Appendix L (i)

BAT assessment report

Ricardo
Energy & Environment

Woodlawn ARC – BAT Assessment

Report for Veolia Environmental Services (Australia) Pty Ltd
00288-R-02-K00-0001-B

Customer:

Veolia Environmental Services (Australia) Pty Ltd

Customer reference:

00288-R-02-K00-0001-B

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06 July 2022

Ricardo Energy & Environment reference:

Ref: ED15223205- Issue Number 4.5

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1. Introduction

Ricardo Energy Environment and Planning Pty Ltd (Ricardo) has been engaged by Veolia Environmental Services (Australia) Pty Ltd (Veolia) to prepare a report that assesses if best available techniques have been incorporated into the design of the Woodlawn Advanced Energy Recovery Centre (Woodlawn ARC).

1.1 Purpose

The Planning Secretary's Environmental Assessment Requirements (SEARS) for the Woodlawn ARC, requires Veolia to demonstrate that the Woodlawn ARC incorporates best available techniques. This requirement stems from the NSW Environment Protection Authority Energy from Waste Policy Statement (NSW EfW Policy), which considers that any Energy from Waste development should use current "Best Practice" techniques, as well as very stringent technical and performance criteria.

The purpose of this report is to examine if the Woodlawn ARC is able to demonstrate that international best practice techniques are incorporated[1] where economically and technically feasible.

1.2 Background

The Woodlawn ARC will be located within Veolia's Eco Precinct, which is situated 250km south of Sydney in regional New South Wales (NSW), near the town of Tarago approximately 40km south-west of Goulburn. The bioreactor landfill and mechanical biological treatment (MBT) facility on site currently process 40% of Sydney's residual putrescible waste.

The Woodlawn ARC will divert and thermally treat up to 380 kilotonnes per annum (ktpa) of residual waste from landfill in line with the NSW EfW Policy. The feedstock will consist predominately municipal solid waste (MSW) with up to 20% commercial and industrial (C&I) waste.

1.3 Assessment

This assessment compares the principles of the Woodlawn ARC against the Best Available Techniques conclusions (BAT-C) issued in November 2019, relating to the European Industrial Emissions Directive (IED) as being representative of international best practice. Within the comparison, we also note the compliance of the Woodlawn ARC with the monitoring requirements stated within the NSW EfW Policy and where differences occur.

The principal areas of difference relate to the air emission levels for the plant which are designed to be in accordance with the NSW Energy from Waste Policy. It is noted that the emission levels for NSW are required to be monitored and maintained over a 1-hour averaged basis. Whilst the target compliance emission levels may be higher than those and other limits specified in Europe and the UK, the shorter averaging timeframe, hourly versus daily, presents further challenges to designers.

The assessment is based upon the following brief/requirements:

a) Qualitative commentary on the "current international best practice" for "proven, well understood technology" as described in the NSW EfW Policy. The commentary includes reference to European (e.g., Industrial Emissions Directive and Best Available Techniques Reference document) and non-European best practice.

b) A summary of the techniques nominated in the project documentation. The scope of techniques/technologies to be considered includes all aspects of the Best Available Techniques Reference document, including receipt of fuel and ash handling.

[1] NSW Energy from Waste Policy Statement June 2021

c) A Quantitative BAT assessment, justifying the techniques/technologies selected in comparison with other technologies. In particular, considering:

   i) Nitrogen oxides (NOx) abatement method (Selective Non-Catalytic Reaction-SNCR vs Selective Catalytic Reaction- SCR).

   ii) Acid gases abatement method (semi-dry vs dry vs wet).

   iii) Acid gases abatement reagent (lime vs sodium bicarbonate).

   iv) Combustion technology and/or parameters.

d) Commentary with a clearly stated conclusion on whether:

   i) The selected technology and techniques are “capable of handling the expected waste and variability” and whether this is adequately demonstrated through the references nominated; and

   ii) The concept design includes “Heat recovery as far as practicable”.

1.4 References

The Woodlawn ARC is currently at the proposal stage and whilst the key principles of the design have been identified, the detailed design has not yet been completed. The information on which this report is predicated has been provided by Veolia, with additional reference information considered for the purposes of completing the BAT assessment.

1.5 Costs

This report discusses the broad technical options that are available to meet and exceed the environmental requirements of the project. At this time a review of the directly associated capital and operational costs of each option has not been progressed.

A further review into the viability of these options against local costs and drivers, for example costs of effluent treatment, water quality, availability and cost of reagents and disposal routes are not within the scope of this report.

2. Woodlawn ARC Design

2.1 General

The overarching requirement of the Woodlawn ARC design is to use proven and established technologies to continuously process residual waste, generating heat and electrical power efficiently and producing as little residue as possible, while meeting the requirements of the NSW EfW Policy.

2.2 Feedstock

Waste for the Woodlawn ARC will be sourced from the Sydney Metropolitan area through Veolia's own transfer terminals at Clyde and Banksmeadow[2]. Source separated residual waste will be managed according to the Council's level of resource recovery and packed into purposely built containers at the transfer terminals and marked for processing at the Woodlawn ARC. The containerised waste will then be transported by rail to Veolia's Crisps Creek Intermodal Facility.

The containers will be transferred onto trucks for delivery to the Woodlawn ARC, where the containers will be emptied into and mixed in the waste bunker to reduce any significant fluctuation in quality of the feedstock as the nature of the MSW and C&I waste are diverse. After mixing, the waste is transferred by crane from the bunker to the feed hopper(s) and fed into the boiler combustion grate.

2.3 Technology

The Woodlawn ARC will comprise a single combustion line, using an inclined moving grate to efficiently combust the full range of waste feedstock. The technology chosen ensures that under normal operating conditions, emission limit values do not exceed the emission levels associated with the NSW EfW Policy. Only proven technology deployed in similar regulatory applications and at similar scale will be used.

The single combustion line will have an independently controlled combustion grate, boiler for the generation of superheated steam and flue gas cleaning system for removal of pollutants from the flue gas. The steam from the combustion line will be managed in a header and drives a steam turbine generating electrical power, with the steam turbine exhaust being condensed in an air-cooled condenser and returned to the process to minimise water loss and consumption.

Part of the waste is incombustible and together with combustion residues is collected at the bottom of the grate as incinerator bottom ash (IBA). Ferrous and non-ferrous metals from the bottom ash are recovered and will be recycled. The residual bottom ash post metal recovery can be used by the construction industry as a raw material, Incinerator Bottom Ash Aggregate (IBAA) following thorough on-site processing and maturation. In line with global experience, IBAA is expected to be of inert and non-hazardous nature. It is a valuable product that can replace virgin aggregates and therefore contribute towards resource recovery and carbon emission savings. The IBA is expected to be non-hazardous waste and is proposed to be initially disposed of to landfill or used as an alternative to daily cover at the Woodlawn Bioreactor, until a re-use pathway has been established and a market has been developed for its use in road construction. The design will maximise recovery of metals from IBA on-site.

After heat recovery in the boiler, flue gases are cleaned in a number of stages to ensure the flue gas released from the stack meets the air quality standards set in the NSW EfW Policy.

Urea or ammonia is injected into the furnace to reduce the NOx. The reagents react with the NOx contained in the flue gas to produce nitrogen and water. This form of Selective Non-Catalytic Reduction (SNCR) can reduce the flue gas NOx concentration as much as 60%. The combustion system design

[2] 00288-R-02-P00-0001 Waste Acceptance Protocol in Appendix G of the EIS

required to reduce the primary NOx reduction by air stagging along with multi-level reagent injection, accurate temperature monitoring and advanced control system for secondary NOx reduction will be considered in the design during the EPC selection process and based on reference plant design basis.

Bag filters and a semi-dry system design are found to be very effective in controlling the environmentally harmful elements. The system consists of a reactor with water and additive injection, fabric filter and residue circulation. Flue gas/adsorbent contact in the reactor removes the pollutants like SO_2, SO_3, HCl and HF. Collected reagent from the baghouse is recirculated into the upper portion of the reactor, minimising the use of new reagent.

Hydrated lime is injected in the flue gas stream to abate acidic pollutants such as sulphur dioxide (SO_2) s and hydrochloric acid (HCl) emissions from the energy from waste facilities. Activated carbon is also injected to capture organic pollutants and heavy metals including furans, dioxins and mercury by adsorption contained in the flue gas treatment plant.

Fly ash from the boiler passes and Air Pollution Control residue (APCr), containing excess reagents and reaction products, along with waste finer particles of fly ash at the flue-gas treatment plant will be collected and treated. The boiler pass fly ash and APCr will be categorised as hazardous waste and will be stabilised, for example by the addition of water or along with solid binding agents before being disposed of in a dedicated encapsulation cell.

2.4 Design Principles

The design of the Woodlawn ARC will be based upon the principles listed below as a minimum requirement:

- Development of the facility with a maximum capacity (MCR) of 380,000 tonnes per annum (tpa). Feedstock supply will be predominantly residual MSW and up to 20% C&I waste.
- Maximum continuous rating (MCR) operation will be designed to deliver the guaranteed net electrical output based upon the net calorific value of the design waste fuel.
- The boiler will be designed to operate in a safe condition across the defined firing diagram up to thermal and throughput overloading conditions. During steady state and normal operating conditions, the boiler will be specified to operate without any auxiliary support fuel requirement above minimum stable generation (MSG) conditions.
- The turbine will be designed to operate in fully condensing mode. It is expected that the plant will have a high electrical efficiency using steam conditions and an efficient thermal cycle including feedwater heating system design. The condensing system for the power plant utilises an air-cooled condenser (ACC).
- The plant is required to operate to the emission limits set out in relevant policies including the NSW Energy from Waste Policy Statement June 2021.
- Equipment redundancy, maintainability and operability will be considered in the detailed design phase to ensure that the facility availability will be no less than 8,000 hours per annum.
- Material resource recovery from post processing streams, including IBA, is to be maximised.
- The plant and system design will be such as to require the minimum manpower for operation of the plant and its associated system, consistent with plant and personnel safety.
- The design will ensure that waste collection and delivery vehicles have a safe and separate access to other vehicles entering and leaving the main site with quick turnaround times.

3. Policy Context

3.1 Policy Overview

In NSW, EfW technology is primarily regulated via the NSW Energy from Waste Policy Statement[3]. The NSW EfW Policy encourages EfW if it can deliver positive outcomes for people and the environment and that it ensures that EfW:

- Poses minimal risk of harm to human health and the environment.
- Facility emissions are below levels that may pose a risk of harm to the community.
- Does not undermine higher-priority waste management options, such as avoidance, re- use or recycling.
- Meets current international best practice techniques, particularly 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.

It is important to note that the NSW EfW Policy sets out two levels of control for EfW processes. The first level applies to certain ‘eligible’ wastes when treated in EfW facilities, and the second to all other waste types, with more stringent controls being applied in facilities that are then termed energy recovery facilities.

3.2 Eligible Waste Fuels

Eligible waste derived fuels are permitted for use in simple combustion processes with limited controls. This is because those fuels pose a low risk of harm to the environment and human health due to origin, low levels of contaminants and consistency over time (what is ‘eligible’ is subject to review by NSW EPA). The NSW EfW Policy defines eligible wastes as:

- Biomass from agriculture.
- Forestry and sawmill residues.
- Uncontaminated wood waste.
- Recovered waste oil.
- Organic residues from virgin paper pulp activities.
- Landfill gas and biogas.
- Source separated green waste when used to make char.
- Tyres in approved cement kilns only.

The NSW EfW Policy notes other criteria for these aims, seeking to ensure that higher order re-use is prioritised, and directs readers to further guidance provided in the EPA’s Eligible Waste Fuels Guidelines[4].

3.3 Energy Recovery Facilities

Any facility, such as the Woodlawn ARC, proposing to utilise a fuel that is not in the Eligible Fuels category listed above must comply with more stringent technical requirements as set out in the NSW EfW Policy.

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[3] https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/waste/21p2938-energy-from-waste-policy-statement.pdf
[4] NSW Eligible Waste Fuels Guidelines – EPA 2016/0756, December 2016

Facilities that do not treat only eligible wastes must meet the requirements of an energy recovery facility, which in summary are:

- Apply current best practice techniques, particularly with respect to process design and control, emission control equipment design and control, emission monitoring with real-time feedback to the controls of the process (and the following which are over and above the requirements for eligible waste) arrangements for the receipt of waste, and management of residues from the energy recovery process.
- Facilities must use technologies that are proven, well-understood, capable of handling the expected variability and type of feedstock and be demonstrated through fully operational plants using the same technologies and treating like waste streams in other similar jurisdictions.
- Facilities must meet the certain technical criteria, including:
    - Technical
        - Meet 850°C for at least 2 seconds in the combustion chamber [equivalent to the European Industrial Emissions Directive] or 1100°C for 2 seconds if the waste contains more than 1% of halogenated organic substances, expressed as chlorine.
        - Total organic carbon (TOC) or loss on ignition (LOI) content of the slag and bottom ashes must not be greater than 3% or 5% (dry weight) respectively.
        - Waste feed interlocks to prevent feeding when required temperature has not been reached.
        - Emissions monitoring data of NOx, CO, particulates, total organic compounds, HCL, HF, SO2, ammonia, N2O and CO2 available publicly in near real time through a web portal
        - Proof of performance trials as part of the licence conditions to demonstrate compliance with emissions limits and subsequently twice-yearly measurements of heavy metals, PAHs, chlorinated dioxins and furans, and all to be subject to continuous monitoring if and when appropriate measurement techniques are available.
        - Air quality impact assessment must be undertaken in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.
    - Thermal efficiency criteria:
        - Plants that do not recover energy are outside the scope of the NSW EfW Policy.
        - At least 25% of energy will be captured as electricity (or an equivalent level of recovery for facilities generating heat alone).
        - Any heat must be demonstrated to be recovered as far as practicable.
    - Resource recovery criteria:
        - Feedstock must be from waste processing facilities or collection systems that meet specific criteria, unless agreed by the EPA on a case-by-case basis.
        - For mixed municipal waste there are limitations on waste that can be subject to EfW depending on whether the council separately collects dry recycling, food and green waste.
        - Mixed commercial and industrial waste that can be subject to EfW is limited if no separate collections are in place for all waste streams being generated.

   - Mixed construction and demolition waste can only be subject to EfW up to 25% by weight.
   - Limits apply to the percentage of residues from the processing of separated recyclables, green and food waste that can be subject to EfW.
   - Waste wood and textiles can be subject to EfW if sourced directly from a waste generator (e.g. manufacturing).
- Other requirements:
   - A Waste Acceptance Protocol will be applied to minimise or exclude inappropriate items (eg batteries, light bulbs, other electrical and hazardous wastes) from the feedstock of the plant.
   - An EfW or ERF development must be subject to public consultation; engage in genuine dialogue with the community; ensure that planning consent and other approval authorities are provided with accurate and reliable information; and be ‘good neighbours’, particularly when near residential areas and employment.

4. Indicative BAT Assessment

4.1 Introduction

This section of the report identifies the technology groupings that are currently considered "Best Practice" internationally, drawing on experience in the UK and Europe, the USA and Asian markets (in particular the European market). The use of these technologies can be dependent on the nature of the fuel and wider scope of the project, and so following a review of the key policy drivers, we identify the fuel type proposed and how it fits within the resource hierarchy.

4.2 Feedstock

Before entering into a discussion on the different technologies, it is important to note that this project is based upon the use of predominantly residual MSW and up to 20% C&I wastes.

Within the NSW EfW Policy there are constraints on the percentage tonnage that can be received by a facility based upon its potential to form part of an integrated waste management strategy and it seeks to encourage recyclable elements being removed at source prior to any processing stage.

In accordance with the NSW EfW Policy, the feedstock will comprise of mixed municipal waste (MSW) that is sourced only from Councils that have implemented separate collection systems for one or more of the following:

- 100% of residual MSW from councils that source segregate dry recyclables and food organics and garden organics (FOGO).
- 40% by weight of residual MSW from councils that source segregate dry recyclables and garden organics only
- 25% by weight of residual from councils that only source segregate dry recyclables.
- 50% by weight of C&I waste as the Woodlawn ARC will receive this waste from facilities processing mixed C&I waste.

The percentage of MSW directed to the Woodlawn ARC from each Council will be based on their collection system and the matching resource recovery criteria listed in the NSW EfW Policy.

Therefore, the waste feedstocks for the Woodlawn ARC will draw upon residual waste streams that comply with the NSW EfW Policy.

4.3 Best Available Techniques

This section considers the Best Available Techniques (BAT) in each of the main areas of consideration under the NSW EfW Policy as they are seen in the EU, but also drawing on the experience elsewhere in the world.

It should be noted that many industrialised nations draw upon UK and European standards for their projects and define their national standards using these as a starting point. As an example, many projects in the Middle East also refer to these standards as being best practice for any implementation of projects. For this reason, consideration of BAT in this report particularly focuses on European standards.

The NSW EfW Policy also draws a distinction that any technology used should be "proven, well understood technology" and therefore those technologies that are considered to be emergent or disruptive technologies are not considered here.

4.3.1 Combustion Techniques

4.3.1.1 Overview

Worldwide, the vast majority of plants used for the thermal treatment of municipal waste utilise moving grate technology. Moving grates exist in a variety of different designs (roller grates, reverse reciprocating, reciprocating) but each involves the use of a system that distributes the fuel across a grate. A mechanism for moving the material down the grate as it combusts, agitating and turning the material as it does so, whilst primary air is blown through the grate to support the combustion. This allows for good mixing of material, breaking it up as it progresses. Secondary air is commonly introduced above the grate, creating areas of turbulence to ensure the complete combustion of volatile compounds.

Moving grate technology can be used for a wide range of fuels as the control systems can improve the residence time that the material remains on the grate thereby ensuring complete combustion and a low TOC content in the bottom ash.

4.3.1.2 Environmental Performance

The moving grate system is well established technology and the provision of advanced control of the combustion system means that it can operate with low NOx levels. However, it will still not achieve the requirements of the industrial emissions directive ('IED') without the addition of secondary measures. Incorporation of SNCR (discussed later) means that the NOx levels set by the IED and its related BAT Conclusions (BAT-C) can be achieved.

In relation to ash generated, in general terms the moving grate presents most of the ash (~80%) as bottom ash with the remainder being carried into the gas path to be extracted by the Flue Gas Treatment (FGT) Plant. Following further treatment, the Incinerator Bottom Ash (IBA) aggregates can be recovered and used as a replacement for virgin construction materials. The use of these aggregates is widespread in Europe and the UK creating even more opportunities for resource recovery and overall emission reduction, for example by its use in concrete within the construction industry.

4.3.1.3 Conclusion

From the above assessment and the requirements of the NSW EfW Policy, it is clear that the most proven, and hence BAT, for the treatment of municipal waste derived fuels is the moving grate combustion system. When fitted with an advanced combustion control system it is able to achieve good burn out of combustion products and produce bottom ash that is low in total organic carbon (TOC). Secondary flue gas treatment systems are still required for the control of oxides of nitrogen as would be standard across the technology selection.

4.3.2 Flue Gas Treatment Technologies

4.3.2.1 Pollution Absorption Systems

Basic FGT is regarded as being raw combustion gas treatment to limit the emissions of:

- Particulate matter or dust
- Acidic gases (Hydrogen chloride HCl, Hydrogen fluoride HF and Sulphur dioxide SO2)
- Heavy metals (mainly adsorbed on the surface of fly ash particles); and
- Complex organic pollutants such as dioxins and furans (highly toxic molecules produced in very small amounts during part of the combustion process, adsorbed by activated carbon reagent)

NOx is treated in a separate system within the EfW plant and is discussed in Section 4.3.2.2.

Carbon monoxide (CO) and TOC content requirements are addressed by controlling the combustion conditions in the furnace.

Abatement systems are categorised into distinct systems: dry, semi-dry, wet systems and combinations thereof:

- 'Dry' systems are where the chlorine and sulphur content of the waste leaves the facility as a dry product with no wastewater being produced. This system is commonly employed in EfW plants. Lime is the most commonly used reagent in a dry system, sodium bicarbonate-based systems are also specified where there is a market that is able to supply and recover the reagent. Another differentiator between lime and sodium bicarbonate is the need to remove the fly ash from the system before the introduction of the reagent, to avoid contamination. The bicarbonate based system requires a higher temperature reaction zone and therefore means that the overall process efficiency can be lower than the equivalent lime system due to an increased stack loss.
- 'Semi-dry' systems are where hydrated lime and water are added to the gas stream, the moisture evaporating to leave dry products with no wastewater being produced. The reagents will be recirculated to reduce reagent consumption. Both dry and semi dry systems employ a bag house filter to capture residues for disposal.
- 'Wet' scrubbing systems have several processing stages. The basic principle of wet collectors is to wet the contaminant particles in order to remove them from the gas stream. The system design should also include a suitable method to prevent water carryover in the cleaned exhaust gas. Wet Scrubbers often convert an air pollution problem into a water pollution problem as a residual wastewater solution is produced that requires further treatment prior to any discharge. For example, a wet scrubber will produce a calcium chloride solution containing the majority of the chloride released from the combusted waste, thereby limiting the generation of solid residues. In addition, wet scrubbers result in a humid exhaust gas which can reduce plume buoyancy and affect ground-level concentrations.

4.3.2.2 Control of NOx

Waste combustion in grate fired systems results in the production of several oxides of Nitrogen described collectively as NOx. The most commonly employed system to remove NOx from the flue gases is Selective Non-Catalytic Reduction (SNCR).

The SNCR process entails ammonia water, or urea, injection in the upper part of the combustion chamber of the furnace where gasses are at a temperature in excess of 850°C. These temperatures are suitable for ammonia to react with oxides of nitrogen (NO and NO_2), resulting in the conversion of NOx to elemental nitrogen gas and water vapour. Optimisation of the process requires careful control of ammonia injection, flow rates and stable combustion control. Depending on the level of optimisation, the process causes some un-reacted ammonia to leave the boiler with the flue gas. This is known as ammonia slip.

In both dry and semi-dry FGT-systems, a certain amount of the ammonia slip is adsorbed onto the surface of the fly ash and unburnt carbon along with reagent residue in the bag house filter. The remaining ammonia leaves the plant with the clean flue gas. A typical requirement for the maximum ammonia slip would be 5 - 10 mg/Nm^3, though the slip is indicated as a limit value in the EU Directive whereas the NSW EfW Policy includes an ammonia slip limit of 5mg/m3 (24 hour average).

Selective Catalytic Reduction (SCR) is an alternative process that can reduce NOx and can be found on large scale power utility plants. However the control systems and use of SNCR have tended to negate the need to use SCR in waste treatment applications. Both SCR and SNCR technologies are relatively simple to install in the plant because they are implemented post-combustion. This means both SNCR and SCR don't interfere with the actual fuel-burning process, but they react with the burned fuel flue gas.
The higher active energy available in the furnace along with the non-requirement of catalyst to achieve target NOx reduction along with low ammonia slip supports the decision to use SNCR as the selected NOx abatement technology for the project.

4.3.3 BAT - Flue Gas Treatment Technologies[5]

With the improvements in combustion control systems and the adoption of multilevel injection of reagents, SNCR remains able to effectively achieve the levels of NOx emissions specified within the IED. Its effectiveness and efficiency of reagent consumption can be monitored using analysis instrumentation to detect ammonia slip allowing the control system to vary the amount of reagent added into the system. Therefore, it is considered that SNCR, with the advanced control and monitoring systems utilised, is the appropriate selection of technology to manage NOx and ammonia slip levels within the upper limit of the IED and NSW EfW Policy requirements.

For the control of dioxins, the BAT is to ensure that the process achieves the time and temperature requirements that are specified in IED and in the NSW EfW Policy of 850°C for 2 seconds and then ensure the correct design of the energy recovery plant to rapidly drop the temperature of the flue gas to prevent de novo reformation of dioxin. For residual control, and also for control of any heavy metals and mercury, activated carbon injection is BAT.

The selected Flue Gas Treatment (FGT) technology is a semi-dry system with monitoring to enhance the efficiency of the system, reducing the consumption of reagents and offering improved performance to the BAT. The reagent, in addition to the aforementioned activated carbon, is a dry, hydrated lime compound that is present in the form of a powder. In this way both reagents are injected at a similar location and reaction time is optimised through the plant control system monitoring both stack conditions and also pressure drop across the bag filter.

The above technology descriptions and the widespread application in similar applications confirms that the selection of these technologies will result in a project that meets the requirements of BAT for the treatment of the proposed feedstock.

[5] Note: Flue Gas Cleaning (FGC) and Flue Gas Treatment (FGT) are synonymous. FGC is used in the context of the original BAT-C wording included in Section 7 of this document.

5. Quantitative BAT Assessment

In this section, a quantitative/semi quantitative BAT assessment is provided, justifying the techniques/technologies selected in comparison with other technologies.

5.1 Nitrogen Oxides Abatement Method

There are two abatement methods that are available for the reduction of NOx emissions from a facility. The difference between these two systems is that one employs a catalyst to provide the conditions for the reaction. SCR is a widely used system especially well-equipped for large-scale utility power plant facilities though grate combustion technology along with staging of air supply will result in lower primary NOx during the combustion process itself with SNCR being the principle secondary control.

Selective Non-Catalytic Reduction (SNCR) systems, where utilised alongside efficient combustion control systems, can achieve NOx emission levels well within the emission limit set in the NSW EfW Policy of 250 mg/Nm³ based on a one-hour average.

SCR cannot be placed upstream of the FGT, to meet the higher reaction temperature required, as to do so would likely introduce contamination of the catalyst elements by ash etc. Implementation of SCR to a waste incineration facility will therefore require additional associated equipment for the reheating of the flue gas where SCR is placed downstream of the flue gas treatment plant. An SCR system would have slightly higher power consumption due to pressure drops in the catalyst and reheating systems. This results in SCR generating higher operating costs whilst resulting in lower plant energy efficiency. It is therefore more appropriate to maintain the emission performance using an SNCR design where these potential impacts are not present.

Most EfW plants opt for SNCR as this provides adequate performance within current IED and similar NSW EfW Policy limits.

The SNCR system proposed is therefore considered to be the best choice in terms of meeting applicable emissions limits. This is supported by the Air Quality Impact Assessment (AQIA) which identifies that the results of the dispersion modelling show that the "introduction of the project will not significantly change air quality impacts currently associated with the Eco Precinct". Seeking to achieve lower NOx emission values via an SCR scheme would result in minimal improvement on the overall environmental performance of the facility and may be detrimental due to unintended cross-media environmental impacts (i.e. increased emissions to other receptors via air, land or water).

5.2 Acid Gases Abatement Method (semi-dry vs dry vs wet)

An assessment of the commonly available FGT systems against multiple criteria is presented in Table 5-1. It can be seen that no single flue gas treatment concept is advantageous under all the evaluation criteria considered. Therefore, the evaluation criteria need to be weighed against the specifics of the project, according to site location, the individual priorities and needs of the operator / owner.

Table 5-1: Assessment of base concepts for dry, semi-dry, combined and wet FGT technology

Evaluation criteria:	Dry	Semi-dry	Wet
Operational availability			
- Performance history of reliable operation	+	+	0
- Availability Risk due to less technical complexity	+	+	0
Capability			
- Ability to handle changes in raw gas composition	0	0	+
Flexibility			
- Ability to meet more stringent future emission limit	-	0	+
Health and safety			
- Reduced human contact with hazardous material	0	0	0
Sensitivity to local conditions			
- Limited plume visibility	+	+	-
- Discharge of treated wastewater	N/A	N/A	-
Other environmental issues			
- Low chemical consumption	-	0	+
- Low water consumption	+	0	-
- Low electricity consumption	+	+	0
- Low residue production	-	0	+

'+'= attractive for project, '0'= neutral and '-'= negative

When the key assessment criteria are considered, the following conclusions are drawn:

Most attractive concept

A semi-dry FGT system is recommended as being the most attractive option for the proposed development. This is due to:

- The system is optimal for EfW plants processing waste where the pollutant content is expected to vary considering the seasonal changes in waste collection, waste management strategy improvements including the implementation of dry recyclate to support circular economy policies and initiatives along with FOGO collection schemes planned in future years.
- Water consumption is low (particularly for a semi-dry system) and there is no production of wastewater requiring specialist treatment and discharge.

- It is not envisaged that flue gas condensation is beneficial; the plume would still be visible under certain weather conditions.
- Relatively simple operational requirements.
- Relatively low capital investment requirements.

Alternatives

Wet scrubbing systems are only of interest where:

- Wastewater discharge is an option.
- The waste pollutant load is higher.
- There are exceptional environmental constraints.
- Low residue generation is a key factor.

The drawbacks of the system are:

- Increased technical complexity – especially where wastewater treatment is necessary.
- Increased plume visibility, particularly in cold climates.
- Higher capital investment requirements.

This would exclude a wet system from consideration for the proposed development, as the plant design is based on a principle of zero liquid discharge.

5.3 Acid Gases Abatement Reagent (Lime vs Sodium-bicarbonate)

Table 5-2 below presents positive, neutral and negative aspects of a dry lime and bicarbonate system relative to each other. Once again, it can be seen that neither reagent is advantageous under all the evaluation criteria considered and specific project circumstances need to be taken into account.

Table 5-2: Assessment of lime and bicarbonate reagents

Evaluation criteria:	Lime	Bicarbonate	Comments
Installation and operation	0	0	Either reagent (in a semi-dry system) has low investment costs and is relatively simple to install and operate
Performance	0	0	Acid gas removal performance is similar for both reagents. Efficiency of lime usage may be improved by using a higher grade of lime with improved reactivity. Lime is used in many plants, particularly smaller facilities, hence the wide availability of references and operational experience.
Chemical consumption	-	+	Bicarbonate consumption is more moderate because approximately 20% excess reagent use is typically required.
Chemical costs and supply	+	-	Bicarbonate is relatively expensive to purchase and there is often a limited number of suppliers.
Chemical residues	-	+	A significant excess of hydrated lime is required to treat flue gases to levels that comply with emission limits. This is typically 100-200% excess hydrated lime and this results in large quantities of residue generation. With bicarbonate, the use of an electrostatic precipitator before the main process results in a chemical residue at the bag filter, which can in principle be recycled. This reduces the amount of residues produced when compared to a lime-based flue gas treatment plant.

‘+’= attractive for project, ‘0’= neutral and ‘-‘= negative

6. Review of Proposed Woodlawn ARC against Indicative BAT

6.1 Introduction

The mix of waste fuel proposed does not fall under the classification of an "Eligible Waste Fuel" and therefore the proposed facility has to comply with the requirements of the NSW EfW Policy in terms of its definition of "Energy Recovery Facilities".

As such, it is required that these plants are using current international best practice techniques in the following key areas:

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

The above parameters are included within the requirements of the BAT-C as set out in the revised draft of the Waste Incineration BAT reference document (BREF)[6].

Ricardo's findings against the BAT-C are identified in Section 5 of this report and we have provided commentary against each element where they are both relevant and our opinion in relation to the requirements of BAT.

6.2 Reference Facility

6.2.1 Emission measurement Standards

Ricardo recognises that within the Australian market the development of Waste to Energy facilities is still very much an emergent theme with much current activity. Globally, there are a huge amount of facilities that have been developed, with each designed to be able to meet the demands of their own regional environmental standards. However, potential reference plants are not currently available that meet the requirements of the NSW EfW Policy as the requirements on energy recovery facilities and the Technical Requirements for emission standards, process monitoring and proof of performance testing for emissions to air are different from other regions; notably within this report against the EU Waste Incineration (WI) Best Available Techniques (BAT) Conclusions[7] published in November 2019, and the minimum requirements for waste incineration specified in Chapter IV of Directive 2010/75/EU on industrial emissions[8] (IED).

The emissions standards in the NSW EfW Policy have been compared to the BAT-AELs[9] in the WI BAT Conclusions, as well as emission limit values (ELVs) in Chapter IV (Annex VI) of the IED and shown in Table 6-1 for all in-scope pollutants. In the EU, BAT-AELS set in the BAT Conclusions document are the reference point for setting emissions limit values in permits and licenses.

All emissions limit concentrations in Table 6-1 are at reference conditions of a temperature of 273.15 K, a pressure of 101.3 kPa and after correcting for the water vapour content of the waste gases (dry gas), and at a reference oxygen concentration of 11%. It should be noted that the BAT-AELs for dust, all heavy metals (& mercury), carbon monoxide, hydrogen fluoride, hydrogen chloride and ammonia

[6] Notified under document C(2019) 7987
[7] Available here https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D2010&from=EN
[8] Available here https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ%3AL%3A2010%3A334%3A0017%3A0119%3Aen%3APDF
[9] Best Available Technique Associated Emission Levels (to note, this can often be a range, depending on the type of process)

are the same for existing plant as they are for new plant. The AELs for existing plant on the other pollutants are all less stringent in their ranges.

Note that there are some differences in species monitored between EU and NSW for heavy metals (EU testing does not typically include Beryllium) and for dioxins/furans (NSW applies lower toxic equivalence factors for Octa and Penta-chlorinated congeners than the IED factors).

Table 6-1: Comparison of emission limits and associated emission levels (BAT-AEL)

Pollutant	NSW EfW Policy Statement Limits		IED Annex VI Limits		WI BAT-AEL[10]	
	ELV (mg/m³ unless stated)	*Averaging Period*	*ELV (mg/m³ unless stated)*	*Averaging Period*	*AEL range (mg/m³ unless stated)*	*Averaging Period*
Dust (Particulates Matter)	20	One Hour*	10 30	Daily Half Hour	<2-5[11]	Daily
Type 1[12] and 2[13] substances in aggregate	0.3	One Hour*	0.6[14] (except Be)	Half Hour – 8 hours	0.02–0.34[15] (except Be)	Average over the sampling period
Mercury	0.04	One Hour*	0.05	Half Hour – 8 hours	0.005-0.020 0.001-0.010	Daily or sampling period Long-term[16]
Cadmium & Thallium (total)	0.02	One Hour*	0.05	Half Hour – 8 hours	0.005–0.02	Average over the sampling period
Dioxins & Furans	0.1 ng/m³	One Hour*	0.1 ng/m³	6-8 hours	0.01–0.04 ng I-TEQ/m³ 0.01–0.06 ng I-TEQ/m³	Average over the sampling period Long-term[15]

[10] BAT AELS are for NEW plant (AELs on existing plant can be less stringent)
[11] For existing plants dedicated to the incineration of hazardous waste and for which a bag filter is not applicable, the higher end of the BAT-AEL range is 7 mg/Nm3.
[12] Type 1 substance means the elements antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements.
[13] Type 2 substance means the elements beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.
[14] Heavy metal limits covered in Annex VI of the IED covers Cadmium, Thallium, Mercury, Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel and Vanadium. Beryllium is NOT included.
[15] Heavy metal limits covered in WI BAT Conclusion covers Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel and Vanadium. Beryllium is NOT included.
[16] The BAT-AEL does not apply if the emission levels are proven to be sufficiently stable.

Pollutant	NSW EfW Policy Statement Limits		IED Annex VI Limits		WI BAT-AEL[10]	
	ELV (mg/m³ unless stated)	*Averaging Period*	*ELV (mg/m³ unless stated)*	*Averaging Period*	*AEL range (mg/m³ unless stated)*	*Averaging Period*
Dioxin like PCB's	Not specified		Not specified		0.01–0.06 ng WHO-TEQ/m³ 0.01–0.08 ng I-TEQ/m³	Average over the sampling period Long-term[15]
Sulphur Dioxide (SO_2)	100	One Hour	50 200	Daily Half Hour	5-30	Daily
Oxides of Nitrogen (NOx) (as NO_2 equivalent)	250	One Hour	200 400	Daily Half Hour	50-120	Daily
Carbon Monoxide (CO)	80	One Hour	50 100 150	Daily Half Hour 10 minutes	10-50	Daily
Hydrogen Chloride (HCl)	50	One Hour	10 60	Daily Half Hour	2-6	Daily
Hydrogen Fluoride (HF)	4	One Hour	1 4	Daily Half Hour	<1	Daily
Volatile Organic Compounds (VOCs)	20	One Hour	10 20	Daily Half Hour	3-10	Daily
Ammonia (NH_3)	5	24 hours	Not specified		2-10	Daily
Carbon Dioxide (CO_2)	Not Specified		Not specified		Not specified	
Nitrous Oxide (N_2O)	Not Specified		Not specified		Not specified	
Polycyclic Aromatic Hydrocarbons (PAHs)	Not specified		Not specified		Not specified	

6.2.2 Averaging Periods

As highlighted in Table 6-1, all the averaging periods of pollutants which have an emission limit value in the NSW EfW Policy which are one hour, with the exception of ammonia which has an averaging period of 24 hours.

Averaging periods stipulated in Annexe VI of the IED states a short term (half hourly) and longer term (daily) emissions limit value for the majority of the pollutants. Under the WI BAT Conclusions, where continuous monitoring is required, the averaging period is daily; where monitoring is not continuous (e.g. dioxins and furans) the average is taken over the sampling period.

It can be seen from Table 6-1 that a comparison of the emissions limits and AELs is difficult as the averaging periods are not the same under NSW EfW Policy compared to European legislation. A comparison is provided in Table 6-2, a key issue is that in all cases except ammonia, the NSW limit value is lower than or equal to the IED Chapter IV maximum ELVs – although these are for a shorter period than the NSW one hour average. The EPC technical provider will design the plant in line with the NSW EPA EfW limits and BAT.

In almost all cases the EU upper BAT-AEL daily average are lower than the NSW hourly averages.

Table 6-2: Comparison of NSW and EU emission limits

Pollutant	NSW ELV > IED Chapter IV, ½ hour ELV	NSW limit > upper BAT-AEL	Comment
Dust (PM)	N	Y	
Type 1 and 2 substances in aggregate	N	Same	Periodic measurement, equivalent averaging period. EU does not include Be
Mercury	N	Y	Periodic measurement, equivalent averaging period.
Cadmium & Thallium	N	Y	Periodic measurement, equivalent averaging period.
Dioxins & Furans	Same	Y	Periodic measurement, equivalent averaging period. NSW toxic equivalence factors lower for some congeners.
Sulphur Dioxide (SO_2)	N	Y	
Oxides of Nitrogen (NOx)	N	Y	
Carbon Monoxide (CO)	N	Y	
Hydrogen Chloride (HCl)	N	Y	
Hydrogen Fluoride (HF)	Same	Y	
Volatile Organic Compounds (VOCs)	Same	Y	
Ammonia (NH_3)	-	N	

The pollutants which are monitored continuously under European legislation have daily and half hourly limits (under IED Chapter IV), of which the half hourly maximum ('not to exceed') limits[17] can be considered comparable to the hourly limits under NSW policy. Hydrogen fluoride and volatile organic compounds both have the same limits when comparing NSW hourly limits to European half hourly limits. NSW hourly limits for carbon monoxide and hydrogen chloride are slightly less than the European half hourly limits, whilst there is a greater gap between the NSW and European limits on dust (particulate matter), oxides of nitrogen and sulphur dioxide, with NSW EfW Policy having more stringent limits on these pollutants.

6.2.3 Staffordshire ERF Reference Plant Analysis

Although many plants exhibit similar attributes, it is a requirement for this project that a reference plant closely resembling that of the proposed Woodlawn ARC be identified. The chosen reference plant for this project is the Staffordshire Energy Recovery Facility (ERF) in the UK.

It is important to note that EfW plants operating within a similar regulatory environment are designed using best available techniques to meet their own regulatory standards which are not aligned with the NSW EfW Policy standards as described above. This misalignment creates complexity when referencing a facility as the measurement of emission limit values under the NSW EfW Policy differ from that used in the IED. However, whilst not conclusive, the reference facility emissions data provided to-date, along with detailed measurement results from other technology providers on other EfW plants, identifies that the plant should be able to meet the NSW ELVs in normal operation.

Whilst the Staffordshire Energy Recovery Facility (ERF) in the UK (reference facility) is comparable in facility size (340,000tpa v 380,000tpa) and exhibits strong similarities to the proposed Woodlawn ARC in its selection of technologies that represent BAT, the scale of the proposed facility is considerably larger than that of the reference facility at around double the size based on a single line. Nevertheless, the adoption of Staffordshire ERF as the reference facility is still considered reasonable, as there exist a number of experienced grate manufacturers that are capable of providing similar technologies at a similar scale to Woodlawn ARC, and that align to the IED.

More information is provided within the BAT-C appraisal, but a summary of key points is noted here:

Table 6-3: Reference Plant Characteristics Applicable to Woodlawn ARC

Key Area	Commentary
Process design and control.	The plant will be controlled by a Distributed Control System (DCS) or Supervisory Control and Data Acquisition (SCADA) that take information from instrumentation plant wide. Control loops within the program monitor all the essential parameters and control the process in real time.
Emission control equipment design and control.	The emissions control equipment follows standard principles to ensure that reagent use is optimised. Monitoring of factors such as pressure drop across the fabric filter as well as feedback from the Continuous Emission Monitoring Systems (CEMS) are all important to reduce operational costs.
Emission monitoring with real-time feedback to the controls of the process.	The CEMS system continuously monitors the emissions leaving the stack and is a key indicator for the emissions control equipment. An example would be the direct link between ammonia injection for NOx control. The first element for control of NOx is the combustion control system which operates to make the combustion process as efficient as possible. However, the NOx levels will always need monitoring and additional control implemented. By monitoring the NOx level from the CEMS it can be identified if reagent needs to be added to reduce the NOx levels further and by monitoring other parameters can determine the optimal level of addition.
Arrangements for the receipt of waste.	The arrangements for the receipt of waste for the reference project have to be in line with Duty of Care requirements, ensuring that any received waste is clearly identified for what it is, who is the producer and where it is going.
Management of residues from the energy recovery process.	Residues from the FGT plant are treated as hazardous waste and much work has been carried out to identify whether these can be used in block manufacture as an example to achieve “End of Waste” status in the EU. Bottom ash is processed and supplied into the aggregates market as an inert material rather than disposed of as a waste. In Australia we understand that this market is yet undeveloped but has potential to recover this material in a similar way.

Table 4 4 - Comparison of Staffordshire ERF and Woodlawn ARC

			Unit	Staffordshire ERF			Woodlawn ARC	
Location				Four Ashes, Staffordshire, UK			Tarago, NSW, AUS	
Waste Capacity			Tonnes/year	340,000			380,000	
Year Constructed				2013			N/A	
Number of Lines				2			1	
Feedstock Mix			C&I:MSW	18:82			20:80	
				Line 1	**Line 2**	**Total**	**Line 1**	**Total**
Furnace		Waste Flow Rate at MCR	t/h	20.00	20.00	**40.00**	43.75	**43.75**
		NCV at MCR	kJ/kg	9,200	9,200		9,000	
		Thermal Capacity	MW	51.11	51.11	**102.20**	109.30	**109.30**
Boiler		Steam Type		Superheated	Superheated		Superheated	
		Steam Pressure	bar(a)	60	60		60	
		Steam Temperature	°C	400	400		425	
		Auxiliary Burner Fuel		Fuel Oil	Fuel Oil		Fuel Oil	

Table 5 4 - Comparison of Staffordshire ERF and Woodlawn ARC (continued)

			Unit	Staffordshire ERF			Woodlawn ARC	
Flue Gas Treatment	DeNOx	Type		SNCR	SNCR		SNCR	
		Reagent		25% Ammonia	25% Ammonia		25% Ammonia	
		Flue Gas Recirculation		No	No		To be defined during detailed design	
	De-acidification	Type		Dry	Dry		To be defined during detailed design	
		Reagent		CaOH2	CaOH2		CaOH2	
	DeDiox	Reagent		Activated Carbon	Activated Carbon		Activated Carbon	
	Filtration	Type		Fabric Filter	Fabric Filter		Fabric Filter	
Continuous Emission Monitoring		Number of Analysers		1	1	+ 1 Standby	1	+ 1 Standby
Turbo-generator		Number of Turbines		1			1	
	at MCR	Gross Power Output	MW	26.00		**26.00**	28.42	**28.42**
		Parasitic Load	MW	3.20		**3.20**	3.13	**3.13**
		Net Power Output	MW	22.80		**22.80**	25.29	**25.29**
		Gross Efficiency	%			**25.44**		**26.00**
		Net Efficiency	%			**22.30**		**23.14**

6.3 Technical Criteria

The tables below identify the Technical Criteria from the NSW EfW Policy and confirms whether the Staffordshire reference plant meets the requirements of the policy.

6.3.1 Plant Design and Operation

Table 6-6: Technical Criteria

Technical criteria:	Proposed Plant	Reference Plant
Meet 850°C for at least 2 seconds in the combustion chamber [equivalent to the European Waste Incineration Directive] or 1100°C for 2 seconds if the waste contains more than 1% of halogenated organic substances, expressed as chlorine.	The proposed plant has been selected to operate at 850°C for at least 2 seconds in the combustion chamber to meet this requirement.	The plant achieves this requirement.
Total organic carbon (TOC) or loss on ignition (LOI) content of the slag and bottom ashes must not be greater than 3% or 5% (dry weight) respectively.	The proposed plant will be including this as standard within its design.	Information has been provided (appended) demonstrating test results that confirm that this requirement is met by the reference plant.
Waste feed interlocks to prevent feeding when required temperature has not been reached.	The proposed plant will be including this as standard within its design.	This is a requirement of the regulations and is installed. This is a common requirement on Energy from Waste plants since the introduction of WID.

6.3.2 Emissions Standards and Monitoring

Table 6-7: Emission standards and monitoring

Technical criteria:	Proposed Plant	Reference Plant
Meet or exceed the “Emissions Standards for energy recovery facilities” (Table 1 within the NSW EfW Policy).	The requirements of the NSW EfW Policy are typically set at a higher figure though on the basis of an hourly average rather than a daily average. Through the general improvement of the control of the technology and more consistent operation, the proposed plant detailed design will be developed in order that the Woodlawn ARC will be able to achieve both the emissions limits stated in European Directive 2010/75/EU,	The plant operates to the requirements of the Waste Incineration Directive (WID), the forerunner of the Industrial Emissions Directive. A review of operations of this plant has identified that there would be transgressions above the emission levels required by the NSW EfW Policy, however it’s important to note the reference plant

Technical criteria:	Proposed Plant	Reference Plant
	the Industrial Emissions Directive and those set within the NSW EfW Policy, during steady state and normal operating conditions.	operates under a different licensing regime. A comparison of the ELV's within the NSW EPA and EU directive indicated that for the report period, there were only single exceedance events over NSW ELVs for both Sulphur dioxide and Oxides of Nitrogen. Within the same timeframe, the levels of Ammonia in the flue gas (commonly referred to as "Ammonia Slip" exhibited exceedances to NSW ELVs for 98 days for Line 1 and 123 days for Line 2. Since the installation of this plant there have been further design improvements to the standard system design with advanced control and monitoring systems constantly optimising ammonia dosing to meet the NOx emissions limits. Also the secondary air distribution which reduces significantly (i.e. up to 25%) the generated NOx. By incorporating such additional measures, the concentration levels of ammonia required to control NOx would be reduced. Whilst not installed at the reference plant, we would consider that the advances in control of emissions would ensure that any new facility building on the reference plant design would be able to achieve the required emission limits. Veolia UK is conducting works to implement this technology

Technical criteria:	Proposed Plant	Reference Plant
		by 2023 as required by BREF.
Continuous measurements of NOx, CO, particulates, total organic compounds, HCL, HF and SO2 and available in near real time to the EPA (if there is an online portal), plus combustion temperature, pressure and temperature in stack, oxygen concentration and water vapour in exhaust gas. Ammonia monitoring shall be continuous unless otherwise agreed with the EPA.	Continuous monitoring of the flue gas at the stack is concepted to be available within the DCS. Subject to providing a secure portal this data will be made available to the EPA.	Continuous monitoring of the flue gas by a CEMS system is in place.

6.3.3 Proof of Performance

Table 6-8: Proof of performance

Technical criteria:	Proposed Plant	Reference Plant
The EPA will require Operators to complete proof of performance (PO) testing to demonstrate compliance with air emissions standards. Proponents must provide a commissioning plan during the EPL application stage, detailing the POP emission testing that will be undertaken.	Relevant documentation is provided in Appendix H of the EIS[18] setting out the standard commissioning processes that demonstrate confidence in the onsite monitoring equipment to be installed.	The reference facility was legally required to ensure that all continuous emissions monitoring equipment at the stack was operating correctly prior to any combustion of waste in the process.

6.3.4 Air Emission Modelling Assessment

Table 6-9: Air emissions modelling assessment

Technical criteria:	Proposed Plant	Reference Plant
Air quality impact assessment must be undertaken in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.*	An Air Quality Impact Assessment has been carried out for the facility by the applicant.	A full air quality impact assessment in accordance with local requirements was undertaken for the facility.

[18] Woodlawn ARC Commissioning – Outline Plan

6.4 Thermal Efficiency Criteria

Table 6-10: Thermal efficiency criteria

Technical criteria:	Proposed Plant	Reference Plant
Plants that do not recover energy are outside the scope of the NSW EfW Policy.	Electricity is generated from the facility and therefore meets this requirement.	Not applicable.
At least 25% of energy will be captured as electricity (or an equivalent level of recovery for facilities generating heat alone).	The plant will be designed to achieve a minimum of 25% energy recovery to electricity or its equivalent in heat output	
Any heat must be demonstrated to be recovered as far as practicable.	The facility will be designed with potential for future heat offtake. There are no practicable offtake options at the current time.	The plant was designed with the potential to supply heat via a tapping on the steam turbine. No supply has to date been implemented.

6.5 Resource Recovery Criteria

Table 6-11: Resource Recovery Criteria

Technical criteria:	Proposed Plant	Reference Plant
Energy recovery facilities may receive feedstocks from waste processing facilities or collection systems that meet the criteria outlined in the NSW EfW Policy.	Waste for the Woodlawn ARC will be sourced from Councils within the Sydney Metropolitan area plus up to 20% C&I through Veolia's own transfer terminals at Clyde and Banksmeadow. Each Council's or commercial customer's waste collection system will be assessed for compliance with the NSW EfW Policy. This will determine the % of MSW and C&I waste that will be sent to the Woodlawn ARC[19]. The waste will be packed into containers marked for processing at the Woodlawn ARC and transported by rail to Woodlawn ARC via Veolia's Crisps Creek intermodal facility.	The reference plant sources the majority of its feedstock from residual waste from household collections where a local source collection scheme operates.

[19] In the event that the Council does not have separate collection systems for dry recyclables and FOGO then only a reduced percentage of that Council's waste can be treated by the Woodlawn ARC in accordance with the NSW EfW Policy

7. Assessment of Woodlawn ARC against the BAT Criteria

The IED specifies that a BAT-C review is considered to be a process whereby site-specific BAT is determined with reference to relevant BAT-C. A BAT-C document is defined in the IED as a document containing the parts of a BREF laying down the conclusions on best available techniques. In basic terms the BAT-C will describe the issues to be considered and the expected performance levels of an installation; it is then for the operator to demonstrate and ensure that the installation can meet these performance levels.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
BAT 1. In order to improve the overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS) that incorporates all of the following features: i. commitment, leadership and accountability of the management, including senior management, for the implementation of an effective EMS; ii. an analysis that includes the determination of the organisation's context, the identification of the needs and expectations of interested parties, the identification of characteristics of the installation that are associated with possible risks for the environment (or human health) as well as of the applicable legal requirements relating to the environment; iii. development of an environmental policy that includes the continuous improvement of the environmental performance of the installation; iv. establishing objectives and performance indicators in relation to significant environmental aspects, including safeguarding compliance with applicable legal requirements; v. planning and implementing the necessary procedures and actions (including corrective and preventive actions where needed), to achieve the environmental objectives and avoid environmental risks; vi. determination of structures, roles and responsibilities in relation to environmental aspects and objectives and provision of the financial and human resources needed; vii. ensuring the necessary competence and awareness of staff whose work may affect the environmental performance of the installation (e.g. by providing information and training); viii. internal and external communication; ix. fostering employee involvement in good environmental management practices; x. establishing and maintaining a management manual and written procedures to control activities with significant environmental impact as well as relevant records; xi. effective operational planning and process control;	YES	The Operator is experienced in the development and implementation of the necessary procedures under an Environmental Management System (EMS) and have already put in place systems with respect to other waste management facilities. The procedures to be put in place for the plant to implement the Environmental Policy will be developed as part of the ongoing review of the operations throughout the design and construction of the project. This will ensure that a robust and viable set of procedures can developed that are effective and achievable at an early stage. The operator will seek to implement a certified ISO14001 EMS for the plant as soon as practicable. The plant is being fully assessed through the Planning and Permitting process to identify areas in which there is potential for any environmental risks to be present and these have been identified for incorporation into the emergency planning for the site. In operation, the plant will be controlled by a DCS/SCADA based system that will allow monitoring of all systems ensuring effective and efficient operation of the plant. The system will provide for logging and monitoring of key process parameters that can be used to seek resolution to any issues that arise on the plant. The plant will employ a safety permitting scheme, ensuring that any operations and maintenance work is carried out in a

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
xii. implementation of appropriate maintenance programmes; xiii. emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations; xiv. when (re)designing a (new) installation or a part thereof, consideration of its environmental impacts throughout its life, which includes construction, maintenance, operation and decommissioning; xv. implementation of a monitoring and measurement programme; if necessary, information can be found in the Reference Report on Monitoring of Emissions to Air and Water from IED Installations; xvi. application of sectoral benchmarking on a regular basis; xvii. periodic independent (as far as practicable) internal auditing and periodic independent external auditing in order to assess the environmental performance and to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained; xviii. evaluation of causes of nonconformities, implementation of corrective actions in response to nonconformities, review of the effectiveness of corrective actions, and determination of whether similar nonconformities exist or could potentially occur; xix. periodic review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness; xx. following and taking into account the development of cleaner techniques. Specifically for incineration plants and, where relevant, bottom ash treatment plants, BAT is also to incorporate the following features in the EMS: xxi. for incineration plants, waste stream management (see BAT 9); xxii. for bottom ash treatment plants, output quality management (see BAT 10); xxiii. a residues management plan including measures aiming to: a. minimise the generation of residues; b. optimise the reuse, regeneration, recycling of, and/or energy recovery from the residues; c. ensure the proper disposal of residues; xxiv. for incineration plants, an OTNOC management plan (see BAT 18); xxv. for incineration plants, an accident management plan (see Section 5.2.4);		safe manner and that "safety from the system" can be achieved prior to any normal maintenance activity. Maintenance procedures will be put in place that will provide for condition monitoring and Planned Preventative Maintenance (PPM). In order to ensure that these, and other monitoring requirements are maintained, the Operator will be subject to a system of both Internal and External audits that will serve to identify any ways in which the EMS and other systems can be improved. The EMS will also incorporate procedures that relate to the monitoring of residues and fugitive emissions generated from the process as well as emissions to air and water, for example from bottom ash. These will be subject to appropriate plan documents that will be put in place as part of the EMS to ensure that adequate controls are present and applied to minimise any impact of the plant. With any facility, it is important that the decommissioning of the plant is covered within the construction phase, to ensure that the plant can be safely taken out of service at the end of its useful life. As such a Decommissioning Plan will be included, covering key aspects of work that will be required. Note that at this time this will be a high-level document in accordance with any local requirements.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
xxvi. for bottom ash treatment plants, diffuse dust emissions management (see BAT 23); xxvii. an odour management plan where an odour nuisance at sensitive receptors is expected and/or has been substantiated(see Section 5.2.4); xxviii. a noise management plan (see also BAT 37) where a noise nuisance at sensitive receptors is expected and/or has been substantiated (see Section 5.2.4). **Note** Regulation (EC) No 1221/2009 establishes the European Union eco-management and audit scheme (EMAS), which is an example of an EMS consistent with this BAT. **Applicability** The level of detail and the degree of formalisation of the EMS will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have (determined also by the type and the amount of waste processed).		
BAT 2. BAT is to determine either the gross electrical efficiency, the gross energy efficiency, or the boiler efficiency of the incineration plant as a whole or of all the relevant parts of the incineration plant. **Description** In the case of a new incineration plant or after each modification of an existing incineration plant that could significantly affect the energy efficiency, the gross electrical efficiency, the gross energy efficiency, or the boiler efficiency is determined by carrying out a performance test at full load. In the case of an existing incineration plant that has not carried out a performance test, or where a performance test at full load cannot be carried out for technical reasons, the gross electrical efficiency, the gross energy efficiency, or the boiler efficiency can be determined taking into account the design values at performance test conditions. For the performance test, no EN standard is available for the determination of the boiler efficiency of incineration plants. For grate-fired incineration plants, the FDBR guideline RL 7 may be used.	YES	The Plant will be combusting waste as a fuel and supplying it to a steam turbine to generate electricity. Whilst the operational efficiency of the plant will be monitored on a continuous basis through the DCS, a more accurate test would be required on a periodic basis to provide validation of the plants operating assumptions. This test would be carried out in compliance with the guidelines set out in FDBR Guideline RL7 and the resultant data would be used to evidence the plants status as a recovery facility under the R1 methodology.
BAT 3. BAT is to monitor key process parameters relevant for emissions to air and water including those given below.	YES	A Continuous Emissions Monitoring System (CEMS) will be installed on the plant located in the stack or flue gas ductwork.

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>
<table>
<tr><th>Stream/Location</th><th>Parameter(s)</th><th>Monitoring</th></tr>
<tr><td>Flue-gas from the incineration of waste</td><td>Flow, oxygen content, temperature, pressure, water vapour content</td><td>Continuous measurement</td></tr>
<tr><td>Combustion chamber</td><td>Temperature</td><td></td></tr>
<tr><td>Wastewater from wet FGC</td><td>Flow, pH, temperature</td><td></td></tr>
<tr><td>Wastewater from bottom ash treatment plants</td><td>Flow, pH,</td><td></td></tr>
</table>
</td><td></td><td>
Sensors within the ductwork will allow the measurement of pressure and temperature and flow rate will be monitored by a flow measurement device.
The parameters will be monitored through the DCS and should there be a significant variation alarms will be raised to alert the operator.
Any wastewater from the plant is normally stored for reuse within the plant and will be monitored for pH, temperature and production rate.
If there are any other residues, these will also be similarly monitored and treated prior to disposal.
</td></tr>
<tr><td>
BAT 4. BAT is to monitor channelled emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.
<table>
<tr><th>Substance/ Parameter</th><th>Process</th><th>Standard(s) (1)</th><th>Minimum monitoring frequency (2)</th><th>Monitoring associated with</th></tr>
<tr><td>NOx</td><td>Incineration of waste</td><td>Generic EN standards</td><td>Continuous</td><td>BAT 29</td></tr>
<tr><td>NH3</td><td>Incineration of waste when SNCR and/or SCR is used</td><td>Generic EN standards</td><td>Continuous</td><td>BAT 29</td></tr>
<tr><td>N2O</td><td>□ Incineration of waste in fluidised bed furnace
□ Incineration of waste when SNCR is operated with urea</td><td>EN 21258 (3)</td><td>Once every year</td><td>BAT 29</td></tr>
</table>
</td><td>
YES
(Exceeds and will be in line with NSW EfW Policy)
</td><td>
Channelled emissions to air relate to the release of emissions from the stack as the single point source emission from the plant.
There is potential for (fugitive) emission from other areas of the plant in the form of noise and dust, though these are subject to local controls as discussed elsewhere in this document.
Channelled emissions to air will be monitored through the use of an appropriately certified Continuous Emissions Monitoring System (CEMS) that will be installed in the stack or flue gas ductwork after all flue gas treatment operations.
This will provide for regular monitoring in accordance with the Industrial Emissions Directive (2010/75/EU) and the NSW EfW Policy. The latter also requires that N2O also be monitored on a continuous basis, unless otherwise agreed with the EPA.
In addition, there are some determinants that are to be monitored on a periodic basis and sampling ports to meet the requirements of the monitoring agency are to be installed on the plant. These include:-
Metals and metalloids except mercury (As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sb, Tl, V)[20]
</td></tr>
</table>

[20] Beryllium will also be monitored although it is not currently a requirement under the EU BREF

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments

CO	Incineration of waste	Generic EN standards	Continuous	BAT 29
SO2	Incineration of waste	Generic EN standards	Continuous	BAT 27
HCl	Incineration of waste	Generic EN standards	Continuous	BAT 27
HF	Incineration of waste	Generic EN standards	Continuous (4)	BAT 27
Dust	Bottom ash treatment	EN 13284-1	Once every year	BAT 26
	Incineration of waste	Generic EN standards and EN 13284-2	Continuous	BAT 25
Metals and metalloids except mercury (As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sb, Tl, V)	Incineration of waste	EN 14385	Once every six months	BAT 25
Hg	Incineration of waste	Generic EN standards and EN 14884	Continuous (5)	BAT 31
TVOC	Incineration of waste	Generic EN standards	Continuous	BAT 30
PBDD/F	Incineration of waste (6)	No EN standard available	Once every six months	BAT 30
PCDD/F	Incineration of waste	EN 1948-1, EN 1948-2, EN 1948-3	Once every six months for short-term sampling	BAT 30
		No EN standard available for long-term sampling, EN 1948-2, EN 1948-3	Once every month for long-term sampling (7)	BAT 30
Dioxin-like PCBs	Incineration of waste	EN 1948-1, EN 1948-2, EN 1948-4	Once every six months for short-term sampling (8)	BAT 30

- PBDD/F, PCDD/F and Dioxin like PCBs

Any sampling point needs to be in a location that can ensure that representative samples can be taken and that a stable gas flow condition has been achieved.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
<table><tr><td></td><td></td><td>No EN standard available for long-term sampling, EN 1948-2, EN 1948-4</td><td>Once every month for long-term sampling (7)(8)</td><td>BAT 30</td></tr><tr><td>Benzo[*a*]pyrene</td><td>Incineration of waste</td><td>No EN standard available</td><td>Once every year</td><td>BAT 30</td></tr></table>(1) Generic EN standards for continuous measurements are EN 15267-1, EN 15267-2, EN 15267-3 and EN 14181. EN standards for periodic measurements are given in the table or in the footnotes. (2) For periodic monitoring, the monitoring frequency does not apply where plant operation would be for the sole purpose of performing an emission measurement. (3) If continuous monitoring of N2O is applied, the generic EN standards for continuous measurements apply. (4) The continuous measurement of HF may be replaced by periodic measurements with a minimum frequency of once every six months if the HCl emission levels are proven to be sufficiently stable. No EN standard is available for the periodic measurement of HF. (5) For plants incinerating wastes with a proven low and stable mercury content (e.g. mono-streams of waste of a controlled composition), the continuous monitoring of emissions may be replaced by long-term sampling (no EN standard is available for long-term sampling of Hg [to check before publication if an EN standard has become available]) or periodic measurements with a minimum frequency of once every six months. In the latter case the relevant standard is EN 13211. (6) The monitoring only applies to the incineration of waste containing brominated flame retardants or to plants using BAT 31 d with continuous injection of bromine. (7) The monitoring does not apply if the emission levels are proven to be sufficiently stable. (8) The monitoring does not apply where the emissions of dioxin-like PCBs are proven to be less than 0.01 ng WHO-TEQ/Nm3.		
BAT 5. BAT is to appropriately monitor channelled emissions to air from the incineration plant during OTNOC. **Description** The monitoring can be carried out by direct emission measurements (e.g. for the pollutants that are monitored continuously) or by monitoring of surrogate parameters if this proves to be of equivalent or better scientific quality than direct emission measurements. Emissions during start-up and shutdown while no waste is being incinerated, including emissions of PCDD/F, are estimated based on measurement campaigns, e.g. every three years, carried out during planned start-up/shutdown operations.	YES	On start-up, the plant will initially be firing on fossil fuel (diesel or other). Only when the plant has been warmed sufficiently will waste fuel be introduced into the plant. Therefore, monitoring of the plant through CEMS will not be applied until the commencement of waste being introduced into the combustion chamber. Emissions during start up and shutdown will be estimated as the start-up conditions will not generally provide for adequately stable conditions for monitoring.

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>BAT 6. BAT is to monitor emissions to water from FGC and/or bottom ash treatment with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.
<table>
<tr><th>Substance/ Parameter</th><th>Process</th><th>Standard(s)</th><th>Minimum monitoring frequency</th><th>Monitoring associated with</th></tr>
<tr><td rowspan="2">Total organic carbon (TOC)</td><td>FGC</td><td rowspan="2">EN 1484</td><td>Once every month</td><td rowspan="17">BAT 34</td></tr>
<tr><td>Bottom ash treatment</td><td>Once every month (1)</td></tr>
<tr><td rowspan="2">Total suspended solids (TSS)</td><td>FGC</td><td rowspan="2">EN 872</td><td>Once every day (2)</td></tr>
<tr><td>Bottom ash treatment</td><td>Once every month (1)</td></tr>
<tr><td>As</td><td>FGC</td><td rowspan="11">Various EN standards available (e.g. EN ISO 11885, EN ISO 15586 or EN ISO 17294-2)</td><td rowspan="6">Once every month</td></tr>
<tr><td>Cd</td><td>FGC</td></tr>
<tr><td>Cr</td><td>FGC</td></tr>
<tr><td>Cu</td><td>FGC</td></tr>
<tr><td>Mo</td><td>FGC</td></tr>
<tr><td>Ni</td><td>FGC</td></tr>
<tr><td rowspan="2">Pb</td><td>FGC</td><td>Once every month</td></tr>
<tr><td>Bottom ash treatment</td><td>Once every month (1)</td></tr>
<tr><td>Sb</td><td>FGC</td><td rowspan="4">Once every month</td></tr>
<tr><td>Tl</td><td>FGC</td></tr>
<tr><td>Zn</td><td>FGC</td></tr>
<tr><td>Hg</td><td>FGC</td><td>Various EN standards available (e.g. EN ISO 12846 or EN ISO 17852)</td></tr>
</table>
</td><td>N/A</td><td>Wastewater from the processes on site will normally be reused within the site, for example bottom ash quenching, and therefore there are not currently anticipated to be any process releases from the site.

Should there be a requirement for wastewater to be released from site, it would be carried out in accordance with regulatory and license requirements.</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)					Compliant	Comments
Ammonium-nitrogen (NH_4-N)	Bottom ash treatment	Various EN standards available (e.g. EN ISO 11732, EN ISO 14911)	Once every month (1)			
Chloride (Cl^-)	Bottom ash treatment	Various EN standards available (e.g. EN ISO 10304-1, EN ISO 15682)				
Sulphate (SO_4^{2-})	Bottom ash treatment	EN ISO 10304-1				
PCDD/F	FGC	No EN standard available	Once every month (1)			
	Bottom ash treatment		Once every six months			
(1) The monitoring frequency may be at least once every six months if the emissions are proven to be sufficiently stable. (2) The daily 24-hour flow-proportional composite sampling measurements may be substituted by daily spot sample measurements.						

BAT 7. BAT is to monitor the content of unburnt substances in slags and bottom ashes at the incineration plant with at least the frequency given below and in accordance with EN standards.

Parameter	Standard(s)	Minimum Monitoring frequency	Monitoring associated with
Loss on ignition (1)	EN 14899 and either EN 15169 or EN 15935	Once every three months	BAT 14
Total organic carbon (1)(2)	EN 14899 and either EN 13137 or EN 15936		
(1) Either the loss on ignition or the total organic carbon is monitored			

Compliant: YES

Comments: As part of the EMS, the plant will implement monitoring procedures to review the quality of bottom ash produced.

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>(2) Elemental carbon (eg determined according to DIN 19539) may be subtracted from the measurement result</td><td></td><td></td></tr>
<tr><td>BAT 8. For the incineration of hazardous waste containing POPs, BAT is to determine the POP content in the output streams (e.g. slags and bottom ashes, flue-gas, waste water) after the commissioning of the incineration plant and after each change that may significantly affect the POP content in the output streams.

Description
The POP content in the output streams is determined by direct measurements or by indirect methods (e.g. the cumulated quantity of POPs in the fly ashes, dry FGC residues, waste water from FGC and related waste water treatment sludge may be determined by monitoring the POP contents in the flue-gas before and after the FGC system) or based on studies representative of the plant.

Applicability
Only applicable for plants that:
 incinerate hazardous waste with POP levels prior to incineration exceeding the concentration limits defined in Annex IV to Regulation (EC) No 850/2004 and amendments; and
 do not meet the process description specifications of Chapter IV.G.2 point (g) of the UNEP technical guidelines UNEP/CHW.13/6/Add.1/Rev.1.</td><td>N/A</td><td>The Plant is not going to be processing Hazardous wastes, and therefore this requirement is not applicable.</td></tr>
<tr><td>BAT 9. In order to improve the overall environmental performance of the incineration plant by waste stream management (see BAT 1), BAT is to use all of the techniques (a) to (c) given below, and, where relevant, also techniques (d), (e) and (f).

<table><tr><th></th><th>Technique</th><th>Description</th></tr><tr><td>(a)</td><td>Determination of the types of waste that can be incinerated</td><td>Based on the characteristics of the incineration plant, identification of the types of waste which can be incinerated in terms of, for example, the physical state, the chemical characteristics, the hazardous properties, and the acceptable ranges of calorific value, humidity, ash content and size.</td></tr><tr><td>(b)</td><td>Set-up and implementation of waste characterisation and pre-acceptance procedures</td><td>These procedures aim to ensure the technical (and legal) suitability of waste treatment operations for a particular waste prior to the arrival of the waste at the plant. They include procedures to collect information about the waste input and may include waste sampling and characterisation to achieve</td></tr></table></td><td>YES</td><td>Veolia's Clyde and Banksmeadow Transfer Terminals provide the first control point in an integrated system. The Transfer Terminals provide an opportunity to separate gross recyclables for recovery and to divert materials that are not suitable for energy recovery into the landfill stream. Waste acceptance and sorting procedures at both the transfer terminals will target recoverable materials and remove non-conforming waste, ensuring waste sent to energy recovery is both suitable and eligible.

The following processes at each Transfer Terminal will ensure that only conforming residual MSW and C&I waste is allocated as feedstock for the Woodlawn ARC:
The mass of waste received from each council and C&I source is weighed and recorded and an appropriate percentage, based on the respective</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)			Compliant	Comments
		sufficient knowledge of the waste composition. Waste pre-acceptance procedures are risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s).		council's level of source separation including the source separation of FOGO, is allocated to be treated by the Woodlawn ARC • The Transfer Terminals demonstrate genuine resource recovery and only residual MSW and C&I waste is designated as feedstock for the Woodlawn ARC. This process will segregate large bulky items such as mattresses, readily recyclable materials such as bricks and gas bottles. • Preparation of waste, containerisation and rail transport The proposed technology has been selected and designed for its ability to accept the waste feedstock and to combust it efficiently and cleanly within the process. The design of the grate is such that it will provide flexibility for the plant across a wide range of calorific value and particle size making it suitable for the proposed residual screened material. The sorting processes installed at the Transfer Terminals not only separate the valuable recyclable materials from the waste stream, they also ensure that the material being passed through to the Woodlawn ARC is of an appropriate quality for the combustion process. A second stage of feedstock quality control is undertaken at the Woodlawn ARC to ensure that non-conforming waste that may have been missed at the Transfer Terminals is removed from the incoming waste stream. Only authorised waste delivery vehicles transporting conforming waste will be granted access to the Woodlawn ARC and directed to deliver their load. Full containers from the Container Marshalling Area will be periodically offloaded into the Waste Bunker via the tipping platforms in the Tipping Hall throughout the day and night. Grapple crane operators will observe the waste from each load as it is deposited into the Waste Bunker via cameras or by visual inspection from the Control Room overlooking the Bunker. If at any point, non-conforming waste is identified within the Bunker, it will be removed using the waste crane grapples and deposited through the reloading hopper on the west of the Waste
(c)	Set-up and implementation of waste acceptance procedures	Acceptance procedures aim to confirm the characteristics of the waste, as identified at the pre-acceptance stage. These procedures define the elements to be verified upon the delivery of the waste at the plant as well as the waste acceptance and rejection criteria. They may include waste sampling, inspection and analysis. Waste acceptance procedures are risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s). The elements to be monitored for each type of waste are detailed in BAT 11.		
(d)	Set-up and implementation of a waste tracking system and inventory	A waste tracking system and inventory aims to track the location and quantity of waste in the plant. It holds all the information generated during waste pre-acceptance procedures (e.g. date of arrival at the plant and unique reference number of the waste, information on the previous waste holder(s), pre-acceptance and acceptance analysis results, nature and quantity of waste held on site including all identified hazards), acceptance, storage, treatment and/or transfer off site. The waste tracking system is risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s). The waste tracking system includes clear labelling of wastes that are stored in places other than the waste bunker or sludge storage tank (e.g. in containers, drums, bales or other forms of packaging) such that they can be identified at all times.		
(e)	Waste segregation	Wastes are kept separated depending on their properties in order to enable easier and environmentally safer storage and incineration. Waste segregation relies on the physical		

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>
<table>
<tr><td></td><td></td><td>separation of different wastes and on procedures that identify when and where wastes are stored.</td></tr>
<tr><td>(f)</td><td>Verification of waste compatibility prior to the mixing or blending of hazardous wastes</td><td>Compatibility is ensured by a set of verification measures and tests in order to detect any unwanted and/or potentially dangerous chemical reactions between wastes (e.g. polymerisation, gas evolution, exothermal reaction, decomposition) upon mixing or blending. The compatibility tests are risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s).</td></tr>
</table>
</td><td></td><td>Bunker, into a skip bin dedicated for this purpose. When the skip bin is filled, the non-conforming waste will be further sorted into the following streams:
Waste suitable for the Bioreactor Landfill will be directed to the Landfill via its dedicated weighbridge
Waste not suitable for the Bioreactor Landfill will be directed for further processing at another suitably licenced facility
If a container that was identified as containing non-conforming waste by one of the Transfer Terminals is deposited into the Waste Bunker, further waste will be prevented from being tipped into the immediate area by temporarily closing the Tipping Platform until the non-conforming waste is removed using the above method.

As the material being received at the plant is all of the same specification, there is no need for specific segregation of material and once deposited in the bunker it will become mixed and blended with other material already in place. This ensures a homogenous mix of material for feed into the combustion, aiding the plant’s ability to maintain stable combustion conditions.</td></tr>
<tr><td>BAT 10. In order to improve the overall environmental performance of the bottom ash treatment plant, BAT is to include output quality management features in the EMS (see BAT 1).

Description

Output quality management features are included in the EMS, so as to ensure that the output of the bottom ash treatment is in line with expectations, using existing EN standards where available. This also allows the performance of the bottom ash treatment to be monitored and optimised.</td><td>YES</td><td>The bottom ash from the Woodlawn ARC will be transported by enclosed conveyor to the IBA processing and maturation area. Within this area ferrous and non-ferrous metals will be removed from the IBA prior to its being deposited into an appropriate area of the storage all for maturation.

IBA will be regularly sampled to ensure that the performance of the Woodlawn ARC is maintained and that following maturation it meets the appropriate standards prior to being landfilled in the adjacent site.

The bottom ash will be monitored in order to ensure that the necessary requirements (BAT 7) are met prior to its transport to the Woodlawn Bioreactor. The intention is to reuse as daily cover or other beneficial reuse either on site or by the construction industry as a replacement for virgin material.</td></tr>
</table>

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>
BAT 11. In order to improve the overall environmental performance of the incineration plant, BAT is to monitor the waste deliveries as part of the waste acceptance procedures (see BAT 9 c) including, depending on the risk posed by the incoming waste, the elements given below.
<table>
<tr><th>Waste type</th><th>Waste delivery monitoring</th></tr>
<tr><td>Municipal solid waste and other non-hazardous waste</td><td>☐ Radioactivity detection
☐ Weighing of the waste deliveries
☐ Visual inspection
☐ Periodic sampling of waste deliveries and analysis of key properties/substances (e.g. calorific value, content of halogens and metals/metalloids). For municipal solid waste, this involves separate unloading.</td></tr>
<tr><td>Sewage sludge</td><td>☐ Weighing of the waste deliveries (or measuring the flow if the sewage sludge is delivered via pipeline)
☐ Visual inspection, as far as technically possible
☐ Periodic sampling and analysis of key properties/substances (e.g. calorific value, content of water, ash and mercury)</td></tr>
<tr><td>Hazardous waste other than clinical waste</td><td>☐ Radioactivity detection
☐ Weighing of the waste deliveries
☐ Visual inspection, as far as technically possible
☐ Control and comparison of individual waste deliveries with the declaration of the waste producer
☐ Sampling of the content of:
    ☐ all bulk tankers and trailers
    ☐ packed waste (e.g. in drums, intermediate bulk containers (IBCs) or smaller packaging)
☐ and analysis of:
    ☐ combustion parameters (including calorific value and flashpoint)
    ☐ waste compatibility, to detect possible hazardous reactions upon blending or mixing of wastes, prior to storage (BAT 9 f)</td></tr>
</table>
</td><td>YES</td><td>
The plant will only be receiving fuel that has been pre-selected from non-hazardous waste streams. Therefore, only the first category of this section is relevant to this project.

Please see BAT 9 above also.

The feedstock for the Woodlawn ARC will be delivered from Veolia’s transfer terminal in Sydney, at Clyde and Banksmeadow via the Crisps Creek Intermodal Facility.

Delivery to the waste storage bunker will be via trucks into the site from the Crisps Creek Intermodal Facility (IMF)

Feedstock will be tipped or deposited into the waste bunker for mixing and blending in the bunker to allow for a well-mixed homogeneous fuel to be supplied into the combustion process.

Vehicles will be weighed via weighbridge both in and out of the site to allow the delivered waste to be quantified and logged.

Random visual inspections will be carried out to determine whether there are any noncompliant items within the feedstock, or for loads where a problem may be apparent such as large items, or serious issues such as a potential hot load (i.e. visible signs of smouldering).
</td></tr>
</table>

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>
<table>
<tr><td></td><td>key substances including POPs, halogens and sulphur, metals/metalloids</td></tr>
<tr><td>Clinical waste</td><td>Radioactivity detection
Weighing of the waste deliveries
Visual inspection of the packaging integrity</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>
BAT 12. In order to reduce the environmental risks associated with the reception, handling and storage of waste, BAT is to use both of the techniques given below.
<table>
<tr><th></th><th>Technique</th><th>Description</th></tr>
<tr><td>a.</td><td>Impermeable surfaces with an adequate drainage infrastructure</td><td>Depending on the risks posed by the waste in terms of soil or water contamination, the surface of the waste reception, handling and storage areas is made impermeable to the liquids concerned and fitted with an adequate drainage infrastructure (see BAT 32). The integrity of this surface is periodically verified, as far as technically possible.</td></tr>
<tr><td>b.</td><td>Adequate waste storage capacity</td><td>Measures are taken to avoid accumulation of waste, such as:
the maximum waste storage capacity is clearly established and not exceeded, taking into account the characteristics of the wastes (e.g. regarding the risk of fire) and the treatment capacity;
the quantity of waste stored is regularly monitored against the maximum allowed storage capacity;
for wastes that are not mixed during storage (e.g. clinical waste, packed waste), the maximum residence time is clearly established.</td></tr>
</table>
</td><td>YES</td><td>Use of a concrete storage bunker is common practice throughout the vast majority of EfW plants worldwide and provides a sealed unit that prevents leachate from the fuel seeping into the local environment. It also means that, in the cases where the bunker extends below surrounding ground levels, groundwater cannot ingress into the fuel causing combustion or environmental problems.

The bunker area is fully enclosed to prevent wind-blown litter and dust emissions from the site and any liquid in the bunker can be extracted and treated.

The bunker will have a normal operating capacity of 4 days, which is based on the requirement to continuously operate through periods when no deliveries are being accepted at the plant. At this level there is little risk of spontaneous combustion of the stockpile. For the majority of the time the storage bunker will not be full (perhaps operating around 50% capacity) and the operators will make reasonable efforts to process “older” fuel feedstock first.

The plant operator would liaise with the logistics provider suppliers to control deliveries as set out in the Operation and Maintenance plan which would be developed during the plant design and construction phase.

The waste bunker represents the area with most potential fire risk. With that in mind a comprehensive fire detection system</td></tr>
</table>

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td></td><td></td><td>will be installed together with appropriate fire protection systems to meet insurer and fire department requirements.

The waste bunker will be constructed as a watertight structure, to prevent ingress of groundwater, but will also serve to contain any “spent” firewater from a bunker fire that can subsequently be pumped out and treated at an appropriate facility.</td></tr>
<tr><td>BAT 13. In order to reduce the environmental risk associated with the storage and handling of clinical waste, BAT is to use a combination of the techniques given below.
<table>
<tr><th></th><th>Technique</th><th>Description</th></tr>
<tr><td>a.</td><td>Automated or semi-automated waste handling</td><td>Clinical wastes are unloaded from the truck to the storage area using an automated or manual system depending on the risk posed by this operation. From the storage area the clinical wastes are fed into the furnace by an automated feeding system.</td></tr>
<tr><td>b.</td><td>Incineration of non-reusable sealed containers, if used</td><td>Clinical waste is delivered in sealed and robust combustible containers that are never opened throughout storage and handling operations. If needles and sharps are disposed of in them, the containers are puncture-proof as well.</td></tr>
<tr><td>c.</td><td>Cleaning and disinfection of reusable containers, if used</td><td>Reusable waste containers are cleaned in a designated cleaning area and disinfected in a facility specifically designed for disinfection. Any leftovers from the cleaning operations are incinerated.</td></tr>
</table></td><td>N/A</td><td>This does not apply as the Woodlawn ARC will not be accepting or processing any Clinical Waste.</td></tr>
<tr><td>BAT 14. In order to improve the overall environmental performance of the incineration of waste, to reduce the content of unburnt substances in slags and bottom ashes, and to reduce emissions to air from the incineration of waste, BAT is to use an appropriate combination of the techniques given below.
<table>
<tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr>
</table></td><td>YES</td><td>The use of a residual MSW and C&I waste introduces the potential for a degree of variability within the feedstock supplied to the plant. The variability arises for a number of reasons, including different demographics between collection areas on a short-term basis and seasonality that can relate to slower changes in composition. However, the fluctuations in quality arise, mixing and blending operations with the bunker</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
(continued, see tables below)		cranes remain a crucial part of the process to ensure good operation of the plant. When delivered and tipped into the bunker much of the waste will have been compacted in the delivery container. In order to de-compact it and store it efficiently within the bunker the cranes will move the material and drop it into selected areas of the bunker for storage, ensuring that the tipping area remains clear for other deliveries. In the process, any bulky or unsuitable large items that may be spotted by the crane operator can be removed. The design of the plant will ensure that 2 cranes are available to operate under normal conditions. This allows for sufficient time to both feed the process and to continually move material around the bunker, mixing it with other delivered waste and therefore ensuring a more consistent feed to the combustion process. The combustion control system incorporated as part of the DCS also provides for online adjustment of primary and secondary combustion air flows and fuel feed-rate to ensure that the combustion process is optimised.

a.	Waste blending and mixing	Waste blending and mixing prior to incineration includes for example the following operations: □ bunker crane mixing; □ using a feed equalisation system; □ blending of compatible liquid and pasty wastes. In some cases, solid wastes are shredded prior to mixing.	Not applicable where direct furnace feeding is required due to safety considerations or waste characteristics (e.g. infectious clinical waste, odorous wastes, or wastes that are prone to releasing volatile substances). Not applicable where undesired reactions may occur between different types of waste (see BAT 9 f).
b.	Advanced control system	See Section 5.2.1	Generally applicable.
c.	Optimisation of the incineration process	See Section 5.2.1	Optimisation of the design is not applicable to existing furnaces.

Table 1: BAT-associated environmental performance levels for unburnt substances in slags and bottom ashes from the incineration of waste

Parameter	Unit	BAT-AEPL
TOC content in slags and bottom ashes (1)	Dry wt-%	1–3 (2)
Loss on ignition of slags and bottom ashes (1)	Dry wt-%	1–5 (2)
(1) Either the BAT-AEPL for TOC content or the BAT-AEPL for the loss on ignition applies. (2) The lower end of the BAT-AEPL range can be achieved when using fluidised bed furnaces or rotary kilns operated in slagging mode.		

The associated monitoring is in BAT 7.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
BAT 15. In order to improve the overall environmental performance of the incineration plant and to reduce emissions to air, BAT is to set up and implement procedures for the adjustment		The plant will be controlled via a Distributed Control System (DCS). This allows for the operators to monitor and control all

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
of the plant's settings, e.g. through the advanced control system (see description in Section 5.2.1), as and when needed and practicable, based on the characterisation and control of the waste (see BAT 11).	YES	aspects of the process from the control room. It will incorporate various automatic control set points for the process that will allow the DCS to monitor and adjust key parameters such that the overall process efficiency is maintained. The advanced combustion and emissions control systems are key components to control the efficiency of the process as well as emissions and will be integrated within the DCS and therefore meets this requirement.
BAT 16. In order to improve the overall environmental performance of the incineration plant and to reduce emissions to air, BAT is to set up and implement operational procedures (e.g. organisation of the supply chain, continuous rather than BAT-Ch operation) to limit as far as practicable shutdown and start-up operations.	YES	In order to ensure optimal control and therefore environmental performance the core principle for the plant, and similarly other facilities of this type, is to operate as "base load", i.e. to be operating continuously at its design point except for periods of planned maintenance. The plant also needs to have a consistent fuel supply, and the plant will maintain strong links with its fuel supply chain, as much as to ensure a consistent quality and regularity of supply. By incorporating a 4 days storage bunker the plant can continue operating even over some days of breakdown of the supply chain, allowing any issues arising to be managed without unnecessary outages.
BAT 17. In order to reduce emissions to air and, where relevant, to water from the incineration plant, BAT is to ensure that the FGC system and the wastewater treatment plant are appropriately designed (e.g. considering the maximum flow rate and pollutant concentrations), operated within their design range, and maintained so as to ensure optimal availability.	YES	At this stage of the design the techniques proposed to control emissions are broadly categorised into two key areas: • Control of NOx • Absorption of Pollutants The selection of these technologies as described here do not require waste water treatment as a "Dry" or "Semi-dry" FGT system is proposed rather than 'Wet' scrubbing systems which have several processing stages. The control of NOx applies through both primary and secondary measures. Primary measures relate to the prevention of NOx generation through the combustion process and the plant will be fitted with a combustion control system that allows the air flows to be monitored to ensure efficient combustion. As part of this system, techniques such as Flue Gas Recirculation, where a proportion of the flue gas is

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
		recirculated back into the combustion system will be determined by the selected contractor at the detailed design stage. Secondary measures for this plant relate to the application of a Selective Non-Catalytic Reaction (SNCR) system. The SNCR process entails urea or ammonia injection in the upper part of the combustion chamber of the furnace where gasses are at a temperature of 850-950°C. These temperatures are optimal for the reaction with nitrogen oxide (NO) and nitrous oxide (N_2O). Multiple levels of injection ports will be present as, dependent on the load conditions of the boiler, the optimal temperature ranges may be experienced at different levels in the boiler. Pyrometers will be therefore be used to monitor conditions and direct the reagent to the appropriate injectors.
BAT 18. In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions to air and, where relevant, to water from the incineration plant during OTNOC, BAT is to set up and implement a risk-based OTNOC management plan as part of the environmental management system (see BAT 1) that includes all of the following elements: identification of potential OTNOC (e.g. failure of equipment critical to the protection of the environment ('critical equipment')), of their root causes and of their potential consequences, and regular review and update of the list of identified OTNOC following the periodic assessment below; appropriate design of critical equipment (e.g. compartmentalisation of the bag filter, techniques to heat up the flue-gas and obviate the need to bypass the bag filter during start-up and shutdown, etc.); set-up and implementation of a preventive maintenance plan for critical equipment (see BAT 1 xii); monitoring and recording of emissions during OTNOC and associated circumstances (see BAT 5); periodic assessment of the emissions occurring during OTNOC (e.g. frequency of events, duration, amount of pollutants emitted) and implementation of corrective actions if necessary.	YES	As part of the design process critical failure items will be identified and, where appropriate, redundancy included within the design with a target availability in excess of 85%. By ensuring that the plant is maintained effectively with routine maintenance being scheduled and planned, the plant can operate at its optimum and ensure that there are limited opportunities for OTNOC to apply. In order to achieve this, planned maintenance procedures will be in place to coordinate and control the maintenance of the plant. By controlling and monitoring the plant through the DCS, many situations can be identified early and a shutdown of the plant avoided. A key component of the design is to ensure that the plant operates to achieve the required post combustion residence requirements of 850°C for 2 seconds. Should the DCS (or operator) identify that the operating temperatures are dropping, then the auxiliary start up burners will be initiated to keep the plant operating at its required temperatures. Should power to the site be lost for any reason, an emergency /standby generator will start to provide sufficient power that the site can shut down in a controlled fashion. This is an inherent

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td></td><td></td><td>part of the design and will ensure that the plants emissions are kept to a minimum.

Other than transient operations (start-up / shutdown) where the CEMS is unable to provide accurate monitoring, the CEMS system will be operational and will ensure that the emissions to air are monitored in accordance with the requirements of the EPA.</td></tr>
<tr><td>BAT 19. In order to increase the resource efficiency of the incineration plant, BAT is to use a heat recovery boiler.

Description

The energy contained in the flue-gas is recovered in a heat recovery boiler producing hot water and/or steam, which may be exported, used internally, and/or used to produce electricity.

Applicability

In the case of plants dedicated to the incineration of hazardous waste, the applicability may be limited by:

 the stickiness of the fly ashes;

 the corrosiveness of the flue-gas.</td><td>YES</td><td>The plant will combust the fuel in an efficient process and will recover energy in the form of steam through a boiler. This steam will be supplied to a steam turbine to generate electricity which, except for some auxiliary supplies for the site, will be exported to the local distribution network.

Steam conditions from the boiler will be at high pressure conditions commensurate with other Energy from Waste facilities. These are selected in order to maintain the conditions within the boiler to a level at which fouling and corrosion of the boiler can be minimised providing for economic operation.</td></tr>
<tr><td>BAT 20. In order to increase the energy efficiency of the incineration plant, BAT is to use an appropriate combination of the techniques given below.

<table><tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>a.</td><td>Drying of sewage sludge</td><td>After mechanical dewatering, sewage sludge is further dried, using for example low-grade heat, before it is fed to the furnace.
The extent to which sludge can be dried depends on the furnace feeding system.</td><td>Applicable within the constraints associated with the availability of low-grade heat.</td></tr></table></td><td>YES</td><td>The Woodlawn ARC will use a variety of techniques in order to maintain high levels of energy efficiency.

As is the norm for these plants, the entire combustion system and boiler will be well insulated and incorporate the use of heat recovery tubes in the membrane walls of the combustion chamber and immediately adjacent gas path.

Combustion air is carefully controlled through the control system to maintain optimum combustion conditions and defines the amount of draught required.

The boiler will incorporate a number of tube bundles as part of the heat recovery system, including evaporator, superheater and economiser tubing sections and these will be positioned to ensure that good quality steam can be produced at the same time as ensuring a rapid temperature drop of the flue</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)				Compliant	Comments
b.	Reduction of the flue-gas flow	The flue-gas flow is reduced through, e.g.: □ improving the primary and secondary combustion air distribution; □ flue-gas recirculation (see Section 5.2.2). A smaller flue-gas flow reduces the energy demand of the plant (e.g. for induced draught fans).	For existing plants, the applicability of flue-gas recirculation may be limited due to technical constraints (e.g. pollutant load in the flue-gas, incineration conditions).		gas through critical temperature bands to prevent the reformation of dioxins furans via deNovo Synthesis. The steam conditions have been selected to match the performance requirements of the steam turbine to ensure optimum conversion of energy to electricity. The potential use of heat exchangers beyond the economiser within the system, e.g. after the FGT system, is restricted in many plants as the flue gas temperature at the exhaust of the stack needs to have sufficient temperature to encourage plume buoyancy and dispersion of the flue gas. In addition, the opportunity for recovering this heat into the cycle remains very low as other sources of waste heat are already utilised in order to preheat combustion air, for example. This is carried out by using the cooling system of the grate to preheat air and, in some circumstances, feed water. As a closed loop circuit, i.e. the steam is condensed and returned to the boiler to generate steam again, there is very little makeup water to the process and subsequently few opportunities to preheat the raw water. However, heat recovery is prioritised in order to improve the efficiency of the overall process and to ensure that the plant is classified as an R1 recovery facility (R1 efficiency = 0.65).
c.	Minimisation of heat losses	Heat losses are minimised through, e.g.: □ use of integral furnace-boilers, allowing for heat to also be recovered from the furnace sides; □ thermal insulation of furnaces and boilers; □ flue-gas recirculation (see Section 5.2.2); □ recovery of heat from the cooling of slags and bottom ashes (see BAT 20 i).	Integral furnace-boilers are not applicable to rotary kilns or to other furnaces dedicated to the high-temperature incineration of hazardous waste.		
d.	Optimisation of the boiler design	The heat transfer in the boiler is improved by optimising, for example, the: □ flue-gas velocity and distribution; □ water/steam circulation; □ convection bundles; □ on-line and off-line boiler cleaning systems in order to minimise the fouling of the convection bundles.	Applicable to new plants and to major retrofits of existing plants.		
e.	Low-temperature flue-gas heat exchangers	Special corrosion-resistant heat exchangers are used to recover additional energy from the flue-gas at the boiler exit, after an ESP, or after a dry sorbent injection system.	Applicable within the constraints of the operating temperature profile of the FGC system. In the case of existing plants, the applicability may be limited by a lack of space.		

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)				Compliant	Comments
f.	High steam conditions	The higher the steam conditions (temperature and pressure), the higher the electricity conversion efficiency allowed by the steam cycle. Working at high steam conditions (e.g. above 45 bar, 400 °C) requires the use of special steel alloys or refractory cladding to protect the boiler sections that are exposed to the highest temperatures.	Applicable to new plants and to major retrofits of existing plants, where the plant is mainly oriented towards the generation of electricity. The applicability may be limited by: the stickiness of the fly ashes; the corrosiveness of the flue-gas.		
g.	Cogeneration	Cogeneration of heat and electricity where the heat (mainly from the steam that leaves the turbine) is used for producing hot water/steam to be used in industrial processes/activities or in a district heating/cooling network.	Applicable within the constraints associated with the local heat and power demand and/or availability of networks.		
h.	Flue-gas condenser	A heat exchanger or a scrubber with a heat exchanger, where the water vapour contained in the flue-gas condenses, transferring the latent heat to water at a sufficiently low temperature (e.g. return flow of a district heating network). The flue-gas condenser also provides co-benefits by reducing emissions to air (e.g. of dust and acid gases). The use of heat pumps can increase the amount of energy recovered from flue-gas condensation.	Applicable within the constraints associated with the demand for low-temperature heat, e.g. by the availability of a district heating network with a sufficiently low return temperature.		
i.	Dry bottom ash handling	Dry, hot bottom ash falls from the grate onto a transport system and is cooled down by ambient air. Energy is recovered by using the cooling air for combustion.	Only applicable to grate furnaces. There may be technical restrictions that prevent retrofitting to existing furnaces.		

Table 2: BAT-associated energy efficiency levels (BAT-AEELs) for the incineration of waste

BAT-AEEL (%)

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>

Plant	Municipal solid waste, other non-hazardous waste and hazardous wood waste		Hazardous waste other than hazardous wood waste (1)	Sewage sludge
	Gross electrical efficiency (2) (3)	Gross energy efficiency (4)	Boiler efficiency	
New plant	25–35	72–91 (5)	60–80	60–70 (6)
Existing plant	20–35			

(1) The BAT-AEEL only applies where a heat recovery boiler is applicable.
(2) The BAT-AEELs for gross electrical efficiency only apply to plants or parts of plants producing electricity using a condensing turbine.
(3) The higher end of the BAT-AEEL range can be achieved when using BAT 20 f.
(4) The BAT-AEELs for gross energy efficiency only apply to plants or parts of plants producing only heat or producing electricity using a back-pressure turbine and heat with the steam leaving the turbine.
(5) A gross energy efficiency exceeding the higher end of the BAT-AEEL range (even above 100 %) can be achieved where a flue-gas condenser is used.
(6) For the incineration of sewage sludge, the boiler efficiency is highly dependent on the water content of the sewage sludge as fed into the furnace.
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<tr><td>

BAT 21. In order to prevent or reduce diffuse emissions from the incineration plant, including odour emissions, BAT is to:

- store solid and bulk pasty wastes that are odorous and/or prone to releasing volatile substances in enclosed buildings under controlled sub-atmospheric pressure and use the extracted air as combustion air for incineration or send it to another suitable abatement system in the case of a risk of explosion;
- store liquid wastes in tanks under appropriate controlled pressure and duct the tank vents to the combustion air feed or to another suitable abatement system;
- control the risk of odour during complete shutdown periods when no incineration capacity is available, e.g. by:
</td><td>YES</td><td>As part of good practice on any waste fuel, when the Woodlawn ARC is operational air for combustion will be drawn from the area above the waste bunker, bringing that area of the building under a slight negative pressure and therefore reducing the potential for release of dusts as well as any residual odour. Limiting the openings into the building through door management procedures also improves this control.

Material in the bunker will be processed in reasonable time frames from receipt and therefore will not be allowed to remain in the bunker for long periods of time that might increase their potential to emit odorous compounds.</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
• sending the vented or extracted air to an alternative abatement system, e.g. a wet scrubber, a fixed adsorption bed; • minimising the amount of waste in storage, e.g. by interrupting, reducing or transferring waste deliveries, as a part of waste stream management (see BAT 9); • storing waste in properly sealed bales		
BAT 22. In order to prevent diffuse emissions of volatile compounds from the handling of gaseous and liquid wastes that are odorous and/or prone to releasing volatile substances at incineration plants, BAT is to introduce them into the furnace by direct feeding. **Description** For gaseous and liquid wastes delivered in bulk waste containers (e.g. tankers), direct feeding is carried out by connecting the waste container to the furnace feeding line. The container is then emptied by pressurising it with nitrogen or, if the viscosity is low enough, by pumping the liquid. For gaseous and liquid wastes delivered in waste containers suitable for incineration (e.g. drums), direct feeding is carried out by introducing the containers directly in the furnace. **Applicability** May not be applicable to the incineration of sewage sludge depending, for example, on the water content and on the need for pre-drying or mixing with other wastes.	N/A	Not applicable – The plant will only be accepting solid fuels or similar materials into the process.
BAT 23. In order to prevent or reduce diffuse dust emissions to air from the treatment of slags and bottom ashes, BAT is to include in the environmental management system (see BAT 1) the following diffuse dust emissions management features: **identification of the most relevant diffuse dust emission sources (e.g. using EN 15445);** **definition and implementation of appropriate actions and techniques to prevent or reduce diffuse emissions over a given time frame.**	YES	The IBA from the process will be transferred by enclosed conveyor to the IBA area which includes a building for screening and recovery. Within this building screening and metals recovery operations will take place with localised dust capture where required. The Environmental Management System developed for the site will carry out an assessment into the relevant dust emission sources and identify control measures for the prevention and/or reduction of dust emissions.

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>
BAT 24. In order to prevent or reduce diffuse dust emissions to air from the treatment of slags and bottom ashes, BAT is to use an appropriate combination of the techniques given below.
<table>
<tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Enclose and cover equipment</td><td>Enclose/encapsulate potentially dusty operations (such as grinding, screening) and/or cover conveyors and elevators.
Enclosure can also be accomplished by installing all of the equipment in a closed building.</td><td>Installing the equipment in a closed building may not be applicable to mobile treatment devices.</td></tr>
<tr><td>b.</td><td>Limit height of discharge</td><td>Match the discharge height to the varying height of the heap, automatically if possible (e.g. conveyor belts with adjustable heights).</td><td>Generally applicable.</td></tr>
<tr><td>c.</td><td>Protect stockpiles against prevailing winds</td><td>Protect bulk storage areas or stockpiles with covers or wind barriers such as screening, walling or vertical greenery, as well as correctly orienting the stockpiles in relation to the prevailing wind.</td><td>Generally applicable.</td></tr>
<tr><td>d.</td><td>Use water sprays</td><td>Install water spray systems at the main sources of diffuse dust emissions. The humidification of dust particles aids dust agglomeration and settling.
Diffuse dust emissions at stockpiles are reduced by ensuring appropriate humidification of the charging and discharging points, or of the stockpiles themselves.</td><td>Generally applicable.</td></tr>
<tr><td>e.</td><td>Optimise moisture content</td><td>Optimise the moisture content of the slags/bottom ashes to the level required for efficient recovery of metals and mineral materials while minimising the dust release.</td><td>Generally applicable.</td></tr>
<tr><td>f.</td><td>Operate under subatmospheric pressure</td><td>Carry out the treatment of slags and bottom ashes in enclosed equipment or buildings (see technique a) under subatmospheric pressure to enable treatment of the extracted air with an</td><td>Only applicable to dry-discharged and other low-moisture bottom ashes.</td></tr>
</table>
</td><td>YES</td><td>
Bottom ash will be transported by enclosed conveyor to the IBA area where any screening operations will take place within a three-sided enclosure.

Conveyor discharge heights into storage piles will be limited to that required for access by transfer vehicles or safe passage of loading shovels.

Whilst the maturation pad is an open area, the site has been selected to provide good shelter from the prevailing winds.

The EMS will consider the use of water spray systems where any operation with potential to generate high dust levels is anticipated, and to maintain appropriate levels of moisture within the stockpiles. A wheel wash will also be provided to reduce any vehicle-borne material.

The screening process is generally completed prior to maturation and storage and is therefore carried out on IBA that is of a moderate moisture content. Dust levels are therefore anticipated to be minimal, though as stated previously localised controls will be used where the site EMS has identified it as necessary.
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<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>
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<tr><td></td><td></td><td>abatement technique (see BAT 26) as channelled emissions.</td><td></td></tr>
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</td><td></td><td></td></tr>
<tr><td>
BAT 25. In order to reduce channelled emissions to air of dust, metals and metalloids from the incineration of waste, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Bag filter</td><td>See Section 5.2.2</td><td>Generally applicable to new plants. Applicable to existing plants within the constraints associated with the operating temperature profile of the FGC system.</td></tr>
<tr><td>b.</td><td>Electrostatic precipitator</td><td>See Section 5.2.2</td><td>Generally applicable.</td></tr>
<tr><td>c.</td><td>Dry sorbent injection</td><td>See Section 5.2.2.
Not relevant for the reduction of dust emissions.
Adsorption of metals by injection of activated carbon or other reagents in combination with a dry sorbent injection system or a semi-wet absorber that is used to reduce acid gas emissions.</td><td>Generally applicable.</td></tr>
<tr><td>d.</td><td>Wet scrubber</td><td>See Section 5.2.2.
Wet scrubbing systems are not used to remove the main dust load but, installed after other abatement techniques, to further reduce the concentrations of dust, metals and metalloids in the flue-gas.</td><td>There may be applicability restrictions due to low water availability, e.g. in arid areas.</td></tr>
<tr><td>e.</td><td>Fixed- or moving-bed adsorption</td><td>See Section 5.2.2.
The system is used mainly to adsorb mercury and other metals and metalloids as well as organic compounds including PCDD/F, but</td><td>The applicability may be limited by the overall pressure drop associated with the FGC system configuration.</td></tr>
</table>
</td><td>YES</td><td>A semi-dry system will be used that allows for the injection of hydrated lime and activated carbon for the control of acid gases and dioxins, mercury and other heavy metals respectively.

This will be separated from the gas steam by means of a bag filter.</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
(continued) Technique row: also acts as an effective polishing filter for dust. — Applicability: In the case of existing plants, the applicability may be limited by a lack of space. **Table 3: BAT-associated emission levels (BAT-AELs) for channelled emissions to air of dust, metals and metalloids from the incineration of waste** Parameter / BAT-AEL (mg/Nm3) / Averaging period: Dust / < 2–5 (1) / Daily average Cd+Tl / 0.005–0.02 / Average over the sampling period Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V / 0.01–0.3 / Average over the sampling period (1) For existing plants dedicated to the incineration of hazardous waste and for which a bag filter is not applicable, the higher end of the BAT-AEL range is 7 mg/Nm3. The associated monitoring is in BAT4		
BAT 26. In order to reduce channelled dust emissions to air from the enclosed treatment of slags and bottom ashes with extraction of air (see BAT 24 f), BAT is to treat the extracted air with a bag filter (see Section 5.2.2). **Table 4: BAT-associated emission levels (BAT-AELs) for channelled dust emissions to air from the enclosed treatment of slags and bottom ashes with extraction of air** Parameter / BAT-AEL (mg/Nm3) / Averaging period: Dust / 2–5 / Average over the sampling period	YES	The IBA screening and metals recovery activities occur within a partially enclosed building. The maturation takes place in an open area.
BAT 27. In order to reduce channelled emissions of HCl, HF and SO2 to air from the incineration of waste, BAT is to use one or a combination of the techniques given below. | | Technique | Description | Applicability |	YES	The plant will incorporate a system for the injection of hydrated lime within the gas path.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
<table><tr><td>a.</td><td>Wet scrubber</td><td>See Section 5.2.2</td><td>There may be applicability restrictions due to low water availability, e.g. in arid areas.</td></tr><tr><td>b.</td><td>Semi-wet absorber</td><td>See Section 5.2.2</td><td>Generally applicable.</td></tr><tr><td>c.</td><td>Dry sorbent injection</td><td>See Section 5.2.2</td><td>Generally applicable.</td></tr><tr><td>d.</td><td>Direct desulphurisation</td><td>See Section 5.2.2. Used for partial abatement of acid gas emissions upstream of other techniques.</td><td>Only applicable to fluidised bed furnaces.</td></tr><tr><td>e.</td><td>Boiler sorbent injection</td><td>See Section 5.2.2. Used for partial abatement of acid gas emissions upstream of other techniques.</td><td>Generally applicable.</td></tr></table>		The plant will use a Dry Sorbent Injection system of hydrated lime and activated carbon for the control of acid gases and dioxins, mercury and other heavy metals respectively. This will be separated from the gas steam by means of a bag filter.
BAT 28. In order to reduce channelled peak emissions of HCl, HF and SO2 to air from the incineration of waste while limiting the consumption of reagents and the amount of residues generated from dry sorbent injection and semi-wet absorbers, BAT is to use technique (a) or both of the techniques given below. <table><tr><td></td><td>**Technique**</td><td>**Description**</td><td>**Applicability**</td></tr><tr><td>a.</td><td>Optimised and automated reagent dosage</td><td>The use of continuous HCl and/or SO2 measurements (and/or of other parameters that may prove useful for this purpose) upstream and/or downstream of the FGC system for the optimisation of the automated reagent dosage.</td><td>Generally applicable.</td></tr><tr><td>b.</td><td>Recirculation of reagents</td><td>The recirculation of a proportion of the collected FGC solids to reduce the amount of unreacted reagent(s) in the residues. The technique is particularly relevant in the case of FGC techniques operating with a high stoichiometric excess.</td><td>Generally applicable to new plants. Applicable to existing plants within the constraints of the size of the bag filter.</td></tr></table>	YES	The FGT system will use online monitoring from the CEMS and raw gas analyser to control the operation of the fabric filter and dosing rates. The fabric filter operates in its most effective mode when it has a collection of material over its surface, decreasing its effective pore size yet also providing increased residence time for acid gas control. However, the deposition of material also creates an increased pressure drop over the system and therefore requires cleaning via a reverse pulse air jet. The system collects the ash in the bottom of the hopper and a proportion of the material is recirculated back to the injection point in the gas path. This means that the efficiency of FGT using hydrated lime and activated carbon is increased yet the consumption of the reagents is much lower.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments

Table 5: BAT-associated emission levels (BAT-AELs) for channelled emissions to air of HCl, HF and SO2 from the incineration of waste

Parameter	BAT-AEL (mg/Nm3)		Averaging period
	New plant	Existing plant	
HCl	< 2–6 (1)	< 2–8 (1)	Daily average
HF	< 1	< 1	Daily average or average over the sampling period
SO2	5–30	5–40	Daily average
(1) The lower end of the BAT-AEL range can be achieved when using a wet scrubber; the higher end of the range may be associated with the use of dry sorbent injection.			

BAT 29. In order to reduce channelled NOx emissions to air while limiting the emissions of CO and N2O from the incineration of waste and the emissions of NH3 from the use of SNCR and/or SCR, BAT is to use an appropriate combination of the techniques given below.

	Technique	Description	Applicability
a.	Optimisation of the incineration process	See Section 5.2.1	Generally applicable.
b.	Flue-gas recirculation	See Section 5.2.2	For existing plants, the applicability may be limited due to technical constraints (e.g. pollutant load in the flue-gas, incineration conditions).
c.	Selective non-catalytic reduction (SNCR)	See Section 5.2.2	Generally applicable.
d.	Selective catalytic reduction (SCR)	See Section 5.2.2	In the case of existing plants, the applicability may be limited by a lack of space.
e.	Catalytic filter bags	See Section 5.2.2	Only applicable to plants fitted with a bag filter.
f.	Optimisation of the SNCR/SCR design and operation	Optimisation of the reagent to NOx ratio over the cross-section of the furnace or duct, of the size of the reagent drops and of the temperature window in	Only applicable where SNCR and/or SCR is used for the reduction of NOx emissions.

Compliant: YES

Comments:

A combination of the techniques will be listed, including:

- Optimisation of the incineration process – The plant and its combustion system will be controlled by a DCS, monitoring the combustion process.
- Flue Gas Recirculation – This will be further considered in the detailed design phase for the further reduction in NOx levels.
- Selective non-Catalytic Reduction (SNCR) – This is a preferred option for the control of NOx, providing easy application in the use of urea or ammonium hydroxide. This will use an enhanced system, monitoring gas path temperatures and multilevel injection locations for the introduction of the reagent into the appropriate level of the combustion chamber.
- Optimisation of the SNCR System – All the FGT systems will be monitored continuously through the DCS.

With the selection of the above processes, there is no anticipated requirement to use SCR, Catalytic Filter Bags or Wet Scrubber.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments

		which the reagent is injected.	
g.	Wet scrubber	See Section 5.2.2. Where a wet scrubber is used for acid gas abatement, and in particular with SNCR, unreacted ammonia is absorbed by the scrubbing liquor and, once stripped, can be recycled as SNCR or SCR reagent.	There may be applicability restrictions due to low water availability, e.g. in arid areas.

Comments: Should it be required at the detailed design phase, enhanced SNCR, will be installed

Table 6: BAT-associated emission levels (BAT-AELs) for channelled NOx and CO emissions to air from the incineration of waste and for channelled NH_3 emissions to air from the use of SNCR and/or SCR

Parameter	BAT-AEL (mg/Nm3)		Averaging period
	New plant	Existing plant	
NOx	20 - 120 (1)	50 - 150 (1) (2)	Daily average
CO	10 - 50	10 – 50	
NH_3	2 – 10 (1)	2 – 10 (1) (3)	

(1) The lower end of the BAT-AEL range can be achieved when using SCR. The lower end of the BAT-AEL range may not be achievable when incinerating waste with a high nitrogen content (e.g. residues from the production of organic nitrogen compounds).
(2) The higher end of the BAT-AEL range is 180 mg/Nm3 where SCR is not applicable.
(3) For existing plants fitted with SNCR without wet abatement techniques, the higher end of the BAT-AEL range is 15 mg/Nm3.

The associated monitoring is in BAT 4.

BAT 30. In order to reduce channelled emissions to air of organic compounds including PCDD/F and PCBs from the incineration of waste, BAT is to use techniques (a), (b), (c), (d), and one or a combination of techniques (e) to (i) given below

	Technique	Description	Applicability

Compliant: YES

Comments: The plant utilises the following strategies to meet the requirements of BAT 30:

a) Optimisation of the incineration process – The plant and its combustion system will be controlled by a DCS, monitoring the combustion process and thereby ensuring that the time / temperature

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)				Compliant	Comments
a.	Optimisation of the incineration process	See Section 5.2.1. Optimisation of incineration parameters to promote the oxidation of organic compounds including PCDD/F and PCBs present in the waste, and to prevent their and their precursors' (re)formation.	Generally applicable.		requirements (2 seconds at 850°C) for ensuring destruction of compounds are met. b) With the fuel for the plant being produced, and subject to a regular sampling regime to ensure continued quality, the operator has good knowledge of the fuel and confidence that the design of the plant will process it effectively. c) In order to keep the boiler and its associated gas passes clear of significant build-up of dust, and to ensure that it operates efficiently as a heat transfer surface, the plant will be equipped with online rappers, or pulse wave cleaning or acoustic cleaning sprays and soot blowers at different points in the gas path. These online measures have been employed on many plants and reduce the requirement to come offline for cleaning. d) The boiler will incorporate a number of tube bundles as part of the heat recovery system, including evaporator, superheater and economiser tubing sections and these will be positioned to ensure that good quality steam can be produced at the same time as ensuring a rapid temperature drop of the flue gas through critical temperature bands to prevent the reformation of dioxins furans via *de Novo* synthesis. By ensuring the destruction and reducing the potential for reforming of PCDD/F compounds the residual quantities are controlled by the injection of sorbents into the gas stream. e) The plant will use a dry sorbent Injection system of hydrated lime and activated carbon for the control of acid gases and dioxins, mercury and other heavy metals respectively. These will be separated from the gas stream by means of a bag filter.
b.	Control of the waste feed	Knowledge and control of the combustion characteristics of the waste being fed into the furnace, to ensure optimal and, as far as possible, homogeneous and stable incineration conditions.	Not applicable to clinical waste or to municipal solid waste.		
c.	On-line and off-line boiler cleaning	Efficient cleaning of the boiler bundles to reduce the dust residence time and accumulation in the boiler, thus reducing PCDD/F formation in the boiler. A combination of on-line and off-line boiler cleaning techniques is used.	Generally applicable.		
d.	Rapid flue-gas cooling	Rapid cooling of the flue-gas from temperatures above 400 °C to below 250 °C before dust abatement to prevent the *de novo* synthesis of PCDD/F. This is achieved by appropriate design of the boiler and/or with the use of a quench system. The latter option limits the amount of energy that can be recovered from the flue-gas and is used in particular in the case of incinerating hazardous wastes with a high halogen content.	Generally applicable.		

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)				Compliant	Comments
e.	Dry sorbent injection	See Section 5.2.2. Adsorption by injection of activated carbon or other reagents, generally combined with a bag filter where a reaction layer is created in the filter cake and the solids generated are removed.	Generally applicable.		
f.	Fixed- or moving-bed adsorption	See Section 5.2.2.	The applicability may be limited by the overall pressure drop associated with the FGC system. In the case of existing plants, the applicability may be limited by a lack of space.		
g.	SCR	See Section 5.2.2. Where SCR is used for NOx abatement, the adequate catalyst surface of the SCR system also provides for the partial reduction of the emissions of PCDD/F and PCBs. The technique is generally used in combination with technique (e), (f) or (i).	In the case of existing plants, the applicability may be limited by a lack of space.		
h.	Catalytic filter bags	See Section 5.2.2	Only applicable to plants fitted with a bag filter.		
i.	Carbon sorbent in a wet scrubber	PCDD/F and PCBs are adsorbed by carbon sorbent added to the wet scrubber, either in the scrubbing liquor or in the form of impregnated packing elements. The technique is used for the removal of PCDD/F in general, and also to prevent and/or reduce the re-emission of PCDD/F accumulated in the scrubber (the so-called memory effect) occurring	Only applicable to plants fitted with a wet scrubber.		

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments

		especially during shutdown and start-up periods.	

Table 7: BAT-associated emission levels (BAT-AELs) for channelled emissions to air of TVOC, PCDD/F and dioxin- like PCBs from the incineration of waste

Parameter	Unit	BAT-AEL		Averaging period
		New plant	Existing plant	
TVOC	mg/Nm^3	< 3–10	< 3–10	Daily average
PCDD/F (1)	ng I-TEQ/Nm^3	< 0,01–0,04	< 0,01–0,06	Average over the sampling period
		< 0,01–0,06	< 0,01–0,08	Long-term sampling period (2)
~~PCDD/F + dioxin-like PCBs (1)~~	~~ng WHO-TEQ/Nm^3~~	~~< 0,01–0,06~~	~~< 0,01–0,08~~	~~Average over the sampling period~~
		~~< 0,01–0,08~~	~~< 0,01–0,1~~	~~Long-term sampling period (2)~~
(1) Either the BAT-AEL for PCDD/F or the BAT-AEL for PCDD/F + dioxin-like PCBs applies. (2) The BAT-AEL does not apply if the emission levels are proven to be sufficiently stable.				

The associated monitoring is in BAT 4.

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>
BAT 31. In order to reduce channelled mercury emissions to air (including mercury emission peaks) from the incineration of waste, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Wet scrubber (low pH)</td><td>See Section 5.2.2.
A wet scrubber operated at a pH value around 1.
The mercury removal rate of the technique can be enhanced by adding reagents and/or adsorbents to the scrubbing liquor, e.g.:
• oxidants such as hydrogen peroxide to transform elemental mercury to a water-soluble oxidised form;
• sulphur compounds to form stable complexes or salts with mercury;
• carbon sorbent to adsorb mercury, including elemental mercury.

When designed for a sufficiently high buffer capacity for mercury capture, the technique effectively prevents the occurrence of mercury emission peaks.</td><td>There may be applicability restrictions due to low water availability, e.g. in arid areas.</td></tr>
<tr><td>b.</td><td>Dry / Semi-Dry sorbent injection</td><td>See Section 5.2.2.
Adsorption by injection of activated carbon or other reagents, generally combined with a bag filter where a reaction layer is created in the filter cake and the solids generated are removed.</td><td>Generally applicable.</td></tr>
<tr><td>c.</td><td>Injection of special, highly reactive activated carbon</td><td>Injection of highly reactive activated carbon doped with sulphur or other reagents to enhance the reactivity with mercury.
Usually, the injection of this special activated carbon is not continuous but only takes place when a mercury peak is detected. For this purpose, the technique can be used in combination with the continuous monitoring of mercury in the raw flue-gas.</td><td>May not be applicable to plants dedicated to the incineration of sewage sludge.</td></tr>
</table>
</td><td>YES</td><td>The plant will use a semi-dry sorbent Injection system of hydrated lime and activated carbon for the control of acid gases and dioxins, mercury and other heavy metals respectively.

The reagents and ash will be separated from the gas steam by means of a bag filter. It is anticipated that the recirculation of some of the FGT residues will improve the efficiency of use of the reagents whilst retaining good emissions performance.</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)				Compliant	Comments
d.	Boiler bromine addition	Bromide added to the waste or injected into the furnace is converted at high temperatures to elemental bromine, which oxidises elemental mercury to the water-soluble and highly adsorbable $HgBr_2$. The technique is used in combination with a downstream abatement technique such as a wet scrubber or an activated carbon injection system. Usually, the injection of bromide is not continuous but only takes place when a mercury peak is detected. For this purpose, the technique can be used in combination with the continuous monitoring of mercury in the raw flue-gas.	Generally applicable.		
e.	Fixed- or moving-bed adsorption	See Section 5.2.2. When designed for a sufficiently high adsorption capacity, the technique effectively prevents the occurrence of mercury emission peaks.	The applicability may be limited by the overall pressure drop associated with the FGC system. In the case of existing plants, the applicability may be limited by a lack of space.		

Table 8: BAT-associated emission levels (BAT-AELs) for channelled mercury emissions to air from the incineration of waste

Parameter	BAT-AEL (µg/Nm3) (1)		Averaging period
	New plant	**Existing plant**	
Hg	< 5–20 (2)	< 5–20 (2)	Daily average or average over the sampling period
	1–10	1–10	Long-term sampling period

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
(1) Either the BAT-AEL for daily average or average over the sampling period or the BAT-AEL for long-term sampling period applies. The BAT-AEL for long-term sampling may apply in the case of plants incinerating waste with a proven low and stable mercury content (e.g. mono-streams of waste of a controlled composition). (2) The lower end of the BAT-AEL ranges may be achieved when: incinerating wastes with a proven low and stable mercury content (e.g. mono-streams of waste of a controlled composition), or using specific techniques to prevent or reduce the occurrence of mercury peak emissions while incinerating non-hazardous waste. The higher end of the BAT-AEL ranges may be associated with the use of dry sorbent injection. As an indication, the half-hourly average mercury emission levels will generally be: < 15–40 µg/Nm3 for existing plants; < 15–35 µg/Nm3 for new plants.		
BAT 32. In order to prevent the contamination of uncontaminated water, to reduce emissions to water, and to increase resource efficiency, BAT is to segregate waste water streams and to treat them separately, depending on their characteristics. **Description** Waste water streams (e.g. surface run-off water, cooling water, waste water from flue-gas treatment and from bottom ash treatment, drainage water collected from the waste reception, handling and storage areas (see BAT 12 (a)) are segregated to be treated separately based on their characteristics and on the combination of treatment techniques required. Uncontaminated water streams are segregated from waste water streams that require treatment. When recovering hydrochloric acid and/or gypsum from the scrubber's effluent, the waste waters arising from the different stages (acidic and alkaline) of the wet scrubbing system are treated separately. **Applicability** Generally applicable to new plants.	N/A	Wastewater arises from the following process areas during normal operation (not exhaustive): • boiler blow down. • boiler drains. • steam circuit drains. • regeneration of the demineralisation plant. • washdown water from process area. Where possible and to the extent there is enough, wastewater will be re-used within the Woodlawn ARC. For example, blowdown water being re-used as top-up water for the bottom ash extractor.

<table>
<tr><th>Excerpts from Waste Incineration BREF – BAT Conclusions (2019)</th><th>Compliant</th><th>Comments</th></tr>
<tr><td>Applicable to existing plants within the constraints associated with the configuration of the water collection system.</td><td></td><td></td></tr>
<tr><td>BAT 33. In order to reduce water usage and to prevent or reduce the generation of wastewater from the incineration plant, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Waste-water-free FGC techniques</td><td>Use of FGC techniques that do not generate wastewater (e.g. dry sorbent injection or semi-wet absorber, see Section 5.2.2).</td><td>May not be applicable to the incineration of hazardous waste with a high halogen content.</td></tr>
<tr><td>b.</td><td>Injection of wastewater from FGC</td><td>Wastewater from FGC is injected into the hotter parts of the FGC system.</td><td>Only applicable to the incineration of municipal solid waste.</td></tr>
<tr><td>c.</td><td>Water reuse/recycling</td><td>Residual aqueous streams are reused or recycled.
The degree of reuse/recycling is limited by the quality requirements of the process to which the water is directed.</td><td>Generally applicable.</td></tr>
<tr><td>d.</td><td>Dry bottom ash handling</td><td>Dry, hot bottom ash falls from the grate onto a transport system and is cooled down by ambient air. No water is used in the process.</td><td>Only applicable to grate furnaces.
There may be technical restrictions that prevent retrofitting to existing incineration plants.</td></tr>
</table></td><td>YES</td><td>The FGT equipment is a semi-dry sorbent injection process and therefore does not generate an aqueous effluent.

Any process derived liquids are reused on site, for example in the bottom ash quench, and the process overall is a net consumer of water.

Where practicable, rainwater will be collected and used in preference to borehole water (no suitable mains supply being present), therefore further reducing resource consumption at the facility.</td></tr>
<tr><td>BAT 34. In order to reduce emissions to water from FGC and/or from the storage and treatment of slags and bottom ashes, BAT is to use an appropriate combination of the techniques given below, and to use secondary techniques as close as possible to the source in order to avoid dilution.
<table>
<tr><th colspan="2">Technique</th><th>Typical pollutants targeted</th></tr>
<tr><td colspan="3">Primary techniques</td></tr>
<tr><td>a.</td><td>Optimisation of the incineration process (see BAT 14) and/or of the FGC system (e.g. SNCR/SCR, see BAT 29 (f))</td><td>Organic compounds including PCDD/F, ammonia/ammonium</td></tr>
<tr><td colspan="3">Secondary techniques (1)</td></tr>
</table></td><td>N/A</td><td>The FGT equipment is a semi-dry sorbent injection process and therefore does not generate an aqueous effluent.

Any process derived liquids are reused on site, for example in the bottom ash quench, and the process overall is a net consumer of water.

It should be noted that any emissions to water would be considered separately by the EPA.</td></tr>
</table>

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments

Preliminary and primary treatment		
b.	Equalisation	All pollutants
c.	Neutralisation	Acids, alkalis
d.	Physical separation, e.g. screens, sieves, grit separators, primary settlement tanks	Gross solids, suspended solids
Physico-chemical treatment		
e.	Adsorption on activated carbon	Organic compounds including PCDD/F, mercury
f.	Precipitation	Dissolved metals/metalloids, sulphate
g.	Oxidation	Sulphide, sulphite, organic compounds
h.	Ion exchange	Dissolved metals/metalloids
i.	Stripping	Purgeable pollutants (e.g. ammonia/ammonium)
j.	Reverse osmosis	Ammonia/ammonium, metals/metalloids, sulphate, chloride, organic compounds
Final solids removal		
k.	Coagulation and flocculation	Suspended solids, particulate-bound metals/metalloids
l.	Sedimentation	
m.	Filtration	
n.	Flotation	
(1) The descriptions of the techniques are given in Section 5.2.3.		

Table 9: BAT-AELs for direct emissions to a receiving water body

Parameter		Process	Unit	BAT-AEL(1)
Total suspended solids (TSS)		FGC Bottom ash treatment	mg/l	10–30
Total organic carbon (TOC)		FGC Bottom ash treatment		15–40
Metals and metalloids	As	FGC		0,01–0,05
	Cd	FGC		0,005–0,03
	Cr	FGC		0,01–0,1
	Cu	FGC		0,03–0,15
	Hg	FGC		0,001–0,01

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)					Compliant	Comments
	Ni	FGC		0,03–0,15		
	Pb	FGC Bottom ash treatment		0,02–0,06		
	Sb	FGC		0,02–0,9		
	Tl	FGC		0,005–0,03		
	Zn	FGC		0,01–0,5		
Ammonium-nitrogen (NH4-N)		Bottom ash treatment		10–30		
Sulphate (SO_4^{2-})		Bottom ash treatment		400–1 000		
PCDD/F		FGC	ng I-TEQ/l	0,01–0,05		
(1) The averaging periods are defined in the General considerations.						

The associated monitoring is in BAT 6.

Table 10: BAT-AELs for indirect emissions to a receiving water body

Parameter		Process	Unit	BAT-AEL(1) (2)
Metals and metalloids	As	FGC	mg/l	0,01–0,05
	Cd	FGC		0,005–0,03
	Cr	FGC		0,01–0,1
	Cu	FGC		0,03–0,15
	Hg	FGC		0,001–0,01
	Ni	FGC		0,03–0,15
	Pb	FGC Bottom ash treatment		0,02–0,06
	Sb	FGC		0,02–0,9
	Tl	FGC		0,005–0,03
	Zn	FGC		0,01–0,5
PCDD/F		FGC	ng I-TEQ/l	0,01–0,05

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
(1) The averaging periods are defined in the General considerations. (2) The BAT-AELs may not apply if the downstream waste water treatment plant is designed and equipped appropriately to abate the pollutants concerned, provided this does not lead to a higher level of pollution in the environment. The associated monitoring is in BAT 6.		
BAT 35. In order to increase resource efficiency, BAT is to handle and treat bottom ashes separately from FGC residues	YES	Bottom ashes from the plant will be collected and handled separately to the FGT residues. Fly ashes collected from the boiler passes will be transferred and mixed with the air pollution control residues (APCr)
BAT 36. In order to increase resource efficiency for the treatment of slags and bottom ashes, BAT is to use an appropriate combination of the techniques given below based on a risk assessment depending on the hazardous properties of the slags and bottom ashes.	YES	The IBA will be subject to screening and sieving processes to ensure consistency within the maturation process and classification for end use. Within this mechanical treatment residual metals (ferrous and non-ferrous) will also be removed.

	Technique	Description	Applicability
a.	Screening and sieving	Oscillating screens, vibrating screens and rotary screens are used for an initial classification of the bottom ashes by size before further treatment.	Generally applicable.
b.	Crushing	Mechanical treatment operations intended to prepare materials for the recovery of metals or for the subsequent use of those materials, e.g. in road and earthworks construction.	Generally applicable.
c.	Aeraulic separation	Aeraulic separation is used to sort the light, unburnt fractions commingled in the bottom ashes by blowing off light fragments. A vibrating table is used to transport the bottom ashes to a chute, where the material falls through an air stream that blows un-combusted light materials, such as wood, paper or plastic, onto a removal belt or into a container, so that they can be returned to incineration.	Generally applicable.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)	Compliant	Comments
(continued table below)		

	Technique	Description	Applicability
d.	Recovery of ferrous and non-ferrous metals	Different techniques are used, including: magnetic separation for ferrous metals; eddy current separation for non-ferrous metals; induction all-metal separation.	Generally applicable.
e.	Ageing	The ageing process stabilises the mineral fraction of the bottom ashes by uptake of atmospheric CO_2 (carbonation), draining of excess water and oxidation. Bottom ashes, after the recovery of metals, are stored in the open air or in covered buildings for several weeks, generally on an impermeable floor allowing for drainage and run-off water to be collected for treatment. The stockpiles may be wetted to optimise the moisture content to favour the leaching of salts and the carbonation process. The wetting of bottom ashes also helps prevent dust emissions.	Generally applicable.
f.	Washing	The washing of bottom ashes enables the production of a material for recycling with minimal leachability of soluble substances (e.g. salts).	Generally applicable

BAT 37. In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a.	Appropriate location of equipment and buildings	Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens.	In the case of existing plants, the relocation of equipment may be restricted by a lack of space or by excessive costs.

Compliant: YES

Comments: The detailed design phase will identify areas in which there are noise generating plant and seek to enclose them where necessary. A noise and vibration impact assessment has been prepared as part of the EIS. The majority of plant will be enclosed within the building envelope that will provide attenuation.

The requirements of the plant to be a good neighbour and to meet local noise emission limits has been considered as part of the planning process for the site.

Excerpts from Waste Incineration BREF – BAT Conclusions (2019)				Compliant	Comments
b.	Operational measures	These include: improved inspection and maintenance of equipment; closing of doors and windows of enclosed areas, if possible; operation of equipment by experienced staff; avoidance of noisy activities at night, if possible; provisions for noise control during maintenance activities.	Generally applicable.		On site noise levels within operational areas will be managed to reflect the access and working requirements in plant areas.
c.	Low-noise equipment	This includes low-noise compressors, pumps and fans.	Generally applicable when existing equipment is replaced or new equipment is installed.		
d.	Noise attenuation	Noise propagation can be reduced by inserting obstacles between the emitter and the receiver. Appropriate obstacles include protection walls, embankments and buildings.	In the case of existing plants, the insertion of obstacles may be restricted by a lack of space.		
e.	Noise-control equipment/ infrastructure	This includes: noise-reducers; equipment insulation; enclosure of noisy equipment; soundproofing of buildings.	In the case of existing plants, the applicability may be limited by a lack of space.		

8. Conclusions

8.1 NSW EfW Policy Statement Reference Facility

The NSW EfW Policy Statement requires that: "*Energy recovery facilities must use technologies that are proven, well understood and capable of handling the expected variability and type of waste feedstock. This must be demonstrated through reference to fully operational plants using the same technologies and treating like waste streams in other similar jurisdictions.*"

In this regard, the Staffordshire Energy Recovery Facility (ERF) that is fully operational within a similar jurisdiction fulfils the requirements of a reference facility as it processes similar waste streams and it uses similar technology, albeit at a different scale.

The technology proposed has many references. *The technology is not novel and has been applied on many projects worldwide and operates effectively* on the waste feedstock proposed for the Woodlawn ARC.

Ricardo concludes that the selected technology and techniques are, in general, *capable of handling and processing the proposed waste feedstock* of residual municipal, commercial and industrial solid wastes, along with their inherent variability.

8.2 Best Available Techniques

The evidence presented to Ricardo demonstrates *the reference facility aligns with the principles of the development against the Best Available Techniques Conclusions (BAT-C)* issued in November 2019 relating to the European Industrial Emissions Directive[21] (IED).

The basis of design and principles of design of the *Woodlawn ARC also meet current international best practice techniques*, particularly with respect to process design and control, emission control equipment design and control, and emission monitoring, with near real-time feedback to the controls of the process.

It is important to note that EfW plants operating within a similar regulatory environment in the UK and Europe are designed using BAT-C to the requirements of the IED and not the NSW EfW Policy and as a result the ultimate design requirements are not directly comparable. Therefore, potential reference plants are not currently available to benchmark against *all* the requirements of the NSW EfW Policy as the requirements on energy recovery facilities are different in other regions; notably, the Technical Requirements for emissions standards.

On the basis of this inherent difference, the reference facility data presented is able to demonstrate that the Woodlawn ARC would be able to operate within the emissions performance envelope of EU emission limit levels effectively at the proposed scale. However, whilst not conclusive, the reference facility emissions data provided to-date, along with detailed measurement results from other technology providers on other EfW plants, identifies that the plant should be able to meet the NSW ELVs in normal operation.

In relation to energy recovery, the proposed plant meets the required objectives for a minimal level of electrical generation efficiency, yet also allows for the potential supply in the future.

8.3 Risk Mitigation

As identified within this report there is a residual risk concerning the ability to benchmark against the NSW EfW Policy emission standards. It should be noted that all other technical criteria set out in the NSW EfW Policy have been benchmarked as they are referenceable elsewhere. Whilst there is

[21] Directive 2010/75/EU

confidence with the benchmarking against the IED, a risk management strategy has been developed to provide certainty that Woodlawn ARC will meet the remaining benchmark of the NSW EfW Policy emission standards.

Design basis documents have been developed to underpin the function and performance of the Woodlawn ARC. These documents are fully aligned to the NSW EfW Policy and will be used as the basis for the procurement of an EPC Contractor to deliver the works and will be measurable throughout not only the procurement phase, but also the design, manufacture, construction and commissioning phases. Prior to construction, a full suite of design documents will be developed.

Key to also managing risk is to ensure that the performance of the Woodlawn ARC can be guaranteed by the EPC Contractor to the satisfaction of the employer and all other legal and policy requirements. This will be achieved through the development of technical schedules that support the EPC Contract. The schedules will include:

- Criteria for the completion of construction.
- Criteria for Inspection and Commissioning Testing.
- Guaranteed Performance Requirements.

The commissioning and proof of performance will be such that plant design can be validated ahead of operations therefore providing certainty that the benchmarking risk against the NSW EfW Policy is fully mitigated.

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