Pacific Environment Limited

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Report

ENERGY FROM WASTE FACILITY – AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

THE NEXT GENERATION

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EXECUTIVE SUMMARY

The Next Generation NSW Pty Ltd (TNG NSW) proposes to construct and operate an Energy from Waste (EfW) facility on land adjacent to the Genesis Xero Waste facility in Eastern Creek. Pacific Environment has been engaged by TNG NSW to prepare an Air Quality and Greenhouse Gas Assessment (AQIA) for the facility.

Air quality impacts are assessed at the closest sensitive receptors, including locations such as schools and hospitals, located within the closest residential suburbs of Minchinbury and Erskine Park.

The primary emissions from the EfW facility, as defined by emission limits for waste incineration set by the European Union (EU) Industrial Emissions Directive (IED; Directive **2010/75/EU**), are anticipated to be as follows:

- Particulate matter (PM), assumed to be emitted as PM_{10} and $PM_{2.5}$[a].
- Hydrogen Chloride (HCl).
- Hydrogen Fluoride (HF).
- Carbon Monoxide (CO).
- Sulfur Dioxide (SO_2)
- Oxides of nitrogen (NO_x) (expressed as Nitrogen Dioxide (NO_2)).
- Heavy metals (including Mercury (Hg), Cadmium (Cd), Arsenic (As) and Chromium (Cr).
- Gaseous and vaporous organic substances (expressed as total organic carbon (TOC)).
- Dioxins and furans.

In addition to the atmospheric emissions identified in the IED, other potential emissions that have been addressed include:

- Hydrogen sulfide (H_2S).
- Chlorine (Cl_2).
- Ammonia (NH_3).
- Polycyclic aromatic hydrocarbons (PAHs).

In March 2014 the NSW Environment Protection Authority (EPA) published its Energy from Waste Policy Statement ("the EfW Policy Statement"). The EfW Policy Statement requires that any facility proposing to recover energy from waste will need to meet current international best practice. The policy also requires that emissions from EfW facilities must satisfy, as a minimum, current emission limits prescribed by the POEO (Clean Air) Regulations.

The proposed technology for the EfW facility is based on existing facilities in the United Kingdom and Europe and will incorporate best available technology (BAT) for flue gas treatment. The flue gas treatment is designed to meet the in-stack concentrations limits for waste incineration set by the EUIED, which are generally more stringent that the Clean Air Regulations. The flue gas treatment system includes:

- Selective Non-Catalytic Reduction (SNCR) for reducing emissions of oxides of nitrogen.
- Dry lime scrubbing for reducing emissions of acid gases, including HCl and SO_2.
- Activated carbon injection for reducing emissions of dioxins and Hg.
- Fabric filters for reducing emissions of particles and metals.
- Following flue gas treatment, emissions will be dispersed via a 100m stack.

[a] Particulate matter with an aerodynamic diameter of less than 10 and 2.5 micrometres respectively.

A review of existing EfW facilities shows that the facility meets current international best practice and can satisfy the emission limit requirements of the IED.

The AERMOD atmospheric dispersion model was selected as a suitable dispersion model due to the source type, location of nearest receiver and nature of local topography. Preliminary iterative modelling was completed and determined that a stack height of 100m was required to demonstrate compliance with the NSW impact assessment criteria.

Modelling predictions at sensitive receptors have been made and the results show:

- The maximum predicted 1-hour NO_2 is 39% of the impact assessment criterion, even assuming 100% conversion from NO_x to NO_2
- The maximum predicted annual NO_2 is 7% of the impact assessment criterion.
- The maximum predicted 10-minute SO_2 is 13% of the impact assessment criterion, for 1-hour; 8%, for 24-hour; 5% and for annual; 3%.
- The maximum predicted 24-hour PM is 3% of the impact assessment criterion for PM_{10} and 7% of the advisory reporting standard for $PM_{2.5}$.
- The maximum predicted annual PM is less than 1% of the impact assessment criterion for PM_{10} and 3.8% of the advisory reporting standard for $PM_{2.5}$.
- The maximum predicted CO 15-minute, 1-hour and 8-hour averaging periods are 0.1% or less than the relevant impact assessment criterion.
- The maximum predicted 24-hour HF is 8% of the impact assessment criterion, for 7-day; 4%, for 30-day,; 7% and for 90-day; 11%.

Modelling predictions for air toxics are assessed against the 99.9th percentile prediction, at and beyond the site boundary. The ambient concentration of H_2S is assessed against the 99th percentile prediction.

In summary, the modelling results show:

- The 99.9th percentile predicted HCl is 12% of the impact assessment criterion.
- The 99.9th percentile predicted Cd is 77% of the impact assessment criterion.
- The 99.9th percentile predicted Hg is 8% of the impact assessment criterion.
- The 99.9th percentile predicted dioxins and furans are 1% of the impact assessment criterion.
- The 99.9th percentile predicted TOC (conservatively expressed as 100% benzene) is 19% of the impact assessment criterion.
- The 99.9th percentile predicted NH_3 is 0.3% of the impact assessment criterion.
- The 99.9th percentile predicted PAH (as benzo(a)pyrene) is 0.1% of the impact assessment criterion.
- The 99.9th percentile predicted Cl_2 is 16% of the impact assessment criterion.
- The 99th percentile predicted H_2S is 49% of the impact assessment criterion.

Modelling is based on the EfW facility emitting at the IED limits and based on this, the prediction for cadmium is 77% of the impact assessment criteria. However, during normal operations emissions will be significantly lower than this limit, as demonstrated by monitoring data from existing facilities.

Cumulative predictions are also presented. There are no exceedances of the EPA criteria when the EfW contribution is added to maximum background concentration, with the exception of PM, which results in a cumulative concentration marginally over the 24-hour PM_{10} criterion of 50 µg/m^3. However, this prediction occurs on a day when the background is already high (at 49.2 µg/m^3) and further analysis demonstrates that no additional exceedances would occur as a result of the EfW facility's activities.

The results of the modelling during upset conditions indicate that, under worst-case dispersion conditions, several pollutants are predicted to exceed the NSW impact assessment criteria including PM_{10}, HF, HCl, Cd, Hg, dioxins and furans.

A probabilistic approach has then been adopted, with results indicating that probability of the above pollutants resulting in adverse impacts (i.e. the potential for upset conditions to coincide with worst-case dispersion conditions) would be less than 0.1%.

Odour emissions from the EfW facility have been addressed in a stand-alone quantitative assessment **(Pacific Environment, 2015a)**. The results of this assessment show that worst-case odour concentrations would be below the impact assessment criterion of 2 ou at nearest sensitive receptors.

A screening assessment of construction phase impacts identified no human receptors within 350 m of the boundary of the site. The screening assessment concluded no detailed assessment of construction phase impact is required and routinely employed 'good practice' mitigation measures for construction sites would be sufficient to control dust impacts to acceptable levels.

The operation of the facility would have a net positive GHG impact, potentially eliminating 1.5 million tonnes of carbon dioxide equivalents (CO_2-e) per annum. The emission intensity for electricity generated from the facility is lower than other non-renewable energy generators in NSW.

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1 INTRODUCTION

The Next Generation NSW Pty Ltd (TNG NSW) proposes to construct and operate an Energy from Waste (EfW) facility on land adjacent to the Genesis Xero Waste facility, located at Honeycomb Drive, Eastern Creek, approximately 36 km west of the Sydney CBD.

Pacific Environment has been engaged by TNG NSW to prepare an Air Quality and Greenhouse Gas Assessment as part of an Environmental Impact Statement (EIS), required under State Significant Development (SSD) provision in Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011.

This assessment has followed the procedures outlined in the NSW Environment Protection Authority (EPA) document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" ("The Approved Methods", **EPA, 2005**).

1.1 Background and context

The development involves the construction and operation of an electricity generation plant, which will allow for unsalvageable and uneconomic residue waste from the Genesis Xero Material Processing Centre (MPC) and Waste Transfer Station (WTS) to be used for generation of electrical power. The EfW facility is proposed to be located on Lots 2 and 3, DP 1145808.

This development site is part of a proposal to construct and operate NSW's largest EfW facility using residual waste as fuel which would otherwise be landfilled, to allow for a "green" electricity generation facility. The plant, fuelled by non-recyclable combustible waste material, will have a capacity for up to 1.35 million tonnes of residual waste fuel per annum, as follows:

- 850,000 tonnes per annum (tpa) from waste already being received at the neighbouring Genesis Xero Waste Facility.
- Up to 500,000 tpa from external (new) sources.

The proposed works will, in addition to the EfW facility, include the adoption of a plan of subdivision and the following ancillary works:

- Earthworks associated with the balance of the site.
- Internal roadways.
- Provision of a direct underpass connection (Precast Arch and Conveyor Culvert) between the Facility and the Genesis Xero Waste Facility.
- Staff amenities and ablutions.
- Staff car parking facilities.
- Water detention and treatment basins.
- Services (Sewerage, Water Supply, Communications, Power Supply).

The proposal has been designed to utilise non-recyclable or non-recoverable materials for combustion under conditions which comply with the NSW Environment Protection Authority (EPA) *Energy from Waste Policy Statement* ("the EfW Policy Statement"; EPA, 2014).

1.2 Assessment requirements

The Air Quality and Greenhouse Gas Assessment is guided by the Director-General's Requirements (DGRs) and Agency requirements, as outlined in **Table 1-1**.

Table 1-1: Agency requirements

Government Agency	Requirement	Relevant Section
DP&I	Air Quality and Human Health - including:	
	- a quantitative assessment of the potential air quality and odour impacts for the development on surrounding landowners and sensitive receptors under the relevant Environment Protection Authority guidelines;	Section 9
	- a description of construction and operational impacts, including air emissions from the transport of materials;	Section 7 and 9
	- a human health risk assessment covering the inhalation of criteria pollutants and exposure (from all pathways i.e., inhalation, ingestion and dermal) to specific air toxics;	Standalone report - note [b]
	- details of any pollution control equipment and other impact mitigation measures for fugitive and point source emissions;	Section 7
	- a demonstration of how the waste to energy facility would be operated in accordance with best practice measures to manage toxic air emissions with consideration of the European Union's *Waste Incineration Directive 2000* and the Environment Protection Authority's draft policy statement *NSW Energy from Waste*;	Section 7
	- an examination of best practice management measures for the mitigation of toxic air emissions;	Section 7
	- details of the proposed technology and a demonstration that it is technically fit for purpose.	Section 2
	Greenhouse Gas - including: - a full greenhouse gas assessment (including an assessment of the potential scope 1, 2 and 3 greenhouse gas emissions of the project, and an assessment of the potential impacts of these emissions on the environment	Section 10
	- a detailed description of the measures that would be implemented on site to ensure that the project is energy efficient.	Section 10.3.2
EPA	Assess the risk associated with potential discharges of fugitive and point source emissions.	Section 9
	Assessment of risk relates to environmental harm, risk to human health and amenity. Justify the level of assessment undertaken on the basis of risk factors, including but not limited to: a. proposal location; b. characteristics of the receiving environment; and c. type and quantity of pollutants emitted.	Section 3, 4, 7 and 9
	Describe the receiving environment in detail. The Proposal must be contextualised within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to: a. meteorology and climate;	Section 6

[b] A Human Health Risk Assessment has been prepared as a standalone assessment as part of the EIS.

	b. topography; c. surrounding land-use; receptors; and d. ambient air quality. e. Include a detailed description of the Proposal.	
	All processes that could result in air emissions (including odour) must be identified and described. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided.	Section 7
	Demonstrate that the proposed facility complies with the requirements of the NSW Energy from Waste *Draft* Policy Statement (2013). In particular: a. An international best practice techniques demonstration with respect to process design and control, emission control equipment design and control and emission monitoring with real time feedback to the controls of the process; and b. Energy Recovery Facility Technical Criteria.	Section 4, 7, 9
	Include a detailed emissions inventory for the Proposal. All point and fugitive sources are to be included in the inventory together with estimates of emission concentration and rate of all air pollutants emitted.	Section 7
	Any nominated controls must be explicitly linked to calculated emission reductions adopted in the air quality impact assessment emissions inventory, with all assumptions documented and justified.	Section 7
	Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits.	Section 9
	Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment.	Section 9
	Include air dispersion modelling where there is a risk of adverse air quality impacts, or where there is sufficient uncertainty to warrant a rigorous numerical impact assessment? Air dispersion modelling must be conducted in accordance with the Approved Methods or the Modelling.	Section 8, 9
	An odour impact assessment must additionally have regard to the technical Framework and Notes for the assessment and Management of 0dour from discretionary sources in NSW (2006).	Section 7.5
	Include a quantitative photochemical smog assessment in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005).	Standalone report – note [c]
	ODOUR A quantitative assessment of the potential odour impacts from the construction and operation of the plant on surrounding landowners and sensitive receptors.	Section 7.5

[c] An ozone impact assessment / photochemical smog assessment has been prepared as a standalone assessment, submitted as part of the EIS.

2 TECHNICAL DESCRIPTION OF THE FACILITY

2.1 EfW facility overview

The EfW facility will operate a well-established technology known as a moving grate furnace. Residual waste fuel is gravity fed onto the incinerator grate. The grate is continually moving thus promoting continuous mixing of the residual waste fuel with the combustion air, extracted from the tipping hall and introduced from beneath the grate into the heart of the fire. Further air is injected just above the fire to promote mixing and complete combustion of the gases.

Diesel generators are installed for start-up and to maintain the furnace temperature, if required. However, during normal operation no support fuel is required to maintain a minimum combustion temperature of 850°C.

Ash from the grate is discharged into a water filled quench bath from where it is moved by conveyor to the enclosed ash storage bunkers prior to being transported off site. All incinerator bottom ash is sent to the adjoining Genesis facility or other licensed facilities for aggregate and road base production. Residue ash from the pollution control system is collected into sealed storage tanks and transported off-site for further treatment or disposal via sealed tanker vehicle.

Hot gases from the combustion of the residual waste fuel pass through a heat recovery boiler. The temperature of the gases is reduced from over 850°C to around 150°C. The energy from the hot gases is transferred to the boiler to produce high pressure steam. This steam is fed to the steam turbine driven generator capable of generating around 140 MW, which, after supplying the site electrical load is exported to the National Grid.

The EfW facility will operate 24 hours a day, seven days a week, with occasional offline periods for maintenance. Over the entire year, it is assumed that the facility would be operational for 8,000 hours as an annual average. Some residual waste fuels would be delivered directly to the facility (by B-double) with the remaining transferred from the existing Genesis Xero Waste facility either via a covered electrically powered conveyor or by truck. It is anticipated that an additional 168 trucks would visit the site as a result of the EfW facility operations. All roads will be sealed to reduce potential for wheel generated dust emissions.

The EfW facility will have capacity between 900,000 to 1,350,000 tonnes of residual waste fuel per annum. The following residual waste fuel types are considered as the main sources of fuel for the facility.

- Chute Residual Waste (CRW) from the Genesis Facility.
- Commercial and Industrial (C&I) Waste.
- Construction and Demolition waste (C&D).
- Flock waste fuel supply from car and metal shredding.
- Other organic waste.

It is understood that the annual average chlorine content of the residual waste fuel will be less than 1%. This is further discussed in **Section 4.2**.

A general arrangement for the facility is shown in **Appendix A**. A list of all adopted assumptions in this assessment is provided in **Appendix B**.

2.2 .Flue gas treatment

The proposed technology for the EfW facility is based on existing facilities in the United Kingdom (UK) and rest of Europe and will incorporate best available technology (BAT) for flue gas treatment. The flue gas treatment is designed to meet the in-stack concentration limits for waste incineration set by the European Union (EU) Industrial Emissions Directive (IED; Directive **2010/75/EU**). The flue gas treatment system includes:

- Selective Non-Catalytic Reduction (SNCR) for reducing emissions of oxides of nitrogen.
- Dry lime scrubbing for reducing emissions of acid gases, including hydrogen chloride (HCl) and Sulfur Dioxide (SO_2).
- Activated carbon injection for reducing emissions of dioxins and mercury (Hg).
- Fabric filters for reducing emissions of particles and metals.

Following flue gas treatment, emissions will be dispersed via a 100m stack. Further details of the flue gas treatment are discussed in **Section 7**.

2.3 Start-up / shut-down conditions

The EfW facility is designed to operate continuously, therefore start-up and shutdown are infrequent events and anticipated to be required during the EfW facility's annual maintenance program. The following description of start-up and shutdown conditions has been provided by the project's design engineers (**Fichtner, 2015**).

> *Start-up of the facility from cold will be conducted with clean support fuel (low sulphur light fuel oil). During start-up waste will not be introduced onto the grate unless the temperature within the oxidation zone is above the 850ºC as required by Article 50, paragraph 4(a) of the IED. During start-up, the flue gas treatment plant will be operational as will be the combustion control systems and emissions monitoring equipment.*
>
> *The same is true during plant shutdown where waste will cease to be introduced to the grate. The waste remaining on the grate will be combusted, the temperature not being permitted to drop below 850ºC through the combustion of clean support auxiliary fuel. During this period the flue gas treatment equipment is fully operational, as will be the control systems and monitoring equipment.*

2.4 Upset conditions

Upset operating conditions can occur for a number of reasons (**Fichtner, 2015**) including:

- Reduced efficiency of:
    - Selective Non-Catalytic Reduction (SNCR) system as a result of blockages or failure
    - particulate filtration system due to bag failure and inadequate isolation, leading to elevated particulate emissions and metals in the particulate phase.
    - lime injection system such as through blockages or failure of fans leading to elevated acid gas emissions.
- Complete failure of:
    - lime injection system leading to unabated emissions of HCl. (Note: this would require the plant to have complete failure of the bag filter system. As a plant of modern design, the plant would have shut down before reaching these operating conditions).
    - the activated carbon injection system and loss of temperature control leading to elevated concentrations of metals and dioxin reformation and their unabated release.

Under any of the above circumstances, the operator will reduce or shut-down operations as soon as practicable until normal operations can be restored. In accordance with the a design to the requirements of the EU IED, such events shall under no circumstance occur for more than four hours uninterrupted where the emission values exceed the limits and no more than 60 hours per year.

2.5 Emergency conditions

To facilitate the safe shutdown and black start[d] there will be two emergency diesel generators with one dedicated to each purpose. Each diesel generator (QSK78) will have a capacity of 2.4 MW that will provide sufficient power for the four incineration lines. A photograph of the proposed diesel generators is shown in Figure 2-1.

The emergency generators will not be used during normal operation of the EfW facility. This includes during planned (scheduled) or forced (unscheduled) outages. Circumstances where the emergency generators may be used include:

- Routine maintenance and specific testing; units will operate for one hour a month.
- In the event of a fire, to provide power supply for emergency lighting and fire-fighting pumps.
- In the simultaneous event of:
    - High Voltage electric grid blackout in the Eastern Creek area or in the whole of Sydney requiring island mode operation of the EfW plant an extremely hot day in the summer time with ambient air temperatures above 35°C (depends on the final sizing of the ACC and on the steam turbine manufacturer) causing an excessively high back pressure in the ACC, in turn initiating a turbine trip and necessitating a shutdown of the whole EfW plant..

This latter event is considered to have a low probability of occurrence, with a worst case frequency estimated to be once every ten years for the two events combined (**HZI, 2015**).

In the event of requiring safe shutdown/black start, it is anticipated that the diesel generators would be required to run for approximately two hours, with a maximum of six hours for black start required if the plant shutdown is over a longer period of time.

Figure 2-1: Emergency diesel generator (QSK78)

[d] Black start is the process of restoring power station operation without relying on the external electric power transmission network.

3 LOCAL SETTING

The proposed Energy from Waste Facility is located at Eastern Creek, approximately 36 km west of the Sydney CBD and surrounded by the residential areas of Minchinbury, Mt Druitt and Rooty Hill to the north, Erskine Park to the east and Colyton to the northwest (shown in Figure 3-1).

The site which is accessed off Honeycomb Drive at Eastern Creek is surrounded by land owned by the Corporate Group Alexandria Landfill Pty Ltd, ThaQuarry Pty Ltd, Australand, Hanson, Jacfin, the Department of Planning and Infrastructure and Sargents.

The site and surrounding land is identified as part of the '*State Environmental Planning Policy (Western Sydney Employment Area) 2009 (WSEA SEPP)*' to be redeveloped for higher end industrial and employment uses over the next decade. The site has a total area of approximately 56 hectares including the Riparian Corridor, with a specific development area circa 9 hectares.

A sensitive receptor is defined as a location where people are likely to work or reside; and may include a dwelling, school, hospital office or public recreational area in addition to known or likely future locations (**EPA, 2005**).

Air quality impacts are assessed at the closest residential areas as shown, including particularly sensitive receptors such as schools and hospitals, as well as isolated semi-rural residential receptors off Burley Road to the southeast. Listed in **Appendix C** are the particularly sensitive receptors (schools, childcare centres), located within the residential suburbs of Minchinbury and Erskine Park (also shown in **Figure 3-1**).

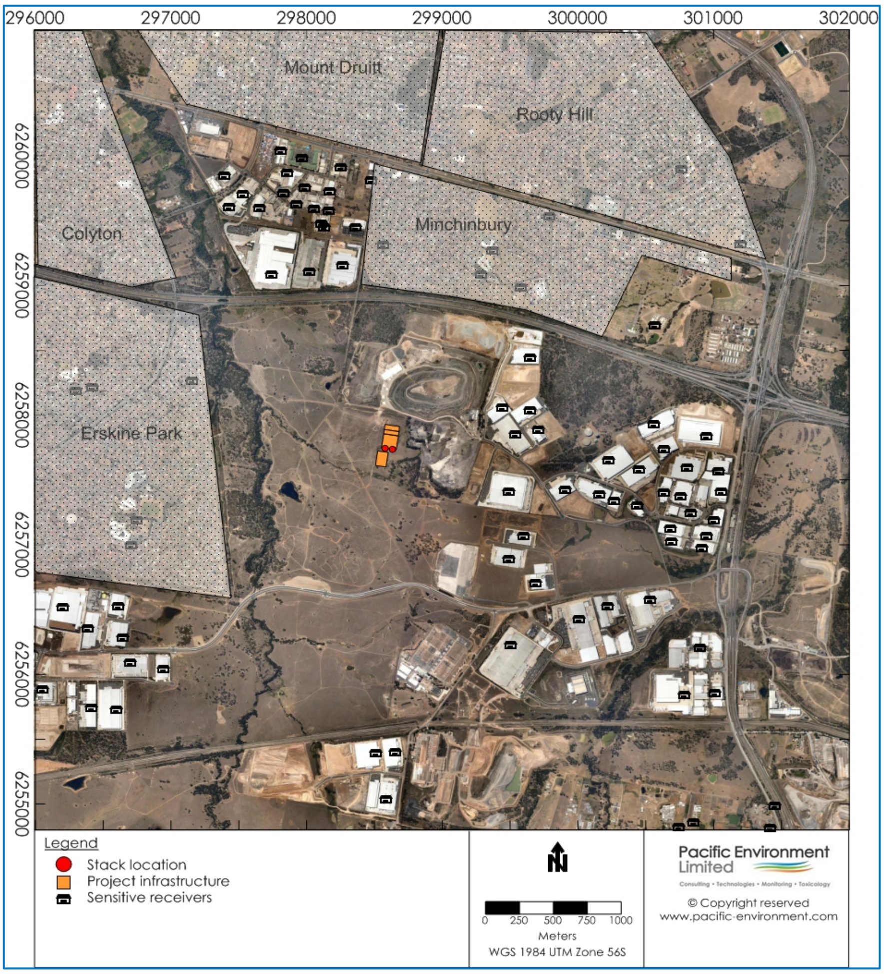

Figure 3-1: Local setting and representative sensitive receptor locations

4 LEGISLATIVE SETTING

4.1 Introduction

The primary emissions from the EfW facility, as defined by emission limits for waste incineration set by the EU IED, are as follows:

- Particulate matter (PM), assumed to be emitted as PM_{10} and $PM_{2.5}$[e].
- Hydrogen Chloride (HCl).
- Hydrogen Fluoride (HF).
- Carbon Monoxide (CO).
- Sulfur Dioxide (SO_2)
- Oxides of nitrogen (NO_x) (expressed as Nitrogen Dioxide (NO_2)).
- Heavy metals (including Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr).
- Gaseous and vaporous organic substances (expressed as total organic carbon (TOC)).
- Dioxins and furans.

In addition to the emission identified in the EU IED, potential emissions also include:

- Hydrogen sulfide (H_2S).
- Chlorine (Cl_2).
- Ammonia (NH_3).
- Poly-aromatic hydrocarbons (PAHs).

The EfW facility will incorporate best available technology (BAT) for flue gas treatment designed to meet the most stringent in-stack concentrations limits and ambient air quality criteria applicable for NSW. An overview of the applicable limits and criteria are provided below.

4.2 NSW EPA Energy from Waste Policy Statement

In March 2014 the NSW Environment Protection Authority (EPA) published its Energy from Waste Policy Statement ("the EfW Policy Statement"; **EPA, 2014**). The EfW Policy Statement sets out the policy framework and overarching criteria that apply to facilities in NSW proposing to thermally treat waste or waste-derived materials for the recovery of energy. Thermal treatment is defined as combustion, thermal oxidation, thermal or plasma gasification, pyrolysis and torrefaction.

Facilities proposing to thermally treat wastes that are not listed as an eligible waste fuel (such as this facility) must meet the requirements of an energy recovery facility, that is must meet international best practice with respect to:

- Process design and control
- Emission control equipment
- Emission monitoring with real time feedback to process controls
- Arrangements for receipt of waste
- Management of residues

The EfW Policy Statement notes that meeting international best practice will ensure that air toxics and particulate emissions are below levels that may pose a risk of harm to the community or environment. The EfW Policy Statement also specifies technical criteria which must be met, as outlined in **Table** 4-1.

[e] Particulate matter with an aerodynamic diameter of less than 10 and 2.5 micrometres respectively.

Table 4-1: Technical criteria as outlined in EfW Policy Statement

Technical Criteria	
1	Combustion chamber minimum temperature of 850°C for at least 2 seconds, after the last injection of air.
2	Where waste contains >1% halogenated organic substances (expressed as chlorine), the combustion chamber temperature should be raised to 1100°C for at least 2 seconds, after the last injection of air.
3	The air emissions must satisfy, as a minimum, the Group 6 emission standards prescribed by the Protection of the Environment Operations (Clean Air) Regulation, 2010.
4	There must be continuous measurement of NO_x, CO, particles (total), total organic compounds, HCl, HF and SO_2.
5	There must be continuous measurement of temperature in the combustion chamber.
6	There must be continuous measurement of temperature, oxygen, pressure in the stack and water vapour in the exhaust gases.
7	Proof of performance trials must be conducted to demonstrate compliance with the emission standards. At least two measurements per year are required for heavy metals, PAHs and dioxins and furans (quarterly for the first year).
8	The total organic carbon (TOC) or loss on ignition (LOI) content of the slag and ash residue must be not greater than 3% and 5% respectively of the dry weight material.
9	Waste interlocks are required to prevent waste being fed before the requirement combustion temperature has been reached.
10	The net energy produced must be positive with at least 25% thermal efficiency (25% of thermal energy capture as electricity).

TNG NSW is seeking clarification on the interpretation of Point 2 in **Table 4-1** with the EPA.

It is understood that this is since in the original EU legislation that the EfW Policy Statement references (the EU Waste Incineration Directive), refers to "hazardous waste with halogenated organic substances >1%". However, the EfW Policy Statement refers simply to "waste" with > 1% chlorine.

The EfW facility will likely combust quantities of poly vinyl chloride (PVC). The European EfW experience has been that EfW facilities typically has to handle concentrations of PVC of around 1% (MSW) with around 0.4% residual (i.e. non-PVC) chlorine contents. Residual fractions from recycling, C&D and C&I can also reportedly reach up to nearly 10% .

It is highlighted that PVC is not classified as a hazardous waste in either the EU or NSW jurisdictions.

Current technology (from all EfW providers) does not allow efficient energy recovery at the higher temperature of 1,100°C referenced in Point 2 in **Table 4-1**.

TNG NSW have expressed that the current wording of the NSW EfW Policy Statement should be amended to reflect the wording within the EU legislation that it was based upon. Within the context of the current assessment, it is understood that, while flue gas treatment is able to abate significantly greater peaks in chlorine concentration of the residual waste fuel, the annual average chlorine content will be 1% and therefore subject to an 850°C combustion temperature. Equally, the EfW facility would not be handling any 'hazardous' waste (with or without halogenated organic substances) as referenced in the EU legislation. As such, the technical criteria around the use of higher combustion temperatures referenced within the EU legislation would not require to be invoked in any event.

4.3 Emission limits

Under the EfW Policy Statement the stack emissions from the facility are required, as a minimum, to meet the Group 6 standards of concentration set out in the *Protection of the Environment Operations (Clean Air) Regulation 2010* ("the Clean Air Regulation"). The Clean Air Regulation sets standards for various activities and those that are applicable to an EfW facility are outlined in **Table 4-2**.

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However, the proposed flue gas treatment will be designed to employ Best Available Technology (BAT) and achieve the emission limits specified by the EU IED[f]. The IED emissions limits (refer **Table 4-3**) are generally more stringent that the Clean Air Regulation limits. The proposed technology is based on existing facilities operated throughout Europe, which are designed to meet the IED limits.

Table 4-2: POEO Clean Air Regulation Standards of Concentration

Pollutant	Standard (mg/Nm^3)	Source	Activity
Solid Particles (Total)	50	Electricity generation	Any activity of plant using liquid or solid standard fuel or non-standard fuel
HCl	100	General standards	Any activity or plant
HF	50	Electricity generation	Any activity of plant using liquid or solid standard fuel or non-standard fuel
SO_2	No applicable standard		
NO_2	500	Electricity generation	Any boiler operating on a fuel other than gas, including a boiler used in connection with an electricity generator that forms part of an electricity generating system with a capacity of 30 MW or more
Type 1 & 2 substances (in aggregate)	1	Electricity generation	Any activity of plant using non-standard fuel
Cd or Hg (individually)	0.2	Electricity generation	Any activity of plant using non-standard fuel
Dioxins or furans	1×10^{-7} (0.1 ng/m^3)	Electricity generation	Any activity of plant using non-standard fuel that contains precursors of dioxin or furan formation
VOC	40 (VOC) or 125 (CO)	Electricity generation	Any activity of plant using non-standard fuel
Cl_2	200	General standards	Any activity or plant
H_2S	5	General standards	Any activity or plant

Reference conditions defined as dry, 273.15 K, 101.3 kPa and 7% O_2 for all air impurities when burning a solid fuel, with the exception of dioxins and furans where the required O_2 concentration is 11% for waste incineration.

Table 4-3: IED Air Emission Limit Values

Pollutant	Daily Average (mg/Nm^3)	Half Hourly Average(mg/Nm^3)	
		100%	97%
Total Dust	10	30	10
Total Organic Carbon (TOC)	10	20	10
HCl	10	60	10
HF	1	4	2
SO2	50	200	50
NO2	200	400	200
Cd	0.05	N/A	
Thallium (Tl)	0.05		
Hg	0.05		
Type 1 and 2	0.5		
Dioxins	1E-07 (0.1 ng/m^3)		
CO	50		

Reference conditions defined as dry, 273.15 K, 101.3 kPa and 11% O_2.

[f] The IED replaces the EU Waste Incineration Directive (2000/76/EC)

No emission limits are prescribed for NH_3 or PAHs under the Australian or European legislative framework. Notwithstanding, these are important emissions that have been addressed within this assessment.

In accordance with clauses 56 of the Clean Air Regulation, power station emissions during start-up and shut-down periods are exempt from the in-stack concentration limits specified in **Table 4-2.** In addition, clause 57A of the Clean Air Regulation states that emergency generators are also exempt if the generators are used no more than 200 hours per year.

4.4 Ambient air quality criteria

The emissions from the EfW facility are also required to comply with the ground level concentrations criteria outlined in the Approved Methods (**EPA, 2005**). **Table 4-4** summarises the ambient impact assessment criteria applicable to this assessment.

Impact assessment criteria for NO_2, SO, PM_{10}, CO and HF are applied at the nearest existing or likely future off-site sensitive receptor and are reported as the 100th percentile (i.e. maximum) of the dispersion modelling prediction. For the assessment of impact, background concentrations for these pollutants needs to be considered.

Impact assessment criteria for 'air toxics' (HCl, Hg, Cd, dioxins, NH_3 and PAHs) are applied beyond the site boundary and reported as the 99.9th percentile of the dispersion modelling prediction. Only incremental impacts for these pollutants need be reported.

Table 4-4: EPA ambient impact assessment criteria

Pollutant	Criterion	Averaging Period
NO_2	246 µg/m³	1-hour average
	62 µg/m³	Annual average
SO_2	712 µg/m³	10-minute average
	570 µg/m³	1-hour average
	228 µg/m³	24-hour average
	60 µg/m³	Annual average
PM < 10 µm (PM_{10})	50 µg/m³	24-hour average
	30 µg/m³	Annual average
CO	100 mg/m³	15-minute average
	30 mg/m³	1-hour average
	10 mg/m³	8-hour average
HF (a)	2.9 µg/m³	24-hour average
	1.7 µg/m³	7 days
	0.84 µg/m³	30 days
	0.5 µg/m³	90 days
HCl	0.114 mg/m³	1-hour
Hg (inorganic)	0.0018 mg/m³	1-hour
Cd	0.000018 mg/m³	1-hour
Dioxins and furans	2.0×10^{-9} mg/m³	1-hour
TOC (as benzene)(b)	0.029 mg/m³	1-hour
NH_3	0.33 mg/m³	1-hour
Cl_2	0.05 mg/m³	1-hour
PAHs (as benzo(a)pyrene)	0.0004 mg/m³	1-hour

Notes: a. Applies to general land use other than areas with vegetation sensitive to fluoride e.g. grape vines and stone fruit.
b. Benzene has been adopted as it has the most stringent impact assessment criterion of the BTEX (benzene, toluene, ethylbenzene and xylene) organic compounds.

The criteria in **Table 4-4** are consistent with applicable standards in the *National Environment Protection Measure for Ambient Air Quality* (referred to as the Ambient Air-NEPM) (**NEPC, 1998a**). In May 2003, the NEPC released a variation to the Ambient Air-NEPM (**NEPC, 2003**) to include advisory reporting standards for fine particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$)). The purpose of the variation was to gather sufficient data nationally to facilitate the review of the Ambient Air-NEPM, which is currently underway.

Table 4-5: $PM_{2.5}$ advisory reporting standards

Pollutant	Advisory Reporting Standard	Averaging Period
PM < 2.5 µm ($PM_{2.5}$)	25 µg/m³	24-hour average
	8 µg/m³	Annual average

4.5 Load based licensing

The load-based licensing (LBL) scheme, sets limits on the pollutant loads emitted by holders of environment protection licences and links licence fees to pollutant emissions.

Schedule 1 of the *Protection of the Environment Operations (General) Regulation 2009* sets out the licence fee system and lists assessable pollutants for energy recovery from waste and hazardous waste. The threshold limits for energy recovery are listed in **Table 4-6**.

Table 4-6: Threshold limits for energy recovery from waste

Air quality parameter	Threshold factor (tonnes)
Arsenic	0.00005
Benzene	0.0000011
Benzo(a)pyrene	0.00002
Fine particulates	0.7
Lead	0.035
Mercury	0.003
Nitrogen oxides and nitrogen oxides (summer)	2.5
Sulfur oxides	0.07

It is acknowledged that the EfW facility will likely be liable under the LBL scheme for a number of air quality parameters.

4.5.1 Hydrogen sulfide

The Approved Methods also include ground-level concentration (glc) criteria for individual odorous air pollutants such as H_2S, taking account of population density in a given area. **Table 4-7** lists the H_2S criteria to be exceeded not more than 1% of the time, for different population densities.

The differences between odour criteria are based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level there will be a wide range of responses in the exposed population. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

An H_2S criterion of 1.38µg/m³ would apply to the built up areas around the facility in any further detailed assessment of proposed operations.

Table 4-7: Odour Performance Criteria for the Assessment of Hydrogen Sulfide

Population of affected community	Criterion for H_2S 99th percentile ($\mu g/m^3$)
≤ ~2	1.38
~10	2.07
~30	2.76
~125	3.45
~500	4.14
Urban (2000) and/or schools and hospitals	4.83

5 DISPERSION METEOROLOGY

Air quality impacts are influenced by meteorological conditions, primarily in the form of gradient wind flow regimes, and by local conditions generally driven by topographical features and interactions with coastal influences, such as the sea breeze. The local dispersion meteorology for the site, in relation to wind speed and direction, has been reviewed based on the data available at nearby meteorological stations.

The Bureau of Meteorology (BoM) collects climatic information at the Horsley Park Equestrian Centre Automatic Weather Station (AWS), located approximately 6 km southeast of the site. The NSW Office of Environment and Heritage (OEH) operate a meteorological station at St Marys, located approximately 5 km west and at Prospect, located approximately 6 km east of the EfW.

The closest site and most representative location in terms of land use and surface roughness is the OEH monitoring site at St Marys. Annual and seasonal wind roses for 2009 and 2013 at St Marys are shown in **Figure 5-1** and **Figure 5-2**, respectively. During both years the dominant annual winds are from the south and south-southwest with a significant portion also from the north-northwest. This pattern is similar in all seasons with summer also showing a proportion of winds from the southeast. The percentage calms (defined as wind speeds less than 0.5 m/s) are 26.2% and 30.9% for the respective years.

As specified in the Approved Methods, five years of data are required to be reviewed so that a representative year of meteorological conditions can be selected. **Appendix D** provides an analysis of the five years of meteorological data from the Horsley Park Equestrian Centre that can also be compared with the St Marys weather data. The review identified 2013 as a representative year for dispersion modelling with no anomalous wind patterns compared to the other years examined and is therefore considered a representative year for dispersion modelling. The prevalence of calm conditions in the western Sydney area is shown to be a common feature of the meteorology in the vicinity of the EfW facility. The percentage of calms measured at the Horsley Park Equestrian Centre ranged between 14.2% and 24.5%. However, wind measurements are made at 10m above ground level. The emission from the Project would be occurring at 100m above ground level where wind speeds are significantly higher and calm conditions far less frequent. These calm conditions are most common during autumn and winter and are often a function of temperature inversions that also occur during these cooler months. Calm conditions are also associated with poor dispersion conditions. In view of the high percentage of calm conditions for 2013 measured at St Marys, using these data for dispersion modelling will provide an additional level of conservatism in the prediction of ground level pollutant concentrations.

A complete year of hourly meteorological data, collected at the St Marys station was used as input within the dispersion modelling. The meteorological data set for modelling is 98% complete (>90% data retrieval is a requirement of the Approved Methods) and was demonstrated to be a representative year.

The AERMOD dispersion model also requires cloud cover and cloud height as input and the closest meteorological station recording these parameters is Bureau of Meteorology (BoM) Bankstown Airport AWS, located approximately 19 km southeast of the EfW facility.

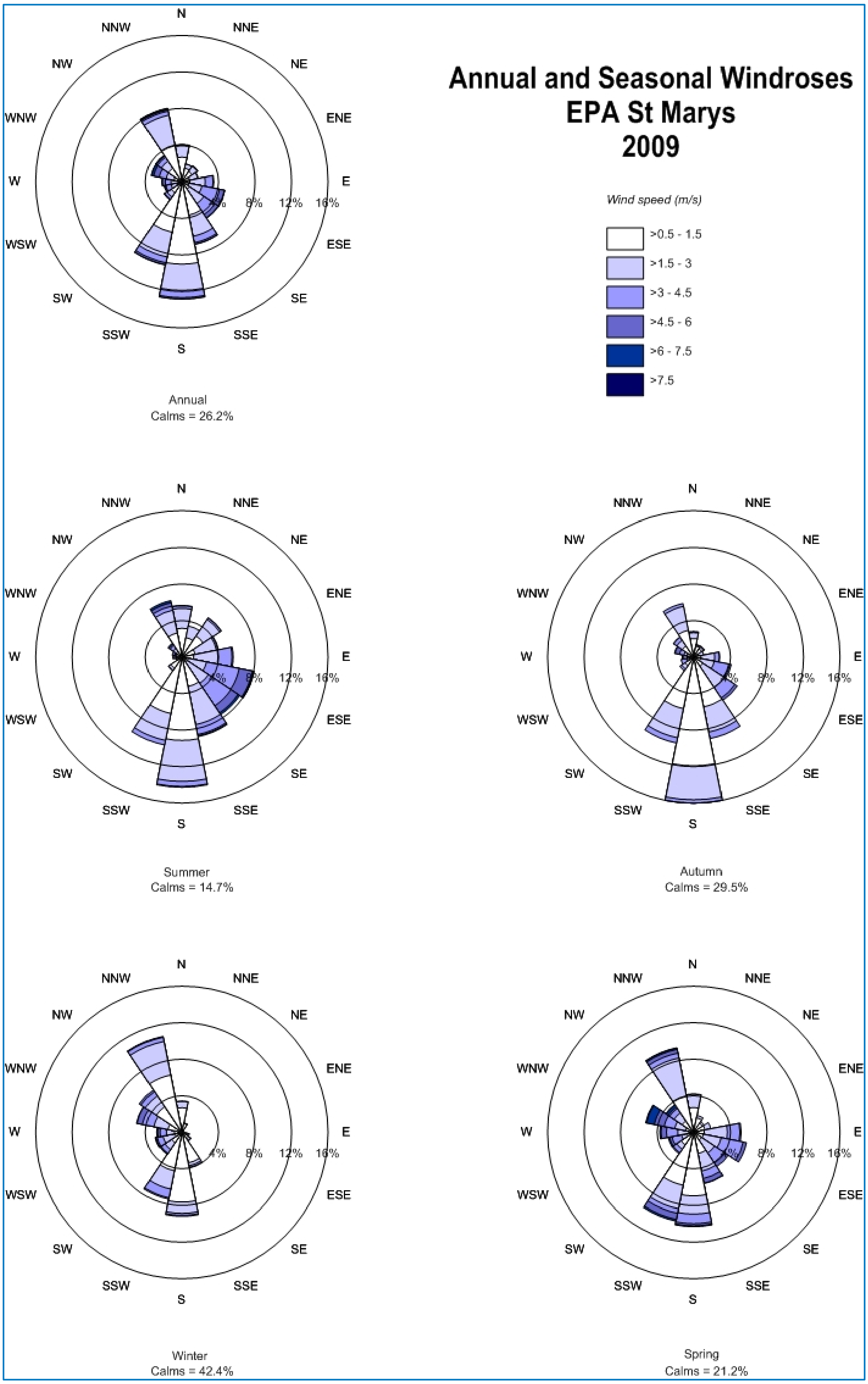


Figure 5-1: Wind roses for St Marys (2009)

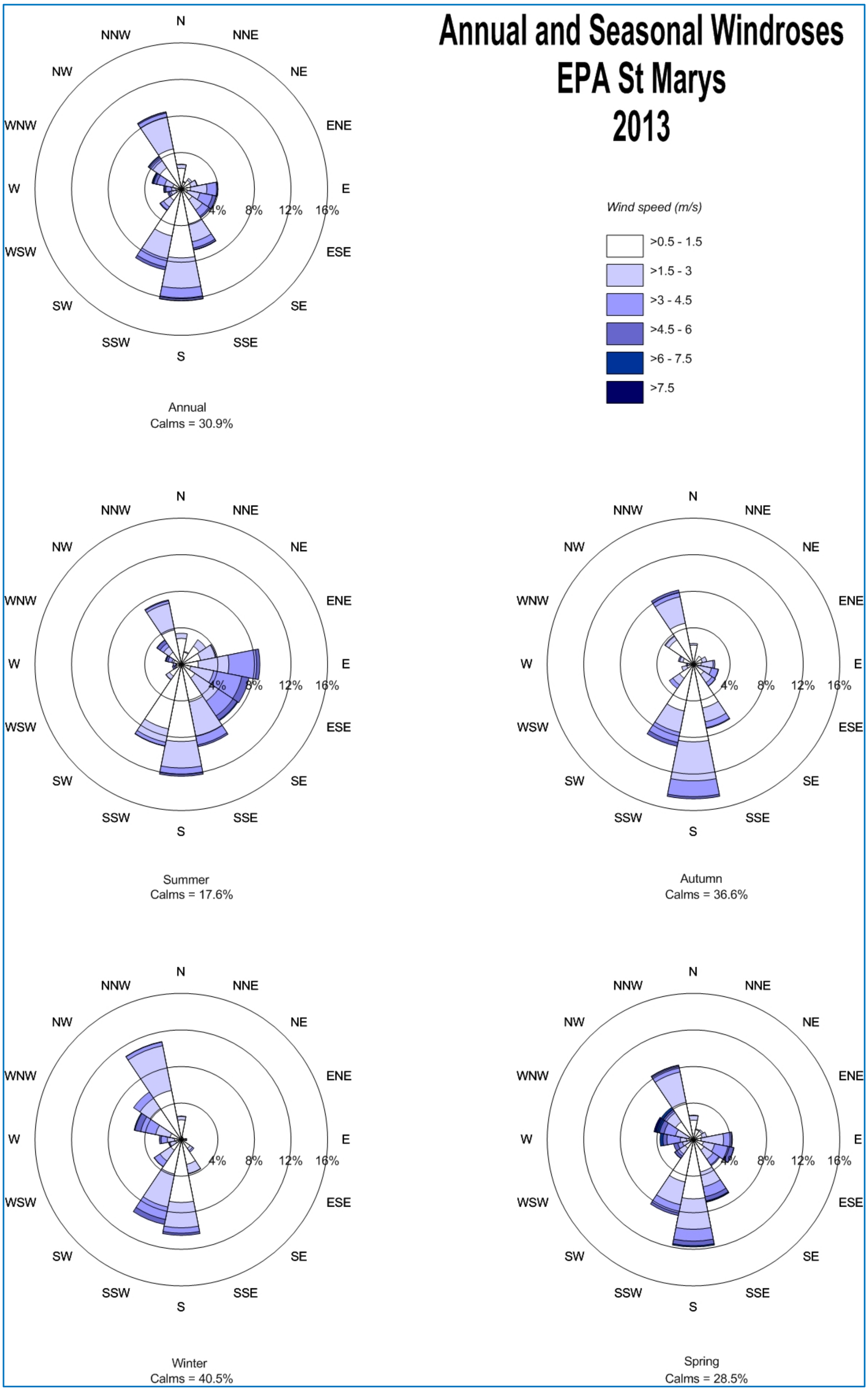


Figure 5-2: Wind roses for St Marys (2013)

6 EXISTING AIR QUALITY

To assess potential impacts against the relevant air quality standards and criteria (see **Section 4.4**) it is necessary to have information or estimates on existing concentrations for the area in which the EfW facility would contribute to these levels.

The OEH monitoring station at St Marys collects air quality data for pollutants including PM_{10}, NO_x and O_3. The OEH monitoring station at Prospect collects air quality data for other pollutants not monitored at St Marys, including SO_2 and CO.

In addition, the adjacent Genesis facility operates a continuous PM_{10} monitor (BAM) at a residence in the suburb of Minchinbury, as a requirement of their Environmental Protection Licence (EPL).

A summary of the available air quality data is provided in the subsequent sections. Generally, air quality for the local area can be described as good, with the exception of isolated high pollution days or extreme events such as dust storms and bushfires.

6.1 Particulate matter (PM_{10})

6.1.1 NSW OEH monitoring at St Marys

A summary of the annual average and maximum 24-hour PM_{10} concentrations measured between January 2009 and December 2013 at St Marys are presented in **Table 6-2**. There were several exceedances of the 24-hour average PM_{10} criterion at St Marys in the last 5 years. During 2009 there were a number of elevated dust events including one of eastern Australia's most significant dust storms events, occurring on 23 September 2009 and recording a maximum 24 hour average concentration of 1,680µg/m^3.

Table 6-1: Annual average and maximum 24 hour average PM_{10} concentrations – St Marys (µg/m^3)

Year	Maximum 24-hour average (µg/m^3)	Annual average (µg/m^3)
EPA Criterion	***50***	***30***
2009	*1661*	23
2010	*52*	15
2011	*74*	15
2012	34	14
2013	*93*	16

A time-series of the 24-hour average PM_{10} concentration for 2013 (the year chosen for modelling) is presented in **Figure 6-1**. The data indicates that concentrations above the EPA criterion of 50µg/m^3 were experienced on two days. It should be noted that the national air quality goal prescribed under the Ambient Air-NEPM (2008) provide for up to five exceedences of the goal per year.

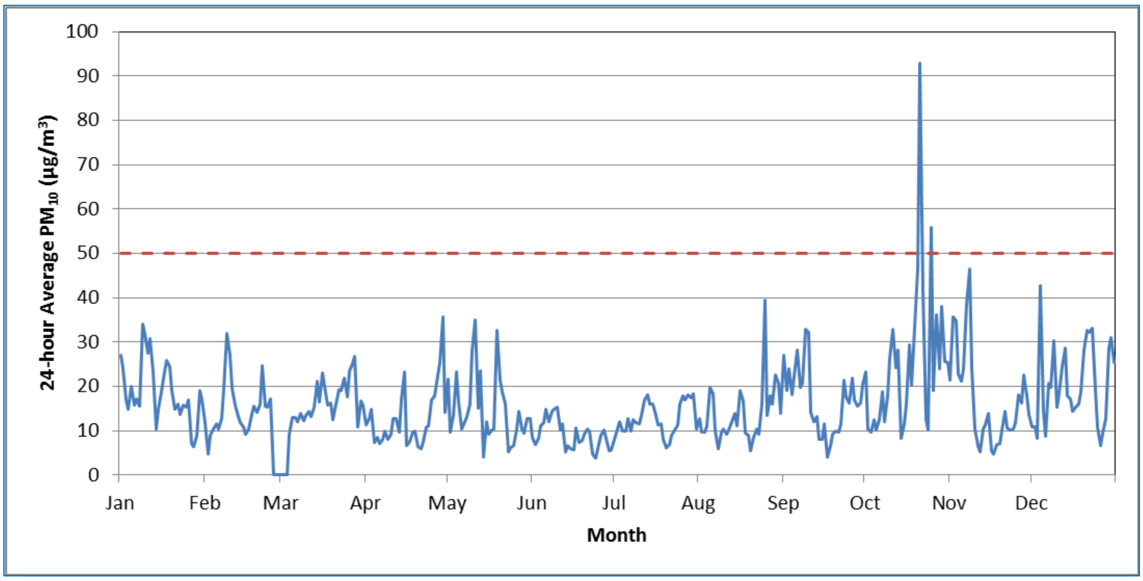


Figure 6-1: 24 hour average PM_{10} concentrations – St Marys (2013)

6.1.2 NSW OEH monitoring at Prospect

A summary of the annual average and maximum 24-hour average PM_{10} concentration measured between January 2009 and December 2013 at Prospect are presented in **Table 6-2**. The annual average PM_{10} concentration at Prospect appears to display an upward trend in the past 4 years which is not reflected in the data recorded at St Marys.

Table 6-2: Annual average and maximum 24 hour average PM_{10} concentrations (µg/m^3)

Year	Maximum 24-hour average (µg/m³)	Annual average (µg/m³)
EPA Criteria	***50***	***30***
2009	1,680	26
2010	40	15
2011	42	16
2012	39	17
2013	82	19

6.1.1 Industry monitoring at Minchinbury

The adjacent Genesis facility operates a BAM PM_{10} monitor at Minchinbury, which has been operational since mid-2012. The 2013 annual average at Minchinbury is the same as Prospect (19µg/m^3) and the maximum 24-hour average for the year is also similar (77µg/m^3). A plot of the 24-hour PM_{10} concentration collected between July 2012 and February 2014 is presented in **Figure 6-2**.

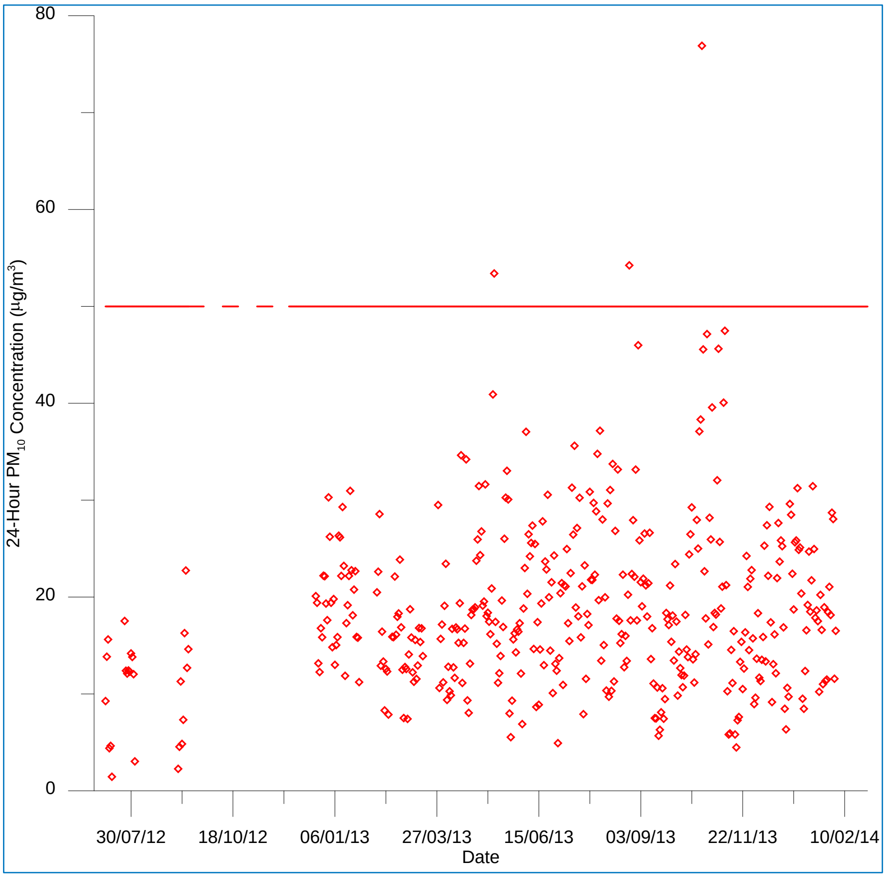


Figure 6-2: 24-Hour PM_{10} monitoring at Minchinbury

6.2 Particulate matter ($PM_{2.5}$)

The two closest OEH monitoring stations do not to currently measure $PM_{2.5}$. Rather than adopt $PM_{2.5}$ data from further afield, a $PM_{2.5}$:PM_{10} ratio (0.35:1) has been applied to the PM_{10} data measured at St Marys and Prospect. The ratio is based on PM measurements from Richmond and Liverpool between 2009 and 2013.

A summary of the calculated annual average and maximum 24-hour average $PM_{2.5}$ concentrations measured between January 2009 and December 2013 at fro St Marys are presented in **Table 6-3**.

Table 6-3: Annual average and maximum 24 hour average $PM_{2.5}$ concentrations (µg/m³)

Year	St Marys		Prospect	
	Maximum 24-hour average (µg/m³)	Annual average (µg/m³)	Maximum 24-hour average (µg/m³)	Annual average (µg/m³)
EPA Criteria	***25***	***8***	***25***	***8***
2009	587	8	594	9
2010	18	5	14	5
2011	26	5	15	6
2012	12	5	14	6
2013	33	6	29	7

6.3 Nitrogen dioxide (NO_2)

6.3.1 NSW EPA monitoring at St Marys

A summary of the NO_2 annual and 1 hour maximum data from 2009 to 2013 at St Marys is presented in **Table 6-5**. During this period there were no exceedences of the 1-hour maximum criterion of 246µg/m³ or the annual average criterion of 62 µg/m³.

A time-series of the 1-hour average NO_2 concentrations recorded at St Marys during 2013 (modelling year) is presented in **Figure 6-3**. The results indicated that hourly NO_2 concentrations are well below the EPA criterion of 246µg/m³. The maximum recorded 1-hour average concentration in 2013 was 76µg/m³.

Table 6-4: Annual average and maximum 1 hour average NO_2 concentrations – St Marys (µg/m³)

Year	Maximum 1-hour average (µg/m³)	Annual average (µg/m³)
EPA Criteria	***246***	***62***
2009	72	12
2010	74	12
2011	74	12
2012	88	10
2013	76	10

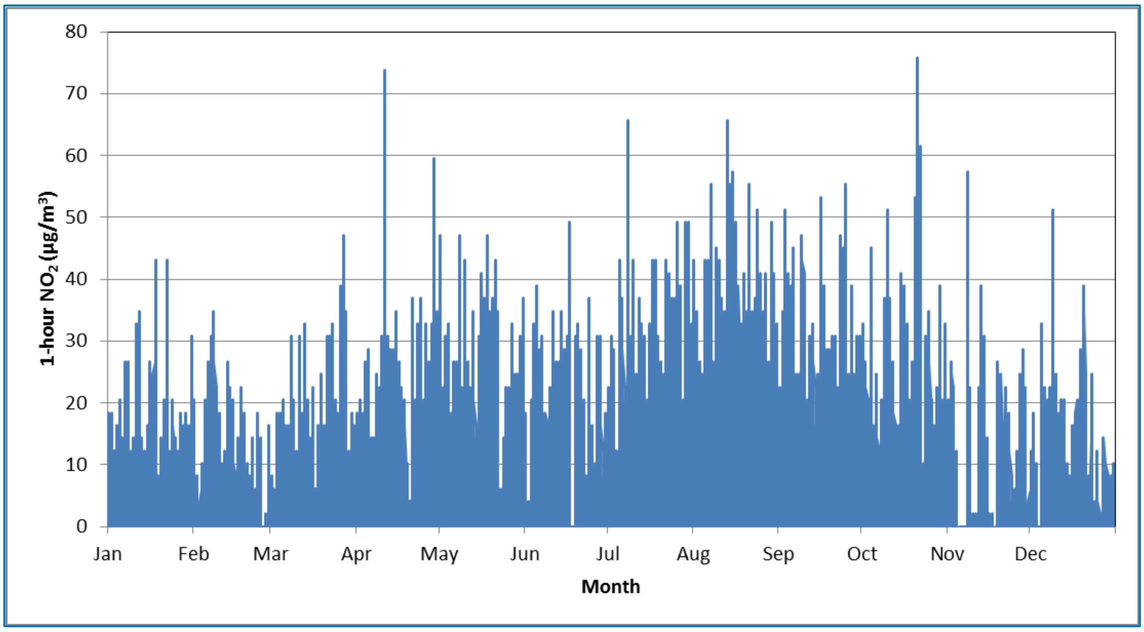


Figure 6-3: 1-hour NO_2 concentrations – St Marys (2013)

6.3.2 NSW EPA monitoring at Prospect

A summary of the NO_2 annual and 1 hour maximum data from 2009 to 2013 at Prospect is presented in **Table 6-5**. During this period there were no exceedences of the 1-hour maximum criterion of 246µg/m³ or the annual average criterion of 62 µg/m³. The maximum 1-hour and annual average concentrations are generally higher than at St Marys.

Table 6-5: Annual average and maximum 1 hour average NO_2 concentrations (µg/m³)

Year	Maximum 1-hour average (µg/m³)	Annual average (µg/m³)
EPA Criteria	***246***	***62***
2009	105	23
2010	88	25
2011	80	21
2012	103	21
2013	100	23

6.4 Sulfur dioxide (SO_2)

6.4.1 NSW EPA monitoring at Prospect

A summary of the annual average and 1-hour maximum data for the 2009 to 2013 period at Prospect is presented in **Table 6-6**. During this period there were no exceedences of the 1-hour maximum criterion of 570µg/m³ or the annual average criterion of 60 µg/m³.

Table 6-6: Annual average and maximum 1 hour average SO_2 concentrations (µg/m³)

Year	Maximum 1-hour average (µg/m³)	Annual average (µg/m³)
EPA Criteria	***570***	***60***
2009	49	N/A
2010	52	3
2011	40	3
2012	34	3
2013	57	3

6.5 Carbon monoxide (CO)

6.5.1 NSW EPA monitoring at Prospect

A summary of the CO monitoring data from the Prospect station for the 2008 to 2012 period at Prospect is presented in **Table 6-7**. During this period there were no exceedences of the 1 hour maximum criterion of 30µg/m³ or the 8-hour criterion of 10 µg/m³.

Table 6-7: Maximum 8-hour average CO concentrations (mg/m³)

Year	Maximum 8-hour average (mg/m³)
EPA Criteria	***10***
2009	3
2010	2
2011	2
2012	2
2013	2

7 EMISSIONS TO AIR

As noted in **Section 4.2**, the EfW Policy Statement indicates that any facility proposing to recover energy from waste will need to meet current international best practice. The EfW Policy Statement also requires that emissions from EfW facilities must satisfy, as a minimum, emission limits prescribed by the Clean Air Regulations.

The proposed technology for the EfW facility is based on existing facilities in Europe and will incorporate best available technology (BAT) for flue gas treatment. The flue gas treatment is designed to meet the in-stack concentrations limits for waste incineration set by the EU IED. The IED emissions limits (**Table** 4-3) are generally more stringent that the Clean Air Regulation limits (**Table 4-2**).

7.1 Best Available Techniques

A summary of the technologies used to control emissions from waste incineration at existing EfW facilities is presented to examine what constitutes current international best practice. The purpose of the review is to demonstrate that existing technology can satisfy the emission limit requirements of the EU IED, and therefore is appropriate for the EfW facility.

7.1.1 General

In 2006 the European Commission published a reference document for best available techniques for waste incineration (**EC, 2006**). The Best Available Techniques Reference Documents (**BREF**) are made under the European directive on Integrated Pollution Prevention and Control (**IPPC**) (Council Directive 96/61/EC).

The BREF defines five sectors for waste incineration (mixed municipal, pre-treated municipal, hazardous, sewage sludge, chemical waste) and covers three types of thermal treatment (pyrolysis, gasification, incineration). The focus of the BAT review within the BREF is for flue gas treatment, however process control is also important and **Table 7-1** presents good practice process control proposed for the facility.

Table 7-1: General good practice procedures / process control

Process	Details
Types of waste received	The technology has been chosen having regard to the characteristics of waste received, which are well known from the operation of the existing Genesis facility., and based on a minimum calorific value of 12.34 MJ/kg.
	A quality control process will be established for waste received at the facility.
Maintenance	Regular maintenance will ensure equipment remains in good working order
Combustion	The furnace and boiler technology is designed for optimal combustion performance
	Proposed use of automated combustion control system, including control and optimisation of oxygen supply, temperature, residence time.
	Air injection
	Minimising uncontrolled ingress of air into combustion chamber during loading.
	Minimise start up / shut downs
	Preheating the combustion chamber for lower calorific wastes.
Monitoring	The facility will employ a Continuous Emissions Monitoring System (CEMS).

7.1.2 Flue Gas Treatment

A range of pollution control equipment are available for the pollutants generated at EfW facilities and an overview of existing BAT for flue gas treatment is provided below and summarised in **Table 7-2**.

Fabric filters (bag houses) are used in the majority of existing EfW facilities as they have high particle removal efficiency and also work in combination with scrubbing systems (i.e. activated carbon injection). Electrostatic Precipitators (ESPs) have been used in conjunction with fabric filters to provide additional level of control where needed.

Scrubbing systems are used to remove acid gases and can be wet, dry or semi-dry. Scrubbers work by adsorption, bringing flue gas into contact with a scrubbing material such as lime, sodium hydroxide or sodium carbonate. Dry/semi dry scrubbers work well in conjunction with activated carbon injection, which is typically used to remove volatile heavy metals (e.g. Hg, Pb, Cd) and dioxins and furans. The used carbon and lime, along with the adsorbed pollutants, are collected on the fabric filter.

NO_x is produced in the combustion process (combining the nitrogen and oxygen present in air) and also from the nitrogen contained within the residual waste fuel. Thermal NO_x is typically controlled with good practice combustion and flue gas recirculation (FGR). FGR lowers the excess air rate, thereby increasing the thermal efficiency and reducing the available nitrogen for NO_x formation.

Selective Non-Catalytic Reduction (SNCR) will be used at the EfW facility for NO_x control. SNCR involves the injection of NH_3, at high temperature, to react with the NO_x (to form nitrogen and water vapour).

Ammonia slippage from a SNCR system (i.e. surplus NH_3 going to atmosphere) normally constitutes in-stack concentrations of between 1 mg/Nm³ and 10 mg/Nm³, with an average of 4 mg of NH_3/Nm³ (**EC, 2006**).

Table 7-2: Best Available Techniques for EfW flue gas treatment (FGT)

Substance	BAT	Comments
Particles	Fabric filters / bag filters Cyclones Electrostatic precipitators	Fabric filters are generally sufficient to meet the emissions limits than prescribed by the EU Waste Incineration Directive and typically employed at existing EfW facilities.
Hydrogen chloride (HCl) Hydrogen Fluoride (HF) Sulfur Dioxide (SO2)	Waste control Wet scrubbers Dry and semi dry scrubbers	Wet FGT results in lowest emissions; however Dry FGT has the co-benefit of removing PCDD/F and mercury (with addition of activated carbon injection). Dry/semi dry most commonly employed at existing EfW facilities.
Oxides of Nitrogen (NOx)	Reduction of thermal NOx through combustion control and Flue Gas Recirculation Selective Catalytic Reduction (SCR) Selective Non Catalytic Reduction (SNCR)	Waste and combustion control with SNCR/SCR can generally result in emissions within limits prescribed by the EU Waste Incineration Directive. SNCR typically employed at existing EfW facilities.
Carbon Monoxide Gaseous and various organic substance (TOC)	Combustion control	Activated carbon injection may provide additional benefit of VOC control.
Mercury	Wet scrubbing with injection Activated carbon injection Condensing scrubbers Resin filters	Adsorption using carbon based reagents generally needed to meet limits prescribed by the EU Waste Incineration Directive. Activated carbon injection typically employed at existing EfW facilities.
Metals	Activated carbon injection Fabric filters	Techniques that control dust will also control metal emissions and fabric filters commonly used. Activated carbon injection additionally controls volatile metals (Hg).
Dioxins and Furans (PCDD/F)	Primary (combustion control) techniques, flue gas recirculation Selective Catalytic Reduction (SCR) Catalytic filter bags Adsorption by activated carbon injection / static beds Wet scrubbing with carbon injection / carbon slurries	Secondary abatement generally needed in combination with primary (combustion control) to meet limits prescribed by the EU Waste Incineration Directive.

A review of existing EfW facilities (mostly in the UK and Europe) indicates that these BAT are routinely implemented at EfW facilities. **Table 7-3** summarises the flue gas treatment that will be installed on commissioning of the TNG EfW facility (in addition to combustion and other process control).

Table 7-3: Flue Gas Treatment for existing EfW facilities

Facility	Flue Gas Treament
Lakeside, London, UK	• SNCR for NOx control • Semi-dry scrubbing using lime • Activated carbon injection • Fabric filter • 75m stack
Issy Les Moulineaux, Paris, France	• Fabric filter plus ESP • Dry scrubbing using sodium bicarbonate • Activated carbon injection • SCR low temperature deNOx system • Gas exit temperature of 200°C and velocity of 30m/s (due to short stack)
Riverside, London, UK	• Semi-dry scrubber with lime and activated carbon injection • Fabric filter • 85m stack
Mainz, Germany	• SNCR for NOx control • High dust catalytic converter to remove surplus ammonia • Spray absorption using lime milk • Activated coke injection • Fabric filter • 95m stack
AEB, Amsterdam, The Netherland (1,370,000 tpa)	• SNCR for NOx control • ESP plus fabric filter with activated carbon/coke injection • Packed bed scrubber for HCl, lime milk injection for SO2 • Fabric filter • Polishing scrubber
Spitteleu, Vienna, Austria	• SCR for NOx control • ESP • Wet scrubber for acid gases, lime slurry for HCl, NaOH for SO2
Kwinana Facility, Western Australia	• SNCR for NOx control • Spray dryer (lime) / high temperature lime scrubbing • Activated carbon injection • Fabric filter
Greatmore Facility, Buckinghamshire, UK	• Ammonia injection to reduce NO_x • Lime injection • Injection of activated carbon • Bag filter • 95m stack
Newhaven Facility, UK	• Ammonia injection • Lime injection • Activated carbon • Fabric filter • 65m stack
Worcestershire EfW facility, UK	• Activated carbon injection • Dry lime scrubbing

Facility	Flue Gas Treament
	• Selective Non-Catalytic Reduction (SNCR) • Fabric filter • 75m stack
Montgomery County, Maryland, USA	• Thermal deNOx using aqueous ammonia • Hydrated lime injection and spray dryer adsorper • Carbon injection • Baghouse • 84m stack

Source: Mercier EnviRecover (2010); SLR (2010); WA EPA (2000); Veolia (2013); WSP (2013)

7.2 Emissions performance

The emission performance of a number of case studies is summarised in **WSP (2013)**, including some of the facilities presented in **Table 7-3**. A number of the case studies presented use the technology provider for the proposed EfW facility (i.e. Issy Les Moulineaux, Paris, and Riverside, London) and most apply the same flue gas treatment as the proposed facility.

The data reviewed in the case studies demonstrates that emissions consistently meet the IED limits. **Appendix B** presents some of this data from **WSP (2013)**.

CEMS reports for the Riverside EfW facility have also been reviewed. Riverside employs similar technology (Hitachi Zosen Inova (HZI)) and flue gas treatment to the proposed EfW facility. The CEMS reports (2011 – 2014) demonstrate that the facility consistently meets the EU IED limits for the pollutants monitored by CEMS and in most cases are significantly lower.

The Riverside EfW CEMS reports are publicly available on the internet (http://www.coryenvironmental.co.uk/page/rrremissions2012.htm). A sample report is presented in **Appendix B**.

HZI has also provided a summary of heavy metals emissions from a number of reference plants in the UK which employ semi-dry FGT (as is proposed for the EfW facility). These results show that emissions of Hg and Cd are an order of magnitude below the EU IED limits. A summary of the data is provided in **Appendix B**.

7.3 Emissions during normal operations

Emission rates for modelling are estimated based on the EfW facility meeting the more stringent limits prescribed in the IED, as outlined in **Table 4-3**. The emission limits prescribed by the IED are expressed as both daily averages and half hourly maximums.

Although the limits are based on the IED, the facility will be licenced under the NSW POEO Clean Air Regulation, which uses standards of concentration expressed as a 1-hour block (or the minimum sampling period in the relevant test methods).

Dispersion modelling is therefore based on the higher short term limits (where available), regardless of the averaging period for assessment of impact on ground level concentration (GLCs). In other words, even though the ambient assessment criteria for PM_{10} are expressed as 24-hour and annual averages, the half hourly IED limit is used for all modelling, not the daily average so as to provide worst case emissions scenario.

In the main, the emission rates (g/s) adopted for modelling of each stackpresented in **Table 7-4** are derived from the concentration limits (mg/Nm^3) in **Table 4-3** and the flue gas flow rate per stack (Nm^3/s) shown in **Table 7-8** (**Fichtner, 2014**).

Where emission limits are not available as part of the EU IED the emission limits from the Clean Air Regulation have been adopted, as in the case for H_2S.

In the case of Cl_2, the Clean Air Regulation limit (200 mg/m³) is considered inapplicable (overly high) to be used to estimate the mass emission rate of this compound. Rather, the EU IED limit for HCl (60 mg/m³ – see **Table 4-3**) is considered a more appropriate in-stack concentration upper limit for Cl_2. This is because of the important role of the Deacon equilibrium, described below:

$$4\,HCl + O_2 \rightleftarrows 2H_2O + Cl_2$$

The equilibrium is shifted to the left side of the above equation when the combustion occurs releasing water vapour (H_2O). The design fuel mix would contain approximately 28% H_2O **(Fichtner, 2014)**, providing the necessary H_2O to favour HCl formation over Cl_2. On the above basis, the release and subsequent impacts of Cl_2 are addressed through the evaluation of HCl.

For the emissions of NH_3 and PAHs data was sourced from the Reference Document on the Best Available Techniques (BREF) for Waste Incineration **(EC, 2006)**. Half hourly and annual average measured data are provided for municipal waste incineration plants. As noted in **Section 7.1**, ammonia slip may yield concentrations of between 1 mg/Nm³ and 10 mg/Nm³, with an average of 4 mg of NH_3/Nm³ (**EC, 2006**). For assessment purposes, the average concentration of NH_3 under ammonia slip conditions has been adopted for the assessment of normal operations.

Table 7-4: Emission rates per stack

Pollutant	Emission rate (g/s)	Source
Oxides of Nitrogen (NO_x expressed as NO_2)	55.7	IED half hourly limit
SO_2	27.9	IED half hourly limit
CO	13.9	IED half hourly limit
PM	4.2	IED half hourly limit
HCl	8.4	IED half hourly limit
HF	0.6	IED half hourly limit
Cd	0.007	IED daily limit
Hg	0.007	IED daily limit
Dioxins and furans	1.4×10^{-8}	IED daily limit
TOC (as benzene)	2.8	IED half hourly limit
NH_3	0.5	BREF half hourly average measurement
H_2S	0.7	POEO Regulation limit
PAH (as benzo(a)pyrene)	0.0001	BREF annual average measurement
Cl_2	N/A	Evaluated as HCl

7.4 Emissions during start-up / shut-down conditions

As discussed in **Section 2.3** a clean auxiliary support fuel will be used in the incinerator to regulate the temperature. It is understood that the fuel would comprise diesel, with all emissions released from the 100m stack. As the nature of the emissions from the combustion of diesel fuel would burn significantly cleaner than the residual waste fuel, and in consideration of the infrequent occurrence of start-up and shut down, emissions during such conditions have not been further assessed.

7.5 Emissions during upset conditions

There are no monitoring data available from existing facilities during 'upset operations'. In the absence of monitoring data worst-case assumptions have been made following consultation with the UK Environment Agency based on their knowledge of plausible upset emissions for key pollutants (**Fichtner, 2015**).

The plausible emissions during upset conditions developed in association with the UK Environment Agency are shown in **Table 7-5**, along with the applicable Clean Air Regulation limit and the percentage such upset conditions would contribute to this limit. Also provided are the mass emission rates adopted in the dispersion modelling.

Table 7-5: Emissions during upset conditions

Emission parameter	POEO Regulation limit (mg/m³) (a)	Plausible n-stack concentration during upset conditions (mg/m³) (a)	Percentage above POEO Regulation limit	Mass emission rate used to model upset conditions (g/s)
Oxides of Nitrogen (NO_x expressed as NO_2)	500	393	79%	76.2
SO_2	n/a	321	n/a	62.7
CO	125	71	57%	13.9
PM	50	107	214%	20.9
HCl	n/a	643	n/a	125.4
HF	n/a	64	n/a	12.5
Cd	0.20	0.5	268%	0.1
Hg	0.20	0.5	268%	0.1
TOC (as benzene)	40	14	36%	2.8
NH_3 (b)	n/a	10	n/a	1.4

Notes: (a)Reference conditions defined as dry, 273.15 K, 101.3 kPa and 7% O_2 for all air impurities when burning a solid fuel.
(b) The NH_3 concentration during upset conditions has been taken as the upper limit of the range of in-stack concentration provided by **Fichtner (2015)**.

When considering upset operating conditions it is always a matter of balance between stated upset emission level, the probability of occurance, and the duration of emission at such elevated rates. Very high emission rates would occur rarely and for short time because plant shutdown would likely be an imminent consequence, whereas slightly elevated levels could occur occasionally and for some length of time until the necessary actions are put into force.

In the event of upset conditions strict management measures should be followed to ensure that elevated emissions are minimised.

7.6 Emission during emergency conditions

The primary emissions during emergency conditions will be released from the operation of the emergency diesel generators. During such times emission would typically comprise NO_x, CO and PM (PM_{10} and $PM_{2.5}$). Other pollutants, such as organic compounds, may also be released.

In view of the infrequent requirement for emergency generators (i.e. during emergency situations described in **Section 2.5** only) in addition to the anticipated single hour of operation each month (~12 hours per year) the potential air quality impacts of the emergency generators have not been addressed quantitatively. Rather, it is considered that the relatively large distance between the EfW facility and the nearest sensitive receptors, combined with the highly infrequent use of this equipment, would ensure that this aspect of the EfW facility would not pose a significant potential for adverse impacts.

Information on the mass emission rates for the emergency generators have been provided by the client and are shown in **Table 7-6**. The calculated mass emission rates have been compared with those that would be generated by the EfW facility during normal operations. The mass emissions from the diesel generators account for no more than 10% of the emissions released by the EfW during normal operations (albeit at a lower discharge height).

Table 7-6: Pollutant mass emission rates for each emergency diesel generator

Pollutant	Emission factor (g/kWm)	Mass emission rate (g/s) [(a)]	Percentage of EfW emissions during normal operations
Oxides of Nitrogen	4.40	3.10	6%
Carbon Monoxide	2.00	1.41	10%
Particulate Matter	0.29	0.20	5%

Notes: based on a mechanical power of 2,539 kWm for a QSK78 diesel generator **(Cummins, 2015)**.

As noted in **Section 4.3**, since the emergency diesel generators will operate less than 200 hours per year the generators are exempt from the in-stack concentration limits that would normally apply, as per the clause 57A of the POEO Regulation.

7.7 Compliance with the NSW Clean Air Regulation in-stack concentration limits

The POEO Regulation in-stack concentration criteria relevant to this assessment along with the calculated (predicted) in-stack concentrations are presented in **Table 7-7**.

The calculated in-stack concentrations were based on the provided exhaust flow and emission rate information along with pollutant mass rates listed in **Table 7-4**. These values have been adjusted to the reference oxygen (O_2) contents referred to within the POEO Regulation. All calculated in-stack concentrations comply with the relevant Clean Air Regulation limits**(EC, 2006)**.

Table 7-7: In-stack concentrations

Emission parameter	POEO Regulation limit (mg/m^3)	Modelled in-stack concentration (mg/m^3)
Oxides of Nitrogen (NOx expressed as NO_2)	500	286
SO_2	n/a	143
CO	125	71
PM	50	22
HCl	n/a	43
HF	n/a	3
Cd	0.20	0.04
Hg	0.20	0.04
Dioxins and furans	1.0x10-7	1.0x10-7
TOC (as benzene)	40	14
NH3	n/a	3
H2S	5	4
PAH (as benzo(a)pyrene)	n/a	5.1x10-4

Reference conditions defined as dry, 273.15 K, 101.3 kPa and 7% O_2 for all air impurities when burning a solid fuel, with the exception of dioxins and furans where the required O_2 concentration is 11% for waste incineration.

7.8 Stack parameters

The facility will be designed in two phases (TNG1 and TNG2), with a dedicated stack servicing each phase. Each stack with comprise two waste streams. For the purposes of this assessment, the emissions associated with the two waste streams reporting to each stack have been combined. The modelled stack parameters for each of stack are provided in **Table 7-8**.

The stack temperature is taken from the technical specifications for a similar facility in the UK. A stack diameter of 2.5m is chosen to achieve an exit velocity of greater than 15 m/s, based on the provided volumetric flow rate (**Fichtner, 2014**).

The final stack height was selected based on a combination of compliance of pollutant ground level concentrations and reference to the US EPA document "Guideline for Determination of Good Engineering Practice Stack Height" **(US EPA, 1985)**. Good engineering practice, with respect to stack height is defined as "the height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the stack, as a result of atmospheric downwash eddies or wake, created by adjacent buildings".

The general rule of thumb for good engineering practice stack height is "Height of building + 1.5 times the lesser of building height or projected width. Assuming the building height is the less of these two dimensions, this results in a stack height of 125m. Preliminary dispersion modelling, per the method described in **Section 8**, was then used to determine what height was actually needed, based on compliance with ground level concentration. The preliminary results indicated that the ground level concentrations for Cd were the limiting design factor, and would potentially be exceeded with a stack height of 80m. At a stack height of 100m, compliance with the NSW impact assessment criteria (see **Section 4.4**) was demonstrated.

Table 7-8: Stack parameters for modelling

Parameter	Value
Stack location (m, MGA, Zone 56)	298632.9 (E) 6257733.5 (N)
	298574.6 (E) 6257741.3 (N)
Base elevation (m, AHD)	~65
Stack Height (m)	100
Stack Diameter (m)	2.5
Temperature (°C)	120 (114)
Flue Gas Flow (Nm^3/s)	139.3
Gas Exit Flow Rate (Am^3/s)	175.8
Gas Exit Velocity (m/s)	35.8

Nm^3/s = reference gas flow, dry at 11% O_2. Am^3/s = actual gas flow, wet, corrected for temperature

7.9 Treatment of Emissions of Oxides of Nitrogen

Nitrogen oxides (NO_x) emitted from combustion are comprised mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). Typically, at the point of emission, NOx would consist of approximately 90-95% of NO and 5-10% of NO_2. The dominant mechanism for short-term conversion of NO to NO_2 is through oxidation with atmospheric ozone (O_3) as an exhaust plume travels from source. Therefore, to predict the ground-level concentration of NO_2 (regulated oxide of nitrogen) it is important to account for the transformation of NO_x to NO_2. Ultimately, all NO emitted into the atmosphere will be oxidised to NO_2 and to other higher oxides of nitrogen. The rate at which this oxidation takes place depends on prevailing atmospheric conditions including temperature, humidity and the presence of other substances in the atmosphere such as O_3. It can vary from a few minutes to many hours. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low, it is unimportant that the oxidation has taken place. However, if the oxidation is rapid then high concentrations of NO_2 can occur when inadequate dispersion / dilution conditions exist. For this report we have conservatively assumed 100% conversion of NO_x to NO_2.

7.10 Odour

Residual waste fuel will arrive to the facility in covered trucks or via an enclosed conveyor from the Genesis facility. The facility will employ high speed roller doors for truck access to ensure fugitive odour emissions are minimal. All residual waste fuel storage and unloading will take place within the tipping hall building, which is kept at negative pressure with air extracted from the building will be used as excess air in the boiler. Odour emissions from the EfW facility have been addressed in a stand-alone quantitative assessment **(Pacific Environment, 2015a)**. The results of this assessment show that the odour concentrations would be below the impact assessment criterion of 2 ou.

7.11 Fugitive dust emissions

As discussed in **Section 2**, residual waste fuel would be transported onsite via sealed roads. The use of sealed roads is considered an effective management strategy in the reduction of fugitive dust emissions, specifically those related to wheel generated dust emissions.

As already discussed, the tipping hall building will also operate under negative pressure whereby air within the building will be used as excess air for the boilers, limiting the release fugitive dust emissions generated within the shed to the ambient environment (as this will subsequently pass through the FGT's bag house).

On the basis of the above, the EfW facility is considered to have minimal potential for the generation of fugitive dust emissions provided good dust management practices are adhered to. Therefore this aspect has not been addressed further.

7.12 Construction

The main air pollution and amenity issues at construction sites are:

- Annoyance due to dust deposition (soiling of surfaces) and visible dust plumes.
- Elevated PM_{10} concentrations due to dust-generating activities.
- Exhaust emissions from diesel-powered construction equipment.

Exhaust emissions from on-site plant and site traffic are unlikely to have a significant impact on local air quality, and in the majority of cases they will not need to be quantitatively assessed (**IAQM, 2014**). Very high levels of soiling can also damage plants and affect the health and diversity of ecosystems.

Dust emissions can occur during the preparation of the land (*e.g.* demolition and earth moving) and during construction itself, and can vary substantially from day to day depending on the level of activity, the specific operations being undertaken, and the weather conditions. A significant portion of the emissions results from site plant and road vehicles moving over temporary roads and open ground. If mud is allowed to get onto local public roads, dust emissions can occur at some distance from the construction site **(IAQM, 2014)**.

The risk of dust impacts from a demolition/construction site causing loss of amenity and/or health or ecological impacts is related to the following **(IAQM, 2014)**:

- The nature of the activities being undertaken.
- The duration of the activities.
- The size of the site.
- The meteorological conditions (wind speed, direction and rainfall). Adverse impacts are more likely to occur downwind of the site and during drier periods.
- The proximity of receptors to the activities.
- The sensitivity of the receptors to dust.
- The adequacy of the mitigation measures applied to reduce or eliminate dust.

It is difficult to quantify dust emissions from construction activities. Due to the variability of the weather it is impossible to predict what the weather conditions would be when specific construction activities are undertaken. Any effects of construction on airborne particle concentrations would also generally be temporary and relatively short-lived. Moreover, mitigation should be straightforward, as most of the necessary measures are routinely employed as 'good practice' on construction sites.

Construction dust impacts are typically assessed as a qualitative assessment. The impacts of construction have not been modelled; rather a risk based approach is used based on a method outlined in **IAQM (2014)**. The IAQM guidance is designed primarily for use in the UK, although it may be applied elsewhere.

7.12.1 Construction activities

Activities on construction sites can be divided into three types to reflect their different potential impacts, and the potential for dust emissions is assessed for each activity that is likely to take place. It is noted that there will be no demolition and therefore demolition works is not assessed.

The activities considered are:

- Earthworks. This covers the processes of soil stripping, ground levelling, excavation and landscaping. Earthworks will primarily involve excavating material, haulage, tipping and stockpiling.
- Construction. Construction is any activity that involves the provision of new structures, modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc.
- Track-out. This involves the transport of dust and dirt by HDVs from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network.

The construction works will follow a staged approach as summarised in **Table 7-9**.

Table 7-9: EfW facility construction timeframes

Stage		Timeframe
Stage 1	Site establishment and clearance	2 weeks
Stage 2	Excavation/Services Lead-in	6-10 months
Stage 3	Structure	5 months
Stage 4	Technology provider plant Installation Structural Steel Works	16-18months 4-6 months
Stage 5	Façade/Roofing	4 months
Stage 6	Fit out/Landscaping	5 months

7.12.2 Assessment procedure

The IAQM assessment procedure for assessing risk is shown in **Figure 7-1**. The assessment is used to define appropriate mitigation measures to ensure that there will be no significant effect.

The assessment methodology considers three separate dust impacts:

- Annoyance due to dust soiling.
- The risk of health effects due to an increase in exposure to PM_{10}.
- Harm to ecological receptors.

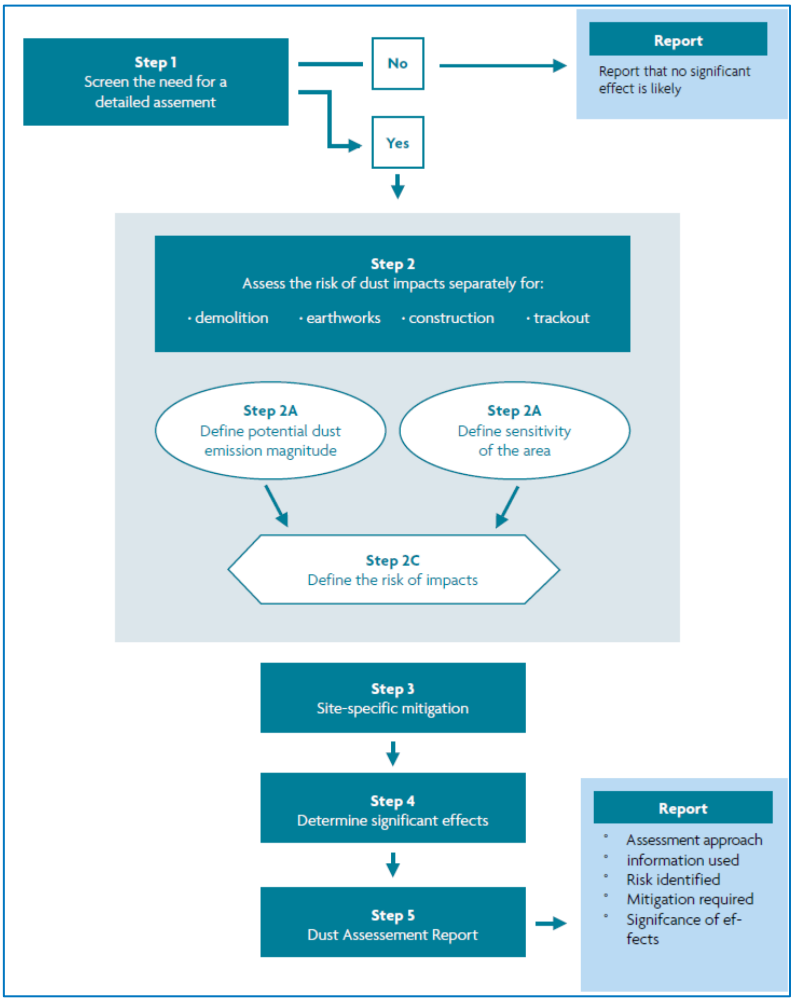


Figure 7-1: Steps in an assessment of construction dust (IAQM, 2014)

7.12.3 Step 1: Screening

Step 1 is a screening assessment to determine if detailed assessment is required. A construction dust assessment will normally be required where:

- There are human receptors within 350 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).
- There are ecological receptors within 50 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

A ‘human receptor’, refers to any location where a person or property may experience the adverse effects of airborne dust or dust soiling, or exposure to PM_{10} over a time period relevant to air quality standards and goals. In terms of annoyance effects, this will most commonly relate to dwellings, but may also refer to other premises such as buildings housing cultural heritage collections (e.g. museums and galleries), vehicle showrooms, food manufacturers, electronics manufacturers, amenity areas and horticultural operations (e.g. salad or soft-fruit production). An ‘ecological receptor’ refers to any sensitive habitat affected by dust soiling. This includes the direct impacts on vegetation or aquatic ecosystems of dust deposition, and the indirect impacts on fauna (e.g. on foraging habitats) **(IAQM, 2014)**.

The screening assessment identified no human receptors within 350 m of the boundary of the site. The main highway (M4) used for construction vehicles is the M4 is located greater than 50 m from human receptors. Additionally, there are no ecological receptors within 50 m of the site boundary or the major routes used by construction vehicles.

In summary, no detailed assessment of construction phase impact is required. It is assumed that, routinely employed 'good practice' mitigation measures for construction sites would be sufficient to control dust impacts to acceptable levels. These mitigation measures would be outlined in the Construction Environmental Management Plan.

8 MODELLING APPROACH

The overall approach to the assessment has followed the Approved Methods using the Level 2 assessment methodology. The Approved Methods specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the EfW facility. The approach taken in this assessment has followed as closely as possible the approaches provided within the Approved Methods.

8.1 Modelling system

AERMOD was chosen as a suitable dispersion model due to the source type, location of nearest receiver and nature of local topography. AERMOD is the US EPA's recommended steady-state plume dispersion model for regulatory purposes. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006. Ausplume, a steady state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications is based on ISC, which has now been replaced by AERMOD. While AERMOD has not been explicitly listed as an approved model by the EPA in the Approved Methods, AERMOD has been used for a number of assessments that have been approved by NSW EPA (**Pacific Environment 2013a; 2013b**).

A significant feature of AERMOD is the Pasquil-Gifford stability based dispersion is replaced with a turbulence-based approach that uses the Monin-Obukhov length scale to account for the effects of atmospheric turbulence based dispersion.

The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation of terrain data. Ground level concentrations were modelled across a 10km by 10km domain at 100m resolution.

Terrain data was sourced from NASA's Shuttle Radar Topography Mission Data (3 arc second [~90m] resolution) and processed to create the necessary input files.

AERMET requires surface and upper air meteorological data as input. Wind speed, wind direction, temperature, relative humidity and sea level pressure were source from the EPA St Marys meteorological station. Cloud cover and cloud height were sourced from the BoM Bankstown Airport AWS. In the absence of upper air sounding data for the area, upper air parameters were calculated using the upper air estimator within the Lakes Environment AERMODview software package.

Appropriate values for three surface characteristics are required for AERMET as follows:

- Surface roughness, which is the height at which the mean horizontal wind speed approaches zero, based on a logarithmic profile.
- Albedo, which is an indicator of reflectivity of the surface.
- Bowen ratio, which is an indicator of surface moisture.

Values of surface roughness, albedo and bowen ratio were determined based on a review of aerial photography for a radius of 3 km centred on the EPA St Marys station. Default values for cultivated land and urban areas were chosen over two sectors across this area.

8.2 Building wake effects

Wind flow is often disrupted in the immediate vicinity of buildings. Plumes emitted nearby are assumed to be unaffected by building wakes if they manage to reach building height plus 1.5 times the lesser of building height or projected building width. If this is not the case, pollutants can be brought to ground within a highly turbulent, generally recirculating cavity region in the immediate lee of the building and/or be subject to plume downwash and enhanced dispersion in a turbulent region which extends further downwind behind the building (**Environmental Protection Authority of Victoria, 1999**).

A simplified building geometry was incorporated for simulation of building wake effects, modelled using BPIP-PRIME model, as shown in **Figure 8-1**. BPIP-PRIME uses heights and corner locations of buildings in the vicinity of the plume to simulate the effective height and width of the structures. The downwash algorithm calculates effective building dimensions relative to the plume, resolved down to ten degree intervals. AERMOD then calculates the impact of these buildings on plume dispersion and consequently on GLCs.

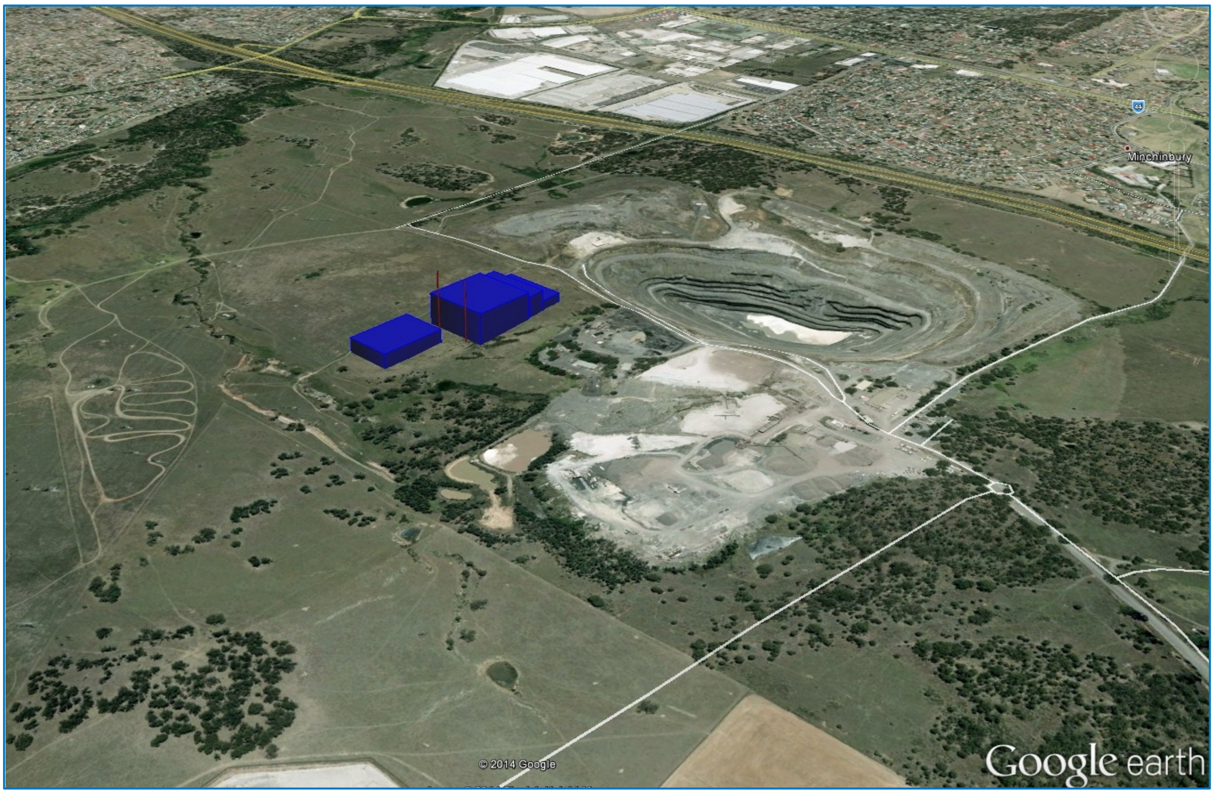


Figure 8-1: Visualisation of the Incorporation of EfW Building Dimensions within the Model

8.3 Sub-hourly predictions

The AERMOD model outputs ground level concentration predictions for averaging periods of 1-hour and greater. For sub-hourly averaging periods, such as for CO and SO_2, predictions were based on the power-law formula from **Borgas (2000)** to estimate short-term peak values referencing longer-term average concentrations. For example, to determine a 10-minute peak value from a one-hour value the formula is:

$$C_{10} = C_{60} \times (60/10)^{0.35}$$

C_{10} is the estimated peak value and C_{60} is the average one-hour value.

9 LOCAL AIR QUALITY ASSESSMENT

9.1 Incremental ground level concentrations

9.1.1 Normal operations

A summary of the predicted ground level concentration (GLC) for each pollutant is presented in **Table 9-1**. GLCs are presented at and beyond the site boundary, as well as the maximum prediction at sensitive receptors.

Contour plots of predicted GLCs are presented **Figure 9-1** to**Figure 9-14**.

Table 9-1: Summary of predicted ground level concentrations during normal operations

Pollutant	Averaging period	Units	Criteria	Highest prediction at and beyond site boundary	Highest prediction at sensitive receptor
NO_2 [(a)]	1 hour	µg/m³	246	159	96
	Annual	µg/ m³	62	5.1	4.1
SO_2	10-minute	µg/ m³	712	149	90
	1 hour	µg/ m³	570	80	48
	24 hours	µg/ m³	228	15	11
	Annual	µg/ m³	60	2.5	2.0
CO	15-minute	mg/ m³	100	0.06	0.04
	1 hour	mg/ m³	30	0.04	0.02
	8 hours	mg/ m³	10	0.02	0.01
PM_{10}	24 hours	µg/ m³	50	2.27	1.67
	Annual	µg/ m³	30	0.38	0.31
$PM_{2.5}$	24 hours	µg/ m³	25	2.27	1.67
	Annual	µg/ m³	8	0.38	0.31
HCl	1 hour	mg/ m³	0.14	0.017	0.014
HF	24 hours	µg/ m³	2.9	0.30	0.22
	7 days	µg/ m³	1.7	0.10	0.07
	30 days	µg/ m³	0.84	0.10	0.06
	90 days	µg/ m³	0.5	0.07	0.06
Cd [(b)]	1 hour	mg/ m³	0.000018	0.000014	0.000011
Hg [(b)]	1 hour	mg/ m³	0.00018	0.00001	0.00001
Dioxins and furans [(b)]	1 hour	mg/ m³	2.00E-09	2.79×10^{-11}	2.27×10^{-11}
TOC (as benzene) [(b)]	1 hour	mg/ m³	N/A	0.0056	0.0045
NH_3 [(b)]	1 hour	mg/ m³	0.33	0.0010	0.0008
H_2S [(c)]	1 hour	µg/ m³	1.38	0.6775	0.0033
PAH (as benzo(a)pyrene) [(b)]	1 hour	mg/ m³	0.0004	2.79×10^{-7}	2.27×10^{7}

Note: (a)based on the assumption of 100% conversion from NO_x to NO_2 [g]

[g] As discussed in **Section 7.9**, for this report we have conservatively assumed 100% conversion of NO_x to NO_2.

(b) expressed as the 99.9th percentile of the dispersion modelling prediction
(c) expressed as the 99th percentile of the dispersion modelling prediction

Modelling predictions at selected closest residences in the suburbs of Minchinbury and Erskine Park are presented in **Appendix F** to further inform the Health Risk Assessment.

Modelling results for criteria pollutants are assessed against the maximum prediction at sensitive receptors. In summary, the modelling results show:

- The maximum predicted 1-hour NO_2 is 39% of the impact assessment criterion, even assuming 100% conversion from NO_x to NO_2
- The maximum predicted annual NO_2 is 7% of the impact assessment criterion.
- The maximum predicted 10-minute SO_2 is 13% of the impact assessment criterion, for 1-hour 8%, for 24-hour SO_2, 5% and for annual, 3%.
- The maximum predicted 24-hour PM is 3% of the impact assessment criterion for PM_{10} and 7% of the advisory reporting standard for $PM_{2.5}$.
- The maximum predicted annual PM is less than 1% of the impact assessment criterion for PM_{10} and 3.8% of the advisory reporting standard for $PM_{2.5}$.
- The maximum predicted CO 15-minute, 1-hour and 8-hour averaging periods are 0.1% or less than the relevant impact assessment criterion.
- The maximum predicted 24-hour HF is 8% of the impact assessment criterion, for 7-day 4%, for 30-day SO_2, 7% and for 90-day, 11%.

For the pollutants above it is also important to consider cumulative impacts due to existing "background" air quality, and other sources of pollution in the area. The cumulative predictions are presented in **Section 9.1.2**.

Modelling predictions for air toxics are assessed against the 99.9th percentile prediction, at and beyond the site boundary. The individual odour compound H2S is assessed against the 99th percentile prediction.

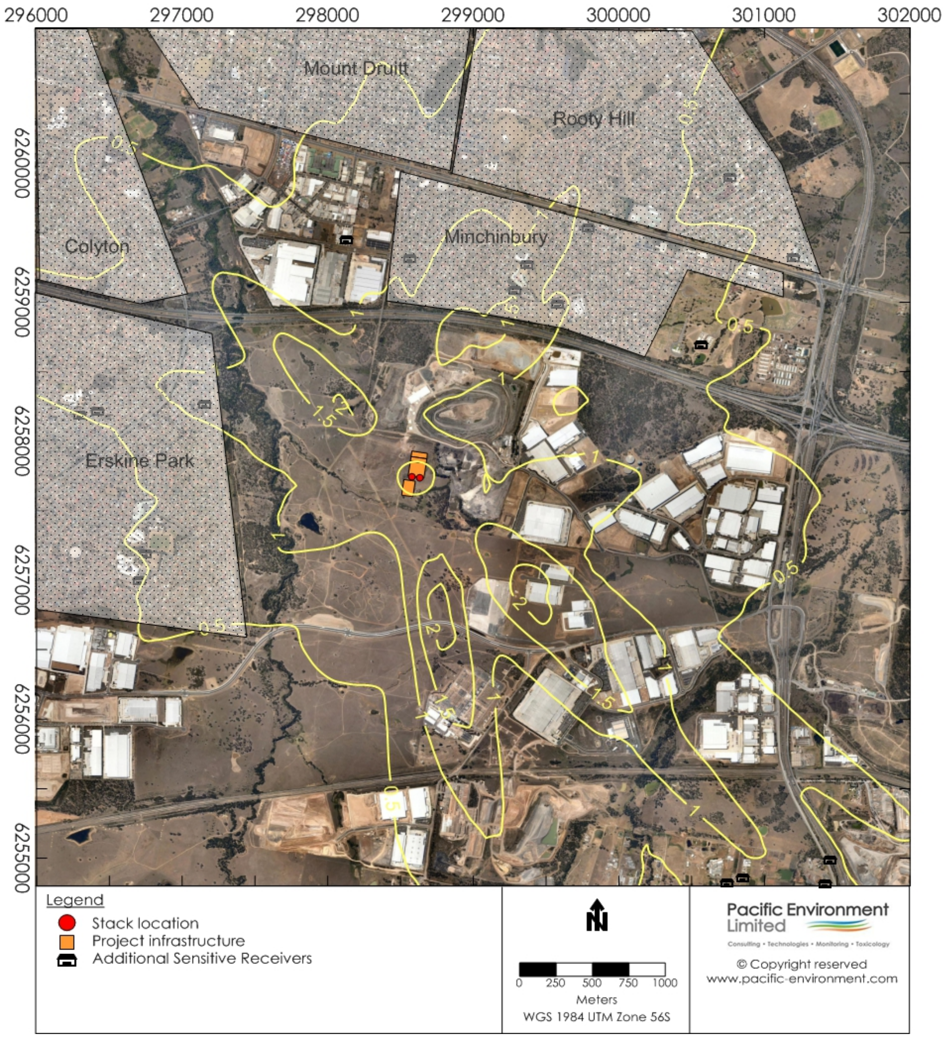
In summary, the modelling results show:

- The 99.9th percentile predicted HCl is 12% of the impact assessment criterion.
- The 99.9th percentile predicted cadmium is 77% of the impact assessment criterion.
- The 99.9th percentile predicted mercury is 8% of the impact assessment criterion.
- The 99.9th percentile predicted dioxins and furans are 1% of the impact assessment criterion.
- The 99.9th percentile predicted TOC (as benzene) is 19% of the impact assessment criterion.
- The 99.9th percentile predicted NH_3 is 0.3% of the impact assessment criterion.
- The 99.9th percentile predicted PAH (as benzo(a)pyrene) is 0.1% of the impact assessment criterion.
- The 99th percentile predicted H_2S is 49% of the impact assessment criterion.

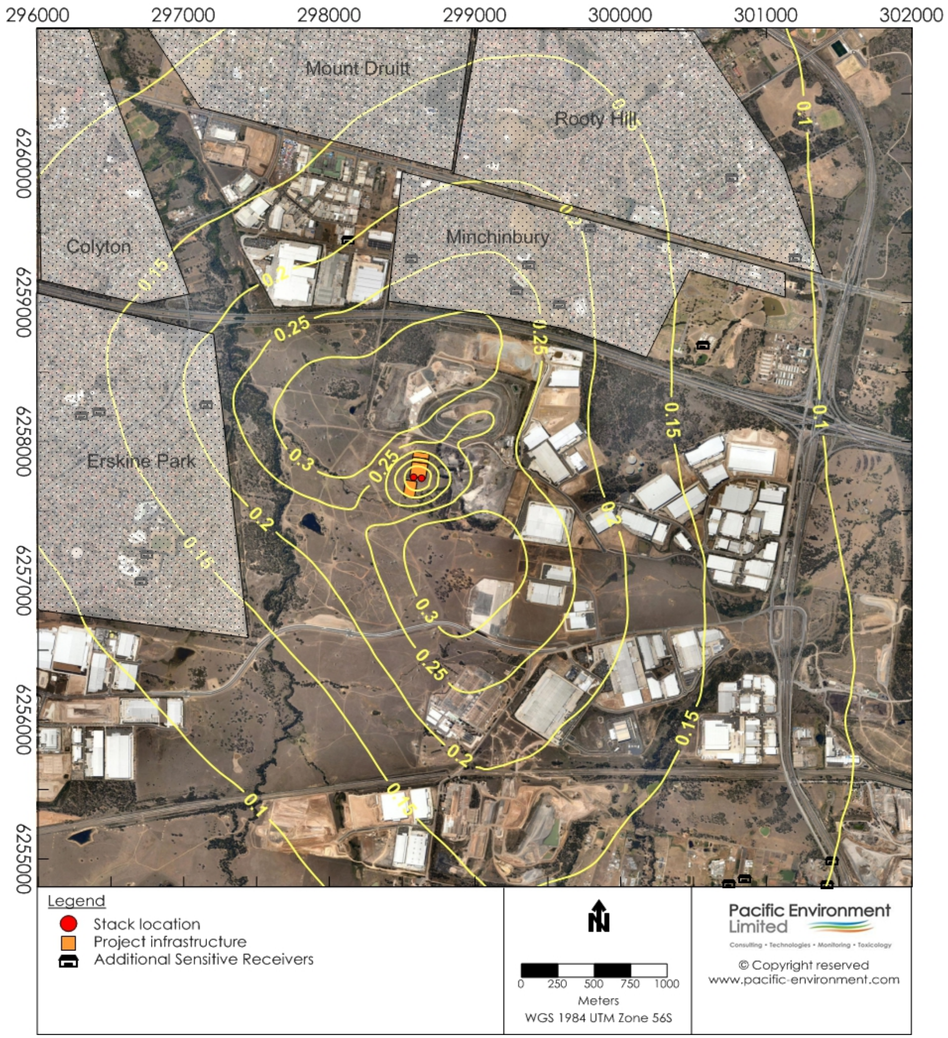
Assuming the EfW facility emits at the limits discussed in **Section 4.3** and **Section 7.3**, the prediction for cadmium is 77% of the impact assessment criteria. However, in reality emissions will be significantly lower than this limit. HZI has provided a summary of heavy metals emissions from a number of reference plants in the UK which employ semi-dry FGT (as is proposed for the EfW facility). These results show that emissions of Hg and Cd are an order of magnitude below the EU IED limits adopted in the current assessment. A summary of these data are provided in **Appendix B**.

Maximum 24-Hour PM_{10} (goal = 50 µg/m³) **Annual Average PM_{10} (goal = 30 µg/m³)**

Figure 9-1: Maximum predicted Ground Level PM_{10} Concentration – µg/m³

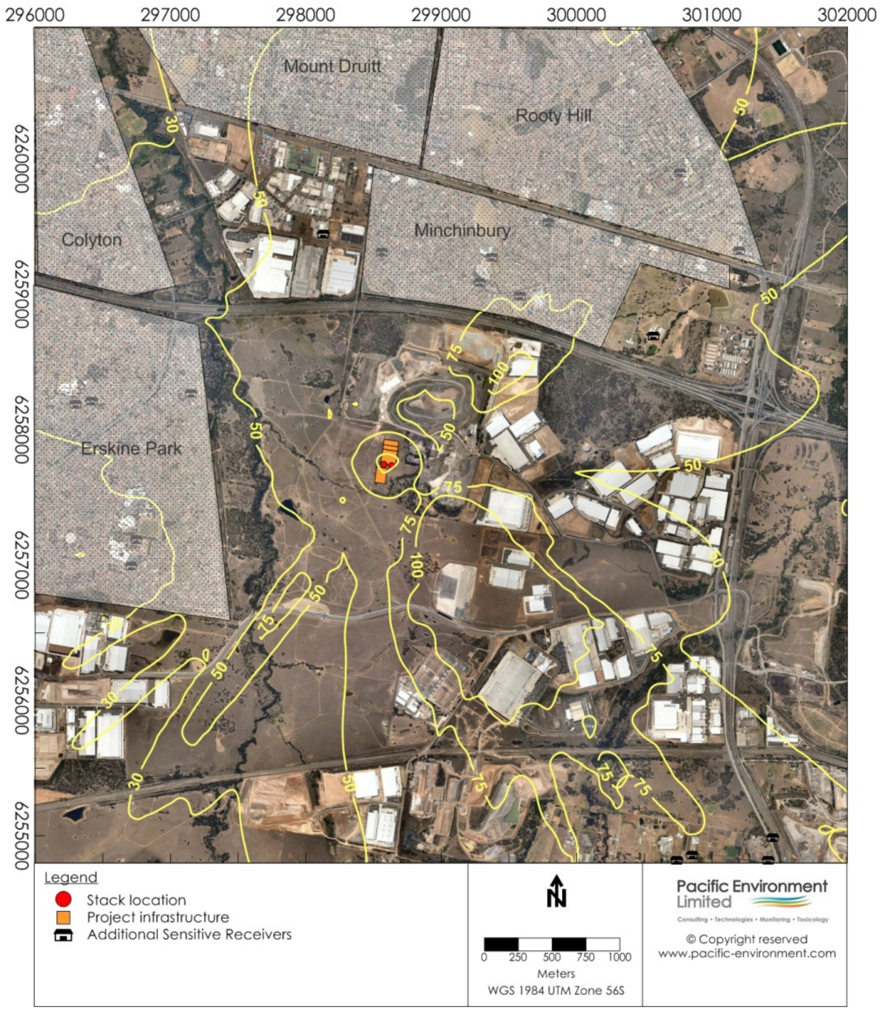


Maximum 24-Hour $PM_{2.5}$ (goal = 25 µg/m³)

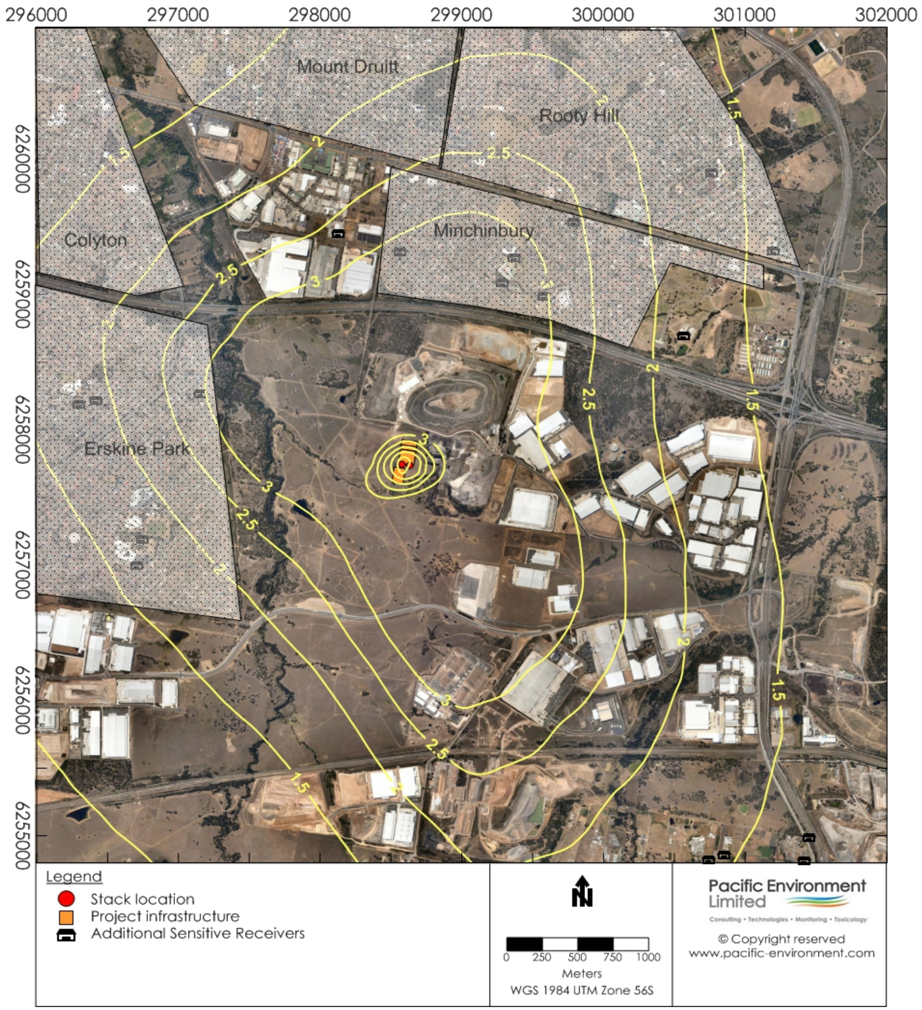


Annual Average $PM_{2.5}$ (goal = 8 µg/m³)

Figure 9-2: Maximum Predicted Ground Level $PM_{2.5}$ Concentration – µg/m³



Maximum 1-Hour NO_2 (goal = 246 µg/m^3)



Annual Average NO_2 (goal = 62 µg/m^3)

Figure 9-3: Maximum Predicted Ground Level NO_2 Concentration – µg/m^3

Maximum 10-Minute SO_2 (goal = 712 µg/m³) **Maximum 1-Hour SO_2 (goal = 570 µg/m³)**

Figure 9-4: Maximum Predicted Ground Level SO_2 Concentration – µg/m³