



# GENT FAIRHEAD & CO RIVENHALL DISPERSION MODELLING ASSESSMENT

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## **MANAGEMENT SUMMARY**

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged to undertake a Dispersion Modelling Assessment to support the Environmental Permit and planning application for the Rivenhall Integrated Waste Management Facility (IMWF). The proposals include a Combined Heat and Power (CHP) plant, Materials Recovery Facility, Anaerobic Digester, Mechanical Biological Treatment plant, Pulp Facility and Water Treatment Plant. The principal fuel for the CHP plant will be refuse derived fuel. Therefore, the Facility will be required to comply with the Industrial Emissions Directive (IED) and the limits on emissions to air will be based on those outlined in Annex VI of the IED for an incinerator. This will include limits on emissions of oxides of nitrogen, sulphur dioxide, heavy metals and dioxins and furans, as well as other substances.

The assessment has been carried out in a number of stages.

## (1) Review of Legislation

In the UK, the levels of pollution in the atmosphere are controlled by a number of European Directives, which have been fully implemented, and by the National Air Quality Strategy. These have led to the setting of a number of Air Quality Objectives (AQOs) for the most significant pollutants, such as oxides of nitrogen and particulate matter. The AQOs are set at a level well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups. For other pollutants, the Environment Agency sets control levels, called Environmental Assessment Levels (EALs), based on work by the World Health Organisation and other national and international bodies. AQOs and EALs are collectively referred to as Air Quality Assessment Levels (AQALs)

The Environment Agency sets Critical Levels for the protection of ecosystems. In addition, it is noted that deposition of nitrogen and acid gases can cause nutrification and acidification of habitats. The Air Pollution Information System provides Critical Loads for different habitats which consider the existing pollution loading for the site.

## (2) Review of Ambient Air Quality

Monitoring information collected by the UK Government and by local authorities has been used to assess the current levels of pollutants in the atmosphere close to the IMWF.

Where local monitoring data is not available, conservative estimates based on national UK monitoring results have been used as a background concentration.

## (3) Identification of Sensitive Receptors

When assessing the impact of the development, the assessment considers the point of maximum impact as a worst-case. In addition, the impact has been assessed at a number of identified sensitive receptors including the closest houses and footpaths, all European statutory designated ecological sites within 10km, and all UK statutory and locally designated ecological sites within 2km of the Facility.

## (4) Dispersion Modelling of Emissions

The ADMS 5.2 dispersion model is routinely used for air quality assessments to the satisfaction of local authorities and the Environment Agency. The model uses weather data from the local area was used to predict the spread and movement of the exhaust gases from the stack for each hour over a five year period. The model takes account of wind speed, wind direction, temperature, humidity and the amount of cloud cover, as all of these have an influence on the dispersion of emissions. The model also takes account of the effects of buildings and terrain on the movement of air.

Emissions from the CHP Plant have been assumed to comply with the limits prescribed within Chapter VI of the IED, with the exception of NOx where an ELV of 150mg/Nm³ is being applied for, and emissions from the gas-fired boilers have been assumed to comply with the limits prescribed within Environment Agency guidance notes for emissions for gas engines. These sources will emit to atmosphere via a common wind shield (i.e. a collective single emission point). In addition, this wind shield will include stacks for the exhaust air from the pulp plant, and the AD biofilter. Although there will be no combustion gases from these additional sources these will impact upon the buoyancy of the plume. The exhaust air from the pulp plant and the biofilter has been included to ensure any reduction is buoyancy is considered in the assessment.

To set up the model, it has been assumed that each item of plant operates for the whole year and releases emissions at the emission limit all the time. In reality this is very conservative, as each item of plant will run below the emission limit and will be offline for part of the year for maintenance.

The model was used to predict the ground level concentration of pollutants on a long term and short term basis across a grid of points. In addition, concentrations were predicted at the identified sensitive receptors.

# (5) Approach and Assessment of Impact on Air Quality - Protection of Human Health

The impact of air quality on human health has been assessed using a standard approach.

- a) The Environment Agency has stated that the contribution to air quality can be screened out as 'insignificant' if the short term contribution is less than 10% of the AQAL and the long term contribution is less than 1% of the AQAL. These screening criteria have been applied initially.
- b) For those pollutants which are not screened out, the background concentration has been reviewed to see if there is any potential for any exceedences of an assessment level.

The impact of many pollutants on human health can be screened out as 'insignificant'. For those which cannot be screened out, the background concentrations are low and there is little chance of significant pollution.

The Environment Agency approach to assessing the impact of metals has been used which considers the risk of exceeding the AQAL based on the existing background levels and contribution from the Facility. Using this approach there is no risk of exceeding the AQAL.

## (6) Approach and Assessment of Impact on Air Quality – Protection of Ecosystems

The impact of air quality on ecosystems has been assessed using a standard approach.

- a) The Environment Agency has stated that, if the contribution within an entire protected site is less than 1% of the long-term and less than 10% of the short term benchmark, the emissions are not significant and it can be concluded no likely significant effect either alone and in-combination with other sources of pollutants, irrespective of background levels.
- b) If the process contribution at European and UK designated sites is greater than 1% of the relevant long-term, or 10% of the short term benchmark, but the total predicted concentration including background levels is less than 70% of the relevant benchmark, the Environment Agency has stated that the emissions are not likely to have a significant effect.
- c) If the process contribution at locally designated sites is less than the relevant benchmark, the Environment Agency has stated that the emissions are not likely to have a significant effect.

The impact of the deposition of nitrogen and acid gases on sensitive habitats has been assessed using a standard approach.

- a) It has been assumed that all items of plant operate at the emission limits for the entire year whereas actual operational emission concentrations will be lower and the plant will be offline for maintenance purposes.
- b) It has been assumed that all habitats are present at the point of greatest impact.

- c) The impact has been calculated based on the maximum predicted concentration over a 5-year period at each ecological site and applying conservative deposition assumptions from the Environment Agency.
- d) The results have been compared to habitat specific Critical Loads.

No European or UK designated site have been identified as requiring consideration within this air quality assessment.

A number of non-statutory designated sites have been identified within 2km of the IWMF. An assessment, based on broad habitat types, has concluded that the impact of emissions on these sites is not significant. This conclusion has been drawn because the Process Contribution is less than 100% of the Critical Level or Load.

## (7) Plume Visibility

A CHP Management Plan for Plume Abatement has been developed to discharge the existing planning conditions for the IWMF. A feedforward mechanism will be used to adjust the temperature of the exhaust air from the pulp plant based on a set of meteorological parameters. The implementation of the proposed operating regimes will increase the buoyancy of the emissions and lead to increased dispersion of emissions. This has not been taken into account in this Dispersion Modelling Assessment, so the results presented are conservative and represent worst case.

In summary, a comprehensive assessment of the impact of the proposed IWMF with a single stack has shown that the proposals would not have a significant impact on local air quality, the general population or the local community.

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## 1 Introduction

# 1.1 Background

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged to undertake a Dispersion Modelling Assessment to support the Environmental Permit application for the proposed Rivenhall Integrated Waste Management Facility (IWMF).

Detailed design work has now been undertaken and an application is being made for an Environmental Permit to operate the Facility. In addition, a planning application is being made to vary Planning Condition 56 of the implemented IWMF planning permission (ESS/34/15/BTE) that limits the height of the IWMF stack, namely:

Planning Condition 56: Only one stack shall be erected on the site to service all elements of the IWMF. The height of the stack shall not exceed 85 m Above Ordnance Datum.

The application seeks to vary the height of the stack to 108 m Above Ordnance Datum and represents a change in stack height of 23 m. This planning application is being twintracked with the EP application.

There will be six principal activities to the Rivenhall IWMF:

- A Combined Heat and Power (CHP) plant consisting of 2 streams with the potential to process up to 595,000 tonnes per annum of non-hazardous Solid Recovered Fuel (SRF) and Refuse Derived Fuel (RDF);
- (2) A Materials Recovery Facility (MRF) designed to process approximately 300,000 tonnes per annum of waste to recover recyclates for transfer off-site, with the residual material being transferred to the Mechanical Biological Treatment (MBT) Facility;
- (3) An Anaerobic Digester (AD) plant designed to process up to 30,000 tonnes per annum of food and organic waste, with the resultant biogas being combusted in a CHP engine;
- (4) An MBT Plant designed to process approximately 170,000 tonnes per annum of waste to produce a non-hazardous waste derived fuel (SRF/RDF) to be incinerated as a fuel within the CHP plant;
- (5) A Pulp Plant designed to process approximately 170,000 tonnes per annum of waste paper to produce approximately 85,500 tonnes per annum of paper pulp; and
- (6) A Water Treatment Plant to process wastewater from the installation.

Of the above activities the CHP and AD gas engines will produce emissions to atmosphere which will be regulated by the Environment Agency. The pulp plant includes a drying process which will result in a moist exhaust which will need to be emitted to atmosphere. A system to condense moisture from the pulp plant exhaust prior to it being emitted to atmosphere is proposed. The proposals also include a building ventilation system to provide abatement of odours from each of the waste treatment processes. This ventilation system will include a biofilter to process the 'dirty' AD air prior to emitting to atmosphere.

The existing planning permission restricts the Facility to having a single stack, emissions from all sources need to emit to atmosphere via a common wind shield. Therefore, the main stack will include emissions from the following sources:

- (1) Exhaust gases from the CHP plant (two streams);
- (2) Exhaust air from the pulp plant;
- (3) Exhaust gases from the two AD gas engines; and
- (4) Exhaust from the bio-filter.

Due to the nature of the feedstock the Facility will require an Environmental Permit to operate which will include limits on emissions to air based on those outlined in Annex VI of the IED for waste incineration plants, with the exception of NOx where an ELV of 150mg/Nm³ is being applied for. This will include limits on emissions of oxides of nitrogen, sulphur dioxide, heavy metals and dioxins and furans. This assessment considers the impact of the pollutants potentially released from the Facility on human health and ecosystems.

A separate Human Health Risk Assessment has been undertaken to assess the pathway intake of these pollutants and impacts compared to the Tolerable Daily Intakes (TDIs).

When considering the impact on ecosystems the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. Deposition of emissions over a prolonged period can have nitrification and acidification impacts. An assessment of the long term deposition of pollutants has been undertaken and the results compared to the habitat specific Critical Loads.

## 1.2 Structure of Report

This report has the following structure.

- National and international air quality legislation and guidance, and local planning policies which relate to air quality, are considered in section 2.
- The assessment methodology is outlined in section 3.
- The current levels of ambient air quality are described in section 4.
- Section 5 highlights residential properties and ecological receptors in the vicinity of the proposed development.
- The inputs used for the dispersion model are contained within section 6.
- Section 7 presents the assessment methodology and results of the impact of emissions at human sensitive receptors.
- Section 8 presents the assessment methodology and results of the assessment of the impact of emissions including their long-term deposition at ecological sites.
- Section 9 presents the analysis of the dispersion modelling of odour emissions from the Facility.
- Section 10 presents the analysis of the effect the implementation of the CHP Management Plan for Plume Abatement will have on the predicted impacts.
- Section 11 provides an analysis of the impact of the flare.
- The results of the stack height analysis are contained in Section 12.
- A detailed analysis of the uncertainty in the dispersion modelling is contained in Section 13.
- The conclusions of the assessment can be found in section 14.
- The Appendices include illustrative figures and detailed results tables.

## 2 LEGISLATION

# 2.1 European legislation

European air quality legislation is consolidated under Directive 2008/50/EC, which came into force on 11<sup>th</sup> June 2008. This Directive consolidates previous legislation which was designed to deal with specific pollutants in a consistent manner and provides new air quality objectives for fine particulates. The consolidated Directives include:

- Directive 99/30/EC the First Air Quality "Daughter" Directive which sets ambient air limit values for nitrogen dioxide and oxides of nitrogen, sulphur dioxide, lead and particulate matter;
- Directive 2000/69/EC the Second Air Quality "Daughter" Directive which sets ambient air limit values for benzene and carbon monoxide; and
- Directive 2002/3/EC the Third Air Quality "Daughter" Directive which seeks to establish long-term objectives, target values, an alert threshold and an information threshold for concentrations of ozone in ambient air.

The fourth daughter Directive – 2004/107/EC - was not included within the consolidation. It sets health-based limits on polycyclic aromatic hydrocarbons, cadmium, arsenic, nickel and mercury, for which there is a requirement to reduce exposure to as low as reasonably achievable.

# 2.2 UK legislation

Directives 2008/50/EC and 2004/107/EC are transposed under UK Law into the Air Quality Standards Regulations (2010).

The UK Air Quality Strategy (2007) is the method of implementation of the air quality limit values in England, Scotland, Wales and Northern Ireland.

The Air Quality Strategy defines "standards" and "objectives" in paragraph 17:

"For the purposes of the strategy

- standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups or on ecosystems
- objectives are policy targets often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedences, within a specified timescale."

The status of the objectives is clarified in paragraph 22, which also emphasises the importance of European Directives.

"The air quality objectives in the Air Quality Strategy are a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except in as far as these mirror any equivalent legally binding limit values in EU legislation. Where UK standards or objectives are the sole consideration, there is no legal obligation upon regulators, to set Emission Limit Values (ELVs) any more stringent than the emission levels associated with the use of Best Available Techniques (BAT) in issuing permits under the PPC Regulations. This aspect is dealt with fully in the PPC Practical Guides."

# 3 AIR QUALITY STANDARDS, OBJECTIVES AND GUIDELINES

In the UK, Ambient Air Directive (AAD) Limit Values, Targets, and air quality standards and objectives (AQOs) for major pollutants are described in The Air Quality Strategy (AQS). In addition, the EA include Environmental Assessment Levels (EALs) for other pollutants in the Environment Agency's 'Air Emissions Risk Assessment for your Environmental Permit' ("Air Emissions Guidance"). The long-term and short-term EALs from this document have been used when the AQS does not contain relevant objectives.

# 3.1 Nitrogen dioxide

All combustion processes produce nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), known by the general term of nitrogen oxides (NOx). In general, the majority of the NOx released is in the form of NO, which then reacts with ozone in the atmosphere to form nitrogen dioxide. Of the two compounds, nitrogen dioxide is associated with adverse effects on human health, principally relating to respiratory illness. The World Health Organisation (WHO) has stated that "many chemical species of nitrogen oxides exist, but the air pollutant species of most interest from the point of view of human health is nitrogen dioxide".

The major sources of NOx in the UK are road transport and power stations. According to the latest annual report from the National Atmospheric Emissions Inventory (NAEI), road transport accounted for 37% of UK emissions, with power stations accounting for a further 27%. High levels of NOx in urban areas are almost always associated with high traffic densities.

The AQS includes two objectives to be achieved by 31<sup>st</sup> December 2005. Both of these objectives are included in the Air Quality Directive, with an achievement date of 1<sup>st</sup> January 2010.

- A limit for the one-hour mean of 200  $\mu$ g/m³, not to be exceeded more than 18 times a year (equivalent to the 99.79th percentile).
- A limit for the annual mean of 40 μg/m<sup>3</sup>.

In addition, the AQS includes objectives for the protection of sensitive vegetation and ecosystems of 30  $\mu g/m^3$  for the annual mean, and 75  $\mu g/m^3$  for the daily mean concentration of nitrogen oxides.

## 3.2 Sulphur dioxide

Sulphur dioxide is predominantly released by the combustion of fuels containing sulphur. Around 68% of UK emissions in 2004 were associated with power stations, with much of the remainder associated with other combustion processes. Emissions of sulphur dioxide have reduced by 87% since 1970, due to a reduction in the number of coal fired combustion plants, the installation of flue gas desulphurisation plants on a number of large coal-fired power stations and the reduction in sulphur content of liquid fuels.

The AQS contains three objectives for the control of sulphur dioxide:

- A limit for the 15 minute mean of 266  $\mu$ g/m³, not to be exceeded more than 35 times a year (the 99.9th percentile) to be achieved by 31<sup>st</sup> December 2005.
- A limit for the one hour mean of 350  $\mu$ g/m³, not to be exceeded more than 24 times a year (the 99.73rd percentile) to be achieved by 31st December 2004.
- A limit for the daily mean of  $125 \mu g/m^3$ , not to be exceeded more than 3 times a year (the 99.2nd percentile) to be achieved by  $31^{st}$  December 2004.

The hourly and daily objectives are included in the Air Quality Directive.

S1552-0700-0011RSF

https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#environmentalstandards-for-air-emissions

In addition, the AQS includes two objectives for the protection of vegetation and ecosystems. These are a concentration of  $20 \mu g/m^3$  (reduced to  $10 \mu g/m^3$  where lichens or bryophytes are present) as an annual mean and as a winter average.

## 3.3 Particulate matter

Concerns over the health impact of solid matter suspended in the atmosphere tend to focus on particles with a diameter of less than 10  $\mu$ m, known as PM<sub>10</sub>s. These particles have the ability to enter and remain in the lungs. Various epidemiological studies have shown increases in mortality associated with high levels of PM<sub>10</sub>s, although the underlying mechanism for this effect is not yet understood. Significant sources of PM10s are road transport (22%), quarrying (16%) and stationary combustion (34%).

The AQS includes two objectives for PM<sub>10</sub>s to be achieved by the end of 2004, both of which are included in the Air Quality Directive.

- A limit for the annual mean of 40  $\mu$ g/m<sup>3</sup>, to be achieved by 2004.
- A daily limit of 50  $\mu$ g/m³, not to be exceeded more than 35 times a year (the 90.4th percentile) to be achieved by 2004.

The previous AQS included some provisional objectives for 2010. These have been replaced by an exposure reduction objective for  $PM_{2.5}s$  in urban areas and a target value for  $PM_{2.5}s$  of 25  $\mu$ g/m³ as an annual mean. This target value is included in the Air Quality Directive.

## 3.4 Carbon monoxide

Carbon monoxide is produced by the incomplete combustion of fuels containing carbon. By far the most significant source is road transport, which produces 67% of the UK's emissions. Carbon monoxide can interfere with the processes that transport oxygen around the body, which can prove fatal at very high levels.

Concentrations in the UK are well below levels at which health effects can occur. The AQS includes the following objective for the control of carbon monoxide, which is also included in the Air Quality Directive:

• A limit for the 8-hour running mean of 10 mg/m³, to be achieved by 1<sup>st</sup> January 2005.

## 3.5 Hydrogen chloride

There are no AQOs for hydrogen chloride contained within the AQS. However the Air Emissions Guidance defines the short term EAL as 750  $\mu$ g/m³. There is no long-term EAL.

## 3.6 Hydrogen fluoride

There are no AQOs for hydrogen fluoride contained within the AQS. However, Environment Agency Horizontal Guidance Note H1 Annex F defines the short term EAL as  $160 \mu g/m^3$  and the long term EAL as  $16 \mu g/m^3$ .

The Air Emissions Guidance also provides Critical Levels for the protection of vegetation and ecosystems of 5  $\mu$ g/m³ as a daily mean and 0.5  $\mu$ g/m³ as a weekly mean concentration of hydrogen fluoride.

## 3.7 Ammonia

There are no AQOs for ammonia contained within the AQS. However, the Air Emissions Guidance defines the short term EAL as 2,500  $\mu g/m^3$  and the long term EAL as 180  $\mu g/m^3$ . In addition, the Air Emissions Guidance also provides Critical Levels for the protection of vegetation and ecosystems. These are a concentration of 3  $\mu g/m^3$  as an annual mean, reduced to 1  $\mu g/m^3$  where lichens or bryophytes are present.

## 3.8 Metals

Lead is the only metal included in the AQS. Lead can have many health effects, including effects on the synthesis of haemoglobin, the nervous system and the kidneys. Emissions of lead in the UK have declined by 98% since 1970, due principally to the virtual elimination of leaded petrol.

The AQS includes objectives to limit the annual mean to  $0.5 \,\mu\text{g/m}^3$  by the end of 2004 and to  $0.25 \,\mu\text{g/m}^3$  by the end of 2008. Only the first objective is included in the Air Quality Directive.

The fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes target values for arsenic, cadmium and nickel. However, the preamble to the Directive makes it clear that the use of these target values is relatively limited. Paragraph (5) states:

"The target values would not require any measures entailing disproportionate costs. Regarding industrial installations, they would not involve measures beyond the application of best available techniques (BAT) as required by Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (5) and in particular would not lead to the closure of installations. However, they would require Member States to take all cost-effective abatement measures in the relevant sectors."

## And paragraph (6) states:

"In particular, the target values of this Directive are not to be considered as environmental quality standards as defined in Article 2(7) of Directive 96/61/EC and which, according to Article 10 of that Directive, require stricter conditions than those achievable by the use of BAT."

Although these target values have been included in the assessment, it is important to note that the application of the target values would not have an effect on the design nor operation of Facility. The Facility will be designed in accordance with BAT and will include cost effective methods for the abatement of arsenic, cadmium and nickel, including the injection of activated carbon and a fabric filter.

Emissions limits have been set in Environmental Permits for similar facilities for a number of heavy metals which do not have air quality standards associated with them. The EALs for these metals, and lead, are summarised in Table 3.1.

Table 3.1: Environmental Assessment Levels (EALs) for Metals						
	Daughter Directive	EALs (µg/m³)				
Metal	Target Level (µg/m³)	Long Term	Short Term			
Arsenic	0.006	0.003	-			
Antimony	-	5	150			
Cadmium	0.005	0.005	-			
Chromium (II & III)	-	5	150			
Chromium (VI)	-	0.0002	-			
Cobalt	-	-	-			
Copper	-	10	200			
Lead	-	0.25	-			
Manganese	-	0.15	1500			
Mercury	-	0.25	7.5			
Nickel	0.020	0.020	-			
Thallium	-	-	-			
Vanadium	-	5	1			

# 3.9 Volatile Organic Compounds (VOCs)

A variety of VOCs could be released from the stack, of which benzene and 1,3-butadiene are included in the AQS and monitored at various stations around the UK. The AQS includes the following objectives for the running annual mean:

Benzene 5 μg/m³, to be achieved by 2010.
 1,3-butadiene 2.25 μg/m³, to be achieved by 2003.

The Air Emissions Guidance includes a short-term EAL for benzene, calculated from occupational exposure. This is a limit of  $195 \,\mu g/m^3$  for an hourly mean. There are no short-term EALs for 1,3-butadiene.

## 3.10 Dioxins and furans

Dioxins and furans are a group of organic compounds with similar structures, which are formed as a result of combustion in the presence of chlorine. Principal sources include steel production, power generation, coal combustion and uncontrolled combustion, such as bonfires. The Municipal Waste Incineration Directive and UK legislation imposed strict limits on dioxin emissions in 1995, with the result that current emissions from incineration of municipal solid waste in the UK in 1999 were less than 1% of the emissions from waste incinerators in 1995. The Waste Incineration Directive, now included in the IED, imposes even lower limits, reducing the limit to one tenth of the previously permitted level.

One dioxin, 2,3,7,8-TCDD, is a definite carcinogen and a number of other dioxins and furans are considered to be possible carcinogens. A tolerable daily intake (TDI) for Dioxins, furans and dioxins like PCBs has been recommended by the Committee on the Toxicity of Chemicals in Food, Consumer Products and the Environment of 2 pg I-TEQ per kg bodyweight per day.

Dioxins are not normally compared with set EALs, but the probable ingestion rates of dioxins by different groups of people is considered as part of the Human Health Risk Assessment contained as a separate document within the application.

## 3.11 Polychlorinated biphenyl (PCBs)

PCBs have high thermal, chemical and electrical stability and were manufactured in large quantities in the UK between the 1950s and mid 1970s. Commercial PCB mixtures, which contained a range of dioxin-like and non-dioxin like congeners, were sold under a variety of trade names, the most common in the UK being the Aroclor mixtures. UK legislative restrictions on the use of PCBs were first introduced in the early 1970s.

Although now banned from production current atmospheric levels of PCBs are due to the ongoing primary anthropogenic emissions (e.g. accidental release of products or materials containing PCBs), volatilisation from environmental reservoirs which have previously received PCBs (e.g. sea and soil) or incidental formation of some congeners during the combustion process.

There are no AQOs for PCBs contained within the AQS. However, the Air Emissions Guidance defines the short term EAL as  $6 \mu g/m^3$  and the long term EAL as  $0.2 \mu g/m^3$ .

A number of PCBs are considered to possess dioxin like toxicity and are known as dioxin-like PCBs. The total intake from dioxins, furans and dioxins like PCBs is compared to the TDI for dioxins, furans and dioxin like PCBs as part of the Human Health Risk Assessment contained as a separate document within the application.

## 3.12 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are members of a large group of organic compounds widely distributed in the atmosphere. The best known PAH is benzo[a]pyrene (B[a]P). The AQS included an objective to limit the annual mean of B[a]P to  $0.25 \text{ ng/m}^3$  by the end of 2010. This goes beyond the requirements of European Directives, since the fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes a target value for benzo(a)pyrene of 1 ng/m³ as an annual mean.

## 3.13 Summary

AAD Target and Limit Values, AQS Objectives, and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups. For the remainder of this report these are collectively referred to as Air Quality Assessment Levels (AQALs). Table 3.2 summarises the AQALs used in this assessment. The sources for each of the values can be found in the preceding sections.

Table 3.2: Air Quality Assessment Levels (AQALs)						
Pollutant	Limit Value (µg/m³)	Averaging Period	Frequency of Exceedences			
Nitrogen dioxide	200	1 hour	18 times per year (99.79 <sup>th</sup> percentile)			
	40	Annual	-			
	266	15 minutes	35 times per year (99.9 <sup>th</sup> percentile)			
Sulphur dioxide	350	1 hour	24 times per year (99.73 <sup>rd</sup> percentile)			
	125	24 hours	3 times per year (99.18 <sup>th</sup> percentile)			
Particulate matter (PM <sub>10</sub> )	50	24 hours	35 times per year (90.41 <sup>th</sup> percentile)			
, ,	40	Annual	-			

Table 3.2: Air Quality Assessment Levels (AQALs)						
Pollutant	Limit Value (µg/m³)	Averaging Period	Frequency of Exceedences			
Particulate matter (PM <sub>2.5</sub> )	25	Annual	-			
Carbon monoxide	10,000	8 hours, running	-			
Hydrogen chloride	750	1 hour	-			
Lludro gon fluorido	160	1 hour	-			
Hydrogen fluoride	16	Annual	-			
Ammonia	2,500	1 hour	-			
Ammonia	180	Annual	-			
Lead	0.25	Annual	-			
Dannana	5.00	Annual	-			
Benzene	195	1 hour	-			
1,3-butadiene	2.25	Annual, running	-			
DCD-	6	1-hour	-			
PCBs	0.2	Annual	-			
PAHs	0.00025	Annual	-			

Table 3.3 Critical Levels for the Protection of Vegetation and Ecosystems						
Pollutant	Concentration (µg/m³)	Measured as				
Nitrogen oxides (as	75	Daily mean				
nitrogen dioxide)	30	Annual mean				
Sulphur dioxide	10	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystems integrity				
	20	Annual mean for all higher plants				
Hydrogon flyorida	<5	Daily mean				
Hydrogen fluoride	<0.5	Weekly mean				
Ammonia	1	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystems integrity				
	3	Annual mean for all higher plants				

# BASELINE AIR QUALITY

The Facility is located to the south-east of the disused airfield known as Rivenhall airfield, in rural Essex approximately 3.4km south east of Kelvedon. Reference should be made to Figure 1 which shows the site location. In this section, we have reviewed the baseline air quality and defined appropriate background concentrations to be used within this assessment.

#### 4.1 Air quality review and assessment

As required under Section 82 of the Environment Act (1995) (Part IV), local authorities are required to undertake an ongoing exercises to review air quality within their area of jurisdiction. The closest Air Quality Management Area (AQMA) is located in Chelmsford approximately 15 to the south-east of the Facility. Due to the distance to the closest AOMAs it is not likely that the emissions from the Facility would have any measurable impact on any designated AOMA.

#### National modelling - mapped background data 4.2

To assist local authorities with their responsibilities under Local Air Quality Management, the Department for the Environment Food and Rural Affairs (DEFRA) provides modelled background concentrations of pollutants throughout the UK on a 1 km by 1 km grid. This model is based on known pollution sources and background measurements and is used by local authorities in lieu of suitable monitoring data. Mapped background concentrations were downloaded for the grid squares containing the Facility and immediate surroundings. A summary is presented within Table 4.1.

In addition, mapped atmospheric concentrations of ammonia are available from DEFRA throughout the UK on a 5 km by 5 km grid. Mapped ammonia background concentrations were downloaded for the grid square containing the Facility, as presented within Table 4.1.

Table 4.1: Mapped Background Data – at Facility						
Annual Mean Concentration (µg/m³)	Dataset					
10.1	2013 mapped background dataset					
13.7	2013 mapped background dataset					
3.5	2001 mapped background dataset					
17.6	2013 mapped background dataset					
12.1	2013 mapped background dataset					
254	2001 mapped background dataset					
0.3	2001 mapped background dataset					
0.1	2001 mapped background dataset					
1.6	2014 mapped background dataset					
	Concentration (µg/m³)  10.1  13.7  3.5  17.6  12.1  254  0.3  0.1					

## Notes:

- (1) 1km x 1km grid square centred upon 582500, 220500
- (2) 5km x 5km grid square centred upon 580000, 220000

The mapped background data is calibrated against monitoring data. For instance, the 2013 mapped background concentrations are based on 2013 meteorological data and are calibrated against monitoring undertaken in 2013. As a conservative approach where mapped background data is used the concentration for the year against which the data was validated has been used for the purpose of this assessment. This eliminates any potential uncertainties over anticipated trends in future background concentrations.

Background concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration within the modelling domain has been calculated as presented in Table 4.2.

Table 4.2: Mapped Background Data – Maximum within Modelling Domain						
Pollutant	Annual Mean Concentration (µg/m³)	Dataset				
Nitrogen dioxide	18.6	2013 mapped background dataset				
Oxides of nitrogen	26.9	2013 mapped background dataset				
Sulphur dioxide	6.2	2001 mapped background dataset				
Particulate matter (as PM <sub>10</sub> )	20.2	2013 mapped background dataset				
Particulate matter (as PM <sub>2.5</sub> )	13.8	2013 mapped background dataset				
Carbon monoxide	301	2001 mapped background dataset				
Benzene	0.4	2001 mapped background dataset				
1,3-butadiene	0.2	2001 mapped background dataset				
Ammonia	1.8	2014 mapped background dataset				

## 4.3 AURN and LAQM monitoring data

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of the DEFRA this includes automatic monitoring of oxides of nitrogen, nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and particulates. No AURN sites have been identified within 20km of the Facility.

In addition to the national AURN, local authorities undertake monitoring of a range of pollutants as part of the LAQM review process. A review of the monitoring undertaken by Braintree District Council as part of their LAQM commitments has shown that they monitor for nitrogen dioxide concentrations at 12 sites using diffusion tubes. Of these only 3 are not classified as roadside sites and classified as either urban centre or urban background locations. A summary of the monitoring data from these sites is presented in the following table. Where the monitored concentration exceeds the AQAL this is highlighted in **bold**.

Table 4.3: Nitrogen Dioxide Diffusion Tubes - Braintree District Council							
Site	Mapped Bg - 2011	2010	2011	2012	2013	2014	
Braintree 1N - Blamford House, London Rd	15.6	36.7	34.3	30.1	36.6	34.7	
Braintree 5N – The While Hart Hotel, Coggeshall Road	15.9	25.8	25.6	25.5	25.3	23.5	
Braintree 4N – Beckers Green Road	15.3	21.1	21.2	21.0	22.8	19.8	
Halstead 1 – Church yard, Colchester Road	15.2	31.5	31.5	30.7	30.0	27.7	
Hadfield Peverel A12	21.2	45.6	49.5	44.7	50.5	47.7	
Kelvedon High Street, Kelvedon	14.9	30.0	29.1	32.5	32.8	27.9	
Bradwell – the Street, Bradwell	13.8	43.5	41.8	38.6	38.1	37.3	
Braintree – Railway Street	15.7	32.4	28.8	29.2	29.5	29.2	
Braintree – Stilemans Wood	15.3	32.6	37.1	33.2	28.1	33.5	
Witham – Chipping Hill	22.4	50.3	47.1	47.0	45.8	38.8	
Rivenahll Hotel A12	19.4	55.3	56.0	49.8	51.8	43.6	
Rivenahll Foxden A12	19.4	50.5	53.2	49.8	51.8	52.1	

NOTES:

Data only available up to the end of 2014,

source Braintree District Council 2015 Updating and Screening Assessment.

The LAQM report explains that although exceedences of the AQAL were monitored these were not at locations of public exposure. At areas where the AQAL applies the concentration was calculated to be below the AQAL.

The monitoring sites are not located in areas where impacts are predicted to occur. Therefore, the data presented in Table 4.3 does not necessarily represent baseline concentrations in the area of concern. Due to the rural nature of the area it is considered appropriate to use the mapped background as a source of baseline data. The choice of background will be considered further if the impact of the Facility cannot be screened out as insignificant.

## 4.4 Hydrogen chloride

Hydrogen chloride is measured on behalf of DEFRA as part of the UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) project. This consolidates the previous Acid Deposition Monitoring Network (ADMN), and National Ammonia Monitoring Network (NAMN). The closest monitoring station is located at London Cromwell Road approximately 60km to the south-east of the Facility. A summary of the data from all background and rural sites in the UK is presented in Table 4.4.

Table 4.4: Hydrogen Chloride Monitoring – UKEAP							
	Annual Mean Concentration (µg/m³)						
2011 2012 2013 2014 2015							
0.10	0.14	0.15	0.10	0.12			
0.72	0.44	0.50	0.45	0.71			
0.29	0.27	0.31	0.25	0.24			
	2011 0.10 0.72	Annual Mea           2011         2012           0.10         0.14           0.72         0.44	Annual Mean Concentration           2011         2012         2013           0.10         0.14         0.15           0.72         0.44         0.50	Annual Mean Concentration (μg/m³)       2011     2012     2013     2014       0.10     0.14     0.15     0.10       0.72     0.44     0.50     0.45			

Notes:

Data for each site downloaded from the DEFRA website.

In lieu of any local monitoring, the maximum monitored at any site has been used for the purpose of this assessment (0.72  $\mu$ g/m³ – 2011). The choice of background will be considered further if the impact of the Facility cannot be screened out as insignificant.

## 4.5 Hydrogen fluoride

Baseline concentrations of hydrogen fluoride are not measured locally or nationally, since these are not generally of concern in terms of local air quality. However, the EPAQS report 'Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects' contains some estimates of baseline levels, reporting that measured concentrations have been in the range of  $0.036~\mu g/m^3$  to  $2.35~\mu g/m^3$ .

In lieu of any local monitoring, the maximum measured baseline hydrogen fluoride concentration has been used for the purpose of this assessment as a conservative estimate. The choice of background will be considered further if the impact of the Facility cannot be screened out as insignificant.

## 4.6 Ammonia

Ammonia is also measured as part of the UKEAP project and the closest site is located at London Crowell Road. In lieu of any local monitoring the maximum mapped background over the modelling domain as presented in Table 4.2 has been used for the purpose of this assessment. The choice of background will be considered further if the impact of the Facility cannot be screened out as insignificant.

# 4.7 Volatile Organic Compounds

As part of the Automatic and Non-Automatic Hydrocarbon Network, benzene and 1,3-butadiene concentrations are measured at sites co-located with the AURN across the UK. The closest monitoring sites are located in London. In lieu of any local monitoring the maximum mapped background over the modelling domain as presented in Table 4.2 has been used for the purpose of this assessment. The choice of background will be considered further if the impact of the Facility cannot be screened out as insignificant.

## 4.8 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). A summary of the maximum average monitored concentrations at rural sites across the UK is presented in Table 4.5.

Table 4.5: Heavy Metals Monitoring – Maximum Annual Mean from Rural Sites							
Metal Annual Mean AQAL (ng/m³)			Max as				
	AQAL	2011	2012	2013	2014	2015	% of AQAL
Antimony	5,000	0.83	0.78	0.62	0.38	-	0.02%
Arsenic	3	0.46	0.47	0.43	0.43	0.39	7.9%
Cadmium	5	0.15	0.09	0.09	0.07	0.07	2.9%
Chromium	5,000	1.14	0.85	1.38	2.62	3.43	0.1%
Cobalt	-	0.07	0.08	0.08	0.05	0.05	-
Copper	10,000	2.57	1.92	1.92	1.59	1.72	0.03%
Manganese	150	2.25	1.53	1.83	1.16	1.67	1.5%
Mercury	250	1.51	1.05	1.27	1.26	-	0.6%
Nickel	20	0.89	0.55	0.72	0.59	1.37	6.8%
Lead	250	4.34	4.40	3.40	2.88	2.83	1.8%
Thallium	-	-	-	-	-	-	-
Vanadium	5,000	1.11	0.76	0.85	0.64	0.46	0.02%

### Notes:

Mercury is based on the monitored mercury in PM10.

Thallium is not currently monitored.

Monitoring of antimony ceased in early 2014.

Data for each site downloaded from the UK Air website.

As shown, the concentrations monitored over the last 5 years at rural sites were significantly lower than the AQALs. In lieu of any local rural monitoring, the maximum annual average monitored metal concentration from rural sites across the UK between 2011 and 2015 has been used as the background concentration within this assessment.

## 4.9 Dioxins, furans and polychlorinated biphenyl (PCBs)

Dioxins, furans and PCBs are monitored on a quarterly basis at a number of urban and rural stations in the UK as part of the Toxic Organic Micro Pollutants (TOMPs) network. London Nobel House is the closest monitoring site with data from the most recent year. A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 4.6 and Table 4.7.

Table 4.6: Dioxin, Furan Monitoring Results - National					
		Annua	l Mean Conc. (r	ng/m³)	
	2008	2009	2010	2011	2012
London	10.94	41.44	38.60	3.70	15.45
Manchester	18.99	14.21	14.21	12.53	33.00
Auchencorth*	6.44	0.56	5.01	0.07	0.13
Middlesbrough	23.98	-	-	-	-
High Muffles*	1.73	9.38	2.76	0.98	4.33
Hazelrigg*	3.67	13.49	8.03	2.03	8.75
Weybourne*	-	22.82	2.49	2.50	9.25
UK Average	10.96	16.98	11.85	3.63	11.82

## Notes:

Data for each site downloaded from the UK Air website.

No data available from the UK-Air website since the end of 2012

Table 4.7: Dioxin Like PCB Monitoring Results - National					
		Annua	l Mean Conc. (r	ng/m³)	
	2008 2009 2010 2011				
London	164.18	317.94	254.90	93.85	83.20
Manchester	133.42	168.38	185.28	119.45	101.72
Auchencorth*	12.12	44.66	37.40	15.17	10.46
Middlesbrough	138.43	-	-	-	-
High Muffles*	20.08	109.94	141.50	24.60	13.74
Hazelrigg*	14.52	89.18	110.00	31.13	28.78
Weybourne*	-	44.66	21.30	19.19	19.54
UK Average	80.46	129.13	125.06	50.56	42.91

## Notes:

Data for each site downloaded from the UK Air website.

No data available from the UK-Air website since the end of 2012

As shown, the concentrations vary significantly between sites and years. As no site is located in close proximity to the Facility, the maximum monitored concentration from a rural site has been used as the background concentration within this assessment (22.82 fg/TEQ/m³ for dioxins and furans (Weybourne 2009) and 141.50 pg/m³ for PCBs (High Muffles 2010)). The choice of background will be considered further if the impact of the Facility cannot be screened out as insignificant.

<sup>\*</sup> rural site

<sup>\*</sup> rural site

#### Polycyclic Aromatic Hydrocarbons (PAHs) 4.10

Polycyclic Aromatic Hydrocarbons (PAHs) are monitored as part of the PAH network. The closest background monitoring site is located at Crystal Palace, London. For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH which an AQAL has been set. A summary of benzo(a)pyrene concentrations from all background monitoring sites within the UK is presented in Table 4.8. Any exceedences of the AOAL are highlighted.

Table 4.8: Benzo(a)pyrene Monitoring - National							
Cito	Ouantitu	AQAL	,	Annual Mea	n Concentra	tion (ng/m³	)
Site	Quantity	(ng/m³)	2011	2012	2013	2014	2015
	Min	0.25	0.03	0.07	0.05	0.04	0.03
Rural Background	Max	0.25	0.13	0.14	0.12	0.10	0.09
20019.000	Average	0.25	0.07	0.09	0.08	0.07	0.06
	Min	0.25	0.10	0.11	0.08	0.06	0.07
Urban Background	Max	0.25	1.12	1.03	0.89	0.85	0.87
	Average	0.25	0.36	0.34	0.29	0.28	0.25
Number of background sites exceeding EC Target Value (1 ng/m³)		1	1	0	0	0	
Number of background sites exceeding EC Upper Assessment Threshold (0.6 ng/m³)		3	2	2	2	2	
Number of background sites exceeding EC Lower Assessment Threshold (0.4 ng/m³)		4	4	3	3	2	

Data for each site downloaded from the UK Air website.

A review of the monitoring data at each location has shown that generally concentrations are decreasing of the past few years, and the locations where the urban background concentration exceeds the AQAL is restricted to dense urban areas with significant amounts of local industry. The local area surrounding the facility and where the greatest impacts are predicted to occur is more similar to the rural monitoring locations. In lieu of any local monitoring the maximum monitored concentration from a rural background site has been used (0.14 ng/m<sup>3</sup> - 2012). The choice of background will be investigated if the impact of the Facility cannot be screened out as insignificant.

#### 4.11 Summary

Table 4.9 outlines the values for the annual average background concentrations that have been used to evaluate the impact of the Facility. Further analysis of the background concentration has been undertaken where impacts cannot be screened out as 'insignificant'. In addition, the impact at all identified monitoring locations within the modelling domain has been quantified.

Table 4.9: Summary of Background Concentrations					
Pollutant	Annual Mean Concentration	Units	Justification		
Nitrogen dioxide	18.6	µg/m³	2013 mapped background dataset		
Oxides of nitrogen	26.9	µg/m³	maximum grid square within the modelling domain.		
Sulphur dioxide 6.2		μg/m³	2001 mapped background dataset maximum grid square within the modelling domain.		
Particulate matter (as PM <sub>10</sub> )	20.2	μg/m³	2013 mapped background dataset		
Particulate matter (as PM <sub>2.5</sub> )	13.8	µg/m³	maximum grid square within the modelling domain.		
Carbon monoxide	301	μg/m³	2001 mapped background dataset maximum grid square within the modelling domain.		
Hydrogen chloride	0.72	μg/m³	Maximum from all UK monitoring sites between 2011 and 2015.		
Hydrogen fluoride	2.35	μg/m³	Maximum measured baseline hydrogen fluoride concentration as presented in the EPAQS report.		
Ammonia	1.8	μg/m³	Maximum mapped background concentration within the modelling domain – 2014 dataset.		
Benzene	0.4	μg/m³	Maximum mapped background		
1,3-butadiene	0.2	µg/m³	concentration within the modelling domain – 2001 dataset.		
Mercury	1.51	ng/m³			
Cadmium	0.15	ng/m³			
Arsenic	0.47	ng/m³			
Antimony	0.83	ng/m³			
Chromium	3.43	ng/m³	The maximum monitored metal		
Cobalt	0.08	ng/m³	concentration from at a rural site		
Copper	2.57	ng/m³	between 2011 and 2015.		
Manganese	2.25	2ng/m <sup>3</sup>			
Lead	4.40	ng/m³			
Nickel	1.37	ng/m³			
Vanadium	1.11	ng/m³			
Dioxins and furans	22.82	fg/m³	The maximum monitored metal		
Polychlorinated biphenyl (PCBs)	141.50	pg/m³	concentration from at a rural site between 2008 to 2012		
Benzo(a)pyrene (PaB)	0.14	ng/m³	Maximum monitored concentration from a rural background site between 2011 and 2015.		

# 5 Sensitive Receptors

# 5.1 Human sensitive receptors

The general approach to the assessment is to evaluate the highest predicted process contribution to ground level concentrations. In addition, the predicted process contribution at a number of sensitive receptors has been evaluated. These sensitive receptors are displayed in Figure 1 of Appendix A and listed in Table 5.1.

	Table 5.1: Sensitive Receptors					
		Loca	ation	Distance		
ID	Receptor Name	X	Y	from the Stack (m)		
D1	Sheepcotes Farm (Hanger No.1)	581564.6	220328.3	882		
D2	Wayfarers Site	582557.4	220185.4	260		
D3	Allshot's Farm (Scrap Yard)	582892.6	220458.3	452		
D4	Haywards	583235.7	221162.6	1088		
D5	Herons Farm	582443.0	221378.3	960		
D6	Gosling's Farm	581426.9	221380.9	1399		
D7	Curd Hall Farm	583261.7	221708.3	1528		
D8	Church (adjacent to Bradwell Hall)	581832.3	222157.9	1844		
D9	Bradwell Hall	581837.5	222319.1	1995		
D10	Rolphs Farmhouse	580675.8	220512.8	1769		
D11	Silver End / Bower Hall / Fossil Hall	581286.5	219730.6	1345		
D12	Rivenhall Pl/Hall	581860.9	219104.3	1437		
D13	Parkgate Farm / Watchpall Cottages	582336.5	219195.2	1228		
D14	Ford Farm / Rivenhall Cottage	582697.7	218597.5	1839		
D15	Porter's Farm	583391.6	219242.0	1511		
D16	Unknown Building 1	583131.7	219462.9	1178		
D17	Bumby Hall / The Lodge / Polish Site (Light Industry)	582947.2	220115.2	589		
D18	Footpath 8, Receptor 1 (East of Site)	582660.7	220977.1	600		
D19	Footpath 8, Receptor 2 (East of Site)	582597.0	220688.5	311		
D20	Footpath 8, Receptor 3 (East of Site)	582609.1	220564.0	221		
D21	Footpath 8, Receptor 4 (East of Site)	582627.3	220497.2	201		
D22	Footpath 8, Receptor 5 (East of Site)	582590.9	220415.2	149		
D23	Footpath 8, Receptor 6 (East of Site)	582761.0	220217.8	376		
D24	Footpath 8, Receptor 7 (East of Site)	583016.1	220026.5	695		
D25	Footpath 35, Receptor 1 (North of Site)	582861.2	220843.4	597		
D26	Footpath 35, Receptor 2 (North of Site)	582454.2	221013.5	595		
D27	Footpath 35, Receptor 3 (North of Site)	582032.1	221162.3	850		
D28	Footpath 31, Receptor 1 (North west of Site)	581877.2	220958.8	782		

	Table 5.1: Sensitive Receptors					
		Loca	Location			
ID	Receptor Name	X	Y	from the Stack (m)		
D29	Footpath 31, Receptor 2 (North west of Site)	581740.6	220764.5	783		
D30	Footpath 31, Receptor 3 (North west of Site)	581379.2	220548.8	1071		
D31	Footpath 7, Receptor 1 (South east of Site)	582505.9	220117.6	307		
D32	Footpath 7, Receptor 2 (South east of Site)	582757.9	220066.0	473		
D33	Footpath 7, Receptor 3 (South east of Site)	582967.5	219959.7	697		
D34	Footpath 7, Receptor 4 (South east of Site)	583167.9	220372.7	727		
D35	Footpath 7, Receptor 5 (South east of Site)	583301.5	220725.0	912		
D36	Elephant House (Street Sweepings)	582368.7	220189.0	241		
D37	Green Pastures Bungalow	581249.9	221176.1	1413		
D38	Deeks Cottage	582873.4	221255.1	941		
D39	Woodhouse Farm	582583.9	220617.9	245		
D40	Gosling Cottage / Barn	581508.4	221305.5	1288		
D41	Felix Hall / The Clock House / Park Farm	584578.8	219574.9	2297		
D42	Glazenwood House	579980.5	222134.8	3001		
D43	Bradwell Hall	580570.6	222802.9	3032		
D44	Perry Green Farm	580899.7	221973.3	2190		
D45	The Granary / Porter Farm / Rook Hall	584106.2	218964.5	2209		
D46	Grange Farm	584888.0	222222.0	3039		
D47	Coggeshall	585070.0	222839.0	3573		

# 5.2 Sensitive ecological receptors

A study was undertaken to identify the following sites of ecological importance in accordance with Environment Agency Horizontal Guidance H1:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 10 km of the Facility (or 15 km coal- or oil- fired power station);
- Sites of Special Scientific Interest (SSSIs) within 2 km of the Facility; and
- National Nature Reserves (NNR), Local Nature Reserves (LNRs), local wildlife sites and ancient woodlands within 2 km of the Facility.

Some large emitters may be required to screen to 10 km or 15 km for SSSIs.

A screening distance of 10km has been used for all SACs, SPAs, Ramsar sites and 2km for all SSSIs. These sensitive ecological receptors are listed in Table 5.2 and displayed in Figure 2 of Appendix A. A review of the citation and APIS website for each site has been undertaken to determine if lichens are an important part of the ecosystem's integrity for the purposes of determining the relevant Critical Level for the habitat.

Table 5.2: Sensitive Ecological Receptors						
	Locatio	on (m)	Distance from	Lichens		
Site	х		the Main Stack at Closest Point (km)	identified as present within APIS database		
European designated sites (within 10km)						
None identified	-	-	-	-		
UK designated sites (SSSIs) (within 2km)						
None identified	-	-	-	-		
Locally designated sites (within	2km)					
Blackwater Plantation	582771	222096	1.7	-		
Maxeys Spring	582665	219976	0.5	-		
Storeys Wood	581817	220983	0.8	-		
Upney Wood	583407	220241	1.0	-		
Link's Wood	580439	221089	2.1	-		
Park House Meadow	581075	222308	2.3	-		

## 6 DISPERSION MODELLING METHODOLOGY

## 6.1 Selection of model

Detailed dispersion modelling was undertaking using the model ADMS 5.2, developed and supplied by Cambridge Environmental Research Consultants (CERC). This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and Environmental Permitting purposes to the satisfaction of the Environment Agency and Local Authorities.

## 6.2 Model inputs

As noted all point source emissions from the Facility will emit to atmosphere via stacks contained within a common windshield. The effect of this is to have one visible stack at a height of 58m above the surrounding ground level as detailed on Figure 4. Emissions from this stack will include the two CHP lines, exhaust air from the pulp plant, the two AD gas engines, and the AD biofilter. The following sections detail the source and emissions data for each item of plant.

## 6.2.1 Source and emissions data – CHP

The principal inputs to the model with respect to the emissions to air from the CHP are presented in Table 6.1. This data has been provided by HZI (the technology provider).

Table 6.1: Source Data - CHP Plant				
Item	Unit	CHP (per stream)		
Stack diameter	m	2.3		
Flue Gas Conditions				
Temperature	°C	138.65		
Exit moisture content	% v/v	17.42%		
Exit oxygen content	% v/v dry	7.34%		
Reference oxygen content	% v/v dry	11%		
Volume at reference	Nm³/s	51.56		
conditions (dry, ref O2)	Nm³/h	185,610		
Volume at actual	Am³/s	69.70		
conditions	Am³/h	250,915		
Flue gas exit velocity	m/s	16.8		
Moisture content	kg/kg	0.1252		
Specific heat capacity (Cp)	J/°C/kg	1114		
Molar mass	g	28.20		

Emissions from the CHP have been assumed to comply with the limits prescribed within Chapter VI Part 3 of the IED.

Table 6.2: Emissions Data – CHP (per stream) – Daily Emission Limit Values				
Pollutant	Conc. (mg/Nm³)	Release Rate (g/s)		
Oxides of nitrogen (as NO <sub>2</sub> )	150	7.734		
Sulphur dioxide	50	2.578		
Carbon monoxide	50	2.578		
Particulates	10	0.516		
Hydrogen chloride	10	0.516		
Volatile organic compounds (as TOC)	10	0.516		
Hydrogen fluoride	1	0.052		
Ammonia	10	0.516		
Cadmium and thallium	0.05	2.578 mg/Nm³		
Mercury	0.05	2.578 mg/Nm <sup>3</sup>		
Other metals	0.5	25.779 mg/Nm³		
Benzo(a)pyrene (PaHs)	0.105 μg/Nm³	5.414 μg/s		
Dioxins and furans	0.1 ng/Nm³	5.156 ng/s		
PCBs	0.005 mg/Nm <sup>3</sup>	0.258 mg/Nm <sup>3</sup>		

## NOTES:

NOX ELV of 150 mg/Nm<sup>3</sup> is being applied for as part of the EP application.

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

As a worst-case it has been assumed that the entire PM emissions consist of either PM10 or PM2.5 for comparison with the relevant AQALs.

The highest recorded emission concentration of B[a]P from the Environment Agency's public register was  $0.105~\mu g/m^3$ , or  $0.000105~mg/m^3$  (dry, 11%~oxygen, 273K). This has been assumed to be the emission concentration for the Facility.

Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co),copper Cu), manganese (Mn), nickel (Ni) and vanadium (V).

The Waste Incineration BREF provides a range of values for PCB emissions to air from European municipal waste incineration plants. This states that the annual average total PCBs is less than  $0.005 \, \text{mg/Nm}^3$  (dry, 11% oxygen, 273K). In lieu of other available data, this has been assumed to be the emission concentration for the Facility.

In addition to the limits shown in Table 6.2, the IED also details half hourly average limits for a number of pollutants. It should be noted that if the CHP continually operated at these limits the daily limits would be exceeded. The CHP will be designed to achieve the limits shown in Table 6.2 and as such will only operate at the shorter term limits for short periods on rare occasions.

The CHP is designed to operate at full capacity and it is not anticipated to have significant changes in loading. Therefore, it is appropriate to base the assessment on the design point of the system.

Table 6.3: Emissions Data – CHP (per stream) – Half Hourly Emission Limit Values				
Pollutant	Conc. (mg/Nm³)	Release Rate (g/s)		
Oxides of nitrogen (as NO <sub>2</sub> )	400	20.623		
Sulphur dioxide	200	10.312		
Carbon monoxide	100	5.156		
Particulates	30	1.547		
Hydrogen chloride	60	3.093		
Volatile organic compounds (as TOC)	20	1.031		
Hydrogen fluoride	4	0.206		
NOTES: All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K				

# 6.2.2 Source and emissions data – Pulp Plant

The principal inputs to the model with respect to the emissions to air from the pulp plant are presented in Table 6.4.

Table 6.4: Source Data - Pulp Plant			
Item	Unit	Pulp Plant	
Stack diameter	m	2.2	
Flue Gas Conditions			
Temperature	°C	119.98	
Exit moisture content	% v/v	1.85%	
Exit oxygen content	% v/v dry	20.95%	
Volume at actual	Am <sup>3</sup> /s	71.01	
conditions	Am <sup>3</sup> /h	255,642	
Flue gas exit velocity	m/s	18.7	
Moisture content	kg/kg	0.01171	
Specific heat capacity (Cp)	J/°C/kg	1024	
Molar mass	g	28.80	

The air from the pulp plant will not include any combustion gases and as such no emissions have been included in the model. The source has been included to ensure the effect of emitting to atmosphere with the other sources is considered.

# 6.2.3 Source and emissions data – gas engines

In addition to the CHP, the AD Facility will include two 450kWe gas engines. The principal inputs to the model with respect to the emissions to air from the AD gas engines are presented in Table 6.5.

Table 6.5: Source Data - AD Gas Engines			
Item	Unit	Gas Engines (per engine) x 2	
Stack diameter	m	0.3	
Flue Gas Conditions			
Temperature	°C	250	
Exit moisture content	% v/v	14.37	
Exit oxygen content	% v/v dry	6.00	
Reference oxygen content	% v/v dry	5.00	
Volume at reference conditions (dry, ref O2)	Nm³/s	0.43	
	Nm³/h	1,531	
Values at actual conditions	Am³/s	1.01	
Volume at actual conditions	Am³/h	3,653	
Flue gas exit velocity	m/s	14.4	
Moisture content	kg/kg	0.1000	
Specific heat capacity (Cp)	J/°C/kg	1135	
Molar mass	g	28.44	

Emissions from the gas engines have been assumed to comply with the limits prescribed within Environment Agency standard rules permit SR2012 No. 12 Anaerobic digestion facility including use of resultant biogas.

Table 6.6: Emissions Data – Gas Engines – Daily Emission Limit Values		
Conc. (mg/Nm³)	Release Rate (g/s)	
500	0.213	
350	0.149	
1400	0.595	
1000	0.425	
	Conc. (mg/Nm³)  500  350  1400	

It is noted that the above emissions are daily averages. EPR 1.01 provides emission limits on a daily basis and states that hourly averages should not exceed 200% of the daily limit. This assumption has been used for the gas engines. It should be noted that if the gas engines continually operated at the higher level the daily limit would be exceeded. The boilers will be designed to achieve the limits shown in Table 6.6 and as such will only operate at the shorter term limits for short periods on rare occasions.

Table 6.7: Emissions Data - Gas Boilers - Half Hourly Emission Limit Values			
Pollutant	Conc. (mg/Nm³)	Release Rate (g/s)	
Oxides of nitrogen (as NO <sub>2</sub> )	1000	0.425	
Sulphur dioxide	700	0.298	
Carbon monoxide	2800	1.191	
VOCs	2000	0.851	
NOTES: All emissions are expressed at reference conditions of dry gas, 5% oxygen, 273.15K			

# 6.2.4 Source and emissions data – AD biofilter

The principal inputs to the model with respect to the emissions to air from the AD biofilter are presented in Table 6.8.

Table 6.8: Source Data - AD Bio-filter			
Item	Unit	AD Bio-filter	
Stack diameter	m	1.2	
Flue Gas Conditions			
Temperature	°C	30.54	
Exit moisture content	% v/v	1.00	
Exit oxygen content	% v/v dry	20.95%	
	Am³/s	17.08	
Volume at actual conditions	Am³/h	61,500	
Flue gas exit velocity	m/s	15.1	
Moisture content	kg/kg	0.006	
Specific heat capacity (Cp)	J/°C/kg	1011	
Molar mass	g	28.86	
Odour concentration	OU <sub>E</sub> /m³	3,000	
Odour release rate	OU <sub>E</sub> /s	51,250	

The air from the AD biofilter will not include any combustion gases and as such no emissions have been included in the model. The source has been included to ensure the effect of emitting to atmosphere with the other sources is considered.

The volume of air to be treated within the AD Plant has been calculated as follows:

- The volume of the 'dirty air' of the AD plant is approximately 24,500 m<sup>3</sup>.
- The biofilter is assumed to provide 2.5 air changes per hour from the 'dirty air' of the AD plant.

On this basis, the biofilter is required to treat approximately  $(24,600 \times 2.5) = 61,500 \text{ m}^3/\text{hour}$ .

As stated within Environment Agency Guidance titled 'Biofilter performance and operation as related to commercial composting':

".... industry has adopted an odour concentration of approximately 3,000 OUE/m3 as the threshold for acceptable odour from biofilter"

It is acknowledged that biofilters can achieve lower concentrations of odour; however, for the purposes of this assessment a conservative approach has been adopted.

Therefore, the release rate for odour has been calculated as follows:

Release rate = Volume of air x odour concentration

 $= 61,500 \times 3,000$ 

= 184,500,500 OUE/hr

= 51,250 OUE/sec

# 6.2.5 Meteorological data and surface characteristics

The impact of meteorological data was taken into account by using weather data from Stansted Airport for the years 2009 – 2013. Stansted Airport is approximately 30km from the Facility. Other sources of weather data include Southend on Sea, but this is likely to be effected by the presence of the coastline. Stansted Airport is located at a similar altitude to the Rivenhall site. Although the Rivenhall site is in a more rural location than Stansted Airport this has been taken into account in the model inputs.

The periods 2009 to 2013 was chosen as this was the full set of data available at the time of starting to the air quality modelling. The Environment Agency recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. Therefore, using 5 years from 2009 to 2013 rather than 2012 to 2016 is not anticipated to affect the results significantly. Wind roses for each year can be found in Figure 3.

The surface roughness length can be selected in ADMS for both the site and the meteorological site. The sensitivity of the results to surface roughness length has been considered by running the model with a range of surface roughness lengths for the dispersion site.

The following parameters were kept constant:

- Stack height 58 m (108 AOD);
- Source all sources;
- Buildings included;
- Terrain excluded; and
- Met data year 2011.

Table 6.9 presents the combined contribution to the ground level concentration of the emissions of oxides of nitrogen at the point of maximum impact.

Table 6.9: Surface Roughness Sensitivity			
Surface roughness (m)	Max annual mean NOx process contribution	Max 1-hour mean NOx process contribution	
0.2 – agricultural areas (min)	1.14	23.30	
0.3 – agricultural areas (max)	1.25	23.16	
0.5 – Parklands and open suburbia	1.43	23.07	
1.0 - Cities and large towns	1.72	23.03	

As shown, increasing the surface roughness leads to the predicted concentration at the point of maximum impact increasing for long term averages, but the peak 1-hour concentration remains constant. The surface roughness of 0.3 m is most representative of agricultural environments like the wider area and has therefore been used within this assessment. The surface roughness has also been set to 0.3m for the meteorological site.

The Monin-Obukov length for the site and meteorological site can be specified in ADMS. This provides a measure of the stability of the atmosphere and indicates the height above which convective turbulence (i.e. thermal) is more important than mechanical (i.e. friction). This allows for the effect of the urban heat island, to prevent the atmosphere from ever becoming very stable, to be simulated within the model. The Monin-Obukov length of the modelling domain was taken to be 1 m which is the value appropriate for rural sites. The Monin-Obukov length of the meteorological data was taken to be 30 m which is the value appropriate for Stansted Airport. This difference in Monin-Obukov length has been used to account for the more rural setting of the Rivenhall site than Stansted Airport.

# 6.2.6 Modelling domain

Modelling has been undertaken over a  $4.5 \text{ km} \times 4.5 \text{ km}$  grid with a spatial resolution of 45 m. The maximum grid spacing in each is less than 1.5 times the stack height in accordance with the Environment Agency modelling rule of thumb.

Table 6.10: Modelling Domain		
Grid	Domain	
Grid Spacing (m)	53	
Grid Points	101	
Grid Start X	579750	
Grid Finish X	585050	
Grid Start Y	217750	
Grid Finish Y	223050	

## 6.2.7 Terrain

It is recommended that, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. A review of the local area has shown that the local area is flat and the effects of terrain will be minimal.

The sensitivity of the results to terrain has been considered by running the model with and without a terrain file.

The following parameters were kept constant:

- Stack height 58 m (108 AOD);
- Source all sources;
- Buildings included;
- Surface roughness length 0.3m; and
- Met data year 2011.

Table 6.9 presents the combined contribution to the ground level concentration of the emissions of oxides of nitrogen at the point of maximum impact.

Table 6.11: Terrain Sensitivity			
Scenario	Max annual mean NOx process contribution	Max 1-hour mean NOx process contribution	
Excluding terrain	1.25	23.16	
Including terrain	1.27	23.18	

As shown, the effect of terrain is minimal as expected as the terrain within the modelling domain is benign. Analysis of the plot files in Figure 5 has shown that the contours are very similar both including and excluding the effects of terrain. For the remainder of this analysis the effects of terrain have been excluded from the dispersion modelling.

# 6.2.8 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

The Environment Agency<sup>2</sup> recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 6.12. The building is to be located within the quarry and as such the height of the building (and stack) has been calculated based on the difference from the ground level outside of the quarry to the top of the building. For example, the height of the main building is  $60.75 \, \text{m}$  AOD, but the height of the surrounding land is  $\sim 50 \, \text{m}$  AOD. Therefore, the building height has been set to  $10.75 \, \text{m}$ .

A site plan showing which buildings have been contained in the model is presented in Figure 4 of Appendix A. A detailed analysis of the sensitivity to the treatment of the building in the modelling is contained in Section 12.

AQTAG06 – Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air – January 2013.

Table 6.12: Building Details								
Buildings	Cent	re Point	Height	Length	Width	Angle (°)		
	X (m)	Y (m)	(m)	(m)	(m)			
Main Building	582287	220485	10.75 <sup>(1)</sup>	247	205	40		

#### NOTES:

(1) Building height reduced to reflect the height of the building around surrounding ground level as detailed in Figure 4.

### 6.3 Chemistry

The plant will release nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) which are collectively referred to as NOx. In the atmosphere, a proportion of nitric oxide will be converted to nitrogen dioxide in a reaction with ozone which is influenced by solar radiation. Since the air quality objectives are expressed in terms of nitrogen dioxide, it is important to be able to assess the conversion rate of nitric oxide to nitrogen dioxide.

Ground level NOx concentrations have been predicted through dispersion modelling. Nitrogen dioxide concentrations reported in the results section assume 70% conversion from NOx to nitrogen dioxide for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario in the Environment Agency methodology. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

### 6.4 Background concentrations

Background concentrations for the assessment have been derived from monitoring as presented previously in Table 4.9.

For short term averaging periods the background concentration has been assumed to be twice the long term ambient concentration as recommended in the Environment Agency's Air Emissions Guidance.

### 7 DISPERSION MODELLING RESULTS

### 7.1 Screening

The Environment Agency's Air Emissions Guidance states that:

"process contributions can be considered insignificant if:

- the long term process contribution is <1% of the long term environmental standard;</li>
   and
- the short term process contribution is <10% of the short term environmental standard."

Predicted process contributions have been compared to the AQAL provided in Section 3. Where the emissions of a particular pollutant cannot be considered to be 'insignificant', the predicted concentrations have been evaluated further.

#### 7.2 Results

As discussed in Section 6.2, emissions from the Facility will be subject to emission limits. This section details the impact of the Facility assuming all items of plant operate for the entire year at the emission limits which were outlined in Section 6.2.

As identified in Section 6.2 the exhaust air from the pulp plant, and the AD biofilter will vent to atmosphere via within the same wind shield as the CHP and gas engines exhaust. Although there will be no combustion gases within the exhaust from the pulp plant or the biofilter, the temperature of the release is much lower than the CHP and will impact upon the buoyancy of the plume. The exhaust air from the pulp plant and the biofilter has been included to ensure any reduction is buoyancy is considered in the assessment.

Table 7.1 presents the results of the dispersion modelling of emissions from the Facility at the point of maximum impact and compares these results with the AQALs presented in Table 3.2. Impacts which cannot be screened out as 'insignificant' are highlighted. This maximum impact has been calculated based on 100% operation of the CHP and AD gas engines. All short term impacts have been calculated based on operation of the CHP and AD gas engines at the short term emission limits concurrently during the worst-case weather conditions for dispersion. This is a highly conservative assumption.

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			Tabl	e 7.1: Dis	spersion	Modelling	g Results	– All So	ırces				
				_	Process	<b>Contribu</b>	tion (PC)	at Point o	f Greatest	Impact	Max as	PEC	PEC as
Pollutant	Quantity	Units	AQAL	Bg Conc.	2009	2010	2011	2012	2013	Max	% of AQO /EAL	(PC +Bg)	% of AQO /EAL
Nitrogen	Annual mean	μg/m³	40	18.60	0.61	0.46	0.88	0.67	0.60	0.88	2.19%	19.48	48.69%
dioxide	99.79th%ile of hourly means <sup>(1)</sup>	μg/m³	200	37.20	16.21	15.76	15.78	15.69	15.40	16.21	8.11%	53.41	26.71%
	99.18th%ile of daily means	μg/m³	125	12.40	2.78	2.34	3.41	2.75	2.75	3.41	2.72%	15.81	12.64%
Sulphur dioxide	99.73rd%ile of hourly means <sup>(1)</sup>	μg/m³	350	12.40	22.69	21.89	22.35	22.05	21.86	22.69	6.48%	35.09	10.03%
	99.9th%ile of 15 min. means <sup>(1)</sup>	μg/m³	266	12.40	26.12	25.98	25.60	26.12	26.37	26.37	9.9%	38.77	14.57%
	Annual mean	μg/m³	40	20.20	0.06	0.04	0.08	0.06	0.06	0.08	0.20%	20.28	50.70%
PM <sub>10</sub> s	90.41th%ile of daily means	μg/m³	50	40.40	0.21	0.19	0.29	0.22	0.22	0.29	0.57%	40.69	81.37%
PM <sub>2.5</sub> s	Annual mean	μg/m³	25	13.80	0.06	0.04	0.08	0.06	0.06	0.08	0.33%	13.88	55.53%
Carbon monoxide	8 hour running mean <sup>(1)</sup>	μg/m³	10,000	602.00	12.48	15.07	12.77	12.20	12.52	15.07	0.15%	617.07	6.17%
Hydrogen chloride	Hourly mean <sup>(1)</sup>	μg/m³	750	1.44	8.72	8.76	9.02	8.91	8.66	9.02	1.20%	10.46	1.39%
Hydrogen	Annual mean	μg/m³	16	2.35	0.01	0.00	0.01	0.01	0.01	0.01	0.05%	2.36	14.74%
fluoride	Hourly mean <sup>(1)</sup>	μg/m³	160	4.70	0.58	0.58	0.60	0.59	0.58	0.60	0.38%	5.30	3.31%
A	Annual mean	μg/m³	180	1.80	0.06	0.04	0.08	0.06	0.06	0.08	0.05%	1.88	1.05%
Ammonia	Hourly mean	μg/m³	2,500	3.60	1.45	1.46	1.50	1.49	1.44	1.50	0.06%	5.10	0.20%
VOCs (as benzene)	Annual mean	μg/m³	5	0.40	0.10	0.08	0.15	0.11	0.10	0.15	2.97%	0.55	10.97%

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			Tabl	e 7.1: Dis	spersion	Modelling	g Results	– All Sou	ırces				
				D ::	Process	Contribu	tion (PC)	at Point o	f Greatest	Impact	Max as	PEC	PEC as
Pollutant	Quantity	Units	AQAL	Bg Conc.	2009	2010	2011	2012	2013	Max	% of AQO /EAL	AQO (PC AQ	% of AQO /EAL
VOCs (as benzene)	Hourly mean <sup>(1)</sup>	μg/m³	195	0.80	5.31	5.33	5.49	5.42	5.27	5.49	2.81%	6.29	3.22%
VOCs (as 1,3- butadiene)	Annual mean	μg/m³	2.25	0.20	0.10	0.08	0.15	0.11	0.10	0.15	6.60%	0.35	15.49%
Maraum	Annual mean	ng/m³	250	1.51	0.28	0.21	0.41	0.31	0.28	0.41	0.16%	1.92	0.77%
Mercury	Hourly mean	ng/m³	7,500	3.02	7.27	7.31	7.52	7.43	7.22	7.52	0.10%	10.54	0.14%
Cadnaium	Annual mean	ng/m³	5	0.15	0.28	0.21	0.41	0.31	0.28	0.41	8.14%	0.56	11.14%
Cadmium	Hourly mean	ng/m³	-	0.30	7.27	7.31	7.52	7.43	7.22	7.52	-	7.82	-
The alliance	Annual mean	ng/m³	-	-	0.28	0.21	0.41	0.31	0.28	0.41	-	-	-
Thallium	Hourly mean	ng/m³	-	-	7.27	7.31	7.52	7.43	7.22	7.52	-	-	-
Dioxins	Annual mean	fg/m³	-	22.82	0.57	0.43	0.81	0.62	0.56	0.81	-	23.63	-
DCD -	Annual mean	ng/m³	200	0.14	0.03	0.02	0.04	0.03	0.03	0.04	0.02%	0.18	0.09%
PCBs	Hourly mean	ng/m³	6,000	0.28	0.73	0.73	0.75	0.74	0.72	0.75	0.01%	1.03	0.02%
PAHs	Annual mean	pg/m³	250	140.00	0.60	0.45	0.85	0.65	0.59	0.85	0.34%	140.85	56.34%
Other	Annual mean	ng/m³	-	-	2.85	2.15	4.07	3.09	2.79	4.07	6-	-1-1	
metals	Hourly mean	ng/m³	-	-	72.73	73.08	75.20	74.30	72.21	75.20	See metals assessme		ssment

# Notes:

- (1) Based on operation of all items of plant at the ST ELV
- (2) Based on operation of the EfW at the long term ELV and the AD gas engines at the daily ELV

As shown in Table 7.1, the process contribution from the Facility does not cause an exceedence of the AQAL for any pollutant. For 24-hour  $PM_{10}$  the PEC is greater than 70% of the AQAL but it has been assumed that the background concentration is 2 times the annual mean background concentration as per Environment Agency's Air Emissions Guidance. LAQM.TG(09) methodology states that to calculate the 90.4%ile of 24-hour particulate matter the annual mean concentration should be used (not 2 times as per the Air Emissions Guidance). If we use the LAQM.TG(09) approach the PEC is predicted to be 40.98% of the AQAL.

The predicted impact cannot be screened out as 'insignificant' for the following pollutants:

- Annual mean nitrogen dioxide process contributions;
- Annual mean VOCs (as benzene) process contributions; and
- Annual mean VOCs (as 1,3-butadiene) process contributions; and
- Annual mean cadmium process emissions.

The impacts of all other pollutants can be screened out as 'insignificant' and further assessment is not required.

Analysis of the background concentrations has shown that the PEC is predicted to be less than 70% of the AQAL for all long term impacts which are not screened out as insignificant. This assessment is considered highly conservative as it assumes that:

- the CHP Facility and AD gas engines operate concurrently at the long term or short term emission limit, as appropriate, for the entire year;
- the entire VOC emissions are assumed to consist of benzene or 1,3-buitadiene; and
- cadmium is released at the combined emission limit for cadmium and thallium, while
  monitoring from waste facilities has indicated concentrations of cadmium are usually
  about 8% of the limit.

### 7.3 Nitrogen dioxide

The maximum predicted impact of annual mean nitrogen dioxide emissions is 2.19% of the AQAL. This impact cannot be screened out as 'insignificant' using the Environment Agency's Air Emissions Guidance screening criteria. Analysis of the mapped background concentration has shown that background concentrations are relatively low and the PEC is predicted to be less than 50% of the AQAL. This is not a significant impact. Reference should be made to the plot files in Appendix A which show the predicted annual mean concentrations as a result of emissions from the Facility. This assumes all items of plant operate for 100% of the time at the long term emission limit values.

The detailed receptor results tables presented in Appendix B show that the maximum predicted impact of annual mean nitrogen dioxide emissions at a sensitive receptor is 2.0% of the AQAL at Haywards. At all receptors the PEC is predicted to be less than 50%. Therefore, it is not likely that emissions will cause an exceedence of the AQAL. This is not a significant impact.

The maximum predicted impact of 99.79%ile 1-hour mean nitrogen dioxide emissions is 8.11% of the AQAL. This assumes all items of plant operate for 100% of the time at the short term emission limit values. This is considered worst-case as it assumes both plants operate at the short term emission limit concurrently and that this operation coincides with the worst case weather conditions for dispersion. Even with these conservative assumptions, the contribution at the point of maximum impact can be screened out as 'insignificant' using the Environment Agency's Air Emissions Guidance screening criteria.

# 7.4 Volatile organic compounds

The maximum predicted impact of annual mean VOC emissions cannot be screened out as 'insignificant'. If it is assumed that the entire VOCs emissions consist of only benzene the impact is 2.97% of the AQAL and if it is assumed the entire VOCs emissions consist of only 1,3-butadiene the impact is 6.60% of the AQAL. Analysis of the mapped background has shown that background concentrations are relatively low and the PEC is predicted to be less than 20% of the AQAL in both cases. This is not a significant impact. Reference should be made to the plot files in Appendix A which show the predicted annual mean VOC concentrations as a result of emissions from the Facility assuming the emissions consist of only benzene or 1,3-butadiene and assuming that all items of plant operate for 100% of the time at the long term emission limit values.

The detailed receptor results tables presented in Appendix B show that the maximum predicted impact of annual mean VOC emissions at a sensitive receptors assuming the entire VOC emissions consist of only benzene or 1,3-butadiene is 2.8% and 6.1% of the AQAL respectively. At all receptors the PEC is predicted to be less than 15%. Therefore, it is not likely that emissions will cause an exceedence of the AQAL. This is not a significant impact.

### 7.5 Cadmium

The maximum predicted impact of annual mean cadmium emissions is 8.14% of the AQAL, and cannot be screened out as 'insignificant'. Analysis of the background data has shown that background concentrations are relatively low and the PEC is predicted to be less than 12% of the AQAL. This is not a significant impact. Reference should be made to the plot files in Appendix A which show the predicted annual mean concentrations as a result of emissions from the Facility. This assumes all items of plant operate for 100% of the time at the long term emission limit values.

The detailed receptor results tables presented in Appendix B show that the maximum predicted impact of annual mean cadmium emissions at a sensitive receptor is 7.5% of the AQAL. At all receptors the PEC is predicted to be less than 12% of the AQAL. Therefore, it is not likely that emissions will cause an exceedence of the AQAL. This is not a significant impact.

This assumes that the cadmium is released at the combined emission limit for cadmium and thallium. Monitoring from waste facilities has indicated that concentrations of cadmium are usually about 8% of the year. If this assumption is applied, the predicted process contribution at the point of maximum impact is only 0.65% of the AQAL, and the maximum impact at a sensitive receptor is 0.6% of the AQAL. This is not a significant impact.

# 7.6 Metals – at point of maximum impact

There is a single emission limit for nine Group 3 metals (arsenic, antimony, chromium, cobalt, copper, lead, manganese, nickel and vanadium). The impact of these metals has been assessed using the screening methodology outlined in the Environment Agency guidance document "Guidance on assessing group 3 metals stack emissions from incinerators – v4".

The first stage (worst-case screening) is to assume that each metal is emitted at 100% of the emission level. Where the PC of any metals exceeds 1% of a long term or 10% of a short term AQAL the Environment Agency consider this a potential for significant pollution. Under these circumstances the PEC should be compared to the AQAL. If the PEC is greater than 100% of the AQAL the assessment should proceed to stage 2.

Stage 2 (case specific screening) is to use the maximum emissions data listed in Appendix A of the guidance to revise the predictions. Again, where the PC of any metals exceeds 1% of a long term or 10% of a short term AQAL the PEC should be compared to the AQAL. This can be screened out where the PEC is less than the AQAL.

The following tables outline the PC and PEC for each metal assuming the worst-case screening and case specific screening. The "case specific screening" assumes the emissions are no worse than a currently operating plant.

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	Table 7.2: Long-Term Metals Results									
Metal	AQAL	Background		d at combined I limit	Metal as %		ed no worse tha ermitted Facilit			
	(ng/m³)	conc. (ng/m³)	PC as % AQAL <sup>(1)</sup>	PEC as % AQAL	of ELV <sup>(2)</sup>	PC (ng/m³)	PC as % AQAL	PEC as % AQAL		
Annual mean										
Arsenic	3	0.47	135.66%	151.32%	5.00%	0.20	6.78%	22.45%		
Antimony	5,000	0.83	0.08%	0.10%	2.30%	0.09	0.002%	0.02%		
Chromium	5,000	3.43	0.08%	0.15%	18.40%	0.75	0.01%	0.08%		
Chromium (VI)	0.2	0.69	2034.83%	2377.83%	0.026%	0.0011	0.53%	343.53%		
Cobalt	-	0.08	-	-	1.12%	0.05	-	-		
Copper	10,000	2.57	0.04%	0.07%	5.80%	0.24	0.0024%	0.03%		
Lead	250	4.40	1.63%	3.39%	10.06%	0.41	0.16%	1.92%		
Manganese	150	2.25	2.71%	4.21%	12.00%	0.49	0.33%	1.83%		
Nickel	20	1.37	20.35%	27.20%	44.00%	1.79	8.95%	15.80%		
Vanadium	5,000	1.11	0.08%	0.10%	1.20%	0.05	0.0010%	0.02%		

#### Note:

(4) Nickel concentration is greater than 11% is due to one single measurement outlier. The average is around 4% of the Group ELV.

<sup>(1)</sup> The long-term process contribution is  $4.45 \text{ ng/m}^3$  for each metal.

<sup>(2)</sup> Metal as maximum percentage of the IED group 3 ELV, as detailed in Environment Agency metals guidance document (V.4) Table A1.

<sup>(3)</sup> Chromium (VI) concentrations are based on stack measurements of total chromium and measurements of the proportion of chromium (VI) to total chromium in Air Pollution Control (APC) residuals collected at the same plant.

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	Table 7.3: Short-Term Metals Results									
Metal	AQAL	Background		d at combined I limit	Metal as %	Metals emitted no worse than a currently permitted Facility				
	(ng/m³)	conc. (ng/m³)	PC as % AQAL <sup>(1)</sup>	PEC as % AQAL	of ELV <sup>(2)</sup>	PC (ng/m³)	PC as % AQAL	PEC as % AQAL		
Annual mean										
Arsenic	-	0.94	-	-	5.00%	3.76	-	-		
Antimony	150000	1.66	0.05%	0.05%	2.30%	1.73	0.0012%	0.002%		
Chromium	150000	6.86	0.05%	0.05%	18.40%	13.84	0.009%	0.014%		
Chromium (VI)	-	1.37	-	-	0.03%	0.02	-	-		
Cobalt	-	0.16	-	-	1.12%	0.84	-	-		
Copper	200000	5.14	0.04%	0.04%	5.80%	4.36	0.002%	0.005%		
Lead	-	8.80	-	-	10.06%	7.57	-	-		
Manganese	1500000	4.50	0.01%	0.01%	12.00%	9.02	0.0006%	0.001%		
Nickel	-	2.74	-	-	44.00%	33.09	-	-		
Vanadium	1000	2.22	7.52%	7.74%	1.20%	0.90	0.09%	0.31%		

#### Note:

<sup>(1)</sup> The long-term process contribution is 78.53 ng/m³ for each metal.

<sup>(2)</sup> Metal as maximum percentage of the IED group 3 ELV, as detailed in Environment Agency metals guidance document (V.4) Table A1.

<sup>(3)</sup> Chromium (VI) concentrations are based on stack measurements of total chromium and measurements of the proportion of chromium (VI) to total chromium in Air Pollution Control (APC) residuals collected at the same plant.

### 7.6.1 Long-term results

As shown in Table 7.2, if it is assumed that the entire emissions of metals consist of only one metal, the annual process contributions of arsenic, chromium (VI), lead, manganese and nickel are predicted to be greater than 1% of the long-term AQAL. However, only the PECs for arsenic and chromium (VI) are predicted to be greater than 100% of the AQAL under this worst-case screening assumption.

If it is assumed that the Facility will perform no worse than a currently permitted Facility, the predicted process contribution is below 1% of the AQAL for all pollutants with the exception of arsenic and nickel. The PECs for arsenic and nickel under this assumption are less than the AQAL, and so the impacts can be screened out. Therefore, under the EA guidance criteria, it can be concluded that there is no risk of exceeding the long-term AQAL for any metals and there is no potential for significant pollution.

### 7.6.2 Short-term results

As shown in Table 7.3, if it is assumed that the entire emissions of metals consist of only one metal, the maximum 1-hour process contribution of all metals is predicted to be less than 10% of the short-term AQAL. Therefore, it can be concluded that there is no risk of exceeding the short-term AQAL for any metal and there is no potential for significant pollution.

### 8 IMPACT AT ECOLOGICAL RECEPTORS

This section provides an assessment of the impact of the operation of the Facility at the identified ecological receptors.

### 8.1 Screening

The Environment Agency have produced Operational Instruction documents which explain how to assess aerial emissions from new or expanding Integrated Pollution Prevention and Control (IPPC) regulated industry applications, issued under the Environmental Permitting Regulations. The process to follow to satisfy the requirements of the Conservation of Habitats and Species Regulations 2010, Countryside and Rights of Way (CRoW) Act 2000, and the Environment Agency's wider duties under the Environment Act 1995 and the Natural Environment and Rural Communities Act 2006 (NERC06) is outlined.

Operational Instruction 67\_12 "Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation" provides the following risk based screening criteria for nature conservation sites.

Table 8.1: Screening Criteria								
Threshold	European Sites	SSSIs	NNR, LNR, LWS, ancient woodland					
Y (% threshold long-term)	1	1	100					
Y (% threshold short-term)	10	10	100					
Z (% threshold)	70	70	100					
NOTES: Short term considers both daily and weekly								

#### Where:

- Y is the long term process contribution calculated (PC) as a percentage of the relevant Critical Level or Load; and
- Z is the long term predicted environmental concentration (PEC) calculated as a percentage of the relevant Critical Level or Load.

Operational Instruction 66-12 states:

- If PC < Y% Critical Level and Load then emissions from the application are not significant, and
- If PEC < Z% Critical Level and Load it can be concluded 'no likely significant effect' (alone and in-combination).

AQTAG 17 – "Guidance on in combination assessments for aerial emissions from EPR permits" states that:

"Where the maximum process contribution (PC) at the European site(s) is less than the Stage 2 de-minimis threshold of the relevant critical level or load, the PC is considered to be inconsequential and there is no potential for an alone or incombination effects with other plans and projects."

Consultation with the Environment Agency has confirmed that the "Stage 2 de-minimis threshold" is the criteria outlined in Operational Instruction 67\_12 outlined above.

### 8.2 Atmospheric emissions - Critical Levels

In addition to the objectives for the protection of human health, the AQS includes Critical Levels for the protection of ecosystems as presented in Table 3.3.

Predicted process contributions have been compared to the Critical Levels for the protection of ecosystems. Where the emissions of a particular pollutant are greater than 1% of the long term or 10% of the short term Critical Level, further assessment has been undertaken.

For the purpose of the ecological assessment the APIS mapped background dataset has been used.

### 8.3 Deposition of emissions – Critical Loads

The Air Pollution Information System (APIS) provides Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication).

An assessment has been made for each habitat feature identified in APIS for the specific site. The search by location tool has been used to identify the feature habitats then the search by location tool to find the habitat specific Critical Load for the specific grid (i.e. the point of maximum impact with the designated site). If the impact of process emissions upon nitrogen or acid deposition is greater than 1% of the Critical Load, further assessment has been undertaken.

APIS does not include site specific Critical Loads for non-designated sites. In lieu of this the search by location function of APIS has been used. The Critical Loads are based on a broad habitat type and location.

# 8.3.1 Nitrogen deposition – eutrophication

A search has been undertaken on for each of the ecological receptors identified in Table 5.2. Appendix C summarises the Critical Loads for nitrogen deposition and background deposition rates as detailed in APIS for each habitat identified.

The impact of the Facility has been assessed against these Critical Loads for nitrogen deposition.

### 8.3.2 Acidification

The APIS Database contains a maximum critical load for sulphur (CLmax), a minimum critical load for nitrogen (CLminN) and a maximum critical load for nitrogen (CLmaxN). These components define the critical load function. Where the acid deposition flux falls within the area under the critical load function, no exceedences are predicted.

A search has been undertaken on for each of the ecological receptors identified in Table 5.2. Each site has a number of habitats, each with different Critical Loads. Appendix C summaries the Critical Loads for acidification and background deposition rates as detailed in APIS for each identified habitat.

The impact of the Facility has been assessed against these Critical Load functions. Where a critical load function for acid deposition is not available, the total nitrogen, sulphur and hydrogen chloride deposition has been presented and compared with the background concentration.

### 8.3.3 Calculation methodology – nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG 6 (March 2014). The steps to this method are as follows.

(1) Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.

- (2) Calculate the dry deposition flux ( $\mu$ g/m²/s) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 8.2.
- (3) Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 8.2.
- (4) Compare this result to the nitrogen deposition Critical Load.

Table 8.2: Deposition Factors								
	Deposition V	Conversion Factor						
Pollutant	Grassland	Woodland	(µg/m²/s to kg/ha/year)					
Nitrogen dioxide	0.0015	0.003	96.0					
Sulphur dioxide	0.0120	0.024	157.7					
Ammonia	0.0200	0.030	259.7					
Hydrogen chloride	0.0250	0.060	306.7					

#### 8.3.3.1 Acidification

Deposition of nitrogen, sulphur, hydrogen chloride and ammonia can cause acidification and should be taken into consideration when assessing the impact of the Facility.

The steps to determine the acid deposition flux are as follows.

- (1) Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 8.3.3.
- (2) Apply the conversion factor for N outlined in Table 8.3 to the nitrogen and ammonia deposition rate in kg/ha/year to determine the total keq N/ha/year.
- (3) Apply the conversion factor for S to the sulphur deposition rate in kg/ha/year to determine the total keq S/ha/year.
- (4) Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the dry keq Cl/ha/year.
- (5) Determine the wet deposition rate of HCl in kg/ha/yr by multiplying the model output by the factors presented in Table 8.2.
- (6) Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the wet keq Cl/ha/year.
- (7) Add the contribution from S to HCl dry and wet and treat this sum as the total contribution from S.
- (8) Plot the results against the Critical Load functions.

The March 2014 version of the AQTAG 6 document states that, for installations with an HCl emission, the process contribution of HCl, in addition to S and N, should be considered in the acidity Critical Load assessment. The  $\rm H^+$  from HCl should be added to the S contribution (and treated as S in the APIS tool). This should include the contribution of HCl from wet deposition.

Consultation with AQMAU confirmed that the maximum of the wet or dry deposition rate for HCl should be included in the calculation. The wet deposition of HCl has been taken as two times the dry deposition rate, in lieu of any precipitation rate in the meteorological data file. This is a conservative screening assumption.

Table 8.3: Conversion Factors						
Pollutant	Conversion Factor (kg/ha/year to keq/ha/year)					
Nitrogen	Divide by 14					
Sulphur	Divide by 16					
Hydrogen chloride	Divide by 35.5					

The process contribution has been calculated using the APIS formula:

Where PEC N Deposition < CLminN:

PC as % of CL function = PC S deposition / CLmaxS

Where PEC N Deposition > CLminN:

PC as % of CL function = (PC S + N deposition) / <math>CLmaxN

## 8.4 Results – statutory designated sites – emissions

No statutory designated sites have been identified within the Environment Agency H1 screening distance.

### 8.5 Results – non-statutory designated sites – emissions

As identified in Section 5.2, there are a number of non-statutory designated sites within 2km of the Facility. The impact of emissions at these locally designated sites has been quantified and the results compared against the Critical Levels presented in Table 3.3. The highest predicted process contributions to ground level concentrations at the identified ecological receptors are presented in Table 8.4.

As shown the PC is not predicted to exceed the Critical Level at any of the locally-designated sites. Therefore, emissions from the Facility at locally designated sites are not significant. Plot files of the maximum process concentration over the 5 years of weather data and a figure showing the location of ecological receptors is provided in Appendix A.

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	Table 8	4: Impact	of Emiss	ions at No	n-Statut	ory Desigr	ated Sen	sitive Eco	logical Re	ceptors		
	Oxides of Nitrogen				Sulphur	Dioxide	Hydrogen Fluoride				Ammonia	
Site	Da	nily	Anr	nual	Anı	nual	Daily		We	ekly	Annual	
	Conc. µg/m³	As % of CL	Conc. µg/m³	As % of CL	Conc. µg/m³	As % of CL	Conc. ng/m³	As % of CL	Conc. ng/m³	As % of CL	Conc. ng/m³	As % of CL
Critical Level	75	-	30	-	20	-	5	-	0.5	-	3	-
Non-statutory design	nated sites	(within 2k	m)									
Blackwater Plantation	4.61	6.2%	0.32	1.1%	0.11	0.6%	29.96	0.6%	10.54	2.1%	20.99	0.7%
Storeys Wood	5.58	7.4%	0.27	0.9%	0.09	0.5%	36.22	0.7%	9.00	1.8%	17.55	0.6%
Maxey's Spring	6.47	8.6%	0.31	1.0%	0.10	0.5%	42.04	0.8%	14.04	2.8%	19.82	0.7%
Upney Wood	5.83	7.8%	0.47	1.6%	0.16	0.8%	37.85	0.8%	11.26	2.3%	30.31	1.0%
Link's Wood	4.36	5.8%	0.14	0.5%	0.05	0.2%	28.29	0.6%	8.98	1.8%	9.34	0.3%
Park House Meadow	2.50	3.3%	0.14	0.5%	0.05	0.2%	16.23	0.3%	4.29	0.9%	8.83	0.3%
Screening Criteria	-	100%	-	100%	-	100%	-	100%	-	100%	-	100%

### 8.6 Results – non statutory designated sites – deposition

APIS does not include site specific Critical Loads for non-statutory designated sites. In lieu of this the search-by-location function of APIS has been used. The broad habitat type has been assumed to apply to each site.

The highest predicted levels of nitrogen and acid deposition are presented in Appendix D. Where process contributions are greater than 100%, or the PEC is greater than 100% of the Critical Load these are highlighted.

The maximum nitrogen deposition PC at a non-statutory designated site is predicted to be 3.30% and the maximum acid deposition is predicted to be 3.76% of the respective Lower Critical Loads. Therefore, the impact of emissions from the Facility at locally designated sites is not significant.

# 8.7 Summary of impact at ecological receptors

As a result of the habitats screening exercise a number of ecologically sensitive sites were identified which needed considering within the Air Quality Assessment. A summary of the impact at each site is provided below:

No European or UK designated sites have been identified as requiring consideration within this air quality assessment.

A number of non-statutory designated sites have been identified within 2km of the Facility. APIS does not include site specific Critical Loads for non-statutory designated sites. In lieu of this the search-by-location function of APIS has been used. The broad habitat type has been assumed. The assessment has concluded that emissions are not significant. This conclusion has been drawn because the PC is less than 100% of the Critical Level or Load.

#### 9 ODOUR ASSESSMENT

An Odour Management Plan has been developed for the Environmental Permit application. This shows that there will be a building ventilation system to manage odorous emissions from the CHP plant bunker, the pulp plant, the AD plant, the MRF and MBT plant. Odorous air will either be used as combustion air or be vented to atmosphere via the main stack following treatment within the AD biofilter. The following section details the impact of the odorous emissions from the AD biofilter. For full details of the odour control measures are provided in the Odour Management Plan (Annex 7 of the EP application). This section details the impact of the odour emission from the main stack.

#### 9.1 Evaluation Criteria

There is no specific legislation regarding acceptable or unacceptable odour levels. The primary means of regulation is through the concept of Statutory Nuisance under Part III of the Environmental Protection Act 1990 and under the Environmental Permitting Regulations, where odour is a type of pollution to be regulated. In both cases, the objective of regulation is to ensure that there is no cause for annoyance.

Odours are characterised in terms of European odour units, OU, and odour concentrations,  $OU_E/m^3$ .

- The OU strength of a release is the number of times the mixture must be diluted, at standard temperature and pressure, to reach the detection limit. A release of 1 OU can be detected by half of the members of an olfactory panel.
- One OU<sub>E</sub> is the mass of a pollutant that, when evaporated into 1 m<sup>3</sup> of odourless gas, has the same odour nuisance as 1 OU of reference odorant.

The Environment Agency have published a guidance note on odour assessment, entitled Technical Guidance Note H4. In Appendix 4 to Part 1 of this document, the Environment Agency recommends some indicative odour exposure criteria for ground level concentrations of mixtures of odorant, below which there would be "no reasonable cause for annoyance". For "highly offensive odours", including those from activities involving putrescible waste, the criterion is 1.5 ouE/m³ as the 98th percentile of hourly averages. This has been used as the evaluation criterion for the odour assessment.

### 9.2 Methodology

The detailed flue gas dispersion modelling was carried out using the computer model ADMS 5.2, as for the main dispersion modelling. For odour modelling, it is assumed that the odour is caused by a substance which disperses in the atmosphere, in the same way that any other pollutant (such as dust or sulphur dioxide) disperses.

#### 9.3 Results

The highest predicted odour concentrations from the AD biofilter are shown in the following table. As with the combustion emissions the buoyancy of the AD biofilter odour emissions will be increased when it is released with the other warmer emissions sources such as the CHP and the AD gas engines. Therefore, this analysis has considered normal operations when all items of plant are operating and any scenario in which only the AD biofilter is operating.

Table 9.1: Summary of Odour Impacts from Biofilter								
	Maximum 1-hour	Odour (OU <sub>E</sub> /m³)	Maximum 98 <sup>th</sup> %ile 1-hour Odour (OU <sub>E</sub> /m³)					
Weather data year	Normal Operations	Only AD Biofilter Operating	Normal Operations	Only AD Biofilter Operating				
2009	0.072	0.768	0.041	0.137				
2010	0.073	0.757	0.038	0.140				
2011	0.075	0.776	0.045	0.129				
2012	0.074	0.796	0.042	0.134				
2013	0.072	0.877	0.041	0.120				
Max all years	0.075	0.877	0.045	0.140				

NOTES:

Normal operations assumes all plant operates and the exhaust from the pulp plant is emitted at 140°C.

As shown under normal operations the other sources provide additional buoyancy to the emissions from the biofilter promoting dispersion. In both cases the  $98^{th}$  percentile of odour concentrations at the point of maximum impact is well below  $1.5 \, \text{OU}_\text{E}/\text{m}^3$ . Therefore, it can be concluded that there would be "no reasonable cause for annoyance" from odour from the proposed operation of the AD biofilter under normal or abnormal operations.

### 10 PLUME VISIBILITY

Gent Fairhead & Co Limited (GFC) originally received planning permission (ESS/37/08/BTE) for the development of the IWMF at Rivenhall Airfield on 2 March 2010 from the Secretary of State following a Public Inquiry (APP/Z1585/V/2104804).

Subsequent amendments have been approved by ECC which relate to:

- Additional wording to Condition 2 as permitted by ESS/37/08/BTE/NMA dated 25 October 2012;
- An extension of time of one year to the commencement of development under Condition 1 (ESS/41/14/BTE);
- The removal of Conditions 28 and 30 that restricted the sourcing of the IWMF's solid recovered fuel and waste paper (ESS/55/14/BTE); and
- A variation to the layout of the IWMF which was not substantially different to that previously approved, with no changes to the types of waste to be handled at the IWMF or maximum vehicle numbers (ESS/34/15/BTE).

In parallel with ESS/34/15/BTE, Gent Fairhead & Co Limited submitted all necessary predevelopment details required under conditions. Planning permission ESS/34/15/BTE was granted on the 26 February 2016 and the development has been implemented.

Consistent throughout, has been the requirement for the Facility to operate with no visible plume.

Under the existing planning permission ESS/34/15/BTE, the submission of details against Condition17, the local planning authority approved a management plan for the CHP plant to ensure there is no visible plume from the stack:

**Condition 17:** The development hereby permitted shall be implemented in accordance with the details submitted with respect to the management plan for the CHP plant to ensure there is no visible plume from the stack. The approved details include: the application for approval of details reserved by condition dated 4 August 2015 and documents referenced

- \$1552-0700-0008RSF entitled "CHP Management Plan for Plume Abatement" Issue no. 5 dated 16/02/16 by Fichtner
- \$1552-0700-0013RSF entitled "Plume Visibility Analysis" both by Fichtner.

The development shall be implemented in accordance with the approved details.

In parallel with the proposed variation in the IWMF's stack height, a change is proposed to the flue gas treatment techniques used within the plant, namely, a change from bicarbonate to lime-based treatment technologies.

A feedforward mechanism will be used to adjust the temperature of the exhaust air from the pulp plant, and CHP Plant based on a set of meteorological parameters. These parameters have been determined based on the results of the dispersion model.

The following four operating conditions will be implemented:

- (1) When the ambient temperatures greater than 8°C, the CHP Plant will be operated normally (i.e. without reheating the flue gases) with flue gas temperatures of approximately 138°C and the MEA from the Pulp Plant heated to a temperature of 120°C using LP steam from the turbine. These conditions occur for on average 58% of the time. Heating the MEA to 120°C is necessary even at high ambient temperatures so that the temperature of the mixed flue gases stays above the dew point temperature in the stack.
- (2) Once the ambient temperature falls to below 8°C but is equal to or greater than 3°C the CHP Plant exhaust will be re-heated to a temperature of 180°C. These conditions occur for on average 24% of the time.
- (3) If the ambient temperature falls below 3°C but is equal to or greater than -2°C the CHP Plant exhaust will be re-heated to a temperature of 180°C and the MEA from the Pulp Plant heated to 210°C. These conditions occur on average 15% of the time.

(4) If the ambient temperature falls to below -2°C the CHP Plant exhaust will be re-heated to a temperature of 180°C and the MEA from the Pulp Plant heated to 260°C. These conditions occur for 3% of the time.

The implementation of the above operating regimes will impact upon the buoyancy of the emissions and thus the impact of emissions at ground level. As the mixed exhaust air from the pulp plant is heated additional buoyancy will be provided aiding the dispersion of pollutants. The following table presents a summary of the maximum impact of process emissions of oxides of nitrogen for each scenario (the model inputs are taken from the CHP Management Plan for Plume Management (document ref: S1552-0700-0008RSF).

Operating scenario	Process Contribution point of maxi	
	Annual Mean	Max 1-hour
Normal operations	1.19	22.04
Increasing temperature of the release from the CHP Plant to 180°C	1.04	18.60
Increasing temperature of the release from the CHP Plant to 180°C and the MEA from the Pulp Plant to 210°C	0.92	17.57
Increasing temperature of the release from the CHP Plant to 180°C and the MEA from the Pulp Plant to 260°C	0.94	17.60

As shown the implementation of the heating of the exhaust from the pulp plant increases buoyancy and reduces the ground level impact of emissions. If the maximum annual mean concentration factored by the number of hours the CHP Plant is expected to operate in each regime, this results in a 6.7% reduction in the annual mean concentration. Therefore, the results presented in this Dispersion Modelling Report are still valid, and in fact are overly conservative, when the CHP Management Plan for Plume Abatement is implemented.

### 11 FLARE

The operation of the flare has not been implicitly modelled as part of this Dispersion Modelling Assessment for the following reasons:

- (1) The gas system has been designed such that the auxiliary flare will only be used for short periods of time during maintenance of gas engines.
- (2) The Standard Rules Permit SR2010No15 for anaerobic digestion plants does not set emission limits for an auxiliary gas flare that is to be used infrequently.
- (3) The auxiliary gas flare will be designed to meet the requirements for landfill gas flares (which state that the flue gas must be maintained at or above 1,000°C for at least 0.3 seconds).
- (4) The emissions from the gas engines have been overestimated, as the period of maintenance and breakdown has not been taken into account when calculating the annual average ground level concentrations.

# 12 STACK HEIGHT ANALYSIS

The dispersion model has been run with a range of stack heights for the IWMF from 25m to 95m using all 5-years of weather data. The following table presents the results at the point of maximum impact. Where concentrations are greater than 1% of the long term AQAL or 10% of the short term AQAL, these are highlighted in bold. It should be noted that the stack height are references above surrounding ground level and that this application is for a stack which is 58m above ground level stack. Detailed analysis is provided in the Stack Height Justification (Annex 12 of the Environmental Permit application).

Table 12.1: Stack Height Analysis – Annual Mean									
Stack Height	Annual Mean Pro	Annual Mean Process Contribution – as % of AQAL – Point of Maximum Impact							
Stack neight	Nitrogen Dioxide	Particulate Matter (as PM10)	Particulate Matter (as PM2.5)						
AQAL	40	40	25						
25	7.78%	0.72%	1.15%						
30	6.05%	0.56%	0.90%						
35	4.85%	0.45%	0.72%						
40	3.97%	0.37%	0.59%						
45	3.31%	0.31%	0.49%						
50	2.80%	0.26%	0.42%						
55	2.40%	0.22%	0.36%						
58	2.19%	0.20%	0.33%						
60	2.07%	0.19%	0.31%						
65	1.81%	0.17%	0.27%						
78	1.40%	0.13%	0.21%						
85	1.12%	0.10%	0.17%						
95	0.91%	0.08%	0.13%						

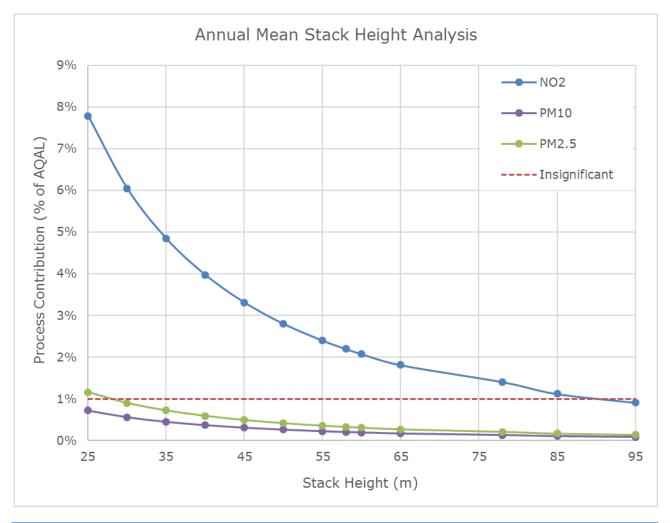


Table 12.2: Stack Height Analysis - Short Term - Daily ELV					
	Process	Contribution – a	s % of AQAL – P	oint of Maximun	ı Impact
Stack Height	99.79%ile of 1-hour Nitrogen Dioxide	99.18%ile of Daily Mean Sulphur Dioxide	99.73%ile of Hourly Mean Sulphur Dioxide	99.9%ile of 15-minute Mean Sulphur Dioxide	90.41%ile of Daily Mean Particulate Matter (as PM10)
AQAL	200	125	350	266	50
25	12.36%	11.56%	6.74%	14.01%	2.12%
30	8.88%	7.64%	4.55%	10.82%	1.62%
35	6.18%	6.24%	3.39%	5.03%	1.28%
40	5.00%	5.12%	2.75%	4.00%	1.03%
45	4.17%	4.23%	2.30%	3.32%	0.86%
50	3.59%	3.44%	1.98%	2.94%	0.72%
55	3.23%	2.96%	1.77%	2.65%	0.62%
58	3.06%	2.72%	1.67%	2.55%	0.57%
60	2.95%	2.59%	1.60%	2.46%	0.54%
65	2.70%	2.26%	1.46%	2.29%	0.47%
78	2.31%	1.73%	1.25%	1.97%	0.37%
85	2.02%	1.41%	1.07%	1.70%	0.30%
95	1.75%	1.14%	0.93%	1.49%	0.25%

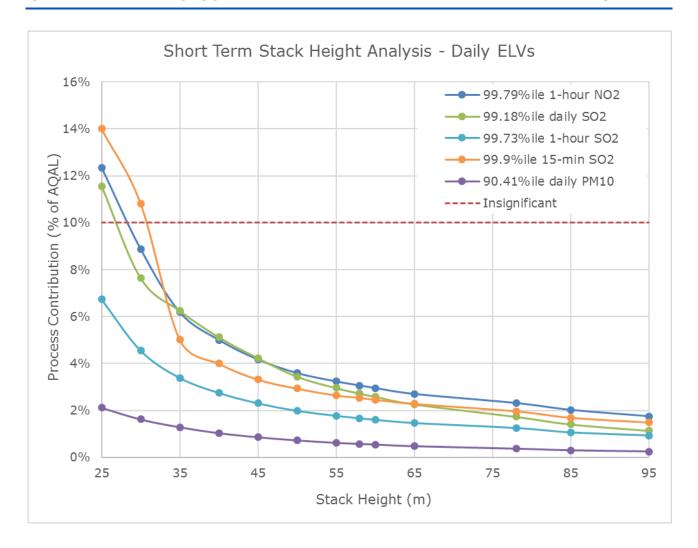
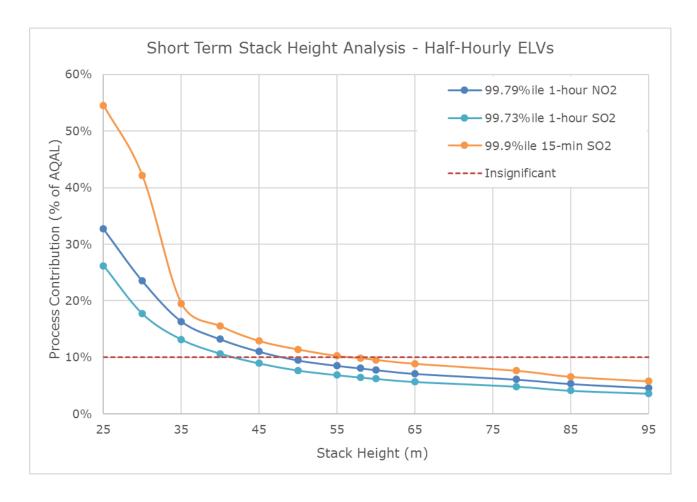


Table 12.3: Stack Height Analysis – Short Term – Half Hourly ELV						
	Process Contribution – as % of AQAL – Point of Maximum Impact					
Stack Height	99.79%ile of 1-hour Nitrogen Dioxide	99.73%ile of Hourly Mean Sulphur Dioxide	99.9%ile of 15- minute Mean Sulphur Dioxide			
AQAL	200	350	266			
25	32.73%	26.22%	54.51%			
30	23.51%	17.72%	42.09%			
35	16.38%	13.18%	19.55%			
40	13.24%	10.69%	15.55%			
45	11.04%	8.96%	12.92%			
50	9.50%	7.71%	11.43%			
55	8.56%	6.90%	10.29%			
58	8.11%	6.48%	9.91%			
60	7.81%	6.24%	9.58%			
65	7.14%	5.70%	8.90%			
78	6.12%	4.87%	7.67%			
85	5.35%	4.15%	6.60%			
95	4.62%	3.63%	5.80%			



#### 13 Uncertainty in the Modelling

### 13.1 Effect of the Building

The effect of the building is to cause some of the plume to entrain into the cavity region in the immediate leeward side of the building. As a consequence, concentrations near the building are increased but further away are decreased.

The IWMF is to be located within the quarry and the height of the building (and stack) has been calculated based on the distance from the ground level outside of the quarry to the top of the building. For example, the height of the main building is 60.75 m AOD, but the height of the surrounding land is  $\sim 50 \text{ m}$  AOD. Therefore, the building height has been set to 10.75 m. This is referred to as the "base model". The results for this model are presented in the preceding sections.

ADMS 5.2 only considers buildings which are greater than a third of the stack height in the modelling. The Environment Agency also recommends that buildings taller than 40% of the stack height are included in modelling. Although the building is included in the model (see Table 6.12), as the building is less than a third of the stack height (i.e. less than 18.3m), building wake effects are not considered.

A 3D site layout including the quarry is shown on Figure 16. The assumption that the building is 10.75m (i.e. less than a third of the stack height) is true for most wind directions as the building is close to the edge of the quarry and so air will flow over the building. However, there is a gentle slope down to the base of the building to the north-west façade. Therefore, if the wind is from this direction the emissions from the stack will potentially be affected by the wake generated by the full height of the building. The crosswind height of the building for winds from the north-west is 25.75m, which is greater than a third of the stack height.

It is not possible to change the height of the building for varying wind direction. Therefore, the following scenarios have been considered to assist in identifying the effect this would have upon the dispersion of emissions from the stack:

### Scenario A - Increased building height

The height of the building has been increased to 25.75m and the height of the stack set to 58m. This results in the building having a much greater effect on the dispersion of emissions as the difference between the top of the building and stack is only 32.25m, compared to the actual 47.25m difference. This is not considered to be representative of the actual situation, as it would over-estimate the building wake effects.

## Scenario B - Increased building height, stack height and receptor elevations

The height of the building has been increased to 25.75m, the height of the stack has been increased to 73m, and the output has been generated for receptors at an elevation of 15m. This results in the actual height of the release being much higher than actually proposed, but the ratio between building and stack height being the same. The height of the receptors has been increased to ensure the difference between release height and receptor height is the same. The limitation of this approach is that the effect of near ground turbulence is not accounted for. In certain conditions the model may also assume emissions are released above the boundary layer and therefore do not come down to ground level, when in fact they would be within the boundary layer and as such be brought down to ground level resulting in an underestimation of the impact.

It is important to note the way in which the model calculates the short term and long term concentrations.

- The 1-hour concentration is calculated in the model as the maximum predicted concertation from any hour at each receptor point.
- The annual mean concentration is calculated in the model as the average of the predicted concentration for each individual hour at each receptor point.

If the peak short term concentrations are predicted to occur when the wind is from the north-west the building wake effect may be underestimated and the peak concentration may be higher than predicted and presented in the preceding sections.

The effect of this on an annual basis is diluted as the concentration is predicted as the average of each hour and for many of the hours the base model would be most appropriate.

### 13.1.1 Effect on short term predicted impacts

Figure 17 shows the peak 1-hour NOx concentration predicted for each of the above options using the 2011 weather data. This shows that the predicted peak concentration for Scenario A is greater than the base modelling, and the predicted peak concentration for Scenario B is lower. This is expected as Scenario A has a significantly larger (and overestimated) building wake effect, resulting in a higher concentration near the building.

Scenario A assumes that the difference between building height and stack is only 32.25m rather than the actual 47.25m difference which would lead to an over estimation. Scenario B excludes the effect of near ground turbulence and the boundary layer which would lead to an under estimation of the actual impacts.

The actual concentration may be slightly greater than predicted for the base model but not as high as that predicted for Scenario A.

Analysis of the maximum predicted concentration for each scenario has shown that the predicted maximum 1-hour impact is 40.6% greater for Scenario A than the base model. At receptor locations the maximum 1-hour increase is 21.5% at the most impacted residential receptor, and the maximum 18<sup>th</sup> highest (99.79%ile) 1-hour impact at the most impacted residential receptor is only 14.3% higher.

#### 13.1.2 Effect on annual mean

If the wind is from the north-east quadrant of 270° to 360° (inclusive) the emissions from the stack will potentially be affected by the wake generated by the full height of the building. The base model may be underestimating the building wake effects for these wind directions. To a lesser degree building wake effects will be underestimated if the wind is from the from the south-west quadrant. However, Scenario A significantly over estimates the building wake effects as it continually assumes the building is 25.75m and the stack height is only 32.25m taller.

Figure 18 shows the annual mean NOx concentration predicted for each of the above options using the 2011 weather data. This shows that the predicted peak concentration for Scenario A is greater than the base modelling, and Scenario B is lower. This is expected as Scenario A has a significantly larger (and overestimated) building wake effect, resulting in a higher concentration near the building. On an annual mean basis the predicted impact is very similar away from the peak for Scenario A and the base modelling.

Analysis of the annual mean contour plots shows that Scenario A predicts a higher peak concentration towards the north-east of the building, and the concentration to the south-east and north-east is slightly greater than the base model. This difference is expected as a result of the greater building wake effects. The annual mean is calculated as the average of the hourly values for each grid point. The base model only underestimates the building wake effects when the winds are from the north-east quadrant which would results in higher 1-hour concentrations to the south-west of the building. Therefore, the actual contour is likely to be a hybrid of the base model and Scenario A. The concentration in the north-east and south-west is likely to be similar to the base model, but the concentration in the south-east and north-west is likely to be similar to (but lower than) Scenario A (as Scenario A significantly overestimates the building wake effects as the building to stack height ratio is not effectively captured). The peak concentration is predicted to occur to the north-east of the building, where the base model is suitable. Therefore, we are confident that way the building is represented in the model will not have a significant impact on the presented maximum annual mean results.

### 13.2 Fluctuation in emission parameters

Dispersion modelling has been undertaken based on the emission parameters presented in the tables contained in Section 6.2. These are based on the design point for the Facility, or at 100% thermal load. The Facility would be operated as a commercial plant and therefore it is beneficial for the Facility to operate at full capacity. For short periods the plant may operate above 100% thermal load due to the variable nature of the fuel. Typically, the system will allow for peaks of up to 10% over the thermal capacity of the plant. In this instance the volumetric flow rate would be higher, resulting in a higher velocity. The dispersion modelling assumes a release rate calculated from the normalised volumetric flow rate and the ELV. As the normalised volumetric flow rate increases so does the assumed release rate. Therefore, for these periods of peaks the amount of pollutants assumed to be released is greater than when operating at the design point. The increase in volumetric flow rate and velocity results in better dispersion and typically this offsets any increase in amount of pollutants released.

#### 13.3 Actual emission rates

The dispersion model has been based on the assumption that the CHP Plant operates continually at the design point and the emissions are at the ELVs stipulated within the IED with the exception of NOx. For NOx a more stringent ELV of 150 mg/Nm³ is being applied for as part of the EP application so the modelling has been based on operation continually at this ELV. It has also been assumed that the gas engines operate continually at the ELVs in Table 6.6.

The CHP Plant and gas engines will operate to achieve the ELV and so will run at emission limits below the ELVs to ensure that they are not breached. Typically, the actual emissions will be at least 10% less than the ELV. The actual emissions will be based on the fuel input and the abatement technology.

When modelling the impact of short term emissions it was assumed that the plant continually operates at the ELV. Where legislation sets a short term and daily ELV, it was assumed that the plant operated continually at the short term ELV although, in reality, the plant would be controlled to operate below the daily ELV and would only operate above the daily ELV for short periods. Therefore, the predicted impact assumes that the worst-case weather conditions for dispersion occur at the same time as the plant is operating at the short term ELV. Even using these worst-case assumptions, the short term impact of all pollutants can be screened out as insignificant.

### 13.4 Operational availability

The dispersion modelling assumes that the Facility continually operates. This assumption was used to ensure that the operation of the Facility during the worst-case weather conditions for dispersion was captured. The CHP Plant and gas engines will need to shut down for periods of maintenance and therefore will not operate for the entire year. Typically, an EfW has a long term availability of approximately 90% and for the purpose of the Environmental Permit application it has been assumed that the availability is 8,150 hours (or 93%).

The long term impact of emissions is calculated by summing the impact for each grid point for each hour over the entire year. As the EfW Facility will not be operating for the entire year the actual impact would be lower than that predicted.

The short term impact of emissions is calculated as the maximum predicted impact for each averaging period over the entire year. Therefore, the operational availability would only influence the short term impact if the EfW Facility was to not operate during the worst-case weather conditions for dispersion.

### 13.5 Model uncertainty

Dispersion models such as ADMS 5.2 attempt to replicate the dispersion of a plume in the real world. The model estimates the ensemble average of numerous repetitions of the same event. Even with the perfect model that predicts the correct ensemble averages there are likely to be deviations from the observed concentrations in individual repetitions of the event due to unknown conditions, this is known as inherent uncertainty. This can in part be attributed to the fact that the model uses hourly sequential inputs of weather data and emissions data, but in the real world these fluctuate on a frequency much shorter than an hour.

Dispersion models are more reliable for estimating longer-term averaged concentrations than for estimating short-term concentrations at specific locations. This is due (in part) to fluctuations in atmospheric conditions, release rates etc. which may not be fully captured in the model. However, models are also reasonably reliable in estimating the magnitude of the highest concentration occurring sometime, somewhere within an area.

Wind tunnel validation studies (CERC 2013³) show that with stack building height ratios >1.5 the model performs very well. In these instances the atmospheric conditions and releases are easily controlled and are known, as are the monitored pollutant concentrations which the model is validated against. The validation studies using real-world data show the model performs well but not at the same level as the wind tunnel validation studies. This is due to a number of factors including uncertainty in the monitoring of the atmospheric conditions and pollutant concentration, in addition to fluctuations in atmospheric conditions on a time scale shorter than an hour. The good performance of the models in the wind tunnel experiments shows that the model is inherently capturing the atmospheric conditions in a controlled environment and there is no systematic uncertainty in the dispersion model.

The wind tunnel exercises have also been able to show that the more complex the model the more uncertainty in the model output, for instance parameterisation of the building wake effects or effects of terrain. This means the more complex the model the more uncertainty in the model output. The model for the Rivenhall IWMF is relatively simple, as the surrounding terrain is flat and, in the base case, the effects of buildings are excluded. This means that the model for the Rivenhall IWMF would be expected to be one of the more accurate models for facilities of this type.

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<sup>&</sup>lt;sup>3</sup> ADMS 5 Building Validation Snyder Wind Tunnel Experiments – CERC June 2013, and Robins and Castro Wind Tunnel Experiments – CERC June 2013 (http://www.cerc.co.uk/environmental-software/model-validation.html)

#### 13.6 Conclusions

There are a number of uncertainties in the dispersion modelling which have been accounted for by using the following conservative assumptions:

- (1) All plant continually operates whereas the plant will be offline for periods of maintenance typically around 10 % of the year;
- (2) All plant continually operate at the ELVs whereas the plant is designed to achieve the ELVs and will typically operate at least 10% below the ELV;
- (3) All lines of the CHP Plant and all of the gas engines operate at the short term ELVs concurrently, which is extremely unlikely;
- (4) When plant operate at the short term ELVs this occurs during the worst-case weather conditions for dispersion;
- (5) 5-years of weather data has been used to account for inter-annual variability and results presented for the maximum over the whole 5-year period; and
- (6) results are presented as the maximum concentration over the gridded domain as well as at the specific receptor locations.

Uncertainties have been identified as a result of:

- (1) the treatment of the building within the model;
- (2) fluctuations in emission rates; and
- (3) model uncertainties.

#### **Effect on predicted long term impacts**

The dispersion model is simple and validation studies show that in a similar setting the model performs well. On a long term basis the main uncertainty lies within the treatment of buildings within the quarry. The analysis has shown that the treatment of the building will have little effect on the peak annual mean concentration, but may lead to a slight increase in the predicted impact for receptors close to the north-west and south-east of the building. However, this is more than offset by the conservatism in the modelling relating to operational availability and emission concentrations. Therefore, we are comfortable that the predicted long term impacts are still conservative.

#### **Effect on predicted short term impacts**

The analysis of the dispersion model has shown that short term impacts occurring at a specific time and location may be underestimated due to inherent uncertainty in part attributed to the fact that the model uses hourly sequential inputs of weather data and emissions data, but in the real world these fluctuate on a frequency much shorter than an hour. However, models are also reasonably reliable in estimating the magnitude of the highest concentration occurring sometime, somewhere within an area. In addition, the treatment of buildings may be underestimated for certain wind directions. As a consequence, the peak concentration may be greater closer to the stack than that presented and the exact location and time which the peak concentration occurs may not be correct.

The dispersion modelling assumed that all items of plant operate concurrently at the short term ELVs during the worst-case weather conditions for dispersion. The plant is designed to meet the daily ELVs, and therefore the probability that these events occur when the wind is from 270° to 360° is low. To account for the uncertainty over the location of the peak short term concentration occurring the results have been presented for the maximum over the modelling domain as well as at receptor locations.

Therefore, we are comfortable that the predicted short term impacts are not likely to be significantly greater than presented.

### 14 CONCLUSIONS

This Dispersion Modelling Assessment has been undertaken to support the Environmental Permit and a planning application to vary the height of the IWMF stack for the Rivenhall Integrated Waste Management Facility.

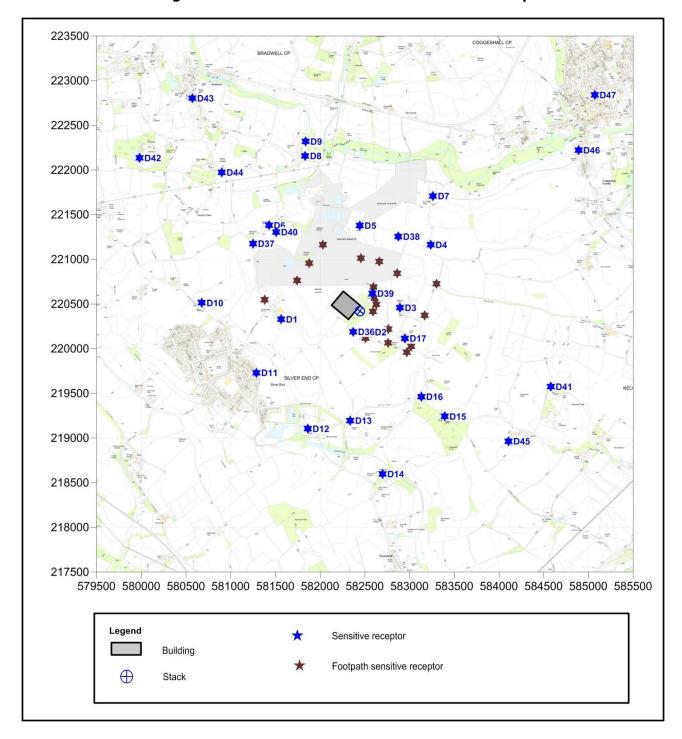
This assessment has included a review of baseline pollution levels, dispersion modelling of emissions and determination of the significance of the impact of these emissions on local air quality.

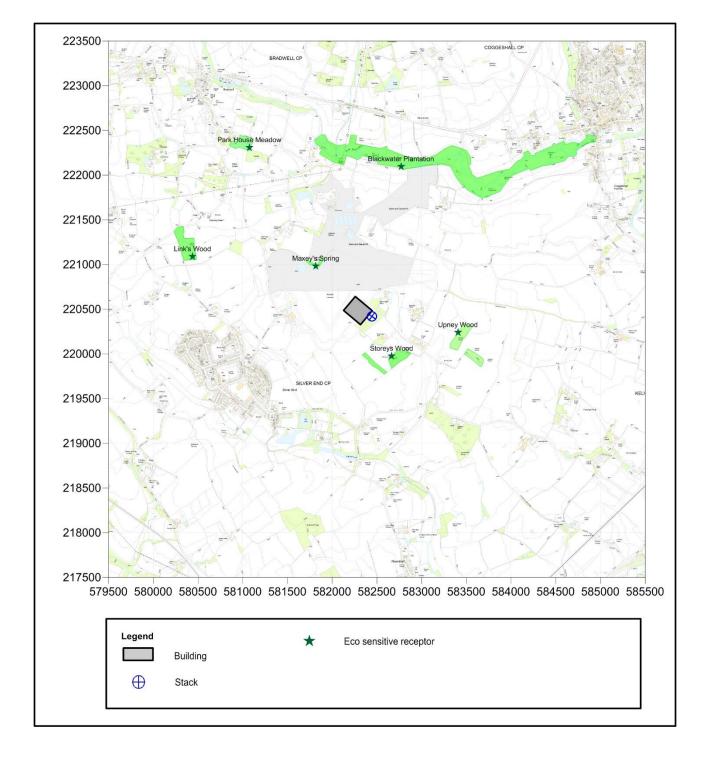
- (1) The review of background monitoring data and DEFRA modelled data has been undertaken to determine the most suitable concentrations for use in the assessment. Where background monitoring is available this has been used in preference to modelled data.
- (2) The methodology used in the assessment of the impact on air quality of the proposals uses a number of conservative assumptions. These include the following:
  - a) The Facility will be applying BAT for the control of emissions and comply with the emission limits outlined in the IED for a waste incineration plant;
  - b) It is assumed that the Facility will continually operate at the proposed limits whereas, in practice, this will not be the case and actual emissions will be less than the limits;
  - c) It has been assumed that all items of plant operate concurrently at the short term emission limit values when determining short term impact to ensure the worstcase is accounted for where all items could be operating during adverse meteorological conditions for dispersion;
  - d) It has been assumed that all items of plant operate concurrently at the daily emission limit values when determining long term impacts; and
  - e) The maximum ground level concentrations are considered in each case. These concentrations occur in small areas; in general, the concentration will be much lower.
- (3) In relation to the impact on ecologically sensitive sites, it has been assumed that all items of plant operate at the emission limits for the entire year as a worst-case. Even with this highly conservative assumption we conclude that:
  - a) No UK or European designated sites have been identified within the H1 screening distance, and have not been considered in this assessment.
  - b) At all locally designated sites emissions are not likely to have a significant impact.

In summary, the proposed Facility would not have a significant impact on local air quality, the general population or the local community.

# Appendix A - Figures

Figure 1: Site Location and Human Sensitive Receptors

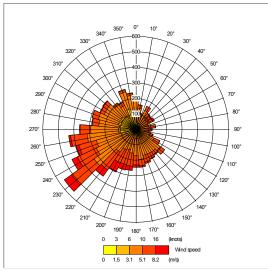




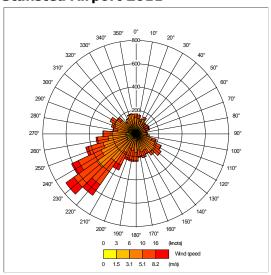
**Figure 2: Sensitive Ecological Receptors** 

Figure 3: Wind Roses

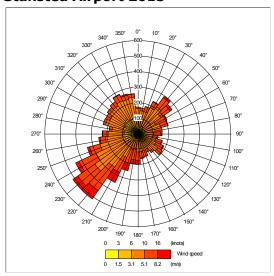
# **Stansted Airport 2009**



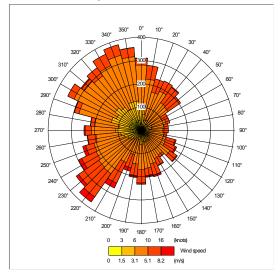
# **Stansted Airport 2011**



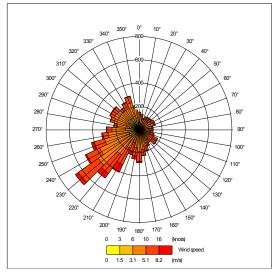
# **Stansted Airport 2013**



# **Stansted Airport 2010**

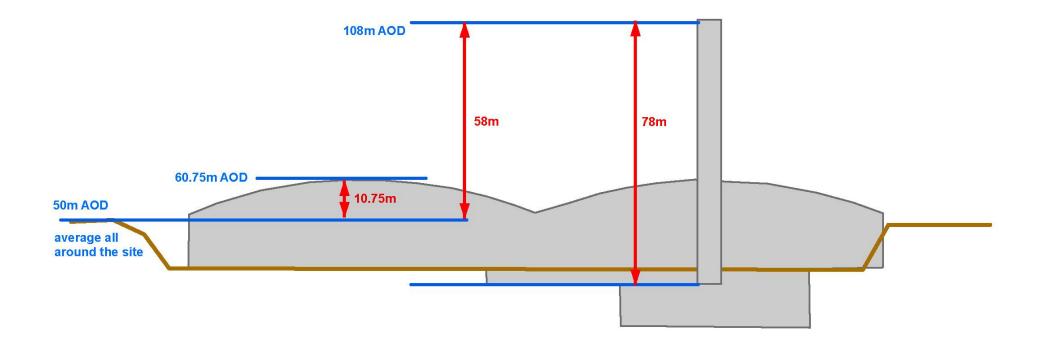


# **Stansted Airport 2012**



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Figure 4: Building Layout



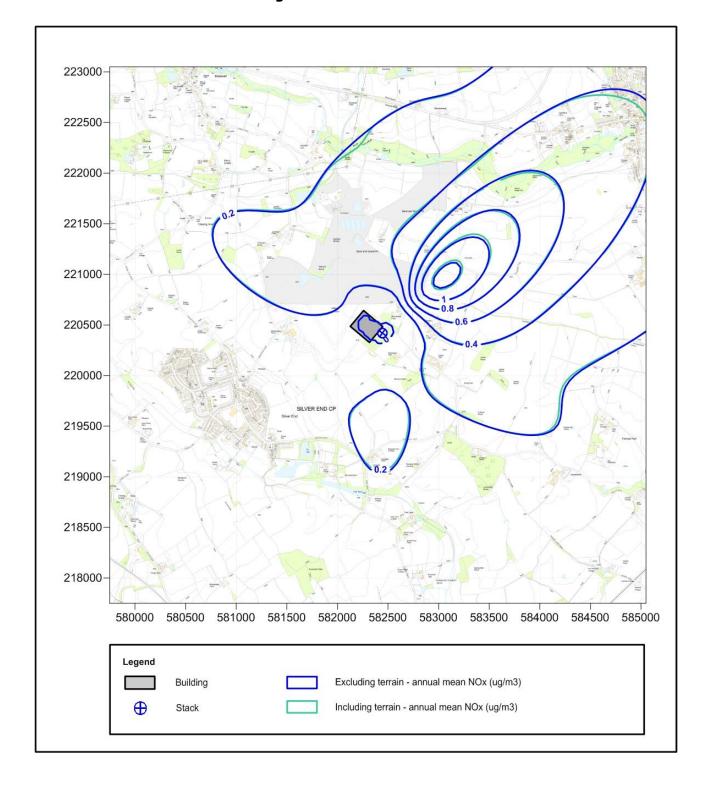


Figure 5: Effect of Terrain

Assumes 100% operation of the all items of plant at the daily ELVs using 2011 weather data only.

Figure 6: Annual Mean Nitrogen Dioxide Process Contribution (as a % of AQAL) – Max All Years

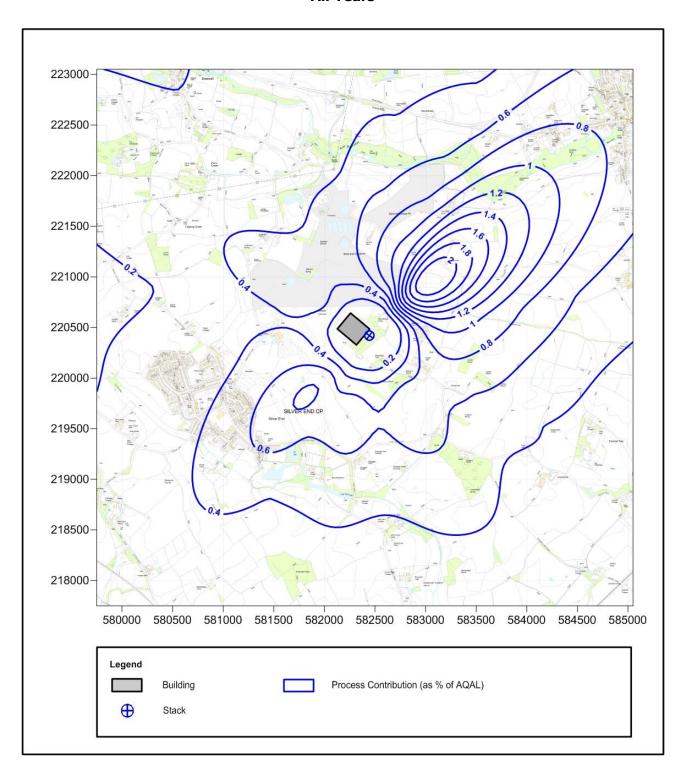
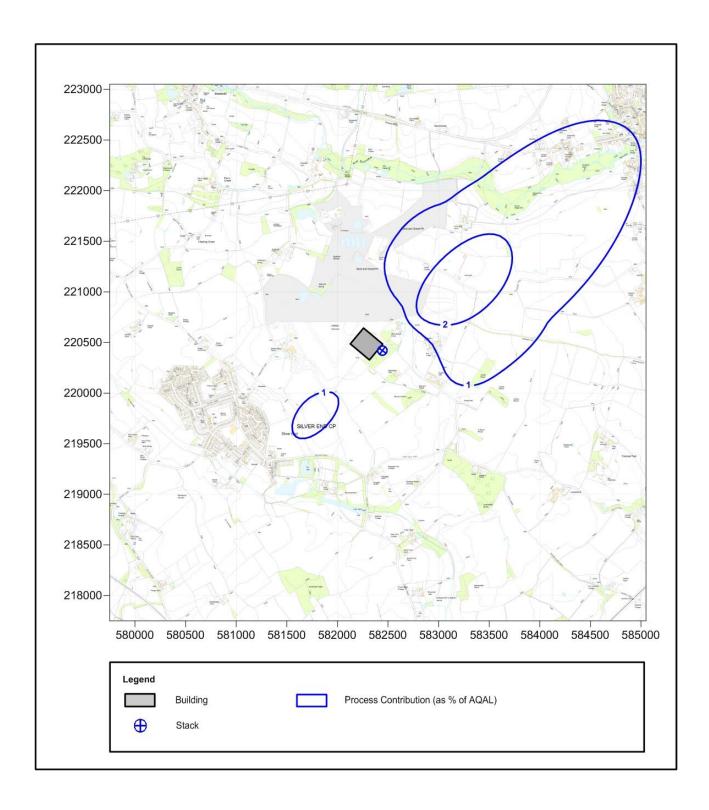


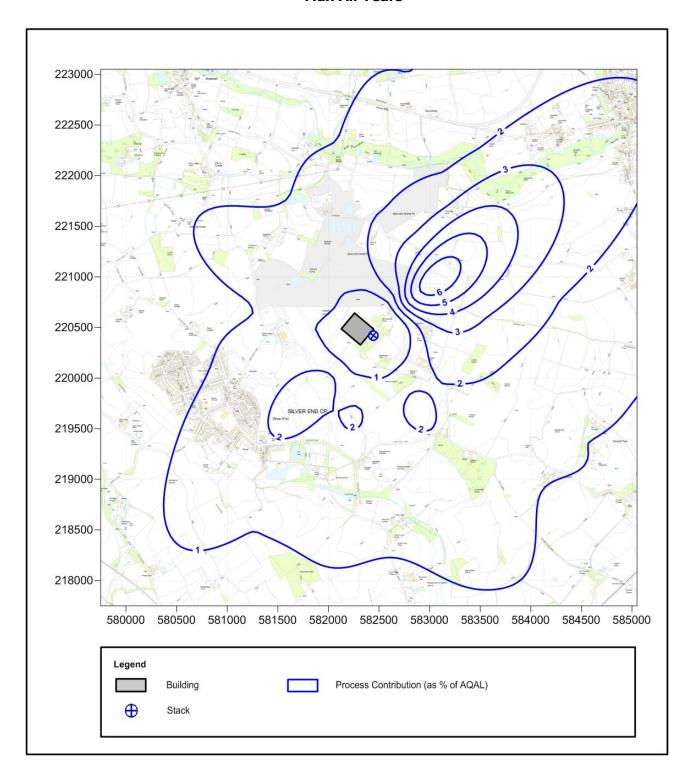
Figure 7: Annual Mean VOCs (as benzene) Process Contribution (as a % of AQAL) – Max All Years



Assumes 100% operation of the all items of plant at the daily ELVs and all TOC emissions consist of only benzene.

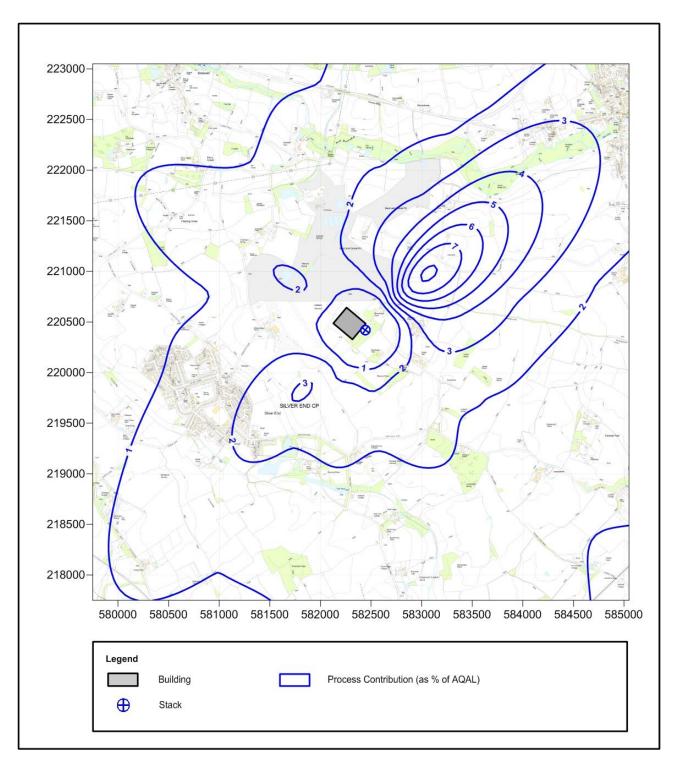
Figure 8: Annual Mean VOCs (as 1,3-butadiene) Process Contribution (as a % of AQAL)

- Max All Years



Assumes 100% operation of the all items of plant at the daily ELVs and all TOC emissions consist of only 1,3-butadiene.

Figure 9: Annual Mean Cadmium Process Contribution (as a % of AQAL) - Max All Years



Assumes emissions of Cadmium are 100% of the combined cadmium and thallium ELV and all items of plant operate at the daily ELVs.

Figure 10: Annual Mean Oxides of Nitrogen Process Contribution (as a % of CL) – Max All Years

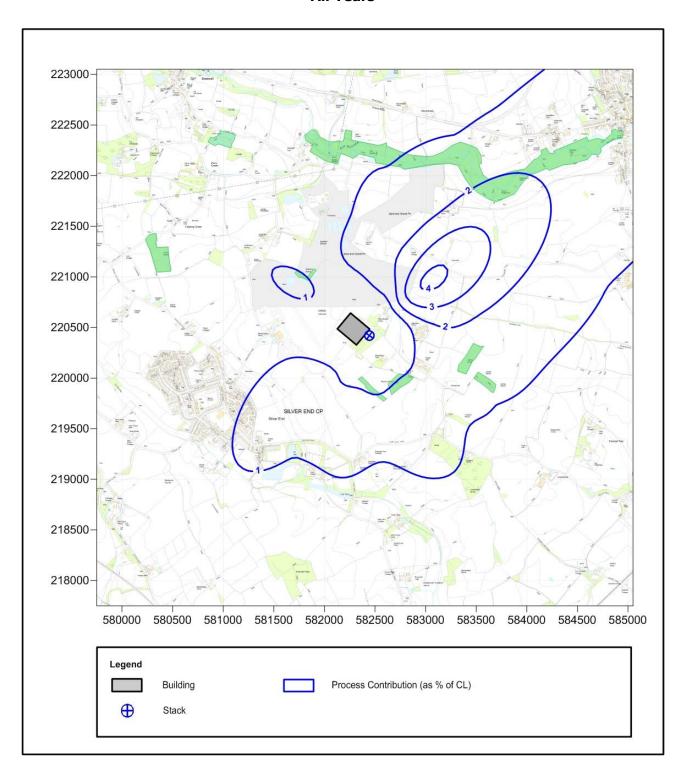


Figure 11: Max Daily Mean Oxides of Nitrogen Process Contribution (as a % of CL) – Max All Years

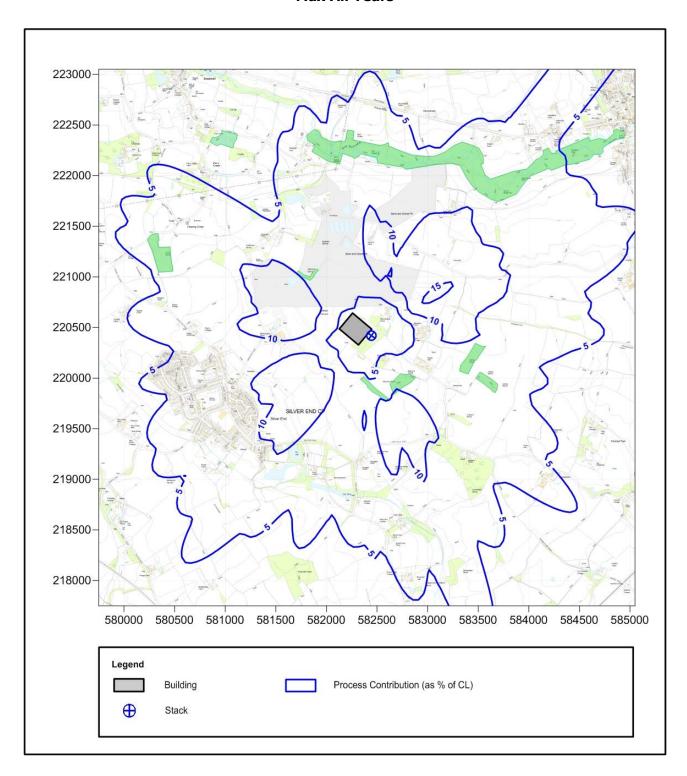


Figure 12: Annual Mean Sulphur Dioxide Process Contribution (as a % of CL) – Max All Years

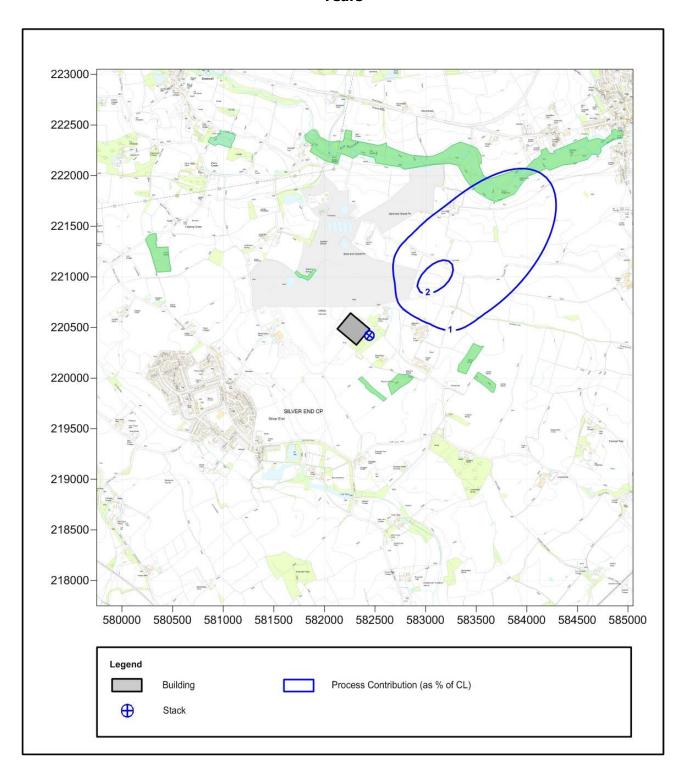


Figure 13: Max Daily Mean Hydrogen Fluoride Process Contribution (as a % of CL) – Max All Years

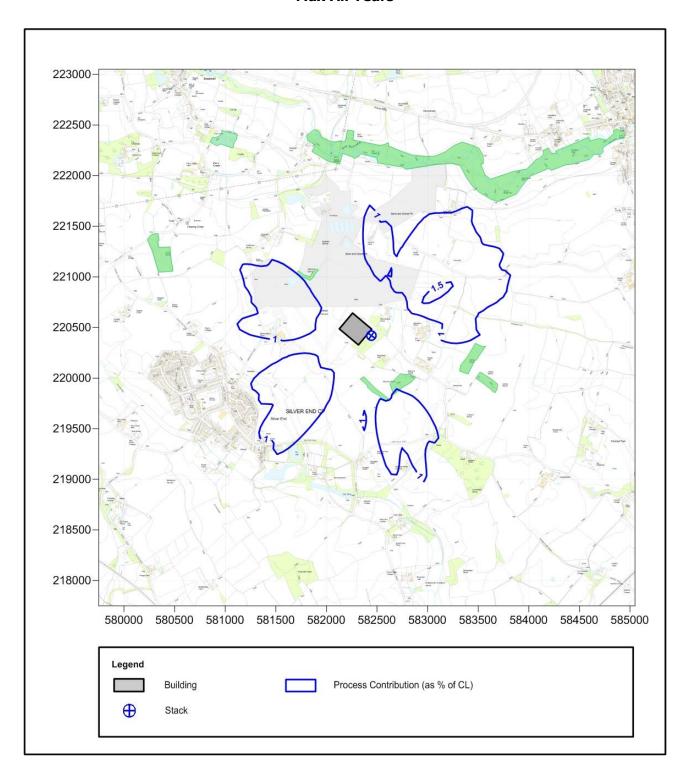


Figure 14: Max Weekly Mean Hydrogen Fluoride Process Contribution (as a % of CL) – Max All Years

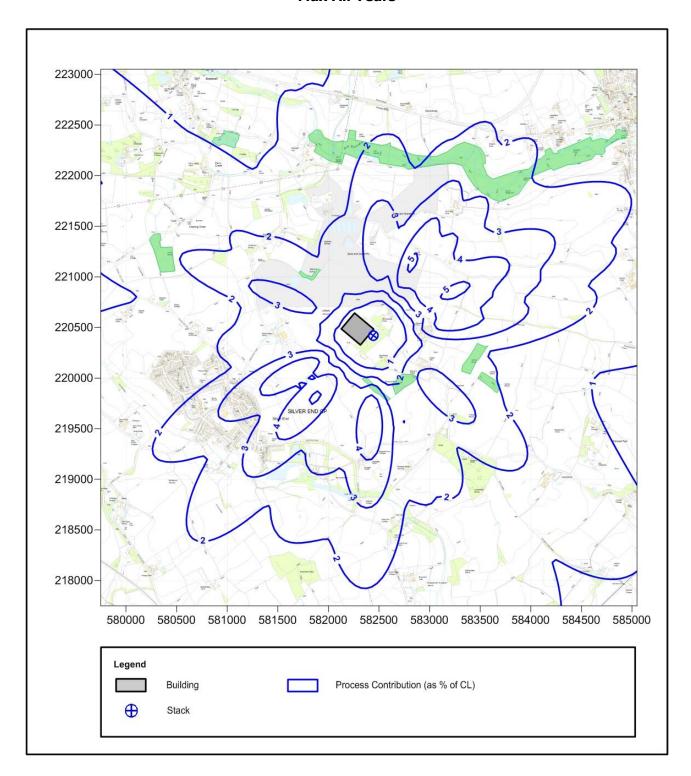
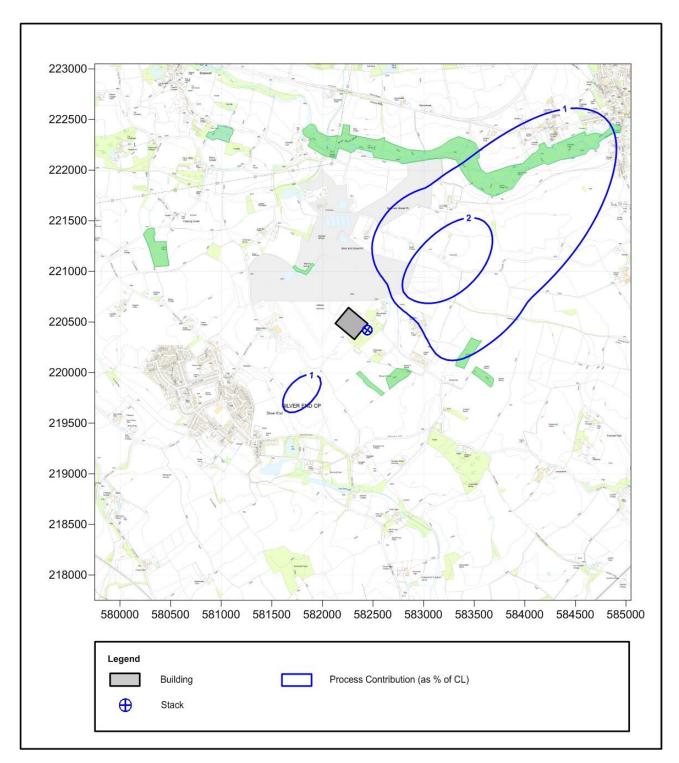


Figure 15: Annual Mean Ammonia Process Contribution (as a % of CL) - Max All Years



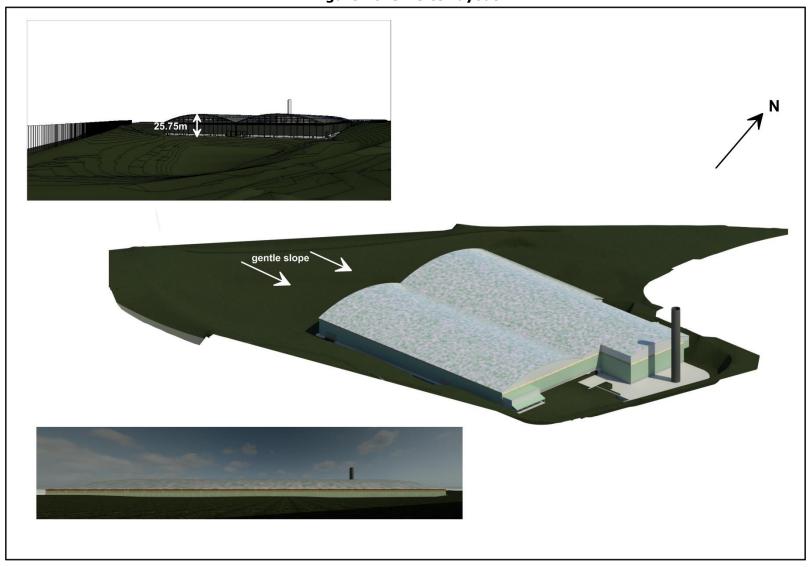
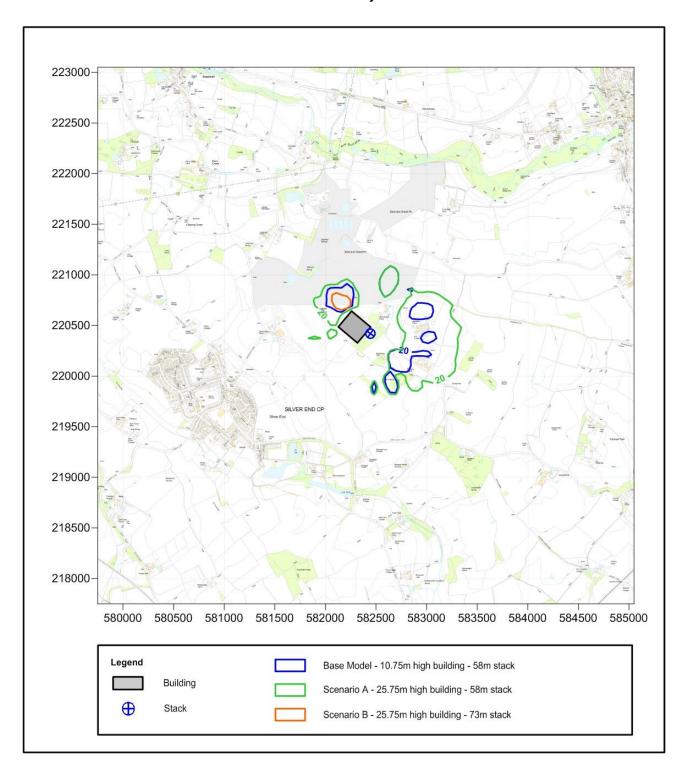


Figure 16: 3D Site Layout

Figure 17: Effect on Predicted Short Term Impacts – Max Hourly NOx (20μg/m³ contour)



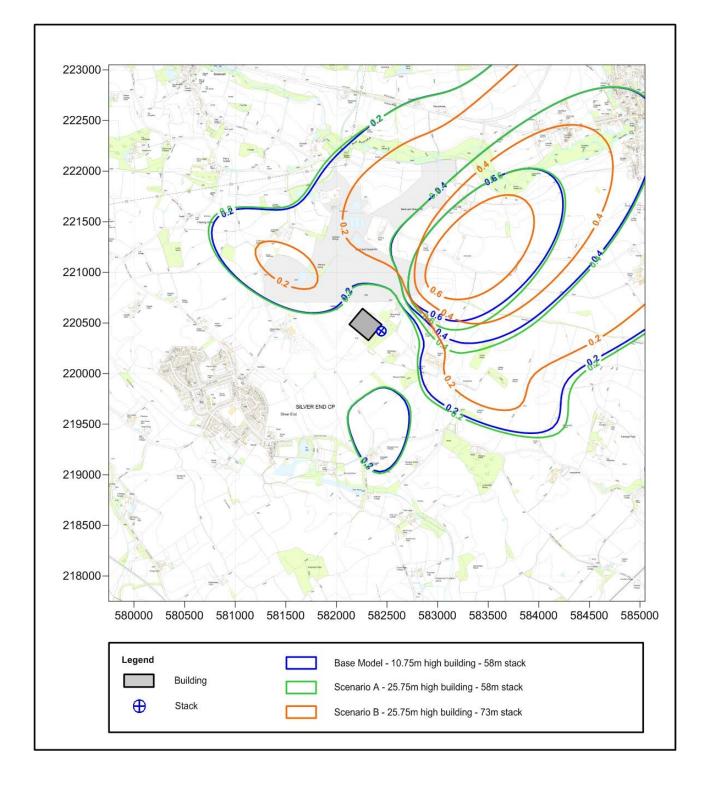


Figure 18: Effect on Predicted Long Term Impacts

Appendix B – Detailed Results at Sensitive Receptors

Receptor	Process Co	ontribution	Predicted Environmental Concentration		
	μg/m³	As % of AQAL	μg/m³	As % of AQAL	
Sheepcotes Farm (Hanger No.1)	0.18	0.5%	18.78	47.0%	
Wayfarers Site	0.03	0.1%	18.63	46.6%	
Allshot's Farm (Scrap Yard)	0.24	0.6%	18.84	47.1%	
Haywards	0.81	2.0%	19.41	48.5%	
Herons Farm	0.28	0.7%	18.88	47.2%	
Gosling's Farm	0.17	0.4%	18.77	46.9%	
Curd Hall Farm	0.44	1.1%	19.04	47.6%	
Church (adjacent to Bradwell Hall)	0.14	0.3%	18.74	46.8%	
Bradwell Hall	0.13	0.3%	18.73	46.8%	
Rolphs Farmhouse	0.11	0.3%	18.71	46.8%	
Silver End / Bower Hall / Fossil Hall	0.23	0.6%	18.83	47.1%	
Rivenhall Pl/Hall	0.20	0.5%	18.80	47.0%	
Parkgate Farm / Watchpall Cottages	0.23	0.6%	18.83	47.1%	
Ford Farm / Rivenhall Cottage	0.16	0.4%	18.76	46.9%	
Porter's Farm	0.21	0.5%	18.81	47.0%	
Unknown Building 1	0.25	0.6%	18.85	47.1%	
Bumby Hall / The Lodge / Polish Site (Light Industry)	0.24	0.6%	18.84	47.1%	
Footpath 8, Receptor 1 (East of Site)	0.38	0.9%	18.98	47.4%	
Footpath 8, Receptor 2 (East of Site)	0.09	0.2%	18.69	46.7%	
Footpath 8, Receptor 3 (East of Site)	0.02	0.0%	18.62	46.5%	
Footpath 8, Receptor 4 (East of Site)	0.01	0.0%	18.61	46.5%	
Footpath 8, Receptor 5 (East of Site)	0.00	0.0%	18.60	46.5%	
Footpath 8, Receptor 6 (East of Site)	0.12	0.3%	18.72	46.8%	
Footpath 8, Receptor 7 (East of Site)	0.26	0.7%	18.86	47.2%	
Footpath 35, Receptor 1 (North of Site)	0.74	1.9%	19.34	48.4%	
Footpath 35, Receptor 2 (North of Site)	0.25	0.6%	18.85	47.1%	
Footpath 35, Receptor 3 (North of Site)	0.19	0.5%	18.79	47.0%	
Footpath 31, Receptor 1 (North west of Site)	0.21	0.5%	18.81	47.0%	
Footpath 31, Receptor 2 (North west of Site)	0.20	0.5%	18.80	47.0%	
Footpath 31, Receptor 3 (North west of Site)	0.15	0.4%	18.75	46.9%	
Footpath 7, Receptor 1 (South east of Site)	0.06	0.1%	18.66	46.6%	

Table B.1: Annual Mean Nitrogen Dioxide Impact at Sensitive Receptors					
Receptor	Process C	ontribution	Predicted Environmental Concentration		
	μg/m³	As % of AQAL	μg/m³ % 18.78 18.86 % 18.96 % 19.18 % 18.62 % 18.78 % 19.10 % 18.63 % 18.78 % 18.78 % 18.78	As % of AQAL	
Footpath 7, Receptor 2 (South east of Site)	0.18	0.5%	18.78	47.0%	
Footpath 7, Receptor 3 (South east of Site)	0.26	0.6%	18.86	47.1%	
Footpath 7, Receptor 4 (South east of Site)	0.36	0.9%	18.96	47.4%	
Footpath 7, Receptor 5 (South east of Site)	0.58	1.5%	19.18	48.0%	
Elephant House (Street Sweepings)	0.02	0.0%	18.62	46.5%	
Green Pastures Bungalow	0.18	0.5%	18.78	47.0%	
Deeks Cottage	0.50	1.3%	19.10	47.8%	
Woodhouse Farm	0.03	0.1%	18.63	46.6%	
Gosling Cottage / Barn	0.18	0.4%	18.78	46.9%	
Felix Hall / The Clock House / Park Farm	0.14	0.4%	18.74	46.9%	
Glazenwood House	0.10	0.2%	18.70	46.7%	
Bradwell Hall	0.08	0.2%	18.68	46.7%	
Perry Green Farm	0.11	0.3%	18.71	46.8%	
The Granary / Porter Farm / Rook Hall	0.14	0.3%	18.74	46.8%	
Grange Farm	0.31	0.8%	18.91	47.3%	
Coggeshall	0.27	0.7%	18.87	47.2%	
NOTES:					

Table B.2: Annual Mean VOCs (as Benzene) Impact at Sensitive Receptors						
Receptor	Process Co	ontribution	Predicted Environmental Concentration			
·	μg/m³	As % of AQAL	μg/m³	As % of AQAL		
Sheepcotes Farm (Hanger No.1)	0.03	0.6%	0.43	8.6%		
Wayfarers Site	0.01	0.1%	0.41	8.1%		
Allshot's Farm (Scrap Yard)	0.04	0.8%	0.44	8.8%		
Haywards	0.14	2.8%	0.54	10.8%		
Herons Farm	0.05	1.0%	0.45	9.0%		
Gosling's Farm	0.03	0.6%	0.43	8.6%		
Curd Hall Farm	0.07	1.5%	0.47	9.5%		
Church (adjacent to Bradwell Hall)	0.02	0.5%	0.42	8.5%		
Bradwell Hall	0.02	0.4%	0.42	8.4%		
Rolphs Farmhouse	0.02	0.4%	0.42	8.4%		
Silver End / Bower Hall / Fossil Hall	0.04	0.8%	0.44	8.8%		
Rivenhall Pl/Hall	0.03	0.7%	0.43	8.7%		
Parkgate Farm / Watchpall Cottages	0.04	0.8%	0.44	8.8%		
Ford Farm / Rivenhall Cottage	0.03	0.5%	0.43	8.5%		
Porter's Farm	0.03	0.7%	0.43	8.7%		
Unknown Building 1	0.04	0.9%	0.44	8.9%		
Bumby Hall / The Lodge / Polish Site (Light Industry)	0.04	0.8%	0.44	8.8%		
Footpath 8, Receptor 1 (East of Site)	0.06	1.3%	0.46	9.3%		
Footpath 8, Receptor 2 (East of Site)	0.02	0.3%	0.42	8.3%		
Footpath 8, Receptor 3 (East of Site)	0.00	0.1%	0.40	8.1%		
Footpath 8, Receptor 4 (East of Site)	0.00	0.0%	0.40	8.0%		
Footpath 8, Receptor 5 (East of Site)	0.00	0.0%	0.40	8.0%		
Footpath 8, Receptor 6 (East of Site)	0.02	0.4%	0.42	8.4%		
Footpath 8, Receptor 7 (East of Site)	0.04	0.9%	0.44	8.9%		
Footpath 35, Receptor 1 (North of Site)	0.13	2.5%	0.53	10.5%		
Footpath 35, Receptor 2 (North of Site)	0.04	0.8%	0.44	8.8%		
Footpath 35, Receptor 3 (North of Site)	0.03	0.6%	0.43	8.6%		
Footpath 31, Receptor 1 (North west of Site)	0.04	0.7%	0.44	8.7%		
Footpath 31, Receptor 2 (North west of Site)	0.03	0.7%	0.43	8.7%		
Footpath 31, Receptor 3 (North west of Site)	0.02	0.5%	0.42	8.5%		
Footpath 7, Receptor 1 (South east of Site)	0.01	0.2%	0.41	8.2%		
Footpath 7, Receptor 2 (South east of Site)	0.03	0.6%	0.43	8.6%		
Footpath 7, Receptor 3 (South east of Site)	0.04	0.9%	0.44	8.9%		

Table B.2: Annual Mean VOCs (as Benzene) Impact at Sensitive Receptors					
Receptor	Process Co	ontribution	Predicted Environmental Concentration		
•	μg/m³	As % of AQAL	μg/m³	As % of AQAL	
Footpath 7, Receptor 4 (South east of Site)	0.06	1.2%	0.46	9.2%	
Footpath 7, Receptor 5 (South east of Site)	0.10	2.0%	0.50	10.0%	
Elephant House (Street Sweepings)	0.00	0.1%	0.40	8.1%	
Green Pastures Bungalow	0.03	0.6%	0.43	8.6%	
Deeks Cottage	0.08	1.7%	0.48	9.7%	
Woodhouse Farm	0.00	0.1%	0.40	8.1%	
Gosling Cottage / Barn	0.03	0.6%	0.43	8.6%	
Felix Hall / The Clock House / Park Farm	0.02	0.5%	0.42	8.5%	
Glazenwood House	0.02	0.3%	0.42	8.3%	
Bradwell Hall	0.01	0.3%	0.41	8.3%	
Perry Green Farm	0.02	0.4%	0.42	8.4%	
The Granary / Porter Farm / Rook Hall	0.02	0.5%	0.42	8.5%	
Grange Farm	0.05	1.0%	0.45	9.0%	
Coggeshall	0.05	0.9%	0.45	8.9%	

## NOTES:

Assumes 100% operation of all items of plant at the daily ELVs Assumes all VOCs are consist only of benzene.

Table B.3: Annual Mean VOCs (as 1,3-butadiene) Impact at Sensitive Receptors					
Receptor	Process Co	ontribution	Predicted Environmental Concentration		
	μg/m³	As % of AQAL	μg/m³	As % of AQAL	
Sheepcotes Farm (Hanger No.1)	0.03	1.4%	0.23	10.3%	
Wayfarers Site	0.01	0.3%	0.21	9.1%	
Allshot's Farm (Scrap Yard)	0.04	1.8%	0.24	10.7%	
Haywards	0.14	6.1%	0.34	15.0%	
Herons Farm	0.05	2.1%	0.25	11.0%	
Gosling's Farm	0.03	1.3%	0.23	10.2%	
Curd Hall Farm	0.07	3.3%	0.27	12.2%	
Church (adjacent to Bradwell Hall)	0.02	1.0%	0.22	9.9%	
Bradwell Hall	0.02	1.0%	0.22	9.8%	
Rolphs Farmhouse	0.02	0.8%	0.22	9.7%	
Silver End / Bower Hall / Fossil Hall	0.04	1.7%	0.24	10.6%	
Rivenhall Pl/Hall	0.03	1.5%	0.23	10.4%	
Parkgate Farm / Watchpall Cottages	0.04	1.7%	0.24	10.6%	
Ford Farm / Rivenhall Cottage	0.03	1.2%	0.23	10.1%	
Porter's Farm	0.03	1.6%	0.23	10.4%	
Unknown Building 1	0.04	1.9%	0.24	10.8%	
Bumby Hall / The Lodge / Polish Site (Light Industry)	0.04	1.8%	0.24	10.7%	
Footpath 8, Receptor 1 (East of Site)	0.06	2.8%	0.26	11.7%	
Footpath 8, Receptor 2 (East of Site)	0.02	0.7%	0.22	9.6%	
Footpath 8, Receptor 3 (East of Site)	0.00	0.1%	0.20	9.0%	
Footpath 8, Receptor 4 (East of Site)	0.00	0.1%	0.20	8.9%	
Footpath 8, Receptor 5 (East of Site)	0.00	0.0%	0.20	8.9%	
Footpath 8, Receptor 6 (East of Site)	0.02	0.9%	0.22	9.8%	
Footpath 8, Receptor 7 (East of Site)	0.04	2.0%	0.24	10.9%	
Footpath 35, Receptor 1 (North of Site)	0.13	5.6%	0.33	14.5%	
Footpath 35, Receptor 2 (North of Site)	0.04	1.9%	0.24	10.8%	
Footpath 35, Receptor 3 (North of Site)	0.03	1.4%	0.23	10.3%	
Footpath 31, Receptor 1 (North west of Site)	0.04	1.6%	0.24	10.4%	
Footpath 31, Receptor 2 (North west of Site)	0.03	1.5%	0.23	10.4%	
Footpath 31, Receptor 3 (North west of Site)	0.02	1.1%	0.22	10.0%	
Footpath 7, Receptor 1 (South east of Site)	0.01	0.4%	0.21	9.3%	
Footpath 7, Receptor 2 (South east of Site)	0.03	1.4%	0.23	10.3%	
Footpath 7, Receptor 3 (South east of Site)	0.04	1.9%	0.24	10.8%	

Table B.3: Annual Mean VOCs (as 1,3-butadiene) Impact at Sensitive Receptors

Receptor	Process Co	ontribution	Predicted Environmental Concentration		
	μg/m³	As % of AQAL	μg/m³	As % of AQAL	
Footpath 7, Receptor 4 (South east of Site)	0.06	2.7%	0.26	11.6%	
Footpath 7, Receptor 5 (South east of Site)	0.10	4.4%	0.30	13.3%	
Elephant House (Street Sweepings)	0.00	0.1%	0.20	9.0%	
Green Pastures Bungalow	0.03	1.4%	0.23	10.3%	
Deeks Cottage	0.08	3.8%	0.28	12.7%	
Woodhouse Farm	0.00	0.2%	0.20	9.1%	
Gosling Cottage / Barn	0.03	1.4%	0.23	10.2%	
Felix Hall / The Clock House / Park Farm	0.02	1.1%	0.22	10.0%	
Glazenwood House	0.02	0.7%	0.22	9.6%	
Bradwell Hall	0.01	0.6%	0.21	9.5%	
Perry Green Farm	0.02	0.8%	0.22	9.7%	
The Granary / Porter Farm / Rook Hall	0.02	1.0%	0.22	9.9%	
Grange Farm	0.05	2.3%	0.25	11.2%	
Coggeshall	0.05	2.0%	0.25	10.9%	

## NOTES:

Assumes 100% operation of all items of plant at the daily ELVs Assumes all VOCs are consist only of 1,3-butadiene

Process Contribution         Predicted Environmental Concentration           µg/m³         As % of AQAL AQAL AQAL         µg/m³         As % of AQAL AQAL AQAL           Sheepcotes Farm (Hanger No.1)         0.09         1.7%         0.24         4.7%           Wayfarers Site         0.02         0.3%         0.17         3.3%           Allshot's Farm (Scrap Yard)         0.11         2.2%         0.26         5.2%           Haywards         0.38         7.5%         0.53         10.5%           Herons Farm         0.13         2.6%         0.28         5.6%           Gosling's Farm         0.08         1.6%         0.23         4.6%           Curd Hall Farm         0.20         4.0%         0.35         7.0%           Church (adjacent to Bradwell Hall)         0.06         1.3%         0.21         4.3%           Bradwell Hall         0.06         1.2%         0.21         4.2%           Rolphs Farmhouse         0.05         1.0%         0.20         4.0%           Silver End / Bower Hall / Fossil Hall         0.11         2.1%         0.26         5.1%           Rivenhall Pl/Hall         0.09         1.9%         0.24         4.9%           Parkgat	Table B.4: Annual Mean Cadmium Impact at Sensitive Receptors						
Pg/m3   AQAL   Pg/m3   AQAL   AQAL	Receptor	Process Co	ontribution	Environmental			
Wayfarers Site       0.02       0.3%       0.17       3.3%         Allshot's Farm (Scrap Yard)       0.11       2.2%       0.26       5.2%         Haywards       0.38       7.5%       0.53       10.5%         Herons Farm       0.13       2.6%       0.28       5.6%         Gosling's Farm       0.08       1.6%       0.23       4.6%         Curd Hall Farm       0.20       4.0%       0.35       7.0%         Church (adjacent to Bradwell Hall)       0.06       1.3%       0.21       4.3%         Bradwell Hall       0.06       1.2%       0.21       4.2%         Rolphs Farmhouse       0.05       1.0%       0.20       4.0%         Silver End / Bower Hall / Fossil Hall       0.11       2.1%       0.26       5.1%         Rivenhall Pl/Hall       0.09       1.9%       0.24       4.9%         Parkgate Farm / Watchpall Cottages       0.11       2.1%       0.26       5.1%         Ford Farm / Rivenhall Cottage       0.07       1.5%       0.22       4.5%         Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%		μg/m³		μg/m³			
Allshot's Farm (Scrap Yard)       0.11       2.2%       0.26       5.2%         Haywards       0.38       7.5%       0.53       10.5%         Herons Farm       0.13       2.6%       0.28       5.6%         Gosling's Farm       0.08       1.6%       0.23       4.6%         Curd Hall Farm       0.20       4.0%       0.35       7.0%         Church (adjacent to Bradwell Hall)       0.06       1.3%       0.21       4.3%         Bradwell Hall       0.06       1.2%       0.21       4.2%         Rolphs Farmhouse       0.05       1.0%       0.20       4.0%         Silver End / Bower Hall / Fossil Hall       0.11       2.1%       0.26       5.1%         Rivenhall Pl/Hall       0.09       1.9%       0.24       4.9%         Parkgate Farm / Watchpall Cottages       0.11       2.1%       0.26       5.1%         Ford Farm / Rivenhall Cottage       0.07       1.5%       0.22       4.5%         Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26	Sheepcotes Farm (Hanger No.1)	0.09	1.7%	0.24	4.7%		
Haywards       0.38       7.5%       0.53       10.5%         Herons Farm       0.13       2.6%       0.28       5.6%         Gosling's Farm       0.08       1.6%       0.23       4.6%         Curd Hall Farm       0.20       4.0%       0.35       7.0%         Church (adjacent to Bradwell Hall)       0.06       1.3%       0.21       4.3%         Bradwell Hall       0.06       1.2%       0.21       4.2%         Rolphs Farmhouse       0.05       1.0%       0.20       4.0%         Silver End / Bower Hall / Fossil Hall       0.11       2.1%       0.26       5.1%         Rivenhall Pl/Hall       0.09       1.9%       0.24       4.9%         Parkgate Farm / Watchpall Cottages       0.11       2.1%       0.26       5.1%         Ford Farm / Rivenhall Cottage       0.07       1.5%       0.22       4.5%         Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.04       0.8%	Wayfarers Site	0.02	0.3%	0.17	3.3%		
Herons Farm   0.13   2.6%   0.28   5.6%	Allshot's Farm (Scrap Yard)	0.11	2.2%	0.26	5.2%		
Gosling's Farm         0.08         1.6%         0.23         4.6%           Curd Hall Farm         0.20         4.0%         0.35         7.0%           Church (adjacent to Bradwell Hall)         0.06         1.3%         0.21         4.3%           Bradwell Hall         0.06         1.2%         0.21         4.2%           Rolphs Farmhouse         0.05         1.0%         0.20         4.0%           Silver End / Bower Hall / Fossil Hall         0.11         2.1%         0.26         5.1%           Rivenhall Pl/Hall         0.09         1.9%         0.24         4.9%           Parkgate Farm / Watchpall Cottages         0.11         2.1%         0.26         5.1%           Ford Farm / Rivenhall Cottage         0.07         1.5%         0.22         4.5%           Porter's Farm         0.10         1.9%         0.25         4.9%           Unknown Building 1         0.12         2.3%         0.27         5.3%           Bumby Hall / The Lodge / Polish Site (Light Industry)         0.11         2.2%         0.26         5.2%           Footpath 8, Receptor 1 (East of Site)         0.18         3.5%         0.33         6.5%           Footpath 8, Receptor 2 (East of Site)         0.04	Haywards	0.38	7.5%	0.53	10.5%		
Curd Hall Farm         0.20         4.0%         0.35         7.0%           Church (adjacent to Bradwell Hall)         0.06         1.3%         0.21         4.3%           Bradwell Hall         0.06         1.2%         0.21         4.2%           Rolphs Farmhouse         0.05         1.0%         0.20         4.0%           Silver End / Bower Hall / Fossil Hall         0.11         2.1%         0.26         5.1%           Rivenhall Pl/Hall         0.09         1.9%         0.24         4.9%           Parkgate Farm / Watchpall Cottages         0.11         2.1%         0.26         5.1%           Ford Farm / Rivenhall Cottage         0.07         1.5%         0.22         4.5%           Porter's Farm         0.10         1.9%         0.25         4.9%           Unknown Building 1         0.12         2.3%         0.27         5.3%           Bumby Hall / The Lodge / Polish Site (Light Industry)         0.11         2.2%         0.26         5.2%           Footpath 8, Receptor 1 (East of Site)         0.18         3.5%         0.33         6.5%           Footpath 8, Receptor 2 (East of Site)         0.04         0.8%         0.19         3.8%           Footpath 8, Receptor 4 (East of Site)	Herons Farm	0.13	2.6%	0.28	5.6%		
Church (adjacent to Bradwell Hall)         0.06         1.3%         0.21         4.3%           Bradwell Hall         0.06         1.2%         0.21         4.2%           Rolphs Farmhouse         0.05         1.0%         0.20         4.0%           Silver End / Bower Hall / Fossil Hall         0.11         2.1%         0.26         5.1%           Rivenhall Pl/Hall         0.09         1.9%         0.24         4.9%           Parkgate Farm / Watchpall Cottages         0.11         2.1%         0.26         5.1%           Ford Farm / Rivenhall Cottage         0.07         1.5%         0.22         4.5%           Porter's Farm         0.10         1.9%         0.25         4.9%           Unknown Building 1         0.12         2.3%         0.27         5.3%           Bumby Hall / The Lodge / Polish Site (Light Industry)         0.11         2.2%         0.26         5.2%           Footpath 8, Receptor 1 (East of Site)         0.18         3.5%         0.33         6.5%           Footpath 8, Receptor 2 (East of Site)         0.04         0.8%         0.19         3.8%           Footpath 8, Receptor 4 (East of Site)         0.00         0.1%         0.15         3.1%	Gosling's Farm	0.08	1.6%	0.23	4.6%		
Bradwell Hall         0.06         1.2%         0.21         4.2%           Rolphs Farmhouse         0.05         1.0%         0.20         4.0%           Silver End / Bower Hall / Fossil Hall         0.11         2.1%         0.26         5.1%           Rivenhall Pl/Hall         0.09         1.9%         0.24         4.9%           Parkgate Farm / Watchpall Cottages         0.11         2.1%         0.26         5.1%           Ford Farm / Rivenhall Cottage         0.07         1.5%         0.22         4.5%           Porter's Farm         0.10         1.9%         0.25         4.9%           Unknown Building 1         0.12         2.3%         0.27         5.3%           Bumby Hall / The Lodge / Polish Site (Light Industry)         0.11         2.2%         0.26         5.2%           Footpath 8, Receptor 1 (East of Site)         0.18         3.5%         0.33         6.5%           Footpath 8, Receptor 2 (East of Site)         0.04         0.8%         0.19         3.8%           Footpath 8, Receptor 4 (East of Site)         0.00         0.1%         0.15         3.1%	Curd Hall Farm	0.20	4.0%	0.35	7.0%		
Rolphs Farmhouse       0.05       1.0%       0.20       4.0%         Silver End / Bower Hall / Fossil Hall       0.11       2.1%       0.26       5.1%         Rivenhall Pl/Hall       0.09       1.9%       0.24       4.9%         Parkgate Farm / Watchpall Cottages       0.11       2.1%       0.26       5.1%         Ford Farm / Rivenhall Cottage       0.07       1.5%       0.22       4.5%         Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Church (adjacent to Bradwell Hall)	0.06	1.3%	0.21	4.3%		
Silver End / Bower Hall / Fossil Hall       0.11       2.1%       0.26       5.1%         Rivenhall Pl/Hall       0.09       1.9%       0.24       4.9%         Parkgate Farm / Watchpall Cottages       0.11       2.1%       0.26       5.1%         Ford Farm / Rivenhall Cottage       0.07       1.5%       0.22       4.5%         Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Bradwell Hall	0.06	1.2%	0.21	4.2%		
Rivenhall Pl/Hall       0.09       1.9%       0.24       4.9%         Parkgate Farm / Watchpall Cottages       0.11       2.1%       0.26       5.1%         Ford Farm / Rivenhall Cottage       0.07       1.5%       0.22       4.5%         Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Rolphs Farmhouse	0.05	1.0%	0.20	4.0%		
Parkgate Farm / Watchpall Cottages       0.11       2.1%       0.26       5.1%         Ford Farm / Rivenhall Cottage       0.07       1.5%       0.22       4.5%         Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Silver End / Bower Hall / Fossil Hall	0.11	2.1%	0.26	5.1%		
Ford Farm / Rivenhall Cottage 0.07 1.5% 0.22 4.5%  Porter's Farm 0.10 1.9% 0.25 4.9%  Unknown Building 1 0.12 2.3% 0.27 5.3%  Bumby Hall / The Lodge / Polish Site (Light Industry) 0.11 2.2% 0.26 5.2%  Footpath 8, Receptor 1 (East of Site) 0.18 3.5% 0.33 6.5%  Footpath 8, Receptor 2 (East of Site) 0.04 0.8% 0.19 3.8%  Footpath 8, Receptor 3 (East of Site) 0.01 0.2% 0.16 3.2%  Footpath 8, Receptor 4 (East of Site) 0.00 0.1% 0.15 3.1%	Rivenhall Pl/Hall	0.09	1.9%	0.24	4.9%		
Porter's Farm       0.10       1.9%       0.25       4.9%         Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Parkgate Farm / Watchpall Cottages	0.11	2.1%	0.26	5.1%		
Unknown Building 1       0.12       2.3%       0.27       5.3%         Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Ford Farm / Rivenhall Cottage	0.07	1.5%	0.22	4.5%		
Bumby Hall / The Lodge / Polish Site (Light Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Porter's Farm	0.10	1.9%	0.25	4.9%		
Industry)       0.11       2.2%       0.26       5.2%         Footpath 8, Receptor 1 (East of Site)       0.18       3.5%       0.33       6.5%         Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Unknown Building 1	0.12	2.3%	0.27	5.3%		
Footpath 8, Receptor 2 (East of Site)       0.04       0.8%       0.19       3.8%         Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%		0.11	2.2%	0.26	5.2%		
Footpath 8, Receptor 3 (East of Site)       0.01       0.2%       0.16       3.2%         Footpath 8, Receptor 4 (East of Site)       0.00       0.1%       0.15       3.1%	Footpath 8, Receptor 1 (East of Site)	0.18	3.5%	0.33	6.5%		
Footpath 8, Receptor 4 (East of Site) 0.00 0.1% 0.15 3.1%	Footpath 8, Receptor 2 (East of Site)	0.04	0.8%	0.19	3.8%		
	Footpath 8, Receptor 3 (East of Site)	0.01	0.2%	0.16	3.2%		
Footback 9 Pagement F (Foot of Cita)	Footpath 8, Receptor 4 (East of Site)	0.00	0.1%	0.15	3.1%		
rootpath 8, Receptor 5 (East of Site) 0.00 0.0% 0.15 3.0%	Footpath 8, Receptor 5 (East of Site)	0.00	0.0%	0.15	3.0%		
Footpath 8, Receptor 6 (East of Site) 0.06 1.1% 0.21 4.1%	Footpath 8, Receptor 6 (East of Site)	0.06	1.1%	0.21	4.1%		
Footpath 8, Receptor 7 (East of Site) 0.12 2.4% 0.27 5.4%	Footpath 8, Receptor 7 (East of Site)	0.12	2.4%	0.27	5.4%		
Footpath 35, Receptor 1 (North of Site) 0.34 6.9% 0.49 9.9%	Footpath 35, Receptor 1 (North of Site)	0.34	6.9%	0.49	9.9%		
Footpath 35, Receptor 2 (North of Site) 0.12 2.3% 0.27 5.3%	Footpath 35, Receptor 2 (North of Site)	0.12	2.3%	0.27	5.3%		
Footpath 35, Receptor 3 (North of Site) 0.09 1.8% 0.24 4.8%	Footpath 35, Receptor 3 (North of Site)	0.09	1.8%	0.24	4.8%		
Footpath 31, Receptor 1 (North west of Site) 0.10 1.9% 0.25 4.9%	Footpath 31, Receptor 1 (North west of Site)	0.10	1.9%	0.25	4.9%		
Footpath 31, Receptor 2 (North west of Site) 0.09 1.9% 0.24 4.9%	Footpath 31, Receptor 2 (North west of Site)	0.09	1.9%	0.24	4.9%		
Footpath 31, Receptor 3 (North west of Site) 0.07 1.4% 0.22 4.4%	Footpath 31, Receptor 3 (North west of Site)	0.07	1.4%	0.22	4.4%		
Footpath 7, Receptor 1 (South east of Site) 0.03 0.5% 0.18 3.5%	Footpath 7, Receptor 1 (South east of Site)	0.03	0.5%	0.18	3.5%		
Footpath 7, Receptor 2 (South east of Site) 0.09 1.7% 0.24 4.7%	Footpath 7, Receptor 2 (South east of Site)	0.09	1.7%	0.24	4.7%		
Footpath 7, Receptor 3 (South east of Site) 0.12 2.4% 0.27 5.4%	Footpath 7, Receptor 3 (South east of Site)	0.12	2.4%	0.27	5.4%		

Table B.4: Annual Mean Cadmium Impact at Sensitive Receptors					
Receptor	Process Co	ontribution	Predicted Environmental Concentration		
•	μg/m³	Concent	As % of AQAL		
Footpath 7, Receptor 4 (South east of Site)	0.17	3.4%	0.32	6.4%	
Footpath 7, Receptor 5 (South east of Site)	0.27	5.4%	0.42	8.4%	
Elephant House (Street Sweepings)	0.01	0.2%	0.16	3.2%	
Green Pastures Bungalow	0.09	1.7%	0.24	4.7%	
Deeks Cottage	0.23	4.7%	0.38	7.7%	
Woodhouse Farm	0.01	0.3%	0.16	3.3%	
Gosling Cottage / Barn	0.08	1.7%	0.23	4.7%	
Felix Hall / The Clock House / Park Farm	0.07	1.3%	0.22	4.3%	
Glazenwood House	0.05	0.9%	0.20	3.9%	
Bradwell Hall	0.04	0.7%	0.19	3.7%	
Perry Green Farm	0.05	1.0%	0.20	4.0%	
The Granary / Porter Farm / Rook Hall	0.06	1.3%	0.21	4.3%	
Grange Farm	0.14	2.9%	0.29	5.9%	
Coggeshall	0.13	2.5%	0.28	5.5%	

## NOTES:

Assumes 100% operation of all items of plant at the daily ELV

Assumes entire cadmium and thallium emissions are consist only of cadmium

# Appendix C – APIS Critical Loads

		Table C.1: N Deposition Critical Loads - APIS			
Site	Habitat type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Background (kgN/ha/yr)
European designated site	s (within 10km)				
None identified					
UK designated sites (with	nin 2km)				
None identified					
Non-statutory designated	l sites (within 2km)				
Blackwater Plantation	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	30.1
Storeys Wood	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	27.44
Maxey's Spring	Calcareous grassland	Sub-atlantic semi-dry calcareous grassland	15	25	17.92
	Neutral grassland	Low and medium altitude hay meadows	20	30	17.92
Upney Wood	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	30.1
Link's Wood	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	30.1
Park House Meadow	Calcareous grassland	Sub-atlantic semi-dry calcareous grassland	15	25	17.92
	Neutral grassland	Low and medium altitude hay meadows	20	30	17.92

		Table C.1: Acid Deposition Critical Loa	ds - APIS				
Site	Broad habitat type	Acidity Class	Min Critica	al Load Function (k	eq/ha/yr)	Maximum Background (keq/ha/yr)	
			ClminN	CLmaxN	ClmaxS	N	S
European designated sites	European designated sites						
None identified							
UK designated sites							
None identified							
Non-statutory designated	sites						
Blackwater Plantation	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.14	1.71	1.57	2.15	0.3
Storeys Wood	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.36	8.62	8.26	1.96	0.31
Maxey's Spring	Calcareous grassland	Calcareous grassland (using base cation)	0.85	4.75	3.89	1.28	0.26
	Neutral grassland	Calcareous grassland (using base cation)	0.85	4.75	3.89	1.28	0.26
Upney Wood	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.21	10.93	10.71	2.15	0.3
Link's Wood	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.36	8.65	8.29	2.15	0.3
Park House Meadow	Calcareous grassland	Calcareous grassland (using base cation)	0.85	4.75	3.89	1.28	0.26
	Neutral grassland	Calcareous grassland (using base cation)	0.85	4.75	3.89	1.28	0.26

Appendix D – Deposition Results Tables

Table D.1: Annual Mean Process Contribution Used for Dry Deposition Analysis								
	Annual Mean Process Contribution (µg/m³)							
Site	Nitrogen Sulphur Dioxide Dioxide		Hydrogen Chloride	Ammonia				
European Designated Sites								
None identified								
UK Designated Sites								
None identified								
Non-statutory designated sites								
Blackwater Plantation	0.2263	0.1109	0.0210	0.0210				
Storeys Wood	0.1892	0.0927	0.0175	0.0175				
Maxey's Spring	0.2137	0.1048	0.0198	0.0198				
Upney Wood	0.3268	0.1602	0.0303	0.0303				
Link's Wood	0.1007	0.0494	0.0093	0.0093				
Park House Meadow	0.0952	0.0467	0.0088	0.0088				

Table D.2: Deposition Calculation – Grassland - Maximum								
Site				Wet Deposition (kg/ha/yr)	osition Total N	Acid Deposition keq/ha/yr		
	Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia	Hydrogen Chloride	(kgN/ha/yr)	N	S
European designated sites								
None identified								
UK designated sites								
None identified								
Non-statutory designated sites	5							
Blackwater Plantation	0.033	0.210	0.161	0.109	0.322	0.142	0.010	0.022
Storeys Wood	0.027	0.176	0.135	0.091	0.269	0.118	0.008	0.019
Maxey's Spring	0.031	0.198	0.152	0.103	0.304	0.134	0.010	0.021
Upney Wood	0.047	0.303	0.232	0.157	0.465	0.205	0.015	0.032
Link's Wood	0.015	0.093	0.072	0.049	0.143	0.063	0.005	0.010
Park House Meadow	0.014	0.088	0.068	0.046	0.135	0.060	0.004	0.009

Table D.3: Deposition Calculation – Woodland - Maximum										
Site	Dry Deposition (kg/ha/yr)				Wet Deposition (kg/ha/yr)	Total N Deposition	Acid Deposition keq/ha/yr			
	Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia	Hydrogen Chloride	(kgN/ha/yr)	N	S		
European designated sites										
None identified										
UK designated sites										
None identified										
Non-statutory designated sites										
Blackwater Plantation	0.065	0.420	0.386	0.164	0.772	0.229	0.016	0.048		
Storeys Wood	0.054	0.351	0.323	0.137	0.646	0.191	0.014	0.040		
Maxey's Spring	0.062	0.397	0.365	0.154	0.730	0.216	0.015	0.045		
Upney Wood	0.094	0.606	0.558	0.236	1.116	0.330	0.024	0.069		
Link's Wood	0.029	0.187	0.172	0.073	0.344	0.102	0.007	0.021		
Park House Meadow	0.027	0.177	0.163	0.069	0.325	0.096	0.007	0.020		

Table D.4: Detailed Results - Nitrogen Deposition - Maximum									
Site		Deposition Velocity	Process Contribution			Predicted Environmental Concentration			
	Habitat		PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	
European designated	sites								
None identified									
UK designated sites									
None identified									
Non-statutory designa	ated sites								
Blackwater Plantation	Broadleaved, mixed and yew woodland	Woodland	0.229	2.29%	1.14%	30.329	303.29%	151.64%	
Storeys Wood	Broadleaved, mixed and yew woodland	Woodland	0.191	1.91%	0.96%	27.631	276.31%	138.16%	
Maxey's Spring	Calcareous grassland	Grassland	0.134	0.89%	0.53%	18.054	120.36%	72.21%	
	Neutral grassland	Grassland	0.134	0.67%	0.45%	18.054	90.27%	60.18%	
Upney Wood	Broadleaved, mixed and yew woodland	Woodland	0.330	3.30%	1.65%	30.430	304.30%	152.15%	
Link's Wood	Broadleaved, mixed and yew woodland	Woodland	0.102	1.02%	0.51%	30.202	302.02%	151.01%	
Park House Meadow	Calcareous grassland	Grassland	0.060	0.40%	0.24%	17.980	119.86%	71.92%	
	Neutral grassland	Grassland	0.060	0.30%	0.20%	17.980	89.90%	59.93%	

Table D.5: Detailed Results – Acid Deposition									
Site		Deposition Velocity	Process Contribution			Predicted Environmental Concentration			
	Habitat		N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of CL Function	
European designated	sites								
None identified									
UK designated sites									
None identified									
Non-statutory design	ated sites								
Blackwater Plantation	Broadleaved, mixed and yew woodland	Woodland	0.016	0.048	3.76%	2.166	0.348	147.04%	
Storeys Wood	Broadleaved, mixed and yew woodland	Woodland	0.014	0.040	0.62%	1.974	0.350	26.96%	
Maxey's Spring	Calcareous grassland	Grassland	0.010	0.021	0.64%	1.290	0.281	33.06%	
	Neutral grassland	Grassland	0.010	0.021	0.64%	1.290	0.281	33.06%	
Upney Wood	Broadleaved, mixed and yew woodland	Woodland	0.024	0.069	0.85%	2.174	0.369	23.27%	
Link's Wood	Broadleaved, mixed and yew woodland	Woodland	0.007	0.021	0.33%	2.157	0.321	28.65%	
Park House Meadow	Calcareous grassland	Grassland	0.004	0.009	0.29%	1.284	0.269	32.71%	
	Neutral grassland	Grassland	0.004	0.009	0.29%	1.284	0.269	32.71%	



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