 85.6 m^3/h would occur. The volume of combustion air required for flaring of that volume of biogas was calculated to be 1088 m^3/h using the landfill gas flaring methodology from the UK EA (UK EA 2002) and a biogas methane content of 57% as provided by the supplier. The flare diameter of 0.32 m was used in the modelling to maintain a nominal 15 m/s exit velocity with the emission flow rate derived from the biogas and combustion air feed rates. An exhaust temperature of 750°C was calculated which is consistent with that provided by the AD Option 1 technology supplier for a similar sized flare.

For the gas engines, the supplier advised that heat recovery technology is an option that can be provided, which results in a reduction in the stack temperature from 450°C to 180°C. It was assumed that heat recovery would be adopted to provide the maximum benefit from the process and therefore the lower stack temperature was used in the modelling.

The characteristics of the three emissions sources associated with AD Option 2 used for input into the CALPUFF model are presented in **Table A** .

Table A 10 AD Option 2 Stack Emission Source Parameters

Parameter	Source 1 (S1)	Source 2 (S2)	Source 3 (S3)
	Flare	Gas Engine A	Gas Engine B
X coordinates	415.741	415.747	415.749
Y coordinates	6478.048	6478.029	648.024
Stack height (m)	10	10	10
Stack diameter (m)	0.32	0.7	0.7
Exit velocity (m/s)	15	13	13
Exit temperature (K)	1023	453	453

A4.3.3.Dispersion Modelling Results for AD Option 2 Facility

The predicted maximum GLCs for the facility for the three emissions sources are presented in **Table A 11** for the direct assessment. The contours for the maximum predicted 1 hour NO_X GLCs from dispersion of emissions from the gas engines is illustrated in **Figure A 3**.

The results show that the engine provides the greatest potential impact, in particular for NOx (as NO_2) and formaldehyde which show the maximum 1 hour average concentrations that are 44% and 38% of the assessment criteria at discrete receptors, respectively (**Table A 11**). The flare will run concurrently with the gas engines for 2 to 3 hours a day and therefore the emissions impacts would be combined during these periods. However, since the flare emissions are very low, then the combined impacts of the flare and gas engines which occur during the day are unlikely to exceed the worst case emission impacts predicted for the engines, which occur during the night (the highest 50 hourly averages fell between 6 pm and 6 am) when the flare would not be operational.

Table A 11 Impact Assessment of the Emission from the AD Option 2 Facility

Pollutant	Standard Concentration ($\mu g/m^3$)	Averaging Period	Predicted Maximum ($\mu g/m^3$)				% of Standard			
			At Discrete Receptor		Anywhere on Grid		At Discrete Receptor		Anywhere on Grid	
			Gas Engines	Flare	Gas Engines	Flare	Gas Engines	Flare	Gas Engines	Flare
CO	100000	15 min	95	1.0	154	6.6	0.1	0.001	0.2	0.007
	60000	30 min	83	0.9	134	5.7	0.1	0.001	0.2	0.01
	30000	1h	72	0.8	117	5.0	0.2	0.003	0.4	0.02
	11249	8h	30	0.3	69	1.48	0.3	0.002	0.6	0.01
NMVOC (as benzene)	29	1h	8.5	0.08	14	0.50	29	0.3	47	1.7
Formaldehyde	100	30 min	8.8	N/A	14	N/A	8.8	N/A	14	N/A
	20	1h	7.7	N/A	12	N/A	38	N/A	62	N/A
NOX (as NO_2)	61.6	Annual	2.9	0.01	7.9	0.142	4.7	0.02	13	0.2
	246.4	1h	109	1.9	177	12	44	0.8	72	5.0
SO_2	500	10 min	6.5	0.1	10	0.82	1.3	0.03	2.1	0.2
	571.8	1h	6.0	0.1	9.7	0.76	1.0	0.02	1.7	0.1
	57.2	Annual	0.2	0.0006	0.4	0.0086	0.3	0.001	0.7	0.02
	228.7	24h	1.4	0.01	2.7	0.075	0.6	0.006	1.2	0.03

The results show that no exceedances of the ambient air assessment criteria are predicted at discrete receptors or any other location in the modelling domain for the various emissions parameters, for both the direct impact and the cumulative impact when background concentrations of the parameters are considered. This suggests that that operation of an AD (Option 2) facility at 150,000 tpa throughput would be highly unlikely to give rise to unacceptable health impacts, even in the presence of existing air pollutants from other sources.

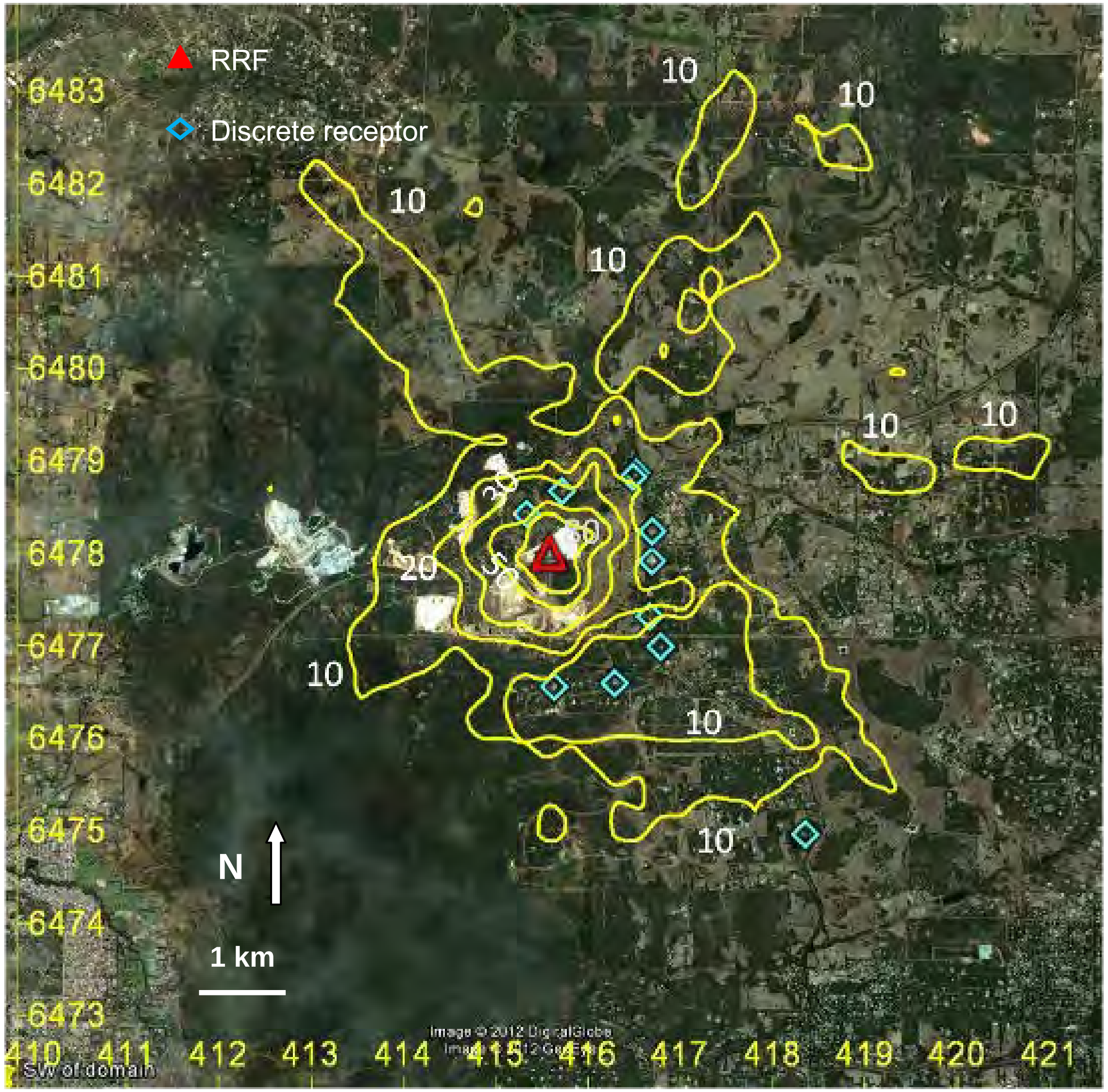


Figure A 3 Maximum 1hr NO_X Concentration Contours ($\mu g/m^3$) for Emissions from Engines

A5. Air Quality Environmental Impacts

A5.1 Point Source Emissions

The largest potential risk to air quality relates to chemical gases (including odorous compounds), greenhouse gases and/or particulate matter being emitted from the facility at levels above the environmental and health regulatory standards defined in the Ministerial Statement. The potential long term impacts associated with the occurrence of an air or particulate matter emission breach include:

- human health issues arising from direct exposure (e.g. air inhalation and incidental ingestion of soil or rainwater from tanks) or indirect exposure (foodchain exposures through human consumption);
- deterioration of the health of surface water ecosystems from exposure to airborne pollution (locally and downstream);
- deterioration of the health of terrestrial (including migratory species) flora and fauna, and disruption of terrestrial ecosystems from exposure to airborne pollution;
- biomagnification of contaminants through different trophic levels, and/or bioaccumulation of contaminants within trophic levels, in surrounding terrestrial and/or aquatic ecosystems;
- degradation of buildings and structures over time through chemical erosion; and
- regional impacts, such as depletion of O_3, increase of pollution in the wider Perth airshed and contribution to global warming.

A5.2 Fugitive Emissions

Fugitive emissions (including gas or vapour leaks) may impact the surrounding environment if emitted in excessive quantities. Potential impacts on the surrounding environment from fugitive emissions of gases and/or particulates at levels above the environmental and health regulatory standards are expected to be the same as those listed in **Section A5.1** for point source emissions.

A5.3 Key Air Pollutants

The key air pollutants that may be generated from the RRF and their potential impacts are described below. The generation of these gases and particulates can cause both environment and/or human health impacts.

A5.3.1. Carbon Oxides

Carbon monoxide (CO) is an odourless, tasteless gas that is poisonous to humans. CO reduces the amount of oxygen carried by haemoglobin around the body in red blood cells which can affect the functioning of vital organs, such as the brain, nervous tissues and the heart (DSWEPC 2005a).

Carbon dioxide (CO_2) is a colourless gas which is odourless at low concentrations and has a sharp, acidic odour at high concentrations. High levels of CO_2 can cause asphyxiation and nose and throat irritation.

CO_2 is a key gas contributing to global warming by increasing the natural greenhouse effect. CO_2 in the atmosphere absorbs infrared (long wave) radiation emitted from the ground and re-emits the infrared radiation in all directions. Some of this infrared radiation is emitted back towards the earth leading to a net warming of the surface (BOM n.d.).

A5.3.2. Nitrogen Oxides

Nitrogen oxides (NO_x) are produced through the process of combustion. NO_x is a broad term which includes nitric oxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O), or mixtures of these compounds. NO_x are all precursors of photochemical smog (WA EPA 2011). Photochemical smog is the reaction of ozone (O_3), NO_x and volatile organic compounds (VOCs) in sunlight and at high temperatures. The resulting combination of these chemicals forms a layer of visible, brown or white haze in the sky. Photochemical smog can impact human health by causing respiratory problems (WA EPA 2011).

NO_x gases react with other air pollutants to form gases such as O_3. NO_x can also contribute to the process of eutrophication. Eutrophication occurs when water bodies increase in nutrients which cause a reduction of oxygen therefore impacting aquatic flora and fauna (US EPA 2010).

NO_x is also a precursor for acidification or acid rain which is produced by a number of chemical reactions to produce nitric acid (HNO_3). Acid rain or acid pollutants can be deposited on the ground either through rain, fog, gases or particulates. Acid rain can impact flora and vegetation through direct contact and cause acidification of soils and also damage the built environment (SA EPA 2004). However, it should be noted that Australia has not experienced problems associated with acid rain due to the small emissions produced (in a global context) and our geographical isolation from pollution caused by other countries (SA EPA 2004).

At high concentrations, NO_2 can reduce plant growth and cause visible damage to foliage. It can also react with surfaces, fabrics, furnishings and reduce visibility (WA EPA 2011).

NO_x gases can affect human health by reacting with ammonia, moisture and other compounds to form small particles which penetrate into the lungs causing or worsening respiratory diseases. Health effects may include emphysema, bronchitis and aggravation of existing heart disease (US EPA 2010).

A5.3.3. Sulfur Dioxide

SO_2 is a colourless, non-flammable gas with a sharp and unpleasant smell. SO_2 reacts easily with other substances to form harmful compounds, such as sulfuric acid, sulfurous acid and sulfate particles (DSEWPC 2005b). SO_2 oxidises in air to produce sulfite (SO_3) which can then dissolve in atmospheric water to forms sulfuric acid and potentially acid rain (WA EPA 2011).

SO_2 is a fast acting nose, throat, and lung irritant which can cause coughing, wheezing, shortness of breath or a tight feeling around the chest. People predisposed with asthma or similar conditions are more susceptible (DSEWPC 2005b).

A5.3.4. Lead

Lead is a soft metal found in air in the form of very small particles. The natural concentration of lead in the air is less than 0.1 $\mu g/m^3$. Lead can be absorbed by humans if dust or fumes that contain lead are swallowed or breathed in (DSEWPC 2005c). High levels of lead in the body can cause pain in joints and muscles, anaemia, nausea, gastric problems, sleep problems, concentration problems, headaches, and high blood pressure. Children are more susceptible to lead exposure causing poor development of motor abilities and memory, reduced attention span and colic and gastric problems (DSEWPC 2005c).

A5.3.5. Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are a complex class of organic compounds containing two or more fused aromatic rings and only carbon and hydrogen atoms. PAHs are released into the atmosphere as a complex mixture of compounds during incomplete combustion of organic matter. A number of PAHs are either known or suspected carcinogens (DSEWPC 2009).

A5.3.6.Dioxins

Dioxins are a group of persistent halogenated aromatic hydrocarbon chemicals that include polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) that are by-products of combustion. Co-planar polychlorinated biphenyls (PCBs) can also be considered when assessing dioxins impacts due to their dioxin-like toxicology. The brominated analogues polybrominated dibenzo-*p*-dioxins (PBDDs) and polybrominated dibenzofurans (PBDFs) can also be found in emissions from combustion of bromine containing materials. Dioxins are highly persistent environmental pollutants. Greater than 90% of human exposure to dioxins and furans is through food, predominantly meat and dairy products, fish and shellfish (WHO 2010). Due to their chemical stability and ability to be absorbed into fat tissue, dioxins can remain in the body for long periods of time. Dioxins half-life in the body is estimated to be seven to 11 years (WHO 2010).

Short-term exposure to high levels of dioxins may result in skin lesions (chloracne), patchy darkening of the skin and altered liver function. Long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions. Chronic exposure of animals to dioxins has resulted in several types of cancer (WHO, 2010).

A5.3.7.Particulates

Particulate matter is a complex mixture of solid particles and liquid droplets. Particulates can consist of number of inorganic and organic components, including sulfates, nitrates, ammonia, sodium chloride, carbon, mineral dust and acids (WHO 2008).

Particulates may inhibit visibility and can be transported by wind over varying distances to then settle on the ground surface, the built environment, vegetation or water bodies. Deposition of particulates may acidify and change the nutrient balance in water bodies, deplete nutrients in soil and affect the diversity of ecosystems (WHO 2008). Dust or particulates may settle on flora and vegetation blocking stomata, inhibiting photosynthesis and causing plant death.

Depending on the size of the particles, they can have the potential to cause minor and serious health problems. PM that is 2.5 micrometers in diameter or less is referred to as $PM_{2.5}$ and PM that is 10 micrometers in diameter or less is referred to as PM_{10}. PM_{10} can pass through the throat and nose and enter the lungs causing serious health effects (US EPA 2003). Further information on particulates an associated human health impacts are outlined in **Section 13.3.3**

Appendix B

Noise

B1. Background Information

B1.1 Measuring Sound

Sound is measured in decibels (dB) and the hearing threshold set at 0dB. Sounds at 0 - 10 dB are so quiet that they are difficult to hear, while sounds at the top end of the scale above 140 dB can cause instant permanent hearing damage. The dB scale is logarithmic with each 10 dB increase perceived as a doubling of loudness. Noise levels are generally A-weighted to represent the way sound is perceived by the human ear, taking into account that people are not as sensitive to lower frequencies as they are to higher frequencies. An A-weighted sound level is described by the symbol dB (A) (WA EPA 2007).

The characteristics of noise (WA EPA, 2007) that can influence how a person responds include, but are not limited to, the following:

- the level of noise (its loudness);
- the frequency (pitch), whether it is high or low;
- how long the noise occurs;
- whether the noise is predictable;
- tonal nature such as ringing or humming, or impulsive nature such as explosions;
- the time of the day the noise occurs;
- the activities of the person affected;
- the relationship between the person affected and the noise;
- familiarity with the noise and its purpose;
- fear of the noise; and
- the person's opinion of the source.

The maximum noise levels deemed acceptable pursuant to the Noise Regulations at noise-sensitive premises are known as assigned noise levels. Acceptable noise is identified in terms of the $\mathbf{L_{A\,max}}$', $\mathbf{L_{A1}}$, and $\mathbf{L_{A1}}$ assigned levels, and takes into account influencing factors (WA EPA 2007).

- $\mathbf{L_{Amax}}$- a noise level which is not to be exceeded at any time.
- $\mathbf{L_{A1}}$ - a noise level which is not to be exceeded for more than 1% of the time, that is, for more than one minute in 100 minutes.
- $\mathbf{L_{A10}}$- a noise level which is not to be exceeded for more than 10% of the time, that is, for more than ten minutes in 100 minutes.

B2. Noise Modelling

B2.1 Existing Modelling Input Parameters

The software used for this study was *SoundPLAN 7.0* with the CONCAWE algorithms selected. Input data required in the model includes:

- meteorological information;
- topographical data;
- ground absorption; and
- source sound power levels.

B2.1.1.Meteorological Information

The meteorological information utilised was based on *EPA Guidance for the Assessment of Environmental Factors No.8 Environmental Noise draft*, (WA EPA 2007) and are shown below in **Table B 1**. These conditions approximate the typical worst-case for enhancement of sound propagation. The EPA policy is that compliance with the assigned noise levels needs to be demonstrated for 98% of the time, during the day and night periods, for the month of the year in which the worst-case weather conditions prevail. In most cases, the conditions in **Table B 1** occur for more than 2% of the time and therefore must be satisfied.

Table B 1 Noise Modelling Meteorological Conditions

Parameter	Night (1900 – 0700)
Temperature (^{0}C)	15
Humidity (%)	50
Wind Speed (m/s)	3
Wind Direction	All
Pasquil Stability Factor	F

Notes: the modelling package used allows for all wind directions to be modelled simultaneously.

At wind speeds greater than those shown above, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

B2.1.2.Topographical Data

Topographical data was already on file from previous projects. This data was updated to include the latest information for the landfill cells. Within the Red Hill WMF, the contours are in 1 m intervals, whereas further away, the interval increases to 5 m.

The topography for the Subject Site of the RRF was levelled out at the nominal level of 290mAHD.

Buildings have also been included as these can provide barrier attenuation when located between a source and receiver, much the same as a hill.

B2.1.3.Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). In this instance, a value of 0.6 has been used as an average for the study area, with Toodyay Road given a value of 0.0.

B2.1.4.Source Sound Power Levels

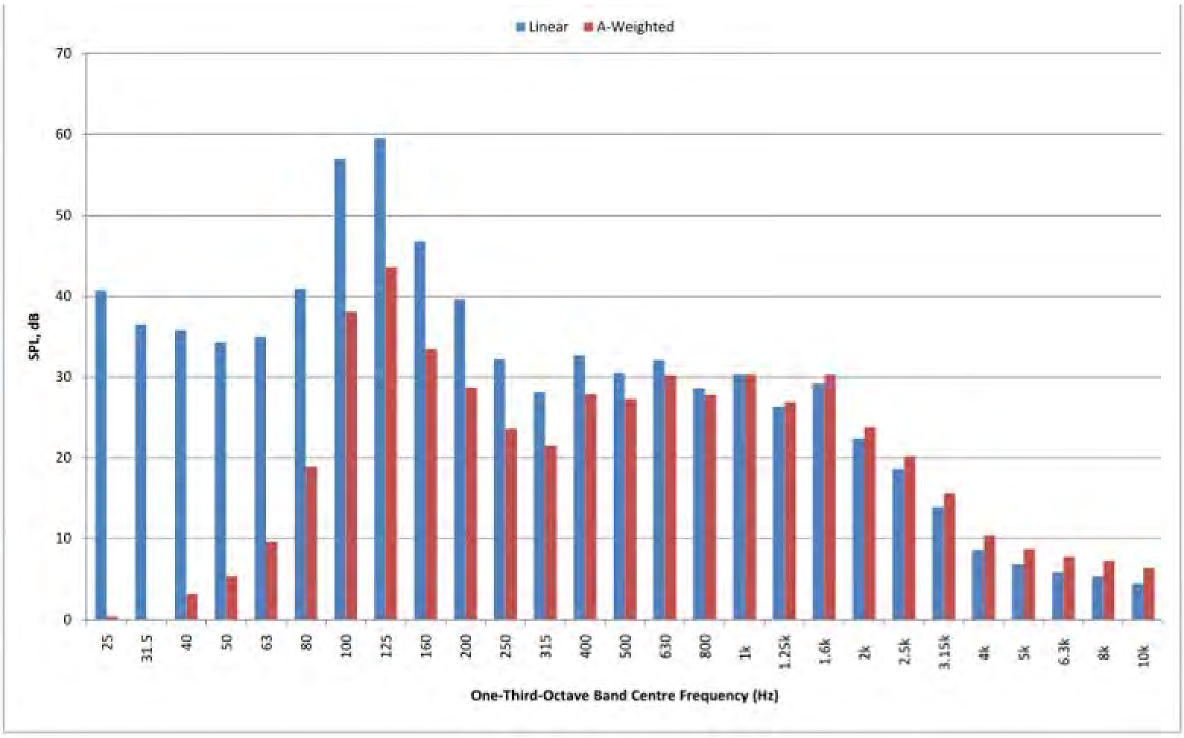
Table B 2 shows the sound power levels which were used in the modelling, which have been calculated from the sound pressure level measurements undertaken on site. These sound power levels were then calibrated against measured levels.

Table B 2 Source Sound Power Levels, dB(A)

Description	Octave Band Centre Frequency (Hz)									Overall
	5	0	00	00	00	00	.6k	.15k	.3k	
	1.5	3	25	50	00	k	k	k	k	
	0	0	60	15	30	.25k	.5k	k	0k	
Power Station										
	45	58	81	82	83	88	87	85	79	
Acoustic Louvre 1	43	60	83	81	85	85	87	81	76	98
	51	72	81	80	85	89	87	79	68	
	46	57	82	81	82	87	88	88	82	
Acoustic Louvre 2	46	65	77	79	84	85	88	84	79	98
	48	68	82	82	87	88	88	80	71	
	46	58	79	84	84	92	89	86	78	
Acoustic Louvre 3	41	63	85	83	87	90	89	84	75	100
	49	69	79	85	86	90	88	82	69	
	44	57	77	77	82	88	90	84	81	
Acoustic Louvre 4	43	61	82	79	85	85	86	82	77	97
	50	67	78	77	85	89	88	79	71	
	45	62	97	86	88	90	86	79	69	
Radiator Fans 1	47	80	77	85	89	89	83	75	9	101
	58	84	86	84	90	88	82	68		
	45	68	96	86	87	90	86	79	68	
Radiator Fans 2	47	80	78	84	90	90	83	75	8	101
	59	83	87	85	90	89	81	69		
	45	68	96	86	88	92	87	80	68	
Radiator Fans 3	48	81	78	86	90	90	84	75	9	101
	59	84	87	85	91	89	82	70		
	46	72	96	89	88	88	86	79	68	
Radiator Fans 4	48	81	76	85	88	88	83	74	8	100
	56	85	84	83	89	89	82	67		
	62	72	93	100	104	103	102	99	100	
Rooftop	63	77	100	98	100	102	101	98	97	114
	65	85	100	104	102	103	99	100	96	
Landfill										

Bomag Compacto r	50	72	88	85	100	103	103	98	90	90
	63	77	95	88	99	102	104	94	88	
	73	79	84	98	103	101	97	93	86	
Cat 973C Dozer	54	76	90	96	106	108	105	107	105	118
	67	78	87	95	104	106	105	108	102	
	70	80	90	101	104	111	105	106	98	
Cat 325L Excavator	45	67	90	85	98	91	88	85	82	103
	50	67	80	87	96	89	88	83	78	
	60	74	83	90	89	90	88	82	73	
Cat 973C Dozer 2	49	65	89	96	102	106	105	108	104	117
	57	68	89	95	101	106	105	108	100	
	63	74	87	99	104	106	106	107	95	

As well as the onsite noise level measurements, another measurement was undertaken on 25 April 2011 at around 9.00pm, at the traffic counter on Toodyay Road, near R01. The results of this measurement indicated a level of just over 45 dB(A). The one-third-octave band analysis is shown in **Graph B 1**. Weather conditions at the time of this measurement were light westerly winds, so worst-case for noise propagation from the power station to R01. This measurement shows the tonal components (100 and 125 Hz) associated with the Power Station.



Graph B 1 Hand Held Noise Measurement 25 April 2011: 8.50pm along Toodyay Road near R01

Results of noise modelling indicate predicted noise levels to this location of 43 dB(A), so the model of the power station may be under-predicting noise levels by around 2-3 dB.

B2.2 Proposed Modelling Input Parameters

To predict the noise emissions from each of the technologies, the computer modelling software *SoundPLAN 7.0* has been used. The following input data used in the baseline modelling was also used for the assessment of the technologies:

- meteorological information;
- topographical data; and
- ground absorption.

Source sound levels that were used were obtained through the EOI process. EMRC required each tenderer to provide noise level information of their proposed technology. From the information provided, typically consisting of sound pressure level information, the sound power levels were calculated and the model run and calibrated against the provided data. In some circumstances, only noise levels inside the building were provided, so in this case a standard transmission loss of a sheet metal building has been assumed.

Appendix C

Odour

C1. Background Information

C1.1 Defining and Measuring Odour

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance goals guide decisions on odour management, but are generally not intended to achieve "no odour".

The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (OU). An odour goal of less than 1 OU would theoretically result in no odour impact being experienced.

Odour concentration is measured in terms of odour units (OU). One OU is the concentration of odour-containing air that can just be detected by 50% of members of an odour panel (persons chosen as representative of the average population sensitivity to odour). This process is defined within *Australian Standard AS4323.3 (2001) Stationary Source Emissions – Part 3: Determination of Odour Concentration by Dynamic Olfactometry*.

An Odour Emission Rate (OER) is the product of the odour concentration (OU) and the volumetric flow rate (m^3/s or m^3/min), and is often annotated as OU.m^3/s, or OU.m^3/min. Alternatively, an odour emission rate can be thought of as the volume of clean air that would be required to dilute the concentration of odorous gas emitted per unit time down to 1 OU.

The Specific Odour Emission Rate (SOER) may be defined as the quantity of odour emitted per unit time from a unit surface area. The quantity of odour emitted is not determined directly by olfactometry, but is calculated from the concentration of odour (as measured by olfactometry) which is then multiplied by the volume of air passing through the measurement system per unit time. SOERs are often annotated as OU.m^3/m^2/s, or OU.m^3/m^2/min.

In practice, the character of a particular odour can only be judged by the receiver's reaction to it, and preferably only compared to another odour under similar social and regional conditions. Based on the literature available, the level at which an odour is perceived to be a nuisance can range from 2 OU to 10 OU depending on a combination of the following factors:

- Odour Quality: whether an odour results from a pure compound or from a mixture of compounds. Pure compounds tend to have a higher threshold (lower offensiveness) than a mixture of compounds.
- Population sensitivity: any given population contains individuals with a range of sensitivities to odour. The larger a population, the greater the number of sensitive individuals it may contain.
- Background level: whether a given odour source, because of its location, is likely to contribute to a cumulative odour impact. In areas with more closely-located sources it may be necessary to apply a lower threshold to prevent offensive odour.
- Public expectation: whether a given community is tolerant of a particular type of odour and does not find it offensive, even at relatively high concentrations. For example, background agricultural odours may not be considered offensive until a higher threshold is reached than for odours from a landfill facility.
- Source characteristics: whether the odour is emitted from a stack (point source) or from an area (diffuse source). Generally, the components of point source emissions can be identified and treated more easily than diffuse sources. Emissions from point sources can be more easily controlled using control equipment. Point sources tend to be located in urban areas, while diffuse sources are more often located in rural locations.

- Health Effects: whether a particular odour is likely to be associated with adverse health effects. In general, odours from agricultural activities are less likely to present a health risk than emissions from industrial facilities.

Odour performance goals need to be designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours, using a statistical approach which depends on the size of the affected population. As the affected population size increases, the number of sensitive individuals is also likely to increase, which suggests that more stringent goals are necessary in these situations. In addition, the potential for cumulative odour impacts in relatively sparsely populated areas can be more easily defined and assessed than in highly populated urban areas. It is often not possible or practical to determine and assess the cumulative odour impacts of all odour sources that may impact on a receptor in an urban environment. Therefore, the proposed odour performance goals allow for population density, cumulative impacts and anticipated odour levels during adverse meteorological conditions and community expectations of amenity.

Discussions with WA DEC (pers. comm. Dave Griffiths, 4 March 2011) have determined that two odour impact criteria apply to this assessment:

- **2.5 OU 99.5th percentile 1 hour concentration** (equivalent to the 44th highest concentration over a year); and,
- **8 OU 99.9th percentile 1 hour concentration** (equivalent to the 9th highest concentration over a year).

C2. Odour Modelling

C2.1 Sensitive Receptors

A number of residential locations have been identified surrounding the Red Hill WMF. These are located on Toodyay Road to the north of the Red Hill WMF, Barbarich Drive, Karrak Court, Persoonia Close and Hillwood Grove to the east of the WMF and Tomallan Close and Hidden Valley Road to the south of the Red Hill WMF.

In total, 27 receptors have been identified and are presented in **Table C1** and **Diagram C1.**

Table C 1 Identification and Location of Sensitive Residential Locations Surrounding the Red Hill WMF

Receptor Number	Location	Easting (m, UTM)	Northing (m, UTM)
1	Toodyay Rd	415425	6478516
2	Toodyay Rd	415887	6478701
3	Toodyay Rd	416003	6478764
4	Toodyay Rd	416435	6478833
5	Toodyay Rd	416607	6478879
6	Karrak Ct	416955	6478701
7	Karrak Ct	416820	6478412
8	Persoonia Cl	416786	6478293
9	Persoonia Cl	416866	6478196
10	Barbarich Dr	416755	6478007
11	Barbarich Dr	416919	6477792
12	Hillwood Grove	416786	6477396
13	Tomallan Ct	416911	6477063
14	Tomallan Ct	416887	6476932
15	Hidden Valley Rd	416526	6476639
16	Hidden Valley Rd	416404	6476660
17	Hidden Valley Rd	416325	6476644
18	Hidden Valley Rd	416218	6476661
19	Hidden Valley Rd	416118	6476682
20	Hidden Valley Rd	416034	6476653
21	Hidden Valley Rd	415954	6476643
22	Hidden Valley Rd	415864	6476632
23	Hidden Valley Rd	415766	6476627
24	Hidden Valley Rd	415624	6476618
25	Hidden Valley Rd	415514	6476611
26	Hidden Valley Rd	415416	6476592
27	Hidden Valley Rd	415274	6476570

Diagram C 1 Location of Sensitive Receptors Surrounding Red Hill WMF

It is acknowledged that additional residences are also located in the immediate area however, those chosen for assessment are the closest to the Red Hill WMF and it is considered that they will be representative of the odour impact over the area. Nevertheless, odour concentration contour plots have also been provided for the area surrounding the Red Hill WMF to allow the spatial distribution of odour to be visually identified at all locations.

C2.2 Regional Topography

The Subject Site and surrounding residences are located in gently undulating terrain. The Subject Site itself is at an altitude of approximately 300mAHD with surrounding residences located at altitudes up to 40 m lower.

Local atmospheric dispersion could be influenced by night-time katabatic drainage flows from elevated terrain or channelling effects in valleys or gullies around the site.

Topography has been included in both the meteorological and dispersion modelling assessment to capture terrain influenced flow conditions which may be important in terms of odour impact.

C2.3 Climate and Dispersion Meteorology

A site specific meteorological dataset has been generated and has been used in the odour impact assessment. The dataset was generated as part of the Air Quality Impact Assessment (AQIA), and full details of the generation and validation of this data can be found in the AQIA (Synergetics Pty Ltd, 2011). The meteorological file was generated by the CALMET processor, and is used in the CALPUFF dispersion model.

C2.4 Local Odour Sources

The EMRC Red Hill WMF is the only source of similar odorous emissions in the local region. It is not considered likely that cumulative impacts between emissions from this and any other site in the surrounding region would occur.

Odour is currently generated by activities taking place at the Red Hill WMF, with the same and additional activities occurring as part of the proposed RRF upgrade. Only odour generating activities occurring as part of the Red Hill WMF and RRF have been assessed within this report. It is anticipated the new landfill cell that will be opened in 2013 will be filled and capped by the time the RRF is operational. Therefore the odour from the new landfill cell is not considered in the odour modelling.

C2.5 Environmental Impact Modelling

CALPUFF is a transport and dispersion model that advects “puffs” of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by CALMET. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain hourly concentration values evaluated at selected receptor locations. CALPOST is then used to process these files, producing tabulations that summarise results of the simulation (Scire *et al.,* 2006).

Air pollutant concentrations were simulated for a regular Cartesian receptor grid covering a 6 km by 6 km computational domain, set within the CALMET modelling domain and centred on the Red Hill WMF, with a grid resolution of 200 M. Concentrations were also predicted at the sensitive receptors identified in **Table C 1**.

C3. **Odour Contour Plots**

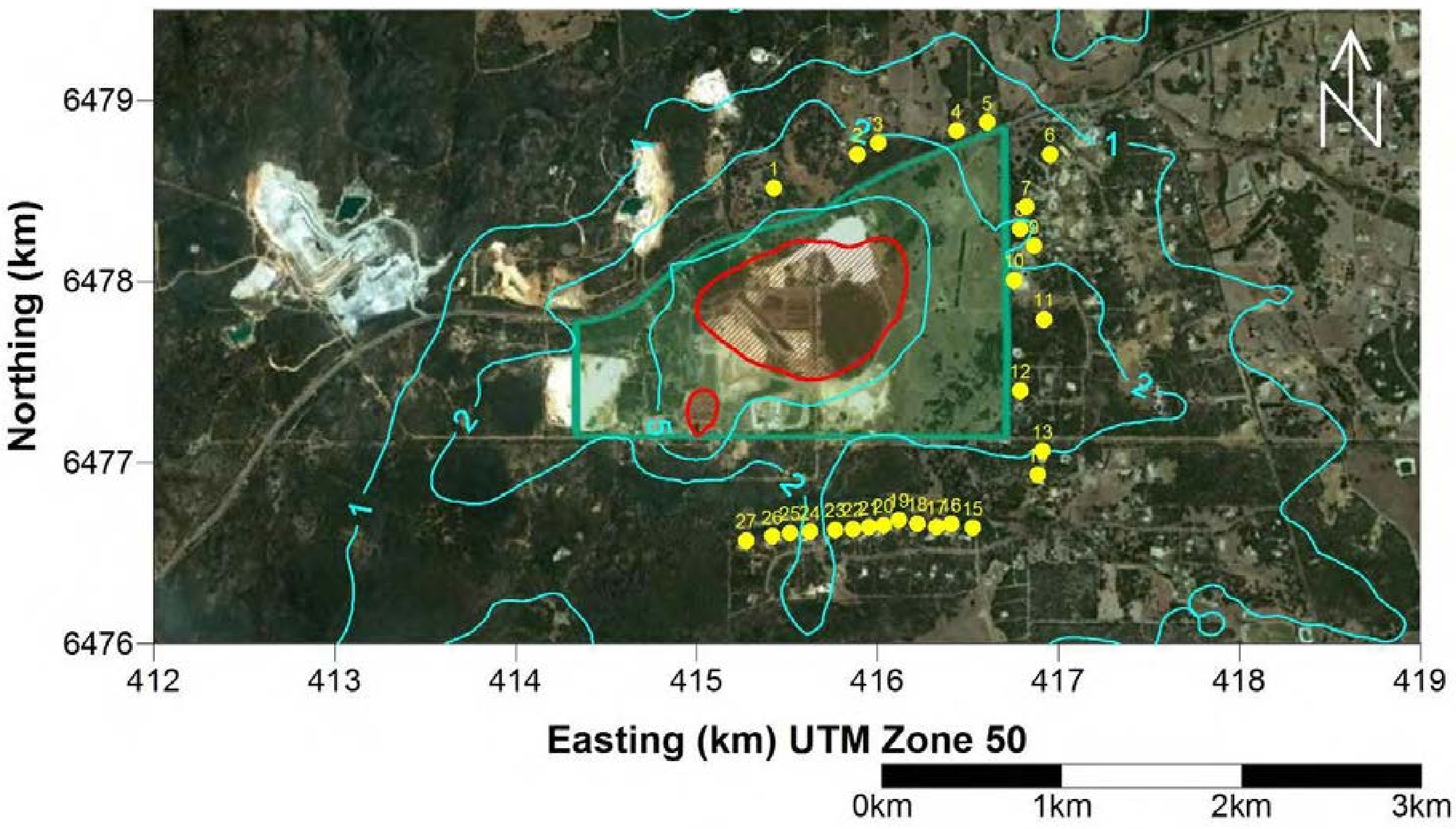


Figure C 1 99.9th Percentile 1-Hour Average Odour Concentration Contours (OU) for Operational emissions from Current Operations (Scenario 1).

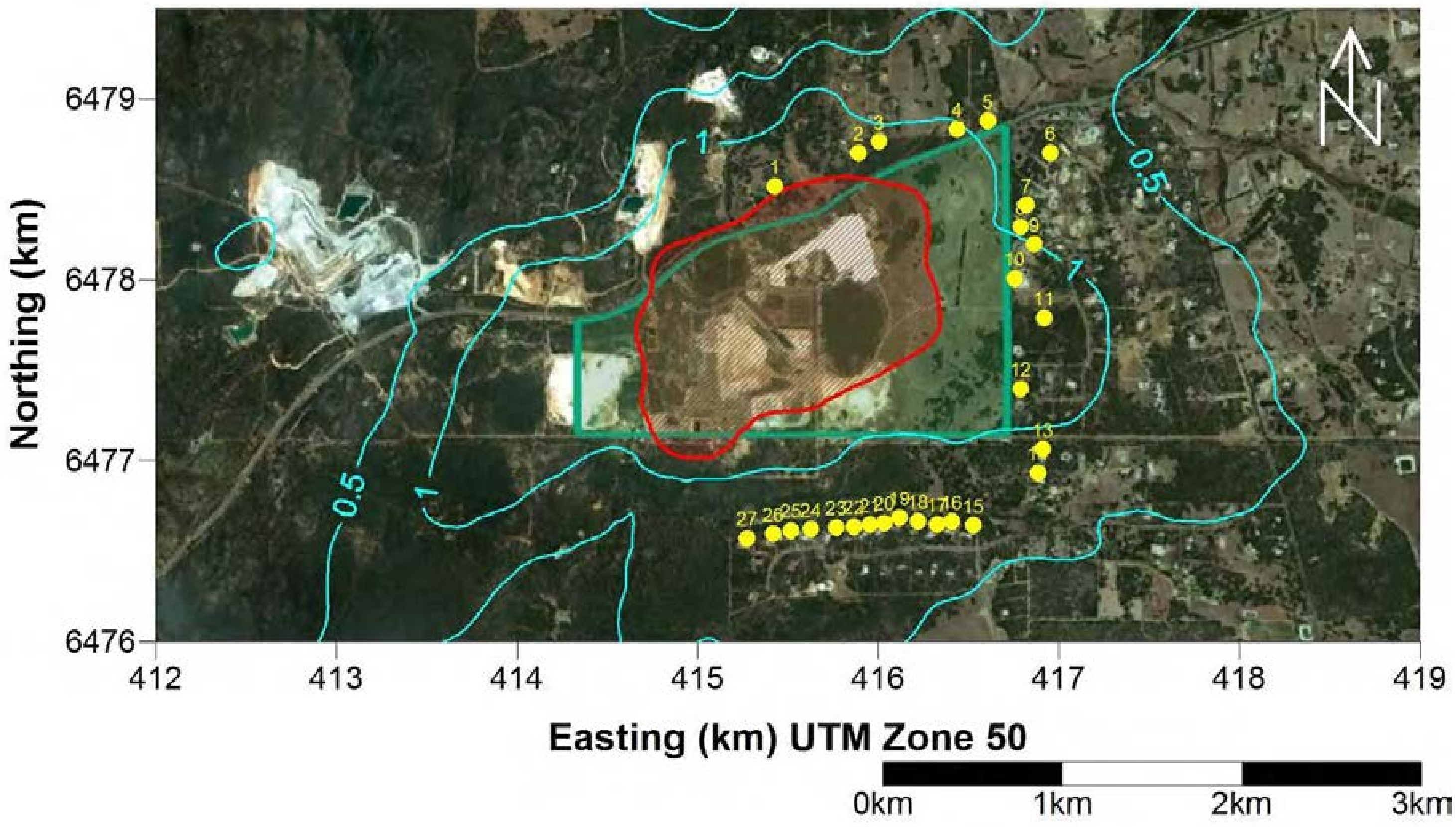


Figure C 2 99.5th Percentile 1-Hour Average Odour Concentration Contours (OU) for Operational emissions from Current Operations (Scenario 1).

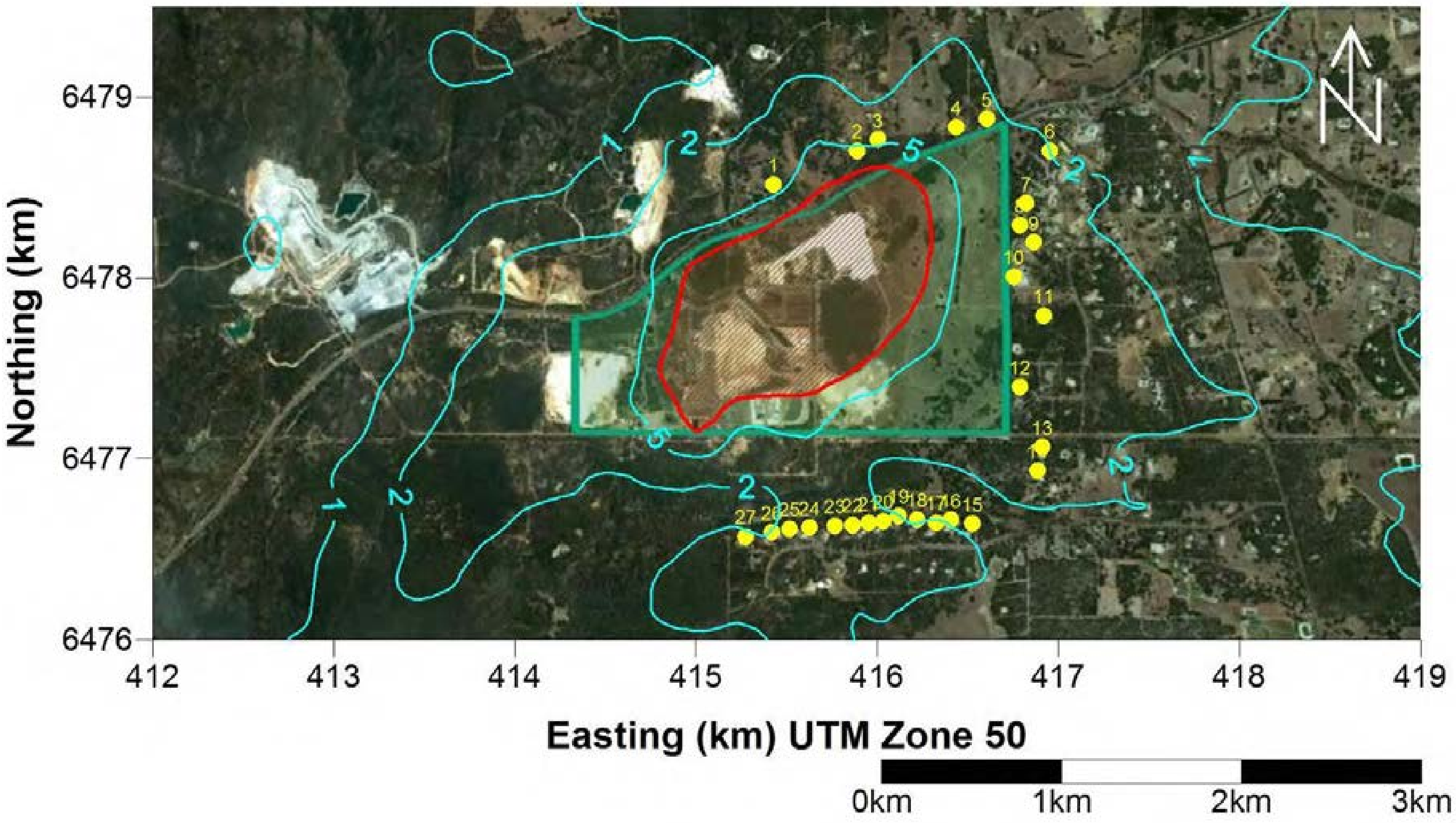


Figure C 3 99.9th Percentile 1-Hour Average Odour Concentration Contours (OU) for Operational emissions from Anaerobic Digestion (Scenario 2a).

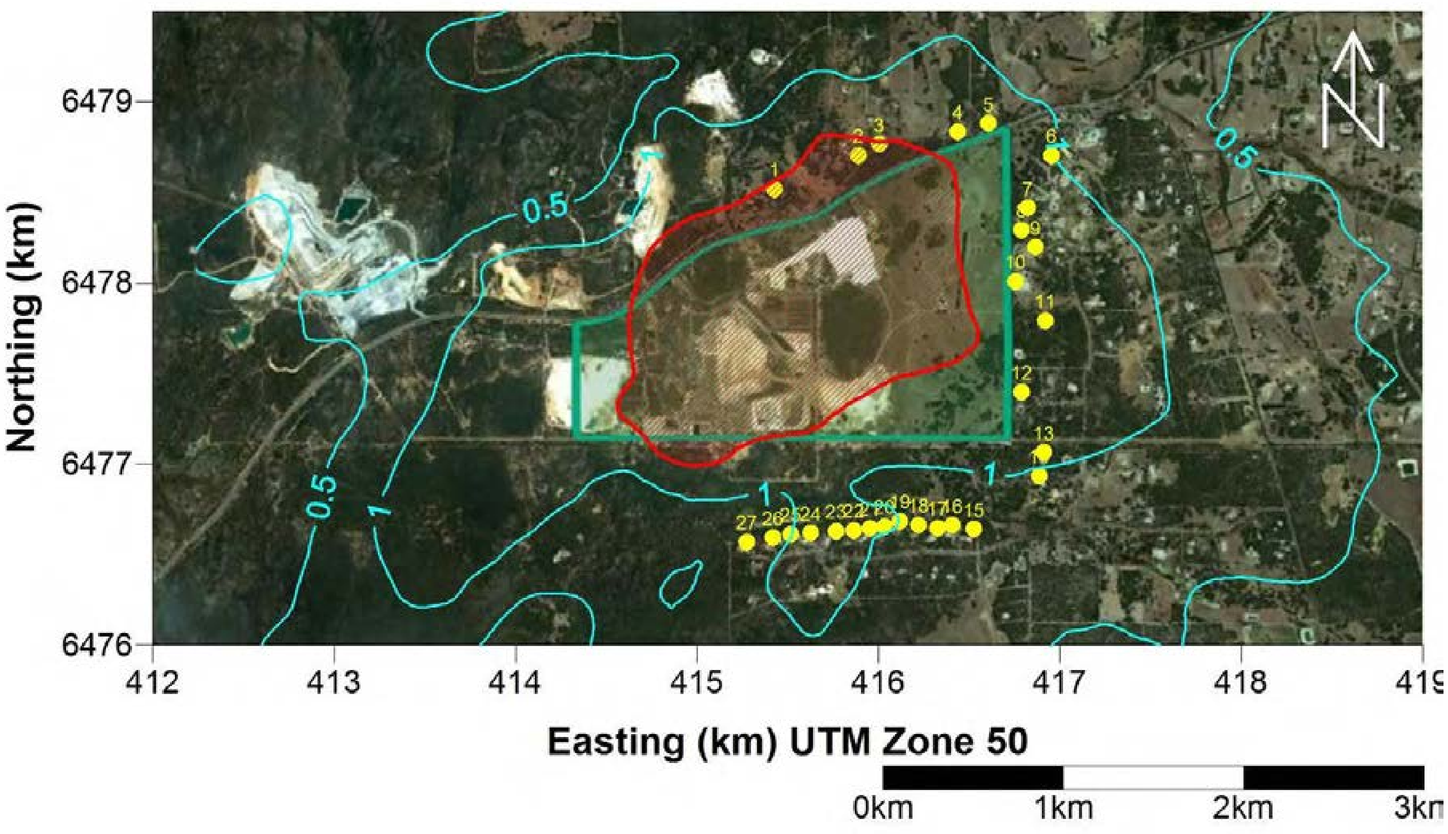


Figure C 4 99.5th Percentile 1-Hour Average Odour Concentration Contours (OU) for Operational emissions from Anaerobic Digestion (Scenario 2a).

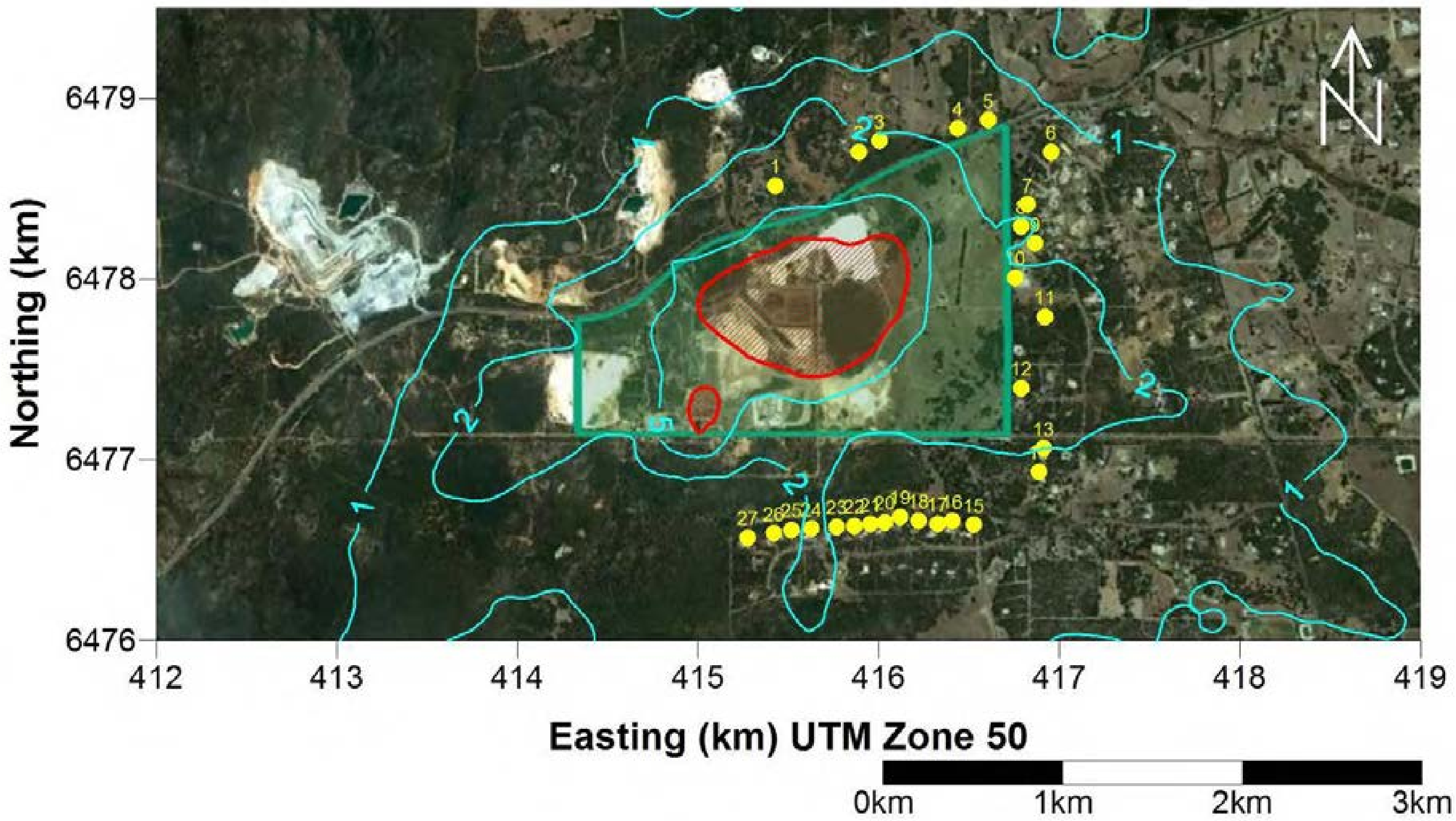


Figure C 5 **99.9th Percentile 1-Hour Average Odour Concentration Contours (OU) for Operational emissions from Gasification (Scenario 2b).**

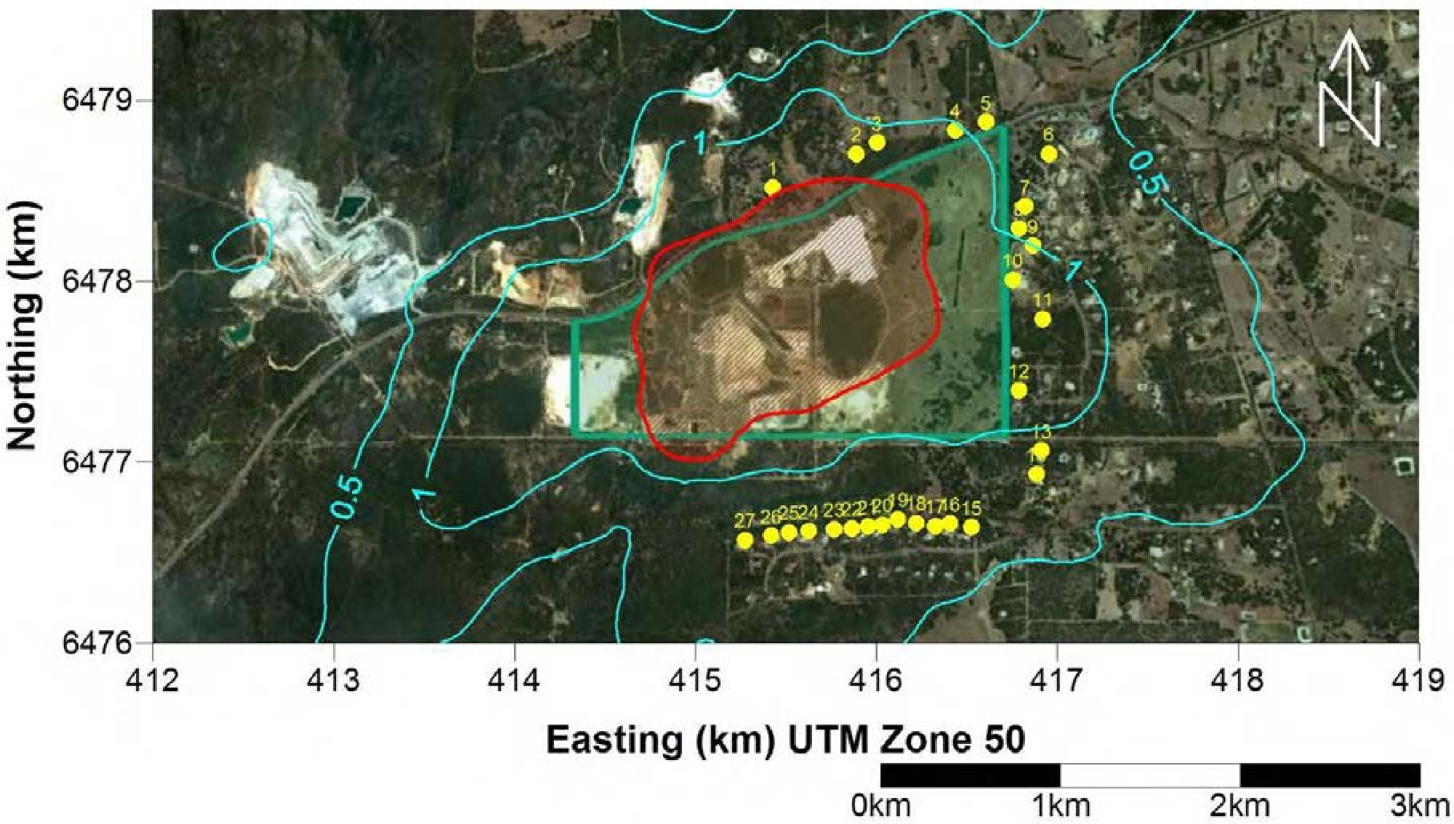


Figure C 6 99.5th Percentile 1-Hour Average Odour Concentration Contours (OU) for Operational emissions from Gasification (Scenario 2b).

Appendix D

Human Health

D1. Case Studies - Multiple Technology Assessment

A report by the UK Department for Environment, Food and Rural Affairs (DEFRA 2004) examined over 600 documents on waste management activities to review air emissions, epidemiological studies and quantify (where possible) the potential health effects of waste management. The review estimated health effects of waste management in the context of other issues which affect health. This included the health effects of air pollution, passive smoking, road traffic accidents and accidents in the home or at work. Air emissions and potential health effects from landfill, MBT, gasification, pyrolysis and incineration were examined and compared during the review.

The study focused principally on the substances with limits on emissions to air specified in European Commission Directive 2000/76/EC. The key air emissions examined were CO_2, CO, NO_x, VOCs, HCl, HF, arsenic, metals, and dioxins and furans and particulates. The emissions information used in the report was provided from four operational facilities handling municipal solid waste (one from the UK, one in Germany, and two in Australia). The data was used in conjunction with estimates of gas volumes produced per tonne of waste to derive mass release rates per tonne of waste. Gas production was estimated from data for proposed and operational plants in the UK. The estimated air emissions per tonne of waste for gasification are shown in **Table D 1**.

The *Independent Waste Technology Report* (JCS 2009) provides an independent review of the gasification process at a number of operational plants. Data extracted from this report has been converted to grams per tonne (g/T) and included in **Table D 1** to provide a comparison of air emission levels from findings within the DEFRA (2004) report and the gasification technology that may be employed.

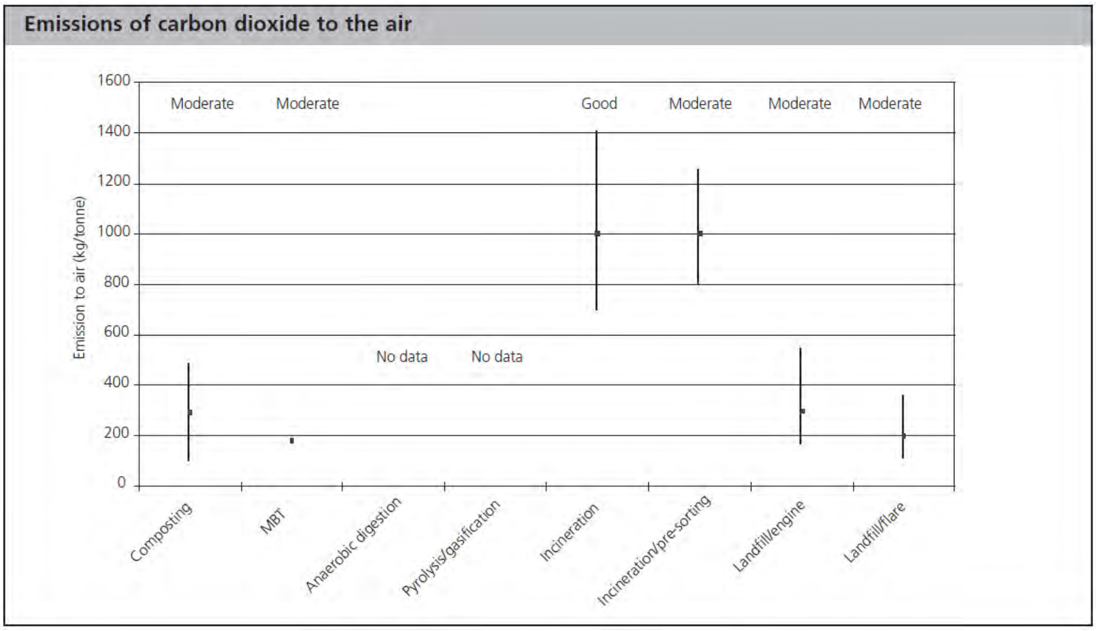
Table D 1 shows that the gasification technology emits very low air emission levels in comparison to those provided in the DEFRA 2004 report. No separate data was provided in the JCS (2009) report for Ni, however, this may have been included in the 'other metals' emissions data. In addition no data was provided for Arsenic and VOCs. Based on the data from the JCS (2009) report and the outcomes of the modelling provided in **Section** 9 air emissions from the RRF are anticipated to be low and will meet NEPM and WHO air quality standards.

Graph D 1 to **Graph D 5** below sourced from the DEFRA (2004) report provide comparisons of some of the key estimated emissions to air from the different waste management operations. The bars on the graphs indicate the margin of uncertainty in the estimated emissions. The quality of information used to generate these graphs was given a pedigree rating of poor, moderate or good.

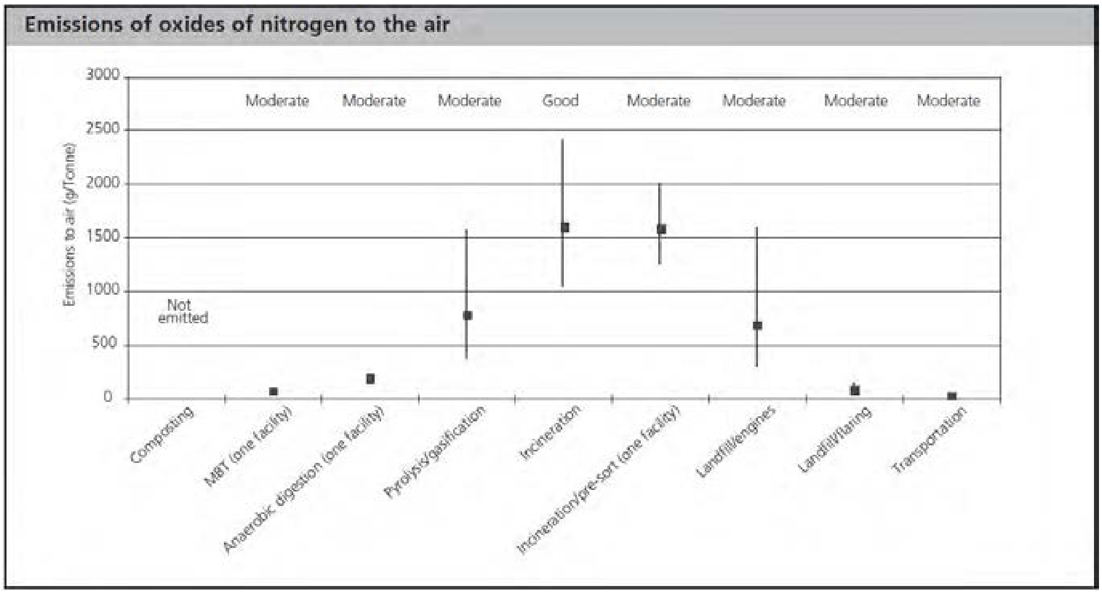
Table D 1 Air Emissions from Pyrolysis/Gasification

	DEFRA			Operating Plant Data			
Substance	Emissions per tonne of waste processed (g/T)						
	Minimum	Best estimate	Maximum	Ranheim Plant	Hurum Plant	Minden Plant	Averoy Plant
NO_x	390	780	1600	1.21638×10^{-5}	2.8×10^{-6}	No data	1.90667×10^{-6}
Particulates/ Dust	6	12	24	1.64719×10^{-8}	3.2705×10^{-8}	1.60865×10^{-8}	5.40224×10^{-8}
SO_2	9	52	312	1.95128×10^{-6}	6.14853×10^{-7}	6.03243×10^{-8}	5.24336×10^{-7}
HCl	16	32	64	3.16766×10^{-7}	5.10197×10^{-8}	1.27083×10^{-7}	7.30892×10^{-8}
HF	0.11	0.34	1.0	3.8012×10^{-9}	6.54099×10^{-10}	2.25211×10^{-9}	1.17578×10^{-9}
VOCs	3	11	44	No Data			
CH_4	Not likely to be emitted						
Cadmium	0.0017	0.0069	0.0276	8.23593×10^{-11}	2.6164×10^{-11}	4.42378×10^{-11}	3.49557×10^{-11}
Nickel	0.02	0.040	0.08	No Data			
Arsenic	0.055	0.060	0.066	No Data			
Mercury	0.017	0.069	0.276	1.33042×10^{-10}	3.2705×10^{-11}	2.41297×10^{-11}	4.76669×10^{-11}
Dioxins (ngTEQ/T)	4×10^{-9}	5×10^{-8}	6×10^{-7}	1.64719×10^{-15}	1.11197×10^{-16}	8.04324×10^{-17}	1.36645×10^{-16}
PBs	No data						
CO_2	No data						
CO	20	100	500	1.03899×10^{-6}	1.43902×10^{-7}	4.2227×10^{-8}	2.5899×10^{-7}

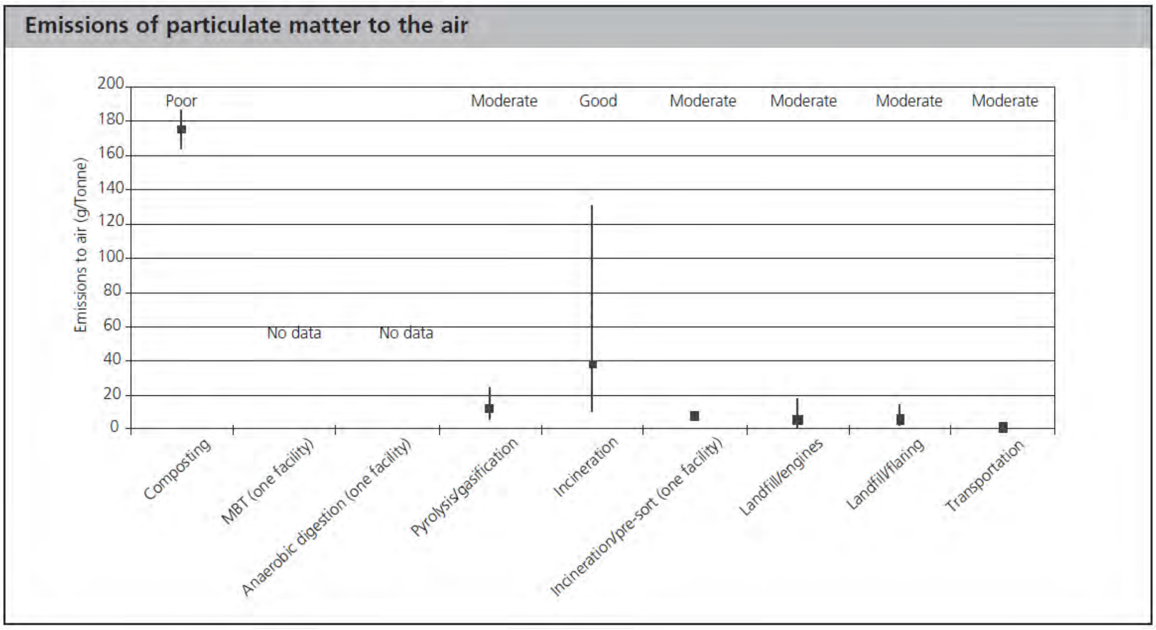
Note: DEFRA study included landfills, MBT, gasification, pyrolysis and incineration.



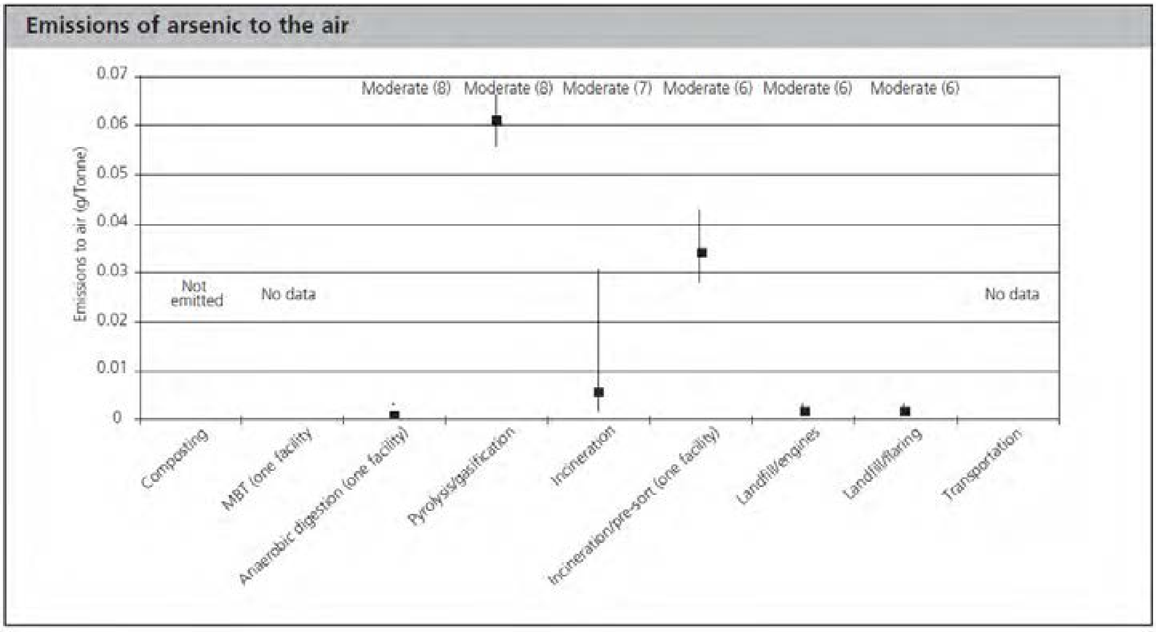
Graph D 1 CO_2 Emissions to Air



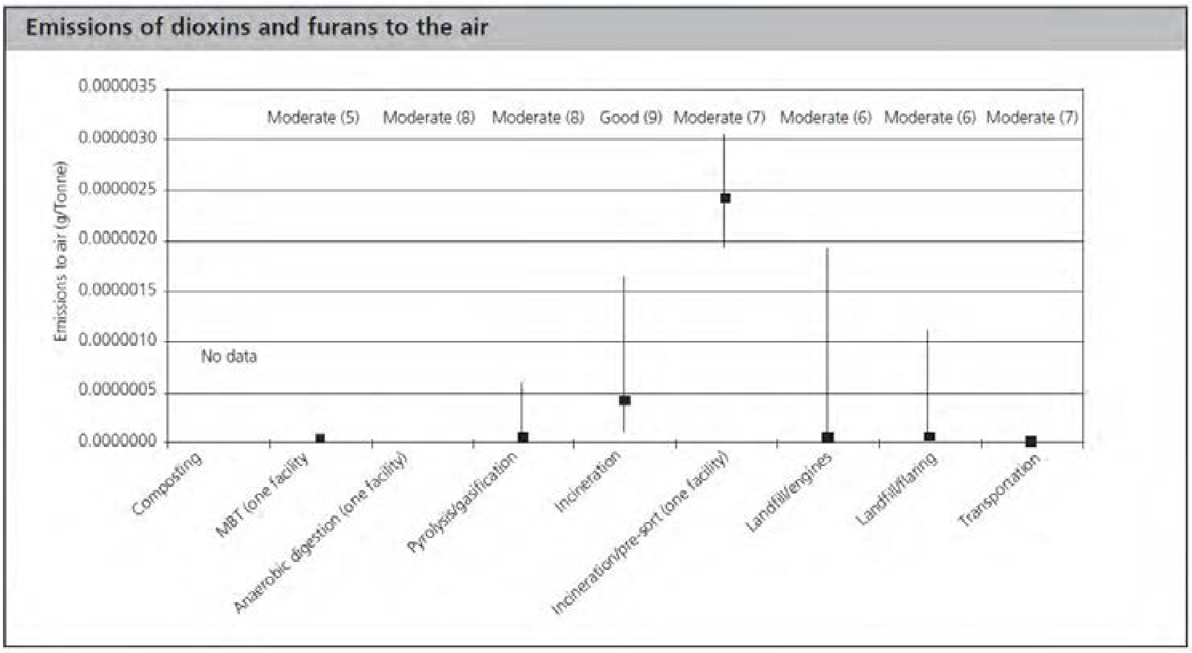
Graph D 2 NOx Emissions to Air



Graph D 3 PM Emissions to Air



Graph D 4 Arsenic Emissions to Air



Graph D 5 Dioxins and Furans Emissions to Air

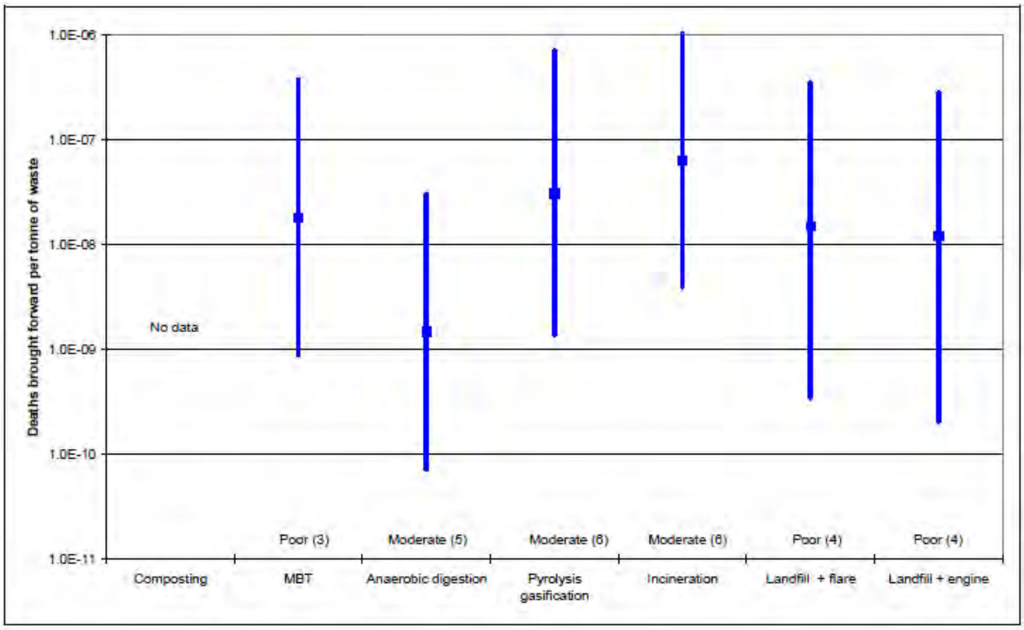
DEFRA (2004) concluded that incineration produces the greatest emissions of NO_x, HCl, particulates, dioxins and furans followed by pyrolysis/gasification. Emissions of NO_x, dioxins and furans and particulates from gasification were estimated to be the same or similar to landfill. The estimated emission level for arsenic was highest for gasification compared to all other waste management options examined.

The review also included a detailed investigation of the health effects of waste management by examining epidemiological studies as well as the health effects of air pollution in general. The studies investigated the occurrence of cancer cases of people living in close proximity to incinerators. These studies mainly considered cancers of the stomach, colorectal, liver, lung, larynx and non-Hodgkins lymphoma.

DEFRA (2004) concluded that no link between human health effects and modern municipal solid waste incinerators (which utilise advanced technology) was found. However, adverse health effects have been observed in populations living around older, more polluting incinerators and industrial areas. This is due to the poor technology used therefore, much higher levels of emissions and exposure of pollutants. Where significant effects have been observed near modern facilities, these incinerators have been close to other sources of potentially hazardous emissions, therefore making it difficult to determine the source of any health effect observed (DEFRA 2004). The Government's independent expert advisory Committee on the Carcinogenicity of Chemicals in Food, Consumer Products and the Environment concluded that *"any potential risk of cancer due to residency (for periods in excess of ten years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern techniques"* (DEFRA 2004).

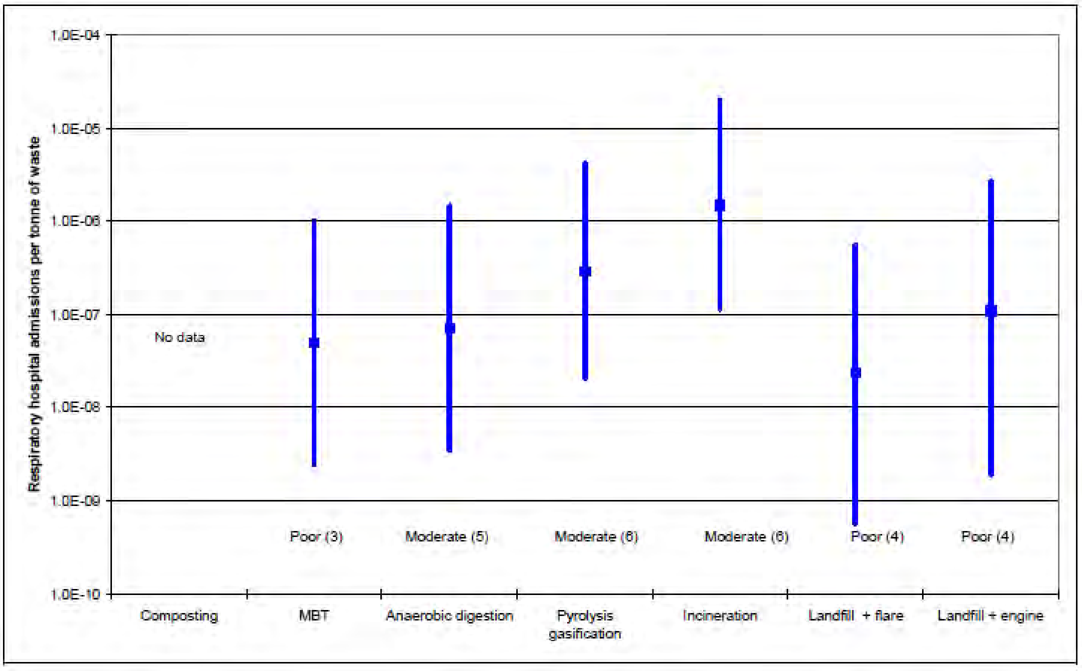
As the key air emissions for gasification overall are lower than incineration (excluding As) and comparable to landfill, it may be concluded that the number of health impacts associated with gasification will be less.

DEFRA (2004) undertook a quantitative risk assessment of health consequences using the air emission data from the literature review. An atmospheric dispersion model was used to evaluate levels of pollution that might be experienced by people living in the vicinity of waste management facilities in the UK. Dose-response functions for each substance were used to estimate the health consequences that would be expected to result from these exposures. The health consequences investigated were additional deaths, hospital admissions and cancer cases due to exposure to air pollutants. The study was unable to investigate the effects of all emissions to air, or the potential effects of exposure to substances released to water or land (DEFRA 2004). The results of the quantitative analysis for deaths brought forward are shown in Graph D 6, the respiratory hospital admissions in Graph D 7 and additional cancer cases are shown in **Graph D 8**. The bars on the graphs indicate the margin of uncertainty in the estimated health effects, and the point in the middle of each bar shows the best estimate of the true value.

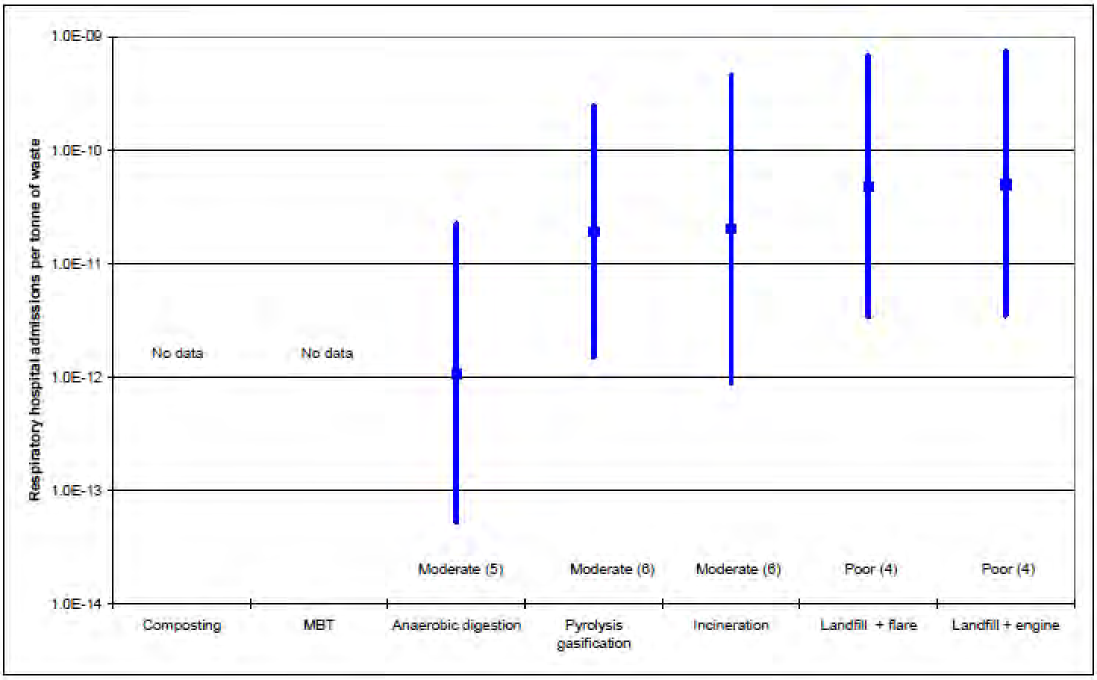


Graph D 6 Estimated Deaths Brought Forward per Tonne of Waste Processed

Note: “1.0E-07” means 1 _ 10-7, or 0.0000001 hospital admissions per tonne of waste managed: that is, 1 hospital admission for every ten million tonnes of waste managed.



Graph D 7 Estimated Respiratory Hospital Admissions per Tonne of Waste Processed



Graph D 8 Estimated Additional Cancer Cases per Tonne of Waste Processed

Graph D 6 to **Graph D 8** show that the estimated deaths brought forward, respiratory hospital emissions and additional cancer cases for both gasification and AD are lower than incineration.

DEFRA (2004) concluded that on a national scale, considering the amount of waste currently managed by each process, air emissions are estimated to result in approximately five hospital admissions for respiratory disease and one death brought forward per year, and one additional cancer case every 500 years in the UK as a whole.

D2. Case Study - Combustion Technology

The Montgomery County (the County), Maryland Solid Waste RRF in the USA, began operations in 1995. Nearby residents raised concerns during the planning process of the potential effect(s) of the RRFs emissions may have on human health and the surrounding environment. The primary issues raised were associated with dioxins/furans and trace metals emissions. As a result, the County initiated a multi-media monitoring programme both prior to development and after the facility began operations. The programmes were conducted on both air media and non-air media (AECOM 2009).

The Solid Waste RRF is made up of three units. Each unit is designed to combust up to 600 tons of solid waste per day and generates approximately 20 MW of electricity. Each unit has a separate flue and is equipped with state of the art air pollution control (APC) equipment. The APC equipment consists of:

- a dry scrubber and fabric filter baghouse for controlling acid gases, particulates and organics;
- direct lime injection into the furnace for additional acid gas control;
- ammonia injection at the top of the furnace for NOx control; and
- activated carbon injection at the scrubber inlet for mercury control (Rao et al. 2003).

Non-air media monitoring was undertaken during 1994 and 1995 during the pre-operational phase. Following this monitoring and after the RRF became operation in 1995, four operational phase monitoring periods were conducted. The first operational phase sampling was conducted over a period of 18 months in 1996-98 and the second operational phase in the autumn of 2001 (approximately six years after the RRF became operational). The third operational phase occurred in July-October 2004 (approximately nine years after the RRF became operational) and the fourth operation phase was conducted in June 2007 (approximately 12 years after the RRF became operational) (AECOM 2009).

The outcome of the fourth operational phase monitoring is provided in the AECOM (2009) report. The non-air media studies sampled during this phase included surface water, sediment and fish, milk and hay. All mediums were tested for levels of dioxins and furans and trace metals. Dioxins and furans known as 17 PCDDs/PCDFs are those considered primarily responsible for the health risks.

Due to their toxicity, WHO, through the International Programme on Chemical Safety (IPCS), assigned risk factors known as Toxic Equivalency Factors (TEF). These TEFs were based upon the relative toxicity of an individual PCDD or PCDF compared to 2,3,7,8-TCDD, the most toxic congener (AECOM, 2009). WHO TEF values were established and are regularly re-evaluated for humans and mammals, birds and fish (WHO 2011). A summary of the findings of the fourth operational phase extracted from AECOM (2009) report are provided below:

D2.1 Surface Water

- The surface water quality measurements were taken at each of the three farm ponds; Pond 2, Pond 3 and Pond 5. The distance to the facility was approximately 1,5 km, 2.8 km and 3.8 km, respectively.
- Pond 2 water quality measurements of pH and dissolved oxygen content were found to be in the normal range
- With the exception of lead and nickel, Pond 2 surface water concentrations of metals were consistent with, or lower than, historical data collected in previous monitoring programmes. Lead concentrations were slightly higher than the data from 2001 and 2004 monitoring programmes but lower than the 1994 (pre-operational) and 1996 (1st operational phase) programmes, Nickel concentrations were slightly higher in 2007 compared to 2004, however, the 2007 nickel

concentrations were lower than concentrations in 1994, 1996 and 2001.Total concentrations of metals in Pond 3 and Pond 5 were all lower than the respective criteria and standards.

- Regardless of the treatment of non-detected congeners, TEQ values are either comparable with or lower than historical sampling results. There is no evidence of any upward trend in PCDD/PCDF (as TEQs).

D2.2 Sediments

- Sediment was sampled from the farm ponds in 2007 for the first time since the 1994 pre operational monitoring programme and the 1996 1st operational phase monitoring programme (i.e., only 3 sampling periods is far).
- Pond 2 sediment concentrations of arsenic, beryllium, and mercury are comparable or lower than historic data collected in previous monitoring programmes. Cadmium concentrations measured in 2007 are lower than in 1996, but comparable to 1994. Chromium, lead and nickel concentrations in 2007 are slightly higher than historic data collected in previous monitoring programmes.
- Pond 3 sediment concentrations of arsenic, cadmium and mercury are comparable or lower than historic data collected in previous monitoring programmes. Beryllium, chromium, lead and nickel concentrations measured in 2007 are slightly higher than historic data.
- Pond 5 sediment concentrations of arsenic, beryllium, cadmium and mercury are comparable or lower than historic data collected in previous monitoring programmes. Chromium, lead and nickel concentrations measured in 2007 are slightly higher or comparable to historic data collected in previous monitoring programmes.
- When assuming zero value for all non-detected congeners, the TEQ sediment concentration appear slightly higher in 2007 than in previous years, however, when detection limits are included, the 2007 TEQ concentrations are either consistent with or lower than previous years. This is the case for all three ponds.

D2.3 Hay

- Metals concentrations in hay collected in 2007 from Pond 3 Farm are generally consistent with concentrations detected in previous sampling events for Pond 3 Farm and Kingsbury Dairy Farm. Metals concentrations collected in 2007 from Arthur Johnson Farm are comparable or lower than 2004 data, but consistent with concentrations in hay from Kingsbury Dairy Farm and Pond 3 Farm.
- Distances of Kingsbury Dairy Farm and Arthur Johnson Farm to the RRF were approximately 7.5 km and 4.2 km, respectively.
- Chromium and nickel concentrations in hay from the background location in Lucketts, Virginia appear to be higher in 2007 than in previous sampling events (2001 and 2004) and have consistently increased since 2001. This trend was not exhibited at either Pond 3 Farm or Arthur Johnson Farm. This, in conjunction with the findings of the dispersion/deposition modelling, indicates that other sources in the upwind direction are contributing these metals.
- In the case of hay collected at the Pond 3 Farm, when assuming zero for non-detected congeners, the 2007 TEQ results are slightly higher than in 2004 but either consistent with or lower than the 2001 results. When including non-detects, the 2007 TEQs for hay at this farm are lower than the 2004 results and substantially lower than the 2001 results. In the case of the Arthur Johnson Farm, which was sampled only in the 2004 and 2007 programmes, regardless of the treatment of non-detects, the 2007 TEQ values are higher in the 2007 sampling period than in 2004. No trend is indicated by these two points, or by consideration of hay data from other farms.
- With respect to the three farms for which hay samples were obtained in three programmes monitoring periods (Kingsbury Dairy Farm ’94, ’96, ’98; Pond 3 Farm ’01, ’04, ‘07; and Background ’01, ’04,’07), TEQ values for succeeding years tend to be either consistent with or lower than prior years. This is the case regardless of the treatment of non-detected congeners.

- The PCDDs/PCDFs detected in hay in 2007 at Pond 3 Farm were predominantly HpCDDs and OCDD, with some HpCDFs and OCDFs, which are the least toxic of the dioxin/furan congeners. Hay samples collected previously from Kingsbury Dairy Farm also contained predominantly HpCDDs and OCDDs and a variety of tetra- through octachlorinated PCDDs/PCDFs at very low levels.
- Samples from Arthur Johnson Farm and the background location were dominated by the higher chlorinated, less toxic congeners, particularly OCDD. This congener pattern is consistent with the hay samples from the Kingsbury Farm and Pond 3 Farm in this study.

D2.4 Fish

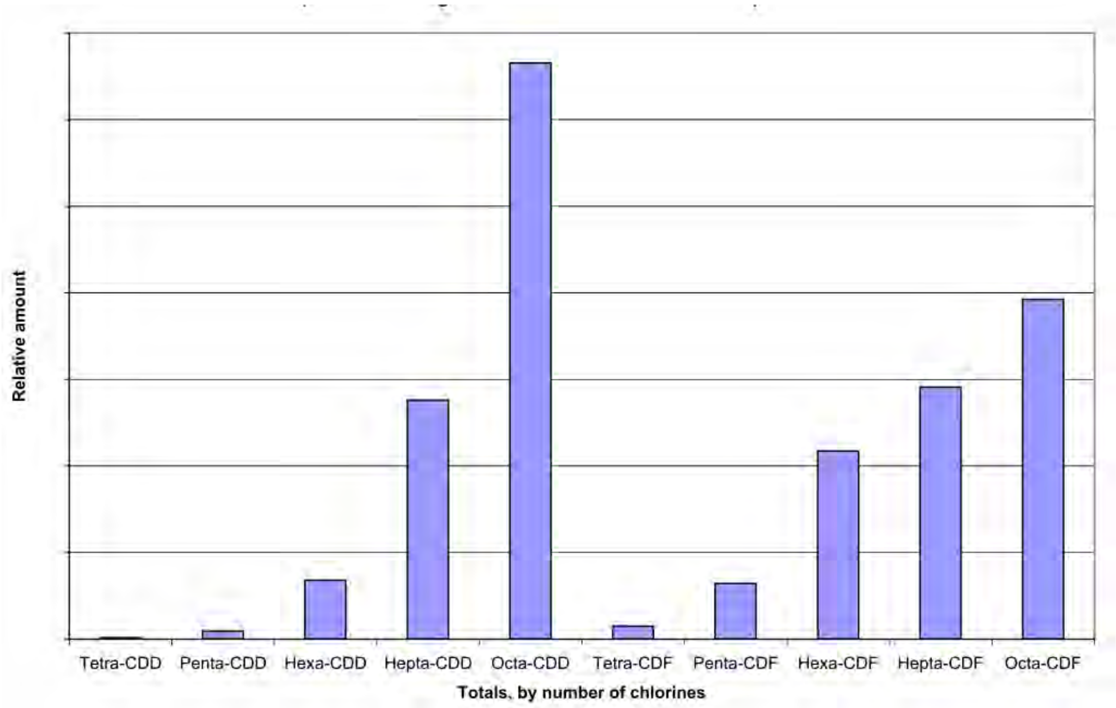
- Trend analyses for the fish tissue evaluations have assumed that the fish collected are comparable across all sampling events. Fish may accumulate toxic chemicals at different rates, depending on factors such as age, size, feeding guild (i.e., predator or prey fish), temperature, stocking rates, pond size, population density and amount of nutrition available to the fish. This variability and uncertainty is inherent in field tissue collection, and not all factors can be accounted for in any sampling programmes. The non-air monitoring sampling programmes has been designed to help control some of the variability. Fish have been collected from the same ponds throughout the sampling programmes. One prey species and one predator species have been targeted from each pond to demonstrate potential differences in accumulation of toxic chemicals in the fish based on feeding guild and size. Although fish age has not been determined for each fish caught, size has been measured. Finally, fish tissue data for dioxins have been adjusted to reflect the fat content of each fish (the lipid-normalization of the data), which helps control for the changing nutrition levels in the ponds.
- Consistent with improved water quality readings, Pond 2 fishing was improved compared to 2004 (18 bluegill sunfish were caught during the field effort).
- Pond 2 metals concentrations in whole body and fillet prey fish are comparable or lower than historic data collected in previous sampling programmes. When assuming zero for all non-detects, the TEQs are slightly higher in 2007 than in previous years 1994, 1996 and 2001. However, when including detection limits, the TEQ for 2007 are lower than previous years.
- Pond 3 prey and predator fish fillet and whole body samples have concentrations of metals in 2007 that are comparable or lower than historic data collected in previous programmes. When assuming zero for all non-detects, TEQ concentrations in fish, particularly largemouth bass, are higher than the data collected in previous years. Concentrations of detected PCDDs/PCDFs are comparable for prey fish but higher for predator fish in 2007 compared to previous years. Given that the observed TEQ increase in 2007 based on detected congeners is very low, 5-40 ppt (depending on the sample), these differences may be attributable to the natural variations in the ambient environment and/or to the effect of lowered detection limits in 2007. In addition, the largemouth bass sampled was the largest bass (17”) caught during the last three programmes. A larger, older fish will have accumulated more PCDDs/PCDFs than a younger fish. When detection limits are included, the 2007 Pond 3 fish TEQs are generally consistent with or lower than the previous years.

D2.5 Milk

- Metals concentrations in milk from 2007 are consistent with, or lower than, historic metals concentrations from previous monitoring programmes.
- Assuming zero values for all non-detected congeners yields an apparent increase in monitored TEQ, however the reverse is true when including the detection limits in the calculation of TEQs. While there is no discernable trend in this respect, the consistency of the TEQ values for 2007, calculated with and without detection limits, reflects the high degree to which congeners are now able to be detected.

- PCDD/PCDF detected in the 2007 data were predominately the higher-chlorinated of the dioxin congeners (HxCDD, HpCDD, and OCDD). The lower-chlorinated dioxin congeners (PeCDD and TCDD) were also present, but furan congeners were not detected. Milk collected in previous sampling events, particularly 2001 Arthur Johnson Farm milk, indicates little to no presence of the lower chlorinated dioxin congeners, and an increased presence of all furan congeners.
- Differences between 2001-2007 and 1994-1998 data could also be associated with the change in sampling locations (milk samples in 2001, 2004 and 2007 were obtained from Arthur Johnson Farm while 1994 and 1996-98 samples were collected from Kingsbury Dairy Farm).

The RRF stack dioxin/furan emission profile (see **Graph D 9**) shows the highest emitted congener is OCDD, but all congeners are present, including the lower chlorinated congeners (tetra- through hexa-chlorinated dioxins and furans). These lower chlorinated congeners are more bioaccumulative than the OCDD (U.S. EPA 2005). These values represent the uptake rate of dioxin/furan congeners from soil to plants and the uptake/biotransfer rate of the congeners from environmental media (i.e. soil, water, food, air, etc.) into cow's milk. Any tissues potentially impacted by the RRF emissions would be expected to have levels of TCDD, TCDF, PeCDF and HxCDF reflective of this fact. This is not the case for either milk or hay from Arthur Johnson Farm. The milk samples have no detections for TCDF and OCDF, very low concentrations for the other furan congeners and TCDD is the lowest detected dioxin congener. Hay samples do not have any detections of TCDD, TCDF, PeCDF or HxCDF, all of which are more bioaccumulative than OCDD. Therefore, there is no evidence indicating that the apparent increase in dioxin concentrations in milk and hay are linked to the RRF (AECOM 2009).



Graph D 9 Pattern of PCDD/PCDF emissions from Montgomery County RRF (Basis: Average of All Stack Tests 1995-2007)

AECOM (2009) state that the overall findings of the report based on the available data for non-air media during the pre-operational phase and three operational phases show that 2007 concentrations of PCDD/PCDF and metals are generally consistent with, or lower than, historical concentrations in previous monitoring programme years. AECOM (2009) concluded that there does not appear to be any evidence to suggest any increases recorded in environmental media are attributable to RRF emissions.

It should be noted that all the media monitored naturally contain various metals and organic compounds. These media also contain metals and organic compounds from numerous anthropogenic sources that include coal-fired electric power generating stations, municipal waste combustion facilities, home wood burning and vehicle emissions (AECOM, 2009).

In addition to the non-air media monitoring program, the County conducted a multiple pathway health risk assessment for a generic facility in 1989. The RRF was then constructed and began operation in 1995. In 2003, the County conducted an update to the 1989 study (ENSR Corporation, 2006). In addition to identifying relevant potential exposure scenarios, a toxicity assessment was conducted to determine the relationship between the magnitude of exposure (dose) for each Compounds of Potential Concern (COPC), and the occurrence of specific health effects for a receptor (response).

The selection of 19 COPC included in the study focused the health risk assessment on those pollutants for which there is a body of evidence that indicates potential effects on human health. These include several heavy metals, PCDD/PCDF, formaldehyde, PCBs and carcinogenic PAHs. All COPC emissions data were compiled from stack tests at the RRF representing the facility's maximum operating emissions.

The purpose of the toxicity assessment was to identify the types of health effects a COPC may potentially cause, and to define the relationship between the dose of a compound and the likelihood or magnitude of a health effect (response). Health effects are characterized by the U.S. EPA as carcinogenic or noncarcinogenic. Based on characteristic land use patterns within the RRF, potential human activities in Montgomery County and the most recent U.S. EPA guidance for risk assessment at combustion facilities, the following potential exposure pathways were identified for evaluation in the health risk assessment update:

- inhalation of particulate and vapor in air;
- incidental ingestion of soil;
- ingestion of vegetables from a backyard garden;
- consumption of milk, beef, pork, chicken and eggs from farms in the area; and
- ingestion of fish from the Potomac River.

Finally the Risk Characterization was conducted to combine the results of the Exposure Assessment with the results of the Toxicity Assessment and to derive an estimate of potential risk to human health. The potential long-term risk to human health is a calculation of the theoretical chance of carcinogenic or noncarcinogenic health effects occurring for the hypothetical human exposure scenarios.

The results of the study indicated that the relative risk of harm to human health presented by the Montgomery County RRF, under the 2003 operating conditions, was very low. In fact, the health risks predicted in the 2003 assessment update were lower than or consistent with the health risks predicted in the 1989 study. The results indicated a very low chance (i.e. less than one chance in one million) for occurrence of potential carcinogenic health effects, and that no adverse noncarcinogenic health effects are expected as a result of exposure to facility-related emissions. The health risk estimates in the updated study indicated that the Montgomery County RRF does not pose unacceptable risks to the surrounding community (Rao *et al*. 2003).

D3. Case Studies - Anaerobic Digestion Technology

A number of health problems have the potential to occur within the AD technology due to the processes involved. These are discussed individually in more detailed below.

D3.1 Pathogens

Pathogens are viruses, bacterium, fungi or microorganisms that cause diseases in animal or plant hosts. According to Epstein (1997), the primary pathogens present in waste are bacteria, enteric viruses, protozoa and helminths. The human response to pathogens varies according to the type of pathogen and the individual's susceptibility. Factors such as age and general health are crucial in determining an individual's dose response.

Sources of pathogens in MSW waste may include nappies, medical equipment, tissues, toilet paper, insects, rodents, domestic animal faecal matter, personal care products and feminine care products. A number of studies directly relating to AD are discussed below in order to put into perspective the likely human health impact of various processes within this technology.

Akin (1983) examined the infective dose data for a range of pathogens. Enteric bacteria were found to have the widest dose response range; low doses of enteric viruses were found to produce infection; 10^5 to 10^8 cells of *Salmonella spp.* produce disease in 50% of healthy adults; and doses of 1 to 10 cysts of *Entamoeba coli* and *Giardia lambia* cause amoebic infections.

Hornick *et al*. (1970) determined the dose response to *Salmonella typhi*. When 1000 organisms were administered to 14 volunteers, none showed any symptoms. When 100,000 organisms were administered, 28% became ill. A dose of 1,000,000 organisms made 95% of the volunteers ill.

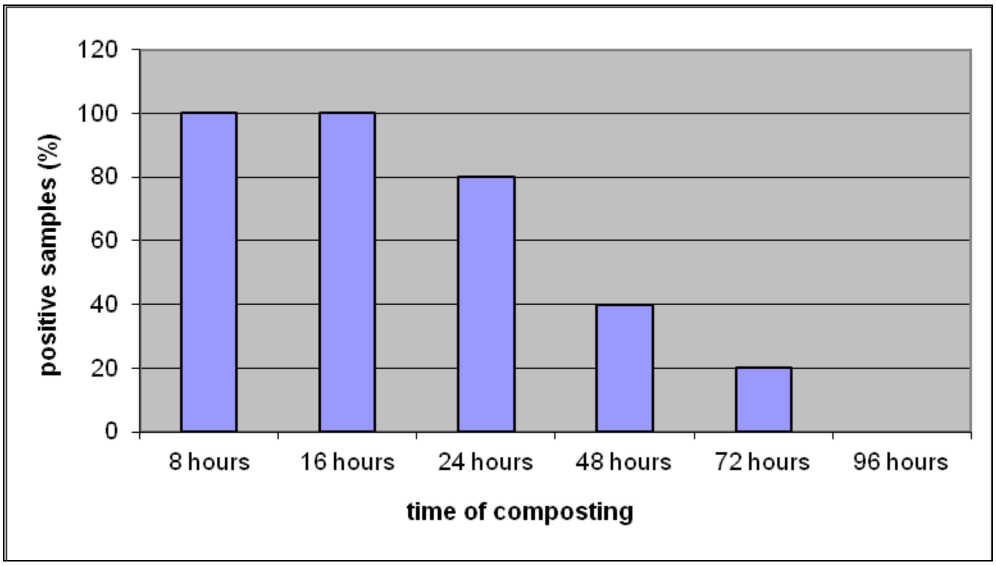
Kowal (1982) identified the oral infective doses from enteric bacteria. No illness was found at levels below the following:

- *Escherichia coli*: 10^4;
- *Salmonella typhimurium*: 10^3;
- *Salmonella derby*: 10^5-10^6; and
- *Streptococcus faecalis var. liquefaciens*: 10^8.

However, most studies that focus on the issue of pathogen destruction during the compost process only consider biosolid compost. Nevertheless, Epstein (1997) suggests that the results of studies into pathogen destruction in biosolid compost are comparable to the expected results for MSW compost.

The US Department of Agriculture (Burge, 1974; Burge, 1987) has conducted a number of studies into pathogen survival in both the windrow and the aerated static pile composting methods. Despite initial increases in salmonella growth, it was destroyed within 10 days of composting in the static pile method and 15 days in the windrow pile method. An indicator virus (f2 bacteriophage), which was chosen because it is particularly resistant to inactivation by heat, was destroyed within 45 to 70 days using the windrow method and 13 days in the static pile method.

Krogstad and Gudding (1975) infected compost with *Salmonella typhimurium*, *Serratia marcescens* and *Bacillus cereus* and regularly measured the die-off rate. **Graph D 10** shows the effect of composting on the survival of *Salmonella typhimurium*.



Graph D 10 Effect of Composting on the Survival of Salmonella Typhimurium

As indicated above, *Salmonella typhimurium* is completely destroyed after 96 hours of composting. "*The researchers concluded that three to five days in a reactor vessel with temperatures of 60-65°C would destroy the pathogens*" (Epstein, 1997).

Pereira-Neto *et al* (1986) examined the efficiency of the aerated static pile method in destroying *Escherichia coli*, *faecal streptococci* and *salmonella* in compost. The study found that *Salmonella* is destroyed in 7 to 15 days, *Escherichia coli* reduces to less than 102 from 107 in 15 days and *faecal streptococci* decreases to less than 102 from 107 in 30 days.

The above studies suggest that pathogens are fully destroyed after a relatively short period of composting. After this period of composting the levels of pathogens are below the dose response levels outlined above. Thus, the pathogens in the compost produced at the proposed RRF will not be a significant human health risk. This sentiment is consistent with a number of independent studies. For example, Clark *et al.* (1980) examined the health risks for 270 employees at four composting facilities. The study did not find any health problems relating to primary pathogens. Epstein (1997) similarly notes, "*workers in composting facilities handling raw sludge or MSW can be exposed to a variety of pathogens … there is no evidence of worker infections or health problems, however*". "*No bacterial, viral, or parasitic diseases have been reported among workers engaged in composting, nor has there ever been reported or documented evidence of public health effects*". For this reason, it is suggested that primary pathogens do not represent a significant human health risk.

During the digestion process there is the potential for human exposure to plant pathogens. Study 1 investigates plant pathogens Tobacco Mosaic Virus (TMV), *Plasmodiophora brassicae*, *Heterodera schachtii*, *Meloidogyne incognita*, *Ralstonia solanacearum.* Study 2 investigates plant pathogens *Fusarium oxysporum*, *Corynebacterium michiganense* and *Globodera pallida.*

D3.1.1.Case Study 1

Ryckeboer *et al.* (2002a) examined the fate of TMV, *Plasmodiophora brassicae*, nematode *Heterodera schachtii*, *Meloidogyne incognita*, *Ralstonia solanacearum* and tomato (*Lycopersicon esculentum*) seeds during the digestion of source-separated MSW (primarily vegetable, fruit and garden wastes).

The study was carried out using the DRANCO digestion process. In this process the MSW is blended with a small amount of digested residue on entering the digester. The waste exits the digester after 16 to 21 days and is followed by a composting phase of between one to three weeks.

Ryckeboer *et al.* (2002b) compared the digestion and composting process against the German BioAbfV regulations. The BioAbfV lays down the health standards for the process.

D3.1.1.1 Tobacco Mosaic Virus

The inactivation of TMV was tested by mixing tobacco leaves harvested from *Nicotiana tabacum* plants infected with TMV with DRANCO digester residue at a weight ratio of 1:10.

In the first experiment, the TMV infested material was only slightly destroyed after 72 hours of digestion at 52°C. This does not meet the German BioAbfV regulations.

In the digestion technology, pathogen destruction is attributed to toxic conversion products or microorganisms (Ryckeboer *et al*., 2002b).

In the second experiment, almost complete inactivation of TMV was achieved by 48 hours of digestion and 19 days of composting at 58°C. The BioAbfV standards had been met after 48 hours of digestion and 10 days of composting.

In the third experiment, the waste was digested for 48 hours followed by 12 days of composting at 58°C or 68°C. TMV infectivity decreased rapidly during five days of composting at 68°C and it remained low thereafter. To achieve the same degree of inactivation during composting at 58°C, eight days of composting was required. The BioAbfV standards were met after 48 hours of digestion followed by five days of composting at 68°C or eight days of composting at 58°C (Ryckeboer *et al*., 2002b).

By way of comparison, it is expected that the RRF digestion process will involve digestion for around 21 to 28 days at a temperature of between 48°C and 55°C followed by composting for around 7-21 days. This regime should ensure that the BioAbfV standards are met.

D3.1.1.2 Plasmodiophora Brassicae

P. brassicae was tested by mixing 30 g of cauliflower roots infected with *P. brassicae* and 430 g of a sandy loam soil infested with *P. brassicae* with 200 g of DRANCO digester residue. The waste mixture was approximately 5% tuberous roots, 65% soil and 30% digester residue.

P. brassicae was completely destroyed within 12 hours of digestion at 52°C in the first experiment.

In the second experiment, samples of the waste were removed after six, seven, eight, nine and 10 hours of digestion. The temperature at the centre of the digester was 48°C after digestion at 52°C for two hours. *P. brassicae* was highly inactivated after nine hours of digestion. It was completely destroyed after 10 hours of digestion (Ryckeboer *et al*., 2002b).

D3.1.1.3 Ralstonia Solanacearum

The survival of *R. solanacearum* was tested by mixing 6 g of ground potato pieces infested with the pathogen and 200 g of non-infested potato peel with 1 kg of the DRANCO digester residue.

The first experiment used a concentration of *R. solancearum* of 10^8 CFU per gram feed material. The pathogen was substantially inactivated after six hours of digestion at 52°C. It was completely destroyed within 12 hours.

The second experiment used a concentration of *R. solancearum* in feed material that was about two orders of magnitude lower than that which was used in the first experiment. The pathogen was removed within six hours of digestion at 52°C (Ryckeboer *et al*., 2002b).

D3.1.1.4 Heterodera Schachtii

The survival of *H. schachtii* was tested by mixing fine nylon mesh nets each with 200 cysts together with 4 kg of DRANCO digester residue. *M. incognita* was examined by mixing 450 g of shredded tomato roots infected with *M. incognita* with 3 kg of DRANCO digester residue.

The cysts of *H. schachtii* were inactivated within 30 minutes of digestion at 52°C. This indicates that the nematode is extremely heat-sensitive.

M. incognita were removed within 12 hours of digestion at 52°C. The samples of infected tomato roots fell from 18 in the control to four, two and zero within three, six and 12 hours of digestion, respectively (Ryckeboer *et al*., 2002b).

D3.1.1.5 Lycopersicon Esculentum (Tomato Seeds)

In the first experiment, the germination of tomato seed was reduced to 0.2% of untreated seeds after 24 hours of digestion at 52°C.

In the second experiment, the tomato seeds were entirely inactivated within 20 hours of digestion.

The study indicated that plant pathogens and seeds do not survive the digestion process and their inactivation is almost ensured with the addition of the composting process.

"*The results of this work show that propagules of the plant pathogens P. brassicae, R. solanacearum, H. schachtii, M. incognita as well as tomato seeds were rapidly destroyed during the treatment of biowastes in a thermophilic anaerobic digester based on the DRANCO process … [and] it seems unlikely that TMV would pass through the DRANCO process as infective particles under full-scale conditions in concentrations high enough to cause disease*" (Ryckeboer *et al*., 2002b).

Therefore, as "*plant pathogenic bacteria are highly sensitive to the anaerobic digestion process*" (Ryckeboer *et al*., 2002b) they do not pose a significant human health risk. Their destruction during the digestion and composting process ensures that the end product compost will not be notably infected with the pathogens.

D3.1.2.Case Study 2

A study by Turner *et al.* (1983) investigated the fate of three plant pathogens in the digestion process. The pathogens studied were *Fusarium oxysporum*, *Corynebacterium michiganense* and *Globodera pallida.*

The digesters processed sewage sludge and were fed with tomatoes and tomato plant cuttings. The waste stayed in the digester for 10 days. The concentration of volatile fatty acids within the waste was between 300 and 1000 mg/l.

D3.1.2.1 Fusarium Oxysporum

F. oxysporum was entirely destroyed after approximately 70 hours of digestion. Despite additional daily injections of the pathogen, it quickly became inactivated due to the digestion process. The greatest percentage fall in pathogen population was 99% in 28 hours. The lowest percentage fall was 65.9% in 22 hours (Turner *et al*. 1983).

D3.1.2.2 Corynebacterium Michiganense

After five days of digestion, *C. michiganense* was 99.9% inactivated. The pathogen was completely removed after less than 7 days (Turner *et al*. 1983).

D3.1.2.3 Globodera Pallida

There was a considerable reduction in the number of larval hatches from the cysts within the 10 day period. **Table D 2** below shows the total hatches per 100 cysts (Turner *et al*. 1983).

Table D 2 Larval Hatch per 100 Cysts in the Digester

Time in digester	Total hatch per 100 cysts
10 minutes	5038
6.5 hours	146
26 hours	5
6 days	1
10 days	0

The number of larval hatches declined sharply within 24 hours. There were no hatches after 10 days of digestion (Turner *et al.,* 1983).

"*The results show that none of the pathogens studied will be present, in detectable numbers, 10 days after their introduction into an anaerobic digester*" (Turner *et al.,* 1983). Therefore, *F. oxysporum*, *C. michiganense* and *G. pallida* pathogens do not pose a risk to human health. The digestion process successfully inactivates the pathogens and the destruction of the pathogens will be ensured by the composting stage of the digestion process.

D3.2 Bioaerosols

Bioaerosols are a suspension of airborne particles that contain living organisms or were released from living organisms which are present in the everyday environment, including at work and home. The mixing and handling of the MSW causes bacterial and fungal spores to become airborne. According to Millner *et al.* (1994), bioaerosols can contain bacteria, fungi, endotoxins, mycotoxins and arthropods. The concentration and type of bioaerosol that is present at a facility depends on the feedstock.

Humans may also be exposed to pathogens through dermal contact or through any hand-to-mouth contact (such as smoking). Therefore, it is necessary to determine the potential risk of the pathogens as a dose response relationship.

Table D 3 shows the dose response relations for several pathogens (Epstein 1997).

Table D 3 Dose Response Relationship for Pathogens found in MSW

Pathogen	Number of Organisms to Produce Disease in 25-75% of Subjects Tested	Number of Organisms to Produce Disease in any of the Subjects
Shigella spp.	10^2 - 10^5	10^1
Salmonella spp.	10^5 - 10^9	10^4
Escherichia coli	10^6 - 10^{10}	10^6
Vibrio cholerae	10^3 - 10^{11}	10^3

D3.3 Bacteria

There are few studies that examine the survival of pathogenic bacteria in compost. Those studies that do exist indicate that the composting process effectively destroys pathogenic bacteria. Bruns *et al.* (1993) found that *Erwinia amylovora*, which causes fire blight in pear trees and ornamental trees, is destroyed when it is exposed to the composting process for seven days at 40°C. Two other bacteria, *Erwinia carotovora* found in chrysanthemum clippings and *Pseudomonas phaseolicola* found in bean leaves, were even less resistant than *Erwinia amylovora*.

Bollen and Volkner (1996) concluded that "*the data available suggests that it is very unlikely that properly prepared compost is infested with bacterial pathogens*". The temperature in the composting process destroys the pathogenic bacteria. As a result, any potential risk that the compost will infect crops with bacteria is insignificant. Therefore, it is concluded that there is no risk from exposure to bacteria during the composting stage of AD.

D3.4 Endotoxins

Endotoxins are a heat-stable macromolecule that forms an important part of the cell wall of gram-negative bacteria. Many bacteria, including many that are non-pathogenic, produce endotoxins. Endotoxins can be found in airborne dust particles. If inhaled in significant quantities endotoxins can cause tissue damage, headaches, fatigue, fever, chest tightness and coughing. Endotoxins are considered toxic to humans and animals. Airborne endotoxin particles have been implicated in a number of work-related health problems in the areas of agricultural animal housing and animal processing plants (Jones *et al.*, 1984), textile mills (Castellan *et al.,* 1984), poultry handling plants (Thelin *et al.*, 1984), humidifiers and wastewater treatment plants and composting operations (Rylander and Haglind, 1984).

In the composting process, potential endotoxin release occurs when the MSW is delivered on the tipping floor and during shredding, screening and other activities involving materials handling (Epstein, 1997).

There are no regulatory standards for dose response values for endotoxins. The International Commission on Occupational Health has, however, suggested occupational levels for endotoxins in the cotton mill and animal feed industries.

Table D 4 summarises the allowable concentrations (Epstein 1997).

Table D 4 Suggested Endotoxin Limit Values

Industry	Suggested Limit (ng/m³)
Cotton mill	1.0 - 20
Animal feed	0.2 - 470

By way of comparison, the levels of endotoxins in a MSW composting facility range from 0.000000001 to 0.000000014 ng/m³. The level of endotoxins in an office reaches a level as high as 0.39 ng/m³ (Epstein and Epstein, 1989).

It is important to note that a large number of gram-negative bacteria (which exist naturally in the mucous membranes of the nose, throat and gut) or large quantities of endotoxins within the intestines do not cause any symptoms of illness.

Epstein and Epstein (1989) concluded that endotoxins do not represent a human health risk. There is little evidence that exposure to endotoxins causes toxic conditions. Further, *"[t]he data today shows that many other work environments have higher levels of endotoxins and workers are at a greater risk than at composting facilities*".

Therefore, based on the information above, the potential health impact of endotoxins from AD is negligible.

D3.5 Nematodes

In a study carried-out by Bollen and Volkner (1996) nematodes were found to be sensitive to the composting process. This similarly applies to the cyst-forming species and root-knot nematodes, which are more resistant to adverse soil conditions (such as dehydration) than most other nematodes. The root-knot nematode *Meloidogyne incognita* in tomato was killed in each of eight experiments conducted (Menke and Grossman 1971). Similar results were found for *M. incognita* from Paprika.

Nematodes are more sensitive than other plant pathogens to the heat generated during the composting process. As a result, the studies that have been conducted on nematodes "*support the conclusion that a properly prepared compost including a heat phase and a maturation phase is free of plant-infecting nematodes. In routine analysis including many samples of aerobically produced compost, they were never found in properly prepared compost*" (Bollen and Volkner 1996). The heat in the compost piles and the compost maturation phase ensures that nematodes are destroyed. To this end, it is anticipated that the compost will not contain nematodes and therefore, will not present a human health impact.

As the temperatures reached during gasification far exceed those in compost piles and the compost maturation phase, nematodes will not survive and therefore do not present a potential health impact.

D3.6 Fungi

Studies focusing on pathogens in MSW compost have generally paid particular attention to fungi. This is largely because inhalation of fungal spores and fungal metabolites has the potential to cause respiratory problems. These problems include allergies, asthma and other pulmonary infections.

Fungal pathogens are generally destroyed quickly in the composting process. These fungi species include *Sclerotium rolfsii* (Yuen and Raabe, 1984), *Sclerotinia trifoliorum* (Dittmer and Weltzien, 1988), *Sclerotium cepivorum* (Bollen and Volkner, 1996) and *Sclerotinia sclerotiorum* (Herrmann *et al.*, 1994). The sclerotia are unable to survive the high temperature during the composting process. Ultimately, the sclerotia pathogen does not pose any human health risks associate with composting.

However, a substantial amount of attention has been paid to *Aspergillus fumigatus* (*A. fumigatus*) with regards to its potential health risk. *A. fumigatus* is a thermo-tolerant fungus that is able to survive in temperatures ranging from 20°C to 50°C (unlike most other pathogens). *A. fumigatus* is just one of many micro-organisms that contribute to the decay of organic matter in the environment. It can be found virtually everywhere. In the ambient environment, *A. fumigatus* is common in grains, leaves, soils, grasses and woodchips. However, a number of everyday activities provide human exposure to the fungus. For example, Kowal (1978) suggests that mowing a lawn is the most common source of exposure to *A. fumigatus* for residential dwellers. Other potential exposures are gardening, raking leaves and potting household plants. A study by Hirsch *et al.* (1976) found the fungus present in 42% of bedrooms, 56% of bathrooms and 85% of basements. As such, humans are in contact with the organism on a regular basis.

The precise dose of *A. fumigatus* required to generate health impacts has not been determined, nor has a threshold spore concentration or duration of sensitisation needed to cause any illness or disease been demonstrated. The US EPA points out that human reaction to *A. fumigatus* varies depending on the route of exposure, age, the quality of their immune system and the existing microbial populations in the host (US EPA, 1989). As such a healthy individual appears to have no reaction from exposure to ambient concentrations, however, severely immuno-compromised humans (such as those undergoing treatment for cancer) may become ill from exposure to a single *A. fumigatus* conidia received in background environmental concentrations. According to the US EPA (1991), *A. fumigatus* concentrations in the outdoors rarely exceed 150 spores/m^3. In clean houses, *A. fumigatus* spores range from 0 to 200 spores/m^3.

Concentrations of *A. fumigatus* vary widely within and at different MSW composting facilities. To a large extent, levels of *A. fumigatus* are dependent upon the specific operation being performed: the screening of woodchips tends to generate the highest levels of fugitive spoors. High concentrations of *A. fumigatus* can also be found about 5 to 15 cm inside the compost pile.

Table D 5 lists the concentrations of *A. fumigatus* spores at three large-scale composting facilities in the United States. It is important to note that these composting facilities process sewage sludge rather than MSW. Nevertheless, **Table D 5** provides an indication of the predicted *A. fumigatus* concentrations generated by the proposed RRF.

Table D 5 Aspergillus Spore Concentrations at US Composting Facilities

Location	Distance from site (m)	Mean Concentration (CFU^1/m^3)
Sewage sludge composting facility – enclosed (1991)		
Upwind	607	3
On-site		250
Downwind	304 - 2621	4
Sewage sludge composting facility – open (1987)		
Upwind	644	1
On-site	-	9
Downwind	644	2
Sewage sludge composting facility – open (1981)		
Upwind	Unknown	16
On-site	-	-
Downwind	804	20

The concentration of *A. fumigatus* is generally higher on-site. The concentration decreases by a substantial amount only a small distance from the facility. Indeed, Maritato *et al*. (1992) found that onsite concentrations of *A. fumigatus* are approximately ten-fold higher than those measured in the background environment and that these concentrations fall to background levels within 150 m of the composting activities.

A further study into *A. fumigatus* concentrations was carried out by Clark *et al.* (1983), who measured airborne concentrations of *A. fumigatus* at four enclosed Swedish composting facilities. Operations at these facilities include MSW and biosolid composting. Onsite *A. fumigatus* concentrations range from 1×10^2 to 6×10^6 CFU/m³, with the average concentration less than 1.26×10^5 CFU/m³.

A number of scholarly studies argue that there is a lack of persuasive evidence suggesting a health risk from *A. fumigatus* for exposed healthy people, whether they work at the facility or live nearby (US EPA, date unknown; Maritato *et al*., 1992; Epstein, 1989; Epstein, 1997). As Olver (1979) states:

"*The fungus [A. fumigatus] is encountered by most people in a wide diversity of environments. The mere presence of the fungus within the human body is very common and is not necessarily indicative of a diseased condition*."

But this is not to say that *A. fumigatus* is not an issue. Composting facilities do represent a site where the fungus can occur in large concentrations. The important consideration however, is that *A. fumigatus* is readily controllable with appropriate management measures. For this reason "*many public health specialists, scientists and engineers in North America and Europe believe that properly operated composting and co-composting operations present little health risk to normal compost facility employees, and negligible if any risk for nearby residences*" (California EPA, date unknown). A study by Epstein (1989) found that employees working at composting facilities, and thus exposed to higher concentrations of *A. fumigatus*, have not shown any significant or consistent abnormalities. Clark *et al.* (1983) found that there is no trend to infection or allergic responses to workers at MSW compost facilities.

Therefore, given that humans are exposed to *A. fumigatus* on a daily basis and that healthy individuals witness no health impacts, the human health risk associated with *A. fumigatus* from the proposed EMRC RRF is considered to be insignificant.

D3.7 VOCs

VOCs are components of products that are used regularly by people in their homes and at work. Examples of these products include cleaning products, paints, cosmetics and polishes which contain VOCs such as alcohols, benzene, acetone, phenols, xylene, formaldehyde and naphthalene (Brown *et al.*, 1997). These products, and in turn the VOCs, are often disposed of as MSW in mobile garbage bins, however, the manual and mechanical separation process at the proposed the RRF means that little VOCs will actually enter into the organic fraction of the waste stream and therefore the final compost product. The use of trommels, screens and magnets (together with manual sorting) means that those containers carrying items with VOCs (such as containers of household chemicals) will be removed prior to the composting process with little likelihood of being ruptured during the biodigester phase.

Should the VOCs be released, they may dissolve into other components of the waste stream, dissolve into water, biodegrade or vaporize (Brown *et al.,* 1997). This issue is considered in a study by Brown *et al.* (1997), which investigated the fate of VOCs once they are injected into a MSW static pile composting process. The composter was injected with benzene (found in gasoline, paint remover, varnish etc.), carbon tetrachloride (found in glass cleaners, oils, paint remover etc.), dichlorobenzene (found in toilet cleaners, dyes, upholstery cleaners etc.) and xylene (found in nail polish remover, cleaning products, adhesives etc.). They were injected at concentrations of 275 mg/kg, 1375 mg/kg and 2750 mg/kg to ensure concentrations were at least those calculated by the US EPA (275 mg/kg of VOCs in MSW based on estimates of MSW/person/day) (Brown *et al.,*1997).

Brown *et al.* (1997) concluded that all VOCs became volatised within a short period of time; benzene and carbon tetrachloride were completely volatised within six hours, xylene was volatised in approximately 18 hours, dichlorobenzene required three days to volatise. "*Thus, the data indicate that VOCs released into MSW are not highly absorbed by the waste constituents and are rapidly lost by volatisation*" (Brown 1997). The VOCs are volatised by the composting process. As a result, it is unlikely that VOCs will infect the AD end product (compost) and represent a human health impact.

D3.8 Trace Elements and Heavy Metals

Trace elements are found in small amounts in the earth's crust. Soil is the major source of trace elements for plants. Waste applications and fertilizers add to the level of trace elements in the soil (Epstein 1997). Trace element contamination of compost and its impact on human health has been the focus of many scientific studies as trace elements in compost could potentially transfer through crops to humans and animals (by way of ingestion).

In past years, trace elements have been confused with and referred to as 'heavy metals'. This is because of the location of some trace elements on the periodic table. Heavy metals have a molecular density above 5 g/cm^3 and are comprised of 40 elements.

It is difficult to generalise about the trace element impact on human and animal health. Several of the elements are critical to the survival of plants, animals and humans. Cadmium, mercury and lead are toxic to humans, barium and antimony are not toxic to plants, animals and humans and copper, nickel and zinc may be phytotoxic (Epstein 1997).

The level of trace elements in the environment varies widely because of the different geological material that produces the soil. **Table D 6** identifies the level of trace elements in natural and agricultural soils together with the level of trace elements found in fertilizers. The findings are based on 3045 samples from 307 different soil series in the United States.

Table D 6 Trace Elements in the Environment

Pollutant	Range in natural soil (mg/kg)[1]	Range in agricultural soil (mg/kg)[2]	Range in Fertilizers (mg/kg)[3]
Arsenic	5-13	NA	0.1-22.5
Cadmium	0.01-7	<0.0010-2.0	0.1-101
Chromium	23-15000	NA	1.1-15000
Copper	1-300	<0.6-495	1.0-597
Lead	2.6-25	<1.0-135	0.3-2700
Molybdenum	3-8	NA	1-27.1
Nickel	3-300	0.7-269	1.1-303
Selenium	0.0001-3.4	NA	NA
Zinc	10-2000	<3.0-264	1.1-8800

Notes: [1]Conner and Shacklett, 1975.
[2]Holmgren, 1993.
[3]Epstein, 1997.

Trace elements enter the MSW waste stream via a range of sources, including batteries, light bulbs, lead foils (such as wine bottle closures), consumer electronic items, used motor oils and so on (Woodbury, 1992).

The mechanical separation process that will be employed at the proposed RRF (see **Section 4.2.1.2** and **Section 4.2.2.2**) will ensure that the majority of the trace elements will be removed prior to the composting process within the AD technology. Magnets and eddy currents remove the ferrous and non-ferrous metals, items such as motor oil containers that inadvertently enter into the waste stream are separated by the trommels and screens and the nature of the composting and digestion processes means that batteries are not broken (and hence their contents do not permeate into the organic matter). Therefore, there is little likelihood that a significant quantity of trace elements will have the potential to contaminate the organic feedstock in the AD technology.

Bedminster and Conporec monitor the level of trace elements in their compost product and the results are outlined in **Table D** 7 with NSW EPA (2002) compost for comparison.

Table D 7 Trace Element Levels in Compost

Pollutant	Content in Bedminster Port Stephen RRF compost[1] (mg/kg)	WA Biosolid Grade C1 (mg/kg)	Content in Conporec Tracey RRF compost[2] (mg/kg)	AS 4454-1999 / ARMCANZ[3] (mg/kg)	NSW Compost Grade A (mg/kg)
Arsenic	4.60	20	8.2	20	20
Cadmium	2.15	3	2	3	3
Chromium	40.00	100	46	400	100
Mercury	0.38	1	0.49	1	1

Nickel	-	60	28	60	60
Lead	-	150	199	200	150
Selenium	0.85	3	<1	3	5

Notes

[1] Information sourced from http://www.bedminster.com.au/; Bedminster uses biosolids in its process and hence, the WA biosolid Grade C1 and AS 4454-1999 standards are applicable to the Bedminster compost.

[2] The standards applicable to the Conporec compost are the NSW compost Grade A and AS 4454-1999 standards. The WA biosolid Grade C1 standard is not relevant because Worley does not use biosolids in its process.

[3] AS 4454-1999 and ARMCANZ data provided by Worley.

Table D 7 shows that the level of trace elements measured in the Bedminster and Conporec compost products are below the AS 4454-1999, WA biosolid Grade C1 and NSW compost Grade A standards. The exception is lead in the Conporec compost, which does not satisfy the NSW compost Grade A standard (but meets the requirements of the AS 4454-1999). This highlights that the compost product is expected to contain trace elements at a level below the required limits for 'unrestricted use' (see **Section 12.1.3.2** for more information on the issue of compost quality).

D3.8.1. Case Study 1

Epstein *et al.* (1992) has carried out a study into the trace element concentrations in compost from US and EU RRF. The US composting RRFs do not separate compostables (i.e. the organic waste stream) and non-compostables (e.g. metals, glass, plastic, etc.). In contrast, the compostables and non-compostables are separated in the EU. This separation occurs either at the source or at the facility. **Table D 8** indicates the level of trace element content in the US mixed waste composts (Epstein *et al.,* 1992)

Table D 8 Trace Element Levels in Compost from Mixed MSW from US Facilities

Pollutant	Number of samples	Range (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Standard Deviation
Arsenic	8	1-4.8	2.6	3.7	1.5
Cadmium	46	1-13.2	2.9	2.9	2.7
Chromium	41	8.2-130	34.8	34.0	29.6
Copper	46	31-623	154.0	162.0	129.0
Lead	46	22-913	215.0	221.0	170.0
Mercury	17	0.46-3.7	1.3	1.2	0.9
Nickel	40	7-101	24.8	28.0	17.9
Zinc	45	152-1363	503.0	469.0	280.0

By way of comparison, **Table D 9** shows the trace element levels in EU MSW compost produced from source separated material (Epstein 1992).

Table D 9 Trace Element Levels in Compost from Separated MSW from EU Facilities

Pollutant	Number of Samples	Range (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Standard Deviation
Cadmium	26	0.4-9.8	1.1	0.9	2.6
Chromium	25	0.6-71.4	29.4	28.0	19.5
Copper	27	24-224	57.0	47.0	56.0
Lead	27	40.7-777	112.0	86.0	159.0
Mercury	14	0.17-3.8	0.9	0.5	1.2
Nickel	26	8-73	19.9	19.3	17.0
Zinc	27	125-1570	281.0	248.0	298.0

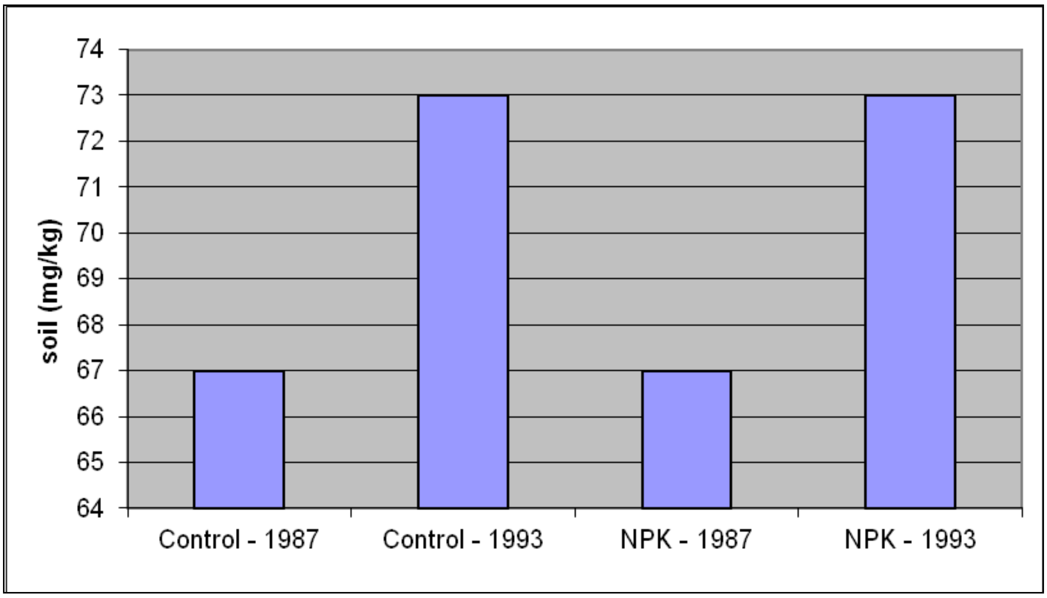
Zinc, copper and lead concentrations are significantly higher in compost from mixed MSW than in compost from separated MSW. Concentrations of chromium, mercury and nickel are not substantially different. Overall, this suggests that the separation of compostables and non-compostables reduces the level of trace elements.

Significantly, a comparison between **Table D 7**, **Table D 8** and **Table D 9** with **Table D 6** shows that the average concentration of trace elements in MSW compost is within the range found in natural soil. The only exception to this is lead, which is above the range found in natural soil but within the range found in agricultural soil. In any case, Woodbury (1992) argues that plants and crops take-up only a small proportion of the lead from most soil types and notes that long-term studies have shown that the lead content in crops increase only marginally even with substantial additions of MSW compost. The evidence thus suggests that trace elements in MSW compost are not a significant human health risk.

D3.8.2. Case Study 2

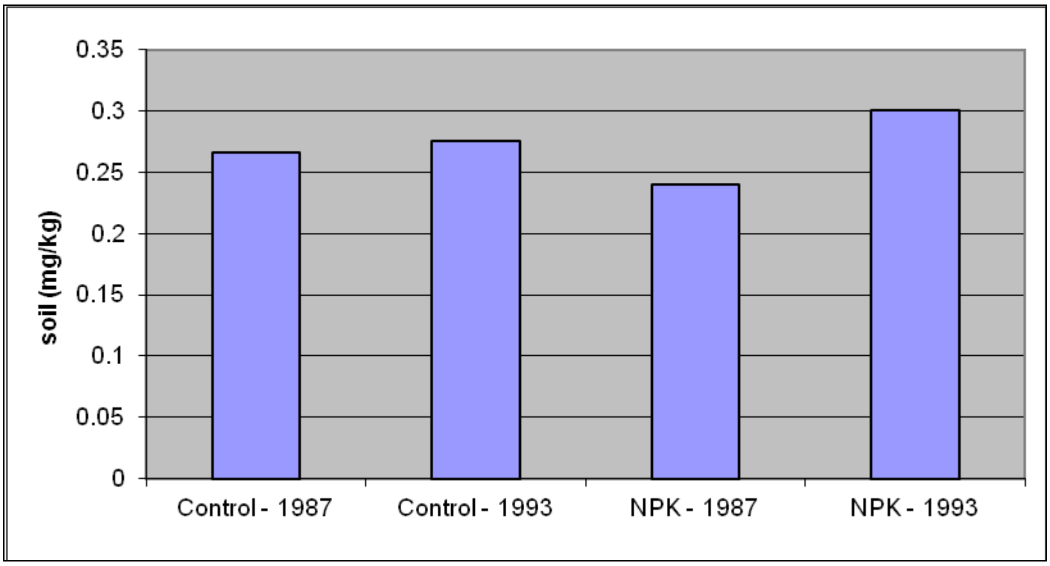
A study by Vogtmann *et al.,* (1996) sought to identify whether MSW compost applied to soil increased ground zinc and cadmium levels over a seven year period. The study compared a 'controlled' area, which did not have compost applied, against a 'NPK' area, which did have compost applied.

Graph D 11 shows the level of zinc content in the soil over a seven year period. Put simply, there is no difference between the zinc content in the controlled area and the compost area. The compost did not add to zinc levels in the soil.



Graph D 11 Zinc Content in Compost Applied Soil, 1987 to 1993

Graph D 12 compares the level of cadmium in the soil over a seven-year period. Again, there is no substantial difference in soil cadmium levels between the controlled area and the compost area in 1993.



Graph D 12 Cadmium Content in Compost Applied Soil, 1987 to 1993

D3.8.3. Case Study 3

Logan *et al.,* (1999) investigated the concentration of trace elements in MSW compost from a number of facilities. The average trace element quantities were compared with the US EPA's regulatory contaminant limits and loading rates for municipal biosolids (commonly called the 503 biosolids limit) and detailed in

Table D 10 (Logan *et al.,* 1999, US EPA, 1993 and DEP, 2002b). The WA biosolid standard is included for comparison.

Table D 10 Trace Elements in MSW Compost Compared to US EPA 503 Limit

Pollutant	Average (mg/kg)	US EPA 503 limit (mg/kg)	WA Biosolid Grade C1 (mg/kg)	WA Biosolid Grade C2 (mg/kg)
Arsenic	5.1	41	20	60
Boron	63.0	-	-	-
Cadmium	2.9	39	3	20
Chromium	57.0	-	100	500
Copper	204.0	1500	100	2500
Molybdenum	7.9	-	-	-
Nickel	37.0	420	60	270
Lead	292.0	300	150	420
Scandium	2.0	100	-	-
Zinc	577.0	2800	2500	2500

All average trace element concentrations fell below the US EPA 503 regulatory limit. The copper and lead concentration exceeded the WA Biosolid Grade C1, but satisfied the WA Biosolid Grade C2 which allows for unrestricted compost use except for around households. This suggests that by following best practice methods the end-product compost should not contain significant concentrations of trace elements.

Epstein (1997) concluded "*the US Environmental Protection Agency's risk analysis in the biosolids regulations (40CFR503) clearly indicates that the levels found in MSW compost do not present a significant risk… Plant uptake by forage and food crops is the primary pathway for the elements to enter humans and animals. There has been no indication or data to show that the use of compost for growing crops has resulted in the concentration of heavy metals in soils or crops that could be toxic to humans or animals*" (Epstein 1997).

It is therefore considered, that the trace element concentration in MSW compost does not pose a significant health risk to humans or animals. Ongoing monitoring in accordance with AS 4454-2003 will help to ensure a low concentration of trace elements in the final compost product.

D3.9 Pesticides

According to the US EPA (2008), a pesticide is defined as "any substance or mixture of substances intended for:

- preventing;
- destroying;
- repelling; or
- mitigating any pest."

The term 'pesticide' also refers to herbicides, fungicides, and other substances to control pests. There are a number of pesticides that can be found in the common household, including cockroach sprays and baits, insect repellents for personal use, kitchen and laundry disinfectants and sanitisers, products that kill mould and mildew and some lawn and garden products (such as weed killers) (US EPA 2008). However, the nature of these products means that they will be mostly removed from the process due to the combination of manual sorting and mechanical separation equipment, such as trommels, screens and magnets. This process effectively removes the containers carrying the pesticide contaminants (such as spray cans and laundry disinfectant bottles, for example) meaning that there is low opportunity for pesticides to enter into the organic stream and ultimately end up in the compost product. Those studies that focus on pesticide contamination have only infrequently detected pesticides in the waste feedstock.

Notwithstanding this, the Recycled Organics Unit (ROU) (at the University of New South Wales) notes that any commercial composting facility has the potential to receive greenwaste material (such as lawn clippings, non-woody garden organics, woody garden organics, etc.) that is contaminated by garden maintenance chemicals (ROU 2007). The receival of contaminated greenwaste will go undetected because there is no way for the composting facility to identify whether the garden organics are contaminated. For this reason, it is important to assess the risk of garden maintenance chemicals in the final compost product.

Until recently, little attention had been paid to the issue of pesticide contamination of compost. Most people generally regarded compost to be relatively consistent in terms of its quality. However, that viewpoint changed in 2000 due to evidence of pesticide contamination of the compost from two facilities in Washington State, United States. The Spokane facility processed yard trimmings, while the Pullman-Moscow facility mainly processed manure and animal bedding, and soil and plant material. The compost from these facilities was contaminated with clopyralid and picloram (respectively), although not enough clopyralid was present to determine its actual concentration. The clopyralid entered the Spokane facility through contaminated lawn clippings (the pesticide was used to control dandelions). Residues of picloram on hay was ingested by livestock, passed through the animals, and deposited in the manure and bedding, which was subsequently processed at the composting facility (Rynk 2000). There has subsequently been a case of clopyralid contamination of compost in New Zealand (Bezdicek *et al.,* 2001, Fietje 2001)

In response to the above cases of compost contamination, the ROU undertook a risk assessment to determine the likelihood of a similar situation occurring in New South Wales (ROU, 2007). The assessment initially identified 49 different garden maintenance chemical products that are available on the domestic market, with seven chemicals found to be potentially persistent. These seven chemicals were investigated further to ascertain their risk of contaminating compost. Details of these investigations are presented below.

D3.9.1. 2,2-Dichloropropionic Acid (DPA)

DPA was found in one garden maintenance chemical product available at 90% of the surveyed outlets. It is a halogenated alkanoic acid herbicide that may persist after composting. However, the consequence of its presence after composting and its potential impact on crops is insignificant because the product is used to target weeds in paths, and this source of waste represents only a very small portion of the overall waste stream (ROU 2007).

D3.9.2. Glyphosate

The study identified nine garden maintenance chemical products that contain glyphosate. These products are used to control grasses, herbaceous plants and conifers. The ROU took a conservative approach to assessing the risk of this pesticide due to the lack of information on its degradation qualities. As such, the consequences of its presence after composting were rated as moderate. Although the Recycled Organics Unit notes that plants and crops do not usually absorb the glyphosate from soil, its herbicidal nature gave its application a high risk (ROU 2007).

D3.9.3. Simazine

Simazine is a triazine herbicide that was found in three garden maintenance chemical products. These products use simazine as a path weed killer, and given the low supply of weeds in the waste stream, the consequence of simazine's presence after composting is insignificant. The low concentration of the pesticide in the final compost product also means that its impact on crops is minor (ROU 2007).

D3.9.4. Triclopyr

Triclopyr is a pyridine selective systemic herbicide found in two garden maintenance chemical products, which are mainly used to control woody and broadleaf plants. The potential for its persistence after composting is possible due to its reported half-life. The consequence of its existence in the compost product is moderate due to the likelihood of crop and plant loss (ROU 2007).

D3.9.5. Chlorpyrifos

Chlorpyrifos was found in 11 garden maintenance chemical products. The consequences of its presence in the compost product are insignificant given that it is an insecticide and a low public health risk. It has a minor impact on plant growth (ROU 2007).

D3.9.6. Imidacloprid

The study found that only one garden maintenance product used imidacloprid. Although the chemical may be present after composting in low concentrations, the consequence is insignificant because it is an insecticide and does not cause damage to plants and crops (ROU 2007).

D3.9.7. Pirimicarb

Pirimicarb is a carbonated insecticide used in one garden maintenance chemical product. Pirimicarb's presence in compost is rare because of its high solubility and weak adsorption to the surface. Moreover, the use of the chemical as an insecticide means that it has an insignificant impact on plant and crop growth (ROU 2007).

The outcome of the risk assessment conducted by the ROU indicates that there are two pesticides that have the potential to destroy plants and crops via its presence in compost: triclopyr and glyphosate herbicides. However, it should be noted that there is only a low probability of the proposed EMRC RRF actually receiving and processing items that are contaminated by these chemicals. This is because the two herbicides are mainly used to control woody and leafy plants. These plants are typically disposed directly to landfill or during a bulk verge rubbish collection, rather than in a mobile garbage bin. Indeed, the quantity of contaminated plants in mobile garbage bins is expected to be insignificant, especially given that green waste makes-up only around 20.9% of the overall waste stream. In fact, the risk assessment stated that there is "*no evidence of the use of these problematic herbicides in applications from which raw materials for commercial compost production are commonly sourced*" (ROU 2007). Therefore, the concentration of the triclopyr and glyphosate herbicides (and other pesticides) in the final compost product is not likely to pose a significant human health impact.

This issue was summarised in a number of *BioCycle* journal articles as follows:

"*There are over 3,000 yard trimmings composting facilities in the US, many of which process grass clippings, and the incidents in Washington State are the first known to report and document this problem with herbicide contamination of the compost … The evidence suggests that problems from herbicide residues are rare (in fact, we have identified no other confirmed cases)*" (Rynk 2000).

"*The widespread use of compost and the lack of reported problems together suggest that herbicide residues in compost are not a serious problem*" (Anonymous 2000).

It should also be noted that none of the shortlisted companies for the RRF have experienced a problem with pesticide contamination of their compost product. The up-front manual and mechanic sorting and screening process will remove the majority of pesticides before they have the opportunity to enter the organic waste stream or the compost. Any pesticides that do inadvertently enter the composting process will be at low concentrations and will likely be degraded, volatized or mineralized in a short period of time (Büyüksönmez *et al.,* 1999; Büyüksönmez *et al.,* 2000; Frederick 1996). It is thus concluded that pesticide contamination of the compost product from AD will not represent a significant human health impact.

Regardless, the successful tenderer that operates the EMRC RRF will have a commercial imperative to create a high quality compost product with minimal pesticide contamination. Ongoing monitoring in accordance with AS 4454-2003 will ensure a low concentration of pesticide in the final product.

Appendix E

Documents provided on CD

E1. Document List

E1.1 Documents Prepared to Satisfy the Requirements of the EP Act

Public Environmental Review, EMRC Resource Recovery Facility Project. Rev 4.1, July 2012.

Environmental Scoping Document, EMRC Resource Recovery Facility Project. EPA Final V3, October 2011.

E1.2 Background Documents

E1.2.1. Air Quality

Synergetics 2011. *Air quality modelling of resource recovery facility scenarios at the Red Hill Waste Management Facility for Eastern Metropolitan Regional Council. 26* October 2011.

Synergetics, 2012. *Addendum: Revised Air Quality Modelling of Resource Recovery Facility Scenarios at the Red Hill Waste Management Facility.* 5 July 2012

E1.2.2. Odour

SLR Consulting, 2011. Red Hill Waste Management Facility Odour Monitoring Report January 2011. 2 March 2011.

SLR Consulting, 2011. Red Hill Waste Management Facility Resource Recovery Facility Odour Impact Assessment. 5 July 2012.

SLR Consulting, 2012. Red Hill Landfill Waste Management Facility Odour Impact Assessment Sensitivity Analysis. 19 June 2012.

SLR Consulting 2012. Red Hill Landfill Waste Management Facility: Dispersion Modelling Validation Study. 7 June 2012.

E1.2.3. Noise

Lloyd George Acoustics, 2011. *Noise Modelling Report. Red Hill Waste Management Facility.* May 2011.

Lloyd George Acoustics, 2011. *Noise Impact Assessment. Red Hill Waste Management Facility. Proposed Resource Recovery Facility.* September 2011.

E1.2.4. Flora and Fauna

Bamford Consulting Ecologists, 2010. *Red Hill Waste Management Facility Lot 12 (Site 2) Toodyay Rd, Gidgegannup Fauna Assessment.* February 2010.

Helena Holdings WA Pty Ltd, 2010. *Flora and Vegetation Assessment Site 2, Lot 12 within the Red Hill Waste Management Facility.* May 2010.

E1.2.5. Waste Characteristics

APrince Consulting, 2004, Waste Stream Audit and Analysis for Eastern Metropolitan Regional Council. October 2004.

Nolan ITU, 2003, Eastern Metropolitan Regional Council – Waste Composition Study, Sydney NSW, Nolan ITU.

Appendix F

EMRC Community Partnership Agreement

Community Partnership Agreement

Statement of intent

This *Community Partnership Agreement (CPA)* represents a commitment by the Eastern Metropolitan Regional Council (EMRC) to work with the community to ensure the construction and ongoing operation of the Resource Recovery Facility (RRF) at the Red Hill Waste Management Facility is undertaken in the best interests of the community.

This document once endorsed by Council represents an agreement that has been developed in consultation with the EMRC Community Taskforce (CTF) and the wider community.

In considering the contents of this document the CTF have set the following objectives:

- That the CPA be useful into the long-term for both the community and the EMRC;
- To provide a mechanism for community aspirations and concerns to be captured, heard and responded to in an ongoing manner;
- To provide community confidence that their aspirations and concerns are being considered throughout the project;
- The CPA has credibility and status with the EMRC and community to enforce compliance with these objectives.

The CPA will form part of the Tender documentation to which tenderers will have to respond. In the long-term it will also provide indicators through which the EMRC and RRF operator can benchmark their performance and report back to the community. The CPA will be used at various stages of the RRF project - tender phase, commissioning, ongoing operation and reporting.

Background to the development of this document

The EMRC has collaborated with its six member Councils: Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and the City of Swan in the development of the Resource Recovery Project.

Given that the proposed RRF is likely to influence all aspects of waste management in Perth's Eastern Region, the EMRC has undertaken extensive research on the various technology options and has actively engaged with the community since 2004.

Community input has been sought through a Waste Management Community Reference Group, the Red Hill Community Liaison Group, community workshops, surveys and information sessions. Information on the RRF has also been made available through newsletters, newspaper advertisements and on the EMRC website (www.emrc.org.au).

Community Partnership Agreement

In 2009 the EMRC completed an Expression of Interest process, which enabled the EMRC Council to make key decisions related to the acceptable technologies for the RRF as well as identifying the Red Hill Waste Management Facility as the preferred site.

Following this the EMRC Council established a Community Task Force (CTF) in mid 2010, tasked with the responsibility of drafting the *Community Partnership Agreement* (CPA). In September 2010 the EMRC organised a Community Forum to gather the views, aspirations and concerns of the community in relation to the construction and operations of the RRF. Members of the CTF attended the forum and used feedback from the forum as input into developing the draft CPA.

CTF members have met regularly following the Community Forum and have undertaken the following activities:

- Analysis of community feedback collected during the Community Forum (a report on the forum is available on the EMRC website).
- Met with members of the Mindarie Regional Council's (MRC) Community Advisory Group following a tour of the Neerabup Resource Recovery Facility. This group was responsible for the development of the Mindarie Community Partnership Agreement, prior to the construction of the Neerabup Resource Recovery Facility, run by BioVision 2020 for the MRC.
- Discussions and meetings with their local community to collect information on their aspirations and concerns for the RRF.
- Regular meetings to formulate a *Community Partnership Agreement* giving consideration to the aspirations and concerns of the community.

This final version of the *Community Partnership Agreement* (CPA) incorporates relevant agreed feedback from the community and was presented to the EMRC Council for consideration and acceptance to form part of the tender document. It is intended that the agreement be reviewed as the project progresses and revised to reflect changes as required.

Community Partnership Agreement

The CPA has six goals for the construction and operation of the RRF:

Goal 1: **Ensure strong community involvement and communication**

Goal 2: **Enhance community education and waste recycling**

Goal 3: **Ensure prudent financial performance and long-term viability**

Goal 4: **Achieve high quality operations and monitoring**

Goal 5: **Minimise the impact on human health and the environment**

Goal 6: **Provide attractive landscaping and site aesthetics**

Notes:

- Some items deemed to be more specifically focused on the tender process (ie: short-term in nature) will be included in the draft Tender Evaluation Criteria (TEC), which will form part of the EMRC's tender and selection process.
- Examples of performance indicators are provided for each objective. These indicators will be finalised during the tender process based on feedback from tenderers.

Goal 1: Ensure strong community involvement and communication

Objective	**Examples of possible indicators**
1.1 Accessible and regular communication with the community • Information about plant operations provided in multiple formats (newsletter, social media, RRF website etc) • Regular reports outlining project milestones and site performance against the CPA	1.1.1 Quarterly reports made available to the community outlining project milestones, compliance reports and site performance against the CPA 1.1.2 Number of visits to RRF website 1.1.3 Bi-ennial survey of nearby residents/landowners
1.2 Timely and accessible complaints management system in place	1.2.1 Hotline and web site access for complaints acknowledged within 48hrs 1.2.2 Number of complaints and resolution times
1.3 Community Engagement Advisory Group be formed to oversee the implementation, monitoring and periodic review of the CPA	1.3.1 Meeting attendance, frequency and committee composition 1.3.3 Periodic review of the CPA completed

Goal 2: **Enhance community education and waste recycling**	
Objective	**Examples of possible indicators**
2.1 Design to enable as much of the RRF operations to be viewed as practically possible from a viewing platform or CCTV	2.1.1 Percentage of operations able to be viewed onsite 2.1.2 Percentage of operations able to be viewed online 2.1.3 Number of visits to RRF website 2.1.4 Provision of an interactive video
2.2 Conduct on-site tours and open days for interested parties	2.2.1 Number of tours per year 2.2.2 Number of participants at Open Day
2.3 Incorporate RRF information into the EMRC's existing Education Centre	2.3.1 Visits to education centre 2.3.2 Level of knowledge and improvement from education centre visits
2.4 Encourage waste reduction and source separation throughout the member Councils (Reuse, Reduce, Recycle, Recover) through EMRC's waste education programme	2.4.1 Percentage recovered through recycling 2.4.2 Percentage diverted from landfill

Goal 3: **Ensure prudent financial performance and long-term viability**	
Objective	**Examples of possible indicators**
3.1 Value for money operation and services provided to member Councils and their communities	3.1.1 Business plan fully costed over the life of the facility (e.g. 20yr plan) 3.1.2 Costs per household per year
3.2 EMRC runs a financially sustainable operation based on prudent financial management	3.2.1 Quarterly financial reporting 3.2.2 Usefulness/marketability of products produced

Goal 4: Achieve high quality operations and monitoring	
Objective	**Examples of possible indicators**
4.1 Ensure reliable, well managed, ongoing operations	4.1.1 Number of unscheduled shutdowns 4.1.2 Comprehensive Business Continuity & Disaster Recovery Plan in place
4.2 Establish monitoring and reporting systems, including real time analysis of key emissions as part of the operations.	4.2.1 On-stream analysis of key emissions as part of operations 4.2.2 Comprehensive monitoring of all emissions that require sampling as required by DEC licence 4.2.3 Analyses to be made publicly available online and published regularly 4.2.4 Onsite display of key emissions
4.3 Implement defined and documented quality control, assurance and reporting systems.	4.3.1 Performance against quality control systems reported to Community Engagement Advisory Group 4.3.2 Performance improvement targets achieved beyond minimal requirements (noise, dust, odour etc)

Goal 5: Minimise the impact on human health and the environment	
Objective	**Examples of possible indicators**
5.1 Facility meets licence conditions for noise, air emissions, dust, odour, light and water	5.1.1 No breach of environmental licence and/or ministerial conditions 5.1.2 Set operational targets for emissions below licence limits
5.2 Ensure safe handling, storage and disposal of all materials	5.2.1 Handling, storage and disposal of materials to meet appropriate regulations
5.3 All environmental standards met to ensure no damage to surrounding flora, fauna or human health	5.3.1 Compliance against environmental standards 5.3.2 Compliance against health standards
5.4 Is a net producer of energy and reduces greenhouse gas emissions relative to landfill	5.4.1 Energy efficiency of operations 5.4.2 Net reduction of greenhouse gas emission relative to landfill
5.5 Minimise the use of scarce natural resources	5.5.1 Water recycling 5.5.2 Capture of water run off

Community Partnership Agreement

Goal 6: Provide attractive landscaping and site aesthetics	
Objective	**Examples of possible indicators**
6.1 Provide a functional and visually acceptable landscaped facility	6.1.1 Community and customer feedback 6.1.2 Use of local native flora where practical
6.2 Retain existing site buffer zones	6.2.1 Facility location complies with site licence buffer zones

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