Addendum 1
Air Quality Assessment of Emissions to Atmosphere from Northacre Renewable Energy, Westbury

P1713

A Report Prepared for
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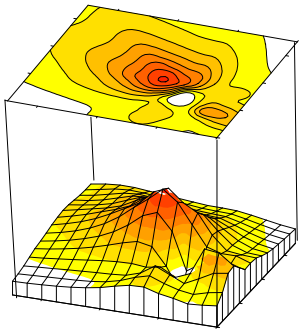

Principal Author: David Harvey BSc, MBA, FIAQM
Client: Hills Waste Solutions Ltd

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1 SUMMARY AND CONCLUSIONS

Hills Waste Solutions Ltd has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to provide an **Addendum** to the February 2018 air quality assessment of emissions to atmosphere from Northacre Renewable Energy, to be located to the north of Westbury, Wiltshire (1).

The only changes to the previously submitted design that are relevant to the air quality assessment are modifications to the layout of the buildings and their heights. Previously, the maximum building height was 37.8 m which has been reduced to 36.8 m which will give rise to less building downwash, improved dispersion and a lowering of the resulting ground level pollutant concentrations.

Although the only change to the design of the proposed facility is beneficial in terms of impacts on air quality this Addendum has been prepared to quantify the reduction and update than conclusions of the previous assessment, where necessary. Also included is modelling with the most recent year of meteorological data.

This **Addendum** should be read and considered alongside the February 2018 Air Quality Assessment which provides full technical details.

The predictions presented in this Addendum show that the changes to building heights and layout make no discernible difference to the predicted short-term impacts and marginally reduce the long-term impacts. The predicted reduction in long-term (annual average) concentration is not sufficient to justify the re-modelling and assessment of the facility. The conclusions detailed in the submitted assessment (February 2018) are still valid and in light of the change in building dimensions should be viewed as being conservative.

2 EMISSIONS DATA

Given that the purpose of this Addendum is to determine the effect on dispersion of the changes to the building dimensions it is only necessary to consider one pollutant. The oxides of nitrogen (NO_x) has been selected as it is the principal pollutant for the proposed facility. **Table 2.1** shows the parameters which describe the physical properties of emissions from the stack, as required for definition of the emissions in dispersion modelling terms.

(1) ADM Ltd (22 Feb 2018) Air Quality Assessment of Emissions to Atmosphere from Northacre Renewable Energy, Westbury.

Table 2.1 Emissions and Physical Properties, Main Stack

Parameter	Value		
Number of stacks	1		
Number of flues	2		
OS Grid Reference (m)	385774 152070		
Release height above ground level (m)	75		
	Flue 1	**Flue 2**	**Combined**
Exhaust gas flow rate ($Am^3\ hr^{-1}$)	99,720	99,720	199,440
Actual volumetric flow rate ($Am^3\ s^{-1}$)	27.7	27.7	55.4
Exhaust gas oxygen content (% v/v wet)	4.8	4.8	4.8
Exhaust gas water content (% v/v)	15.1	15.1	15.1
Flue diameter (m)	1.40	1.40	1.98 (a)
Exit velocity ($m\ s^{-1}$)	18.0	18.0	18.0
Flue gas emission temperature (deg C)	125	125	125
Normalised volumetric flow ($Nm^3\ s^{-1}$) (b)	24.9	24.9	49.9
Oxides of nitrogen (NO_x as NO_2, mg Nm^{-3}) (b)	200	200	200
Oxides of nitrogen (NO_x as NO_2, g s^{-1})	4.99	4.99	9.98

(a) Effective diameter of two flues.
(b) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 11% v/v O_2.

3 BUILDING DOWNWASH

The presence of buildings can significantly affect the dispersion of the atmospheric emissions. Wind blowing around a building distorts the flow and creates zones of turbulence that are greater than if the building were absent. Increased turbulence causes greater plume mixing; the rise and trajectory of the plume may be depressed generally by the flow distortion. For elevated releases such as those from stacks, building downwash leads to higher ground level concentrations closer to the stack than those present if a building was not there. The effects of building down wash are usually only significant where the buildings are more than 40% of the stack height.

Table 3.1 shows the dimensions of the buildings included in the modelling. Other than the building information shown in **Table 3.1,** all the modelling input data and assumptions are the same as detailed in the February 2018 air quality assessment and are not reproduced in this Addendum.

Table 3.1 Dimensions of Buildings Included in the Modelling

Building	Centre (m)	Height (m) [(a)]	Length (m)	Width (m)	Angle (deg) [(b)]
1	385710 152027	36.8	30.9	37.1	57
2	385685 151984	31.2	59.2	37.0	57
3	385679 152020	31.2	30.2	30.3	57
4	385687 152046	16.8	31.6	20.3	57
5	385714 152064	23.5	32.5	20.3	57
6	385731 152045	21.5	24.7	29.9	57
7	385590 152110	40 [(c)]	50	25	43

(a) Height above ground level.
(b) Angle building length makes to north.
(c) Approximate height of highest building of the dairy.

4 PREDICTIONS

The principal pollutant released to atmosphere from the proposed facility is the oxides of nitrogen (NO_x) which will progressively oxidise to nitrogen dioxide (NO_2) in the atmosphere.

Table 4.1 shows the maximum predicted ground level concentration of nitrogen dioxide (NO_2) occurring as a consequence of emissions to atmosphere from the facility for each of the six years of meteorological data. The predictions include the effects of terrain and building downwash. Also shown are the predictions made using the previous building dimensions to allow for a direct comparison to determine the effect that the change in building layout and heights has made on dispersion. Also shown in the table are predictions made using 2017 meteorological data which was not available when the February 2018 assessment was prepared.

Table 4.1 ADMS 5.2 Maximum Predicted (Process Contribution) Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3}) [(a)]

Year	Annual Average		99.8th Percentile of Hourly Averages	
	Proposed	Previous	Proposed	Previous
2012	0.94	1.03	8.0	8.0
2013	0.67	0.74	7.8	7.7
2014	0.81	0.83	10.1	10.1
2015	0.93	0.94	8.4	8.4
2016	0.62	0.64	8.5	8.5
2017	0.80	0.84	8.9	8.8
Maximum	**0.94**	**1.03**	**10.1**	**10.1**
Assessment Criteria	**40**		**200**	

(a) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.

Table 4.1 shows that the changes to building dimensions and layout make no difference to the predicted short-term impacts and marginally reduce the long-term impacts. The predicted reduction in long-term (annual average) is not sufficient to justify the re-modelling and assessment of the facility.

The predictions made using 2017 are lower than the maximum for the years 2012 to 2017. If the assessment had been updated to use the most recent five years of meteorological data (ie 2013 to 2017) this would exclude the use of 2012 which gives rise to the highest impact. The exclusion of predictions made using 2012 meteorological data would reduce the maximum predicted concentrations.

The conclusions detailed in the submitted assessment (February 2018) are still valid and in the light of the change in buildings should be viewed as been conservative.

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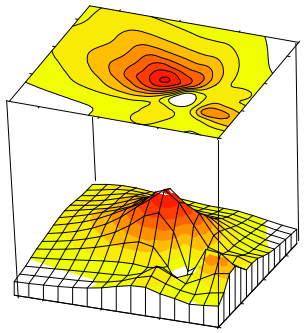

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File=P1418\text\Northacre Renewable Energy AQ v6.doc	16 Dec 2014
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File=P1713\text\Northacre Renewable Energy AQ v9.doc	19 Feb 2018
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1 INTRODUCTION

Hills Waste Solutions Ltd has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality assessment of emissions to atmosphere from Northacre Renewable Energy, to be located to the north of Westbury, Wiltshire.

The technology being proposed is an advanced thermal treatment process known as gasification. The facility will have the capacity to convert 160,000 tonnes of a combination of high calorific solid recovered fuel (SRF) blended with lower calorific commercial and Industrial waste destined for landfill into a synthetic gas which is used on site to generate the 25.5 MWe of renewable energy. The products of combustion will be released to atmosphere via a single 75 m high twin flue stack.

Since the granting of planning permission on 23/9/2015 (Ref 14/12003/WCM) the technology provider for the gasifier has been changed which has given rise to changes to building locations and heights and a corresponding increase in the main and ventilation stack heights.

This assessment is an update of the previous assessment that was submitted to support the 2015 planning application (1).

During operation, emissions to atmosphere will occur from the following sources:

- Twin flue 75 m high stack
- 40 m high ventilation stack

The ADMS 5.2 dispersion model has been used to make predictions of ground level concentrations of the following pollutants released to atmosphere from the facility:

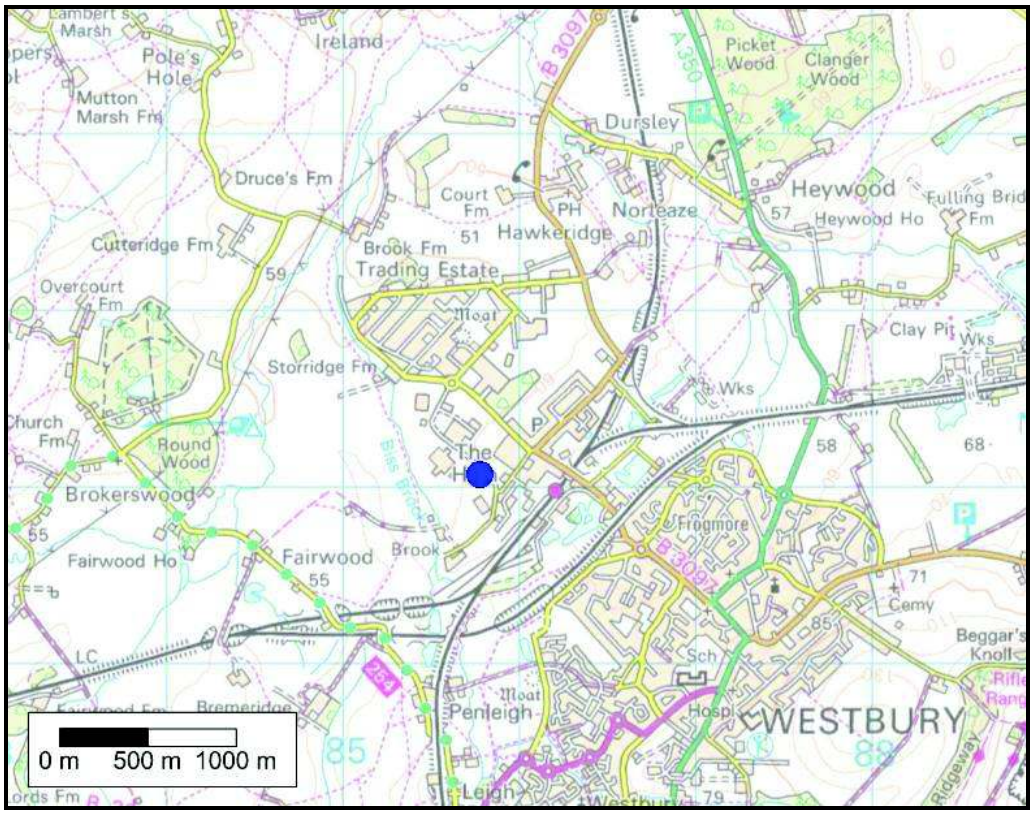
- the oxides of nitrogen (NO_x)
- sulphur dioxide (SO_2)
- fine particulate matter (PM_{10} and $PM_{2.5}$)
- carbon monoxide (CO)
- hydrogen chloride (HCl)
- hydrogen fluoride (HF)
- ammonia (NH_3)
- benzene (C_6H_6)
- dioxins and furans
- twelve metals
- polychlorinated biphenyls (PCBs)
- polycyclic aromatic hydrocarbons (PAHs)

Modelling has also been undertaken of emissions of odour and bio-aerosols from the 40 m high air extraction system stack.

(1) ADM (16 December 2014) Air Quality Assessment of Emissions to Atmosphere from Northacre Renewable Energy, Westbury.

Figure 1.1 shows the location of the proposed facility.

Figure 1.1 Location of Northacre Renewable Energy



The remainder of this report is structured as follows:

- Section 2 - description of the assessment and significance criteria
- Section 3 - presents and assesses the existing air quality
- Section 4 - describes the modelling methodology
- Section 5 - presents the predicted concentrations (human health)
- Section 6 - presents the predicted concentrations (vegetation and ecosystems)
- Section 7 - sensitivity analysis
- Section 8 - mitigation and residual impacts
- Section 9 - provides a summary and conclusions

2 ASSESSMENT AND SIGNIFICANCE CRITERIA

2.1 INTRODUCTION

This section presents the planning context with regard to air quality, together with the assessment and significance criteria.

2.2 PLANNING CONTEXT

2.2.1 EUROPEAN LEGISLATION

The air quality criteria used in this assessment have been taken from European and national legislation and guidance.

Local authorities currently have no statutory obligation to assess air quality against European limit values but are encouraged to do so. In order to assist with longer-term planning and the assessment of development proposals in their local areas, Defra's Technical Guidance LAQM TG16 for Local Authorities provides guidance on how to assess against the time-frame of the European limit values (1).

The Air Quality (England) Regulations 2000 (SI 2000 No. 928) and Air Quality (England) (Amendment) Regulations 2002 (SI 2002 No. 3043) include national air quality objectives which, in most cases, are numerically synonymous with the European limit values although they may have different compliance target dates and can apply to different locations. The air quality objectives are for specific use by local authorities when undertaking their Local Air Quality Management (LAQM) duties in pursuit of Part IV of the Environment Act 1995. Of principal concern to this assessment are nitrogen dioxide (NO_2) and particulate matter smaller than 10 µm in aerodynamic diameter (PM_{10}).

2.2.2 NATIONAL LEGISLATION AND GUIDANCE

The Government's policy on air quality within the UK is set out in the Air Quality Strategy for England, Scotland, Wales & Northern Ireland Strategy (AQS), published in July 2007 in accordance with the requirements of Part IV of the Environment Act 1995. The Air Quality Strategy (AQS) sets out a framework to reduce adverse health effects from air pollution and ensures that international commitments are met. The AQS sets standards and objectives for pollutants to protect human health, vegetation and ecosystems.

Air quality objectives, limit values and guidelines which currently apply in the United Kingdom can be divided into four groups:

- United Kingdom air quality objectives set down in regulations for the purpose of Local Air Quality Management (LAQM);
- United Kingdom air quality objectives not included in regulations;
- European Union (EU) Limit Values transcribed into UK legislation; and
- Guidelines: eg World Health Organization (WHO) guidelines.

(1) DEFRA (April 2016) Local Air Quality Management, Technical Guidance LAQM TG16.

Many of the objectives in the Air Quality Strategy (AQS) were made statutory in England with the Air Quality (England) (Amendment) Regulations 2002 for the purpose of Local Air Quality Management (LAQM).

The principal difference, with regard to the assessment of impacts on air quality, between the Air Quality Standards Regulations which implement EU Directives and the Air Quality (England) Regulations (as amended) is the location that they apply to. The Air Quality Standards Regulations apply to 'ambient air' which is defined as 'outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access' which essentially is any off-site location. The Air Quality (England) Regulations apply to places where 'members of the public are regularly present' and this is interpreted as being 'regularly present' for the averaging time of the objective.

For example, the Air Quality (England) Regulations annual average objective apply to locations such as houses but not pavements whereas the Standards Regulations annual average limit values apply to any off-site location including pavements.

It should be noted that the Air Quality Standards Regulations 2010 do not supersede the 2002 regulations and are to ensure full compliance with the UK obligations under the various EU air quality directives. For the purpose of this assessment, which is to support the planning application to the Local Authority, the 2002 regulations are the most relevant assessment criteria.

2.2.3 REVIEW AND ASSESSMENT

Under Part IV of the Environment Act, local planning authorities must review and assess the air quality within their area by way of staged appraisals; with the aim of meeting the objectives by target dates defined in the Air Quality (England) (Amendment) Regulations. Where the air quality objectives are unlikely to be or have not been achieved by the target date, a local planning authority is required to designate an AQMA and to draw up an air quality action plan (AQAP) towards achieving air quality objectives in the future.

The Department for Environment, Food and Rural Affairs (Defra) has published technical guidance for use by local planning authorities in their review and assessment work [(1)].

2.2.4 NATIONAL PLANNING POLICY FRAMEWORK

In March 2012 the Department of Communities and Local Government published the National Planning Policy Framework (NPPF) [(2)]. The purpose of the framework is to help achieve sustainable development. Section 11 of the policy makes the following references to air quality.

- The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely

(1) DEFRA (April 2016) Local Air Quality Management, Technical Guidance LAQM TG16.

(2) Department of Communities and Local Government (March 2012) National Planning Policy Framework.

affected by unacceptable levels of soil, air, water or noise pollution or land instability.

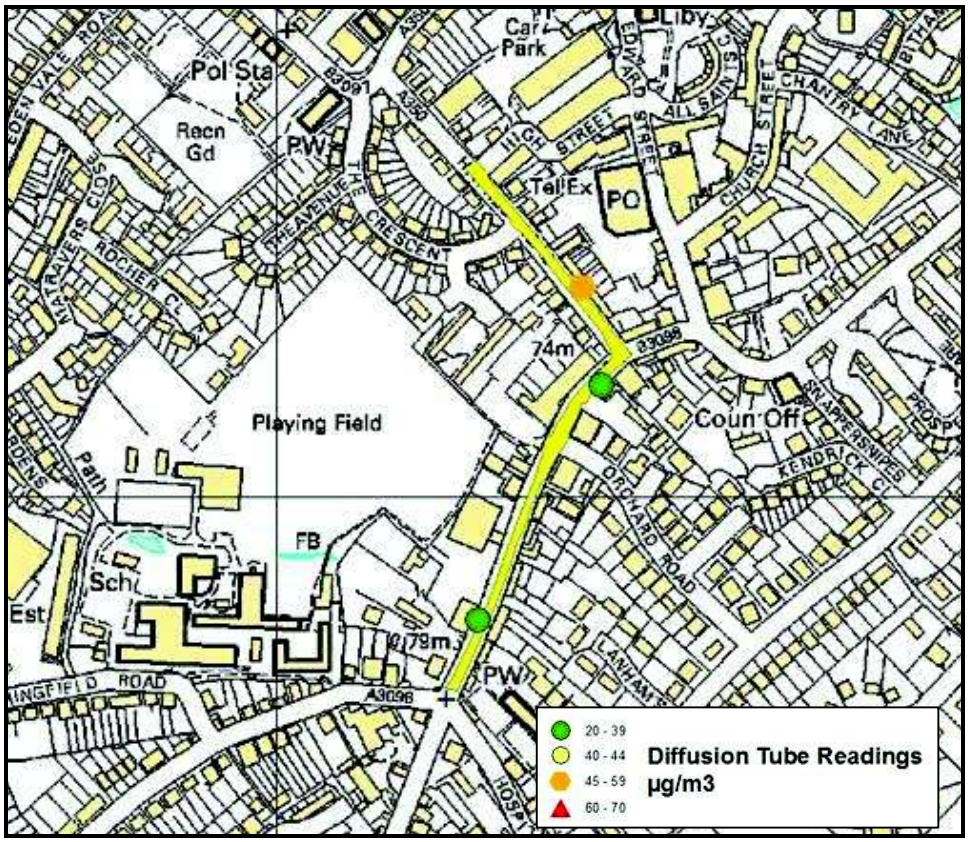
- Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan.

The National Planning Practice Guidance (NPPG) for air quality is available on the NPPG web site (1). The NPPG states that 'air quality concerns can be relevant to neighbourhood planning'.

2.2.5 LOCAL PLANNING GUIDANCE

Wiltshire Council has declared eight Air Quality Management Areas (AQMAs). The closest to the proposed development is the Westbury AQMA which is as shown in **Figure 2.1**. The effect of the proposed development on this the Westbury AQMA is considered in this assessment.

Figure 2.1 Westbury Air Quality Management Area (AQMA)



Source: www.wiltshire.gov.uk

(1) https://www.gov.uk/guidance/air-quality--3

Wiltshire Council has published an Air Quality Strategy for Wiltshire which sets out measures to maintain and improve air quality and also have an Air Quality Action Plan [1] [2].

2.2.6 IAQM GUIDANCE ON CONSTRUCTION DUST

In February 2014 the Institute of Air Quality Management (IAQM) published guidance on how to assess impacts of emissions of dust from demolition and construction sites [3]. The guidance is used in this assessment.

2.2.7 DEVELOPMENT CONTROL: PLANNING FOR AIR QUALITY

In January 2017 the Institute for Air Quality Management (IAQM) and Environmental Protection UK published an update to its guidance document that contains a framework for air quality consideration to be accounted for in local development control [4]. The IAQM guidance has been taken into account when undertaking this assessment.

2.2.8 ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2016

The Environmental Permitting (England and Wales) Regulations 2016 (referred to as EPR herein), came into force om 1 January 2017 [5]. The new Regulations revoke the Environmental Permitting (England and Wales) 2007 (and amendments) as well as the Environmental Permitting (England and Wales) Regulations 2010.

The PPC component of the EPR provides an integrated approach to controlling pollution from industrial sources. Its main aim is to achieve “a high level of protection of the environment taken as a whole…”, by measures designed to prevent or, where that is not practicable, reduce emission to air, water and land. An operator is required to obtain an EPR permit from the regulatory authority which for Part A installations is the Environment Agency which has responsibility for determining applications for permits and setting appropriate permit conditions.

The PPC programme has a number of objectives which include the setting of emission limit values based on the assessment of Best Available Techniques (BAT) and the consideration of any relevant site-specific issues. BAT is defined as “the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole”.

Activity-specific guidance for the sectors regulated under the EPR is available

(1) Wiltshire Council: Air Quality Strategy for Wiltshire 2011 to 2015.
(2) Wiltshire Council (June 2015): Air Quality Action Plan for Wiltshire.
(3) IAQM (February 2014) Guidance on the Assessment of dust from demolition and construction.
(4) IAQM (2017) Land-Use Planning & Development Control: Planning for Air Quality.
(5) Environmental Permitting Regulations (England and Wales) (Amendment) Regulations 2016.

to assist with the preparation of an application and the operation of a facility. In addition, supplementary guidance is available that is relevant to all sectors and is referred to as horizontal guidance for example H1 Environmental Risk Assessment [1].

An application will be made to the Environment Agency (EA) for a permit to operate the facility which will be required to comply with the requirements of the Industrial Emissions Directive (IED) [2].

2.2.9 ENVIRONMENTAL AGENCY GUIDANCE

The Environment Agency benchmark levels are used in this assessment where assessment criteria are not available from EU Directives or the Air Quality Strategy (AQS) [3].

2.3 DESCRIPTION OF POLLUTANTS

This section describes the principal pollutants considered in this assessment.

2.3.1 NITROGEN DIOXIDE (NO_2)

Where road traffic is the dominant source of air pollution, which is usually the case in urban environments, Local Authorities have found that the objectives for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) are the most difficult to achieve. It is also generally the case that, where annual average concentrations of nitrogen dioxide (NO_2) and fine particulate matter (PM_{10}) meet their respective objectives and where there are no other local significant sources of air pollution, concentrations of all other pollutants in the air quality strategy will also be achieved.

Nitrogen dioxide (NO_2) is a reddish brown gas (at sufficiently high concentrations) and occurs as a result of the oxidation of nitric oxide (NO), which in turn originates from the combination of atmospheric nitrogen (N_2) and oxygen (O_2) during combustion processes. In terms of ground level concentrations in many parts of the United Kingdom, concentrations of nitrogen dioxide (NO_2) are dominated by emissions from road transport. This applies particularly in urban areas, where traffic densities are at their highest.

2.3.2 PARTICULATE MATTER (PM_{10}, $PM_{2.5}$)

Particulate matter (PM) is a term used to describe all suspended matter, sometimes referred to as total suspended particulate matter. Sources of particles in the air include road transport, power stations and other industry, quarrying, mining and agriculture. Chemical processes in the air can also lead to the formation of particles. PM_{10} is the subject of health concerns because of the ability to penetrate and remain deep within the lungs. In recent years,

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.
(2) Directive 2000/76/EC of the European Parliament and of the Council (4 December 2000) on the incineration of waste. The requirements of WID are now maintained under Chapter IV and Annex VI of the Industrial Emissions Directive (IED) 2010/75/EC.
(3) Environment Agency (April 2010) Horizontal Guidance Note H1 - Annex (f).

epidemiological studies have shown increases in mortality correlated with concentrations of PM_{10} (COMEAP, 2009). There is increasing focus on $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm) which gives a stronger association with ill-heath than PM_{10}. Given that $PM_{2.5}$ is a subset of PM_{10}. ie all $PM_{2.5}$ is also PM_{10}, consideration is made of the effects of $PM_{2.5}$ by making that conservative assumption that all the PM_{10} is $PM_{2.5}$.

It is sometimes claimed that PM_{10}/$PM_{2.5}$ or nanoparticulates (particles between 1 and 100 nanometres, nm) emitted to atmosphere from waste to energy facilities are somehow more ' toxic' than typical/normal prevailing background particulate matter. There is no evidence to support this, the health effects attributed to PM_{10}/$PM_{2.5}$ are derived from a large number of epidemiological studies from a full range of sources. In this context, the Health Protection Agency (HPA) state ' It is it is worth noting that PM_{10} and $PM_{2.5}$ samples from around the world can vary substantially in their chemical composition and size distribution but nonetheless exhibit similar concentration-response coefficients in time-series epidemiological studies.' (1)

2.3.3 SULPHUR DIOXIDE (SO_2)

Sulphur dioxide (SO_2) is a colourless gas which is produced from some natural processes, notably volcanoes, but is associated most strongly with the combustion of fossil fuels containing sulphur. When coal burning was more widespread in the UK than it is at present, sulphur dioxide (SO_2) concentrations were monitored extensively. Since coal has ceased to be used as a common fuel in homes, concentrations of sulphur dioxide (SO_2) in urban areas have fallen dramatically. Partly as a result of this improvement, sulphur dioxide (SO_2) is not regarded as a serious threat to air quality in the way it once was.

Sulphur dioxide (SO_2) is a potent respiratory irritant when inhaled at high concentrations, both in laboratory conditions and during air pollution episodes; especially for asthmatics.

2.3.4 OXIDES OF NITROGEN (NO_X)

The atmospheric pollutant of most concern for sensitive vegetation and best understood is the oxides of nitrogen (NO_x). Both the EU and WHO have set limit and guidelines for the annual average concentration of NO_x for the protection of vegetation. For the protection of vegetation and ecosystems there is an AQS objective and an EU target of 30 µg m^{-3} as an annual average This objective does not apply to locations within 5 km of built up areas of more than 5,000 people, or industrial sources regulated under Part A of the 1990 Environment Act. It also does not apply to locations within 20 km of towns with >250,000 inhabitants and does not apply in those areas where assessment of compliance with the limit value is not required. However, as UNECE and WHO have set a critical level for NO_x Natural England's policy is

(1) Health Protection Agency (September 2009) The Impacts on Health of Emissions to Air from Municipal Waste Incinerators

to apply the criteria as a benchmark, hence objective is used in the assessment

There is also a WHO guideline of 75 µg m^{-3} as a daily average which is also used in this assessment.

2.3.5 NITROGEN DEPOSITION

The deposition of nitrogen (N) from the atmosphere acts as a fertiliser which affects the natural balance of vegetation. The critical load for the deposition of nitrogen, normally expressed as Kg N ha^{-1} $year^{-1}$, is the exposure below which there should be no harmful effects on sensitive elements of the ecosystem. The critical loads vary for the type of ecosystem from as low as 5-10 Kg N ha^{-1} $year^{-1}$ for sensitive lichen found on mountain tops to 20-30 Kg N ha^{-1} $year^{-1}$ for some type of meadows.

2.3.6 DIOXINS AND FURANS

Dioxins and furans are a group of organic compounds that are formed as a result of incomplete combustion in the presence of chlorine. Sources include vehicles, domestic and industrial coal burning, power generation and incinerators.

There are no regulatory air quality standards set for dioxins and furans. This group of substances, however, are important in terms of the risk to human health. A human health risk assessment (HHRA) is the method by which the effect of dioxins can be assessed and has been undertaken for the proposed facility.

2.3.7 METALS

The metals considered in this report can be released from both natural sources and man's activities. The contribution of the possible sources varies for each metal, both temporally and spatially. Natural sources include windblown material, sea salt aerosols and forest fires. Manmade sources include metal industries, coal combustion, vehicles, cement production, fertiliser plants and incineration.

2.3.8 HYDROGEN CHLORIDE (HCL)

Hydrogen chloride (HCl) is a colourless gas at room temperature, which dissociates readily in water, forming an acidic solution. Sources of HCl include combustion of coal and waste incineration, although it is also produced from marine aerosols.

2.3.9 HYDROGEN FLUORIDE (HF)

Hydrogen fluoride (HF) is a colourless gas at room temperature, which dissociates readily in water, forming an acidic solution. Sources of HF include combustion of coal, steel, tile, brick and glass works and aluminium processing plants.

2.4 ASSESSMENT CRITERIA

2.4.1 AIR QUALITY

This section describes the criteria used to assess the impacts on air quality of emissions to atmosphere from the proposed facility, both in terms of the impacts on human health and vegetation and ecosystems.

The Environment Agency H1 guidance benchmark levels are used in this assessment where assessment criteria are not available from EU Directives or the Air Quality Strategy (AQS).

Table 2.1 shows the assessment criteria used in the assessment to assess the impacts on human health, vegetation and ecosystems which are the benchmark level detailed in the Environment Agency's risk assessment guidance (1).

The Environment Agency H1 guidance does not provide an assessment criterion for thallium (Tl) and therefore this metal has not been considered further. The Air Quality Strategy (AQS) includes a 15% exposure reduction target for $PM_{2.5}$ which cannot be assessed when considering the incremental impacts of a single development.

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

Table 2.1 Assessment Criteria

Substance	Averaging time	Assessment Criteria (µg m^{-3})
Particulate matter (PM_{10})	Annual mean 90.4th %ile of 24 hour means	40 50
Particulate matter ($PM_{2.5}$)	Annual mean	20
Benzene (C_6H_6)	Annual mean Maximum hourly mean	5.0 195
Hydrogen chloride (HCl)	Maximum hourly mean	750
Hydrogen fluoride (HF)	Annual mean Maximum hourly mean	16 160
Hydrogen fluoride (HF, vegetation)	Maximum 24 hour mean	5
Carbon monoxide (CO)	Maximum 8 hour mean	10,000
Sulphur dioxide (SO_2)	99.9th percentile of 15 minute 99.7th percentile of hourly means 99.2nd percentile of 24 hour	266 350 125
Sulphur dioxide (SO_2,vegetation)	Annual mean	10 to 20
Nitrogen dioxide (NO_2)	Annual mean 99.79th percentile of hourly means	40 200
Oxides of nitrogen (NO_x, vegetation)	Annual mean Maximum 24 hour mean	30 75
Ammonia (NH_3)	Annual mean Maximum hourly mean	180 2,500
Ammonia (NH_3, vegetation)	Annual mean	1 to 3
Cadmium (Cd)	Annual mean	0.005
Mercury (Hg)	Annual mean Maximum hourly mean	0.25 7.5
Antimony (Sb)	Annual mean Maximum hourly mean	5 150
Arsenic (As)	Annual mean	0.003
Lead (Pb)	Annual mean	0.25
Chromium (Cr)	Annual mean Maximum hourly mean	5 150
Chromium (Cr (VI))	Annual mean	0.0002
Copper (Cu)	Annual mean	10
Manganese (Mn)	Annual mean Maximum hourly mean	0.15 1,500
Nickel (Ni)	Annual mean	0.02
Vanadium (Vn)	Annual mean Maximum 24 hour mean	5 1
PAHs as benzo(a)pyrene	Annual mean	0.00025
Polychlorinated biphenyls (PCBs)	Annual mean Maximum hourly mean	0.2 6

2.4.2 ODOURS

The UK's Environment Agency H4 guidance suggests a range of benchmarks for unacceptable pollution, these are shown below [1].

- 1.5 OU_e m^{-3} 98th Percentile of Hourly Averages for ' most offensive' odours.
- 3.0 OU_e m^{-3} 98th Percentile of Hourly Averages for ' moderately offensive' odours.
- 6.0 OU_e m^{-3} 98th Percentile of Hourly Averages for ' less offensive'odours.

Table 2.2 shows the UK's Environment Agency examples a range of odours

Table 2.2 UK Environment Agency - Odour Characterisation

Category	Examples
Most Offensive	Processes involving decaying animal or fish remains Processes involving septic effluent or sludge Biological landfill odours
Moderately Offensive [a]	Intensive livestock rearing Fat frying (food processing) Sugar beet processing Well aerated green waste composting
Less Offensive	Brewery Confectionery Coffee roasting Bakery
(a) Most odours from processes fall into this category ie any odours which do not obviously fall within the 'most offensive' or 'less offensive' categories.	

The odour emissions from the proposed facility would be best categorised as being moderately offensive. Therefore, for the purpose of this assessment a benchmark of 3 OU_e m^{-3} 98th percentile of hourly averages is appropriate for assessment of the potential for annoyance.

2.4.3 BIO-AEROSOLS

Bio-aerosols are microscopic, airborne particles including bacteria, fungal spores, protozoa and organic constituents of microbial and fungal origin.

There is a wide range in natural background concentrations of bio-aerosols with measured concentrations reported in one paper ranging from 0 colony forming units (cfu) m^{-3} to 2,968 cfu m^{-3} [2]. There are no legal standards or guidelines for bio-aerosols concentration, the assessment criteria for bio-aerosols normally used is 1,000 (cfu) m^{-3}. This criteria is cited in a number of documents including the Environment Agency's (EA) guidance on monitoring around waste facilities and Environment Agency (EA) policy statement on

(1) Environment Agency (March 2011) Horizontal Guidance Note H4 Odour Management.
(2) Gilbert et al (May 2002) Preliminary Results of Monitoring the Release of Bioaerosols from Composting Facilities in the UK.

composting and potential health effects [1] [2]. It is however, unclear over what averaging time the benchmark of 1,000 (cfu) m^{-3} should be applied. It is understood that concentrations are normally measured using a hi-volume sampler over a 24-hour period and therefore this may be the most appropriate averaging period, however, the EA's M17 guidance states that the averaging period should be 8 hours.

It was reported in the 2008 air quality assessment for the Northacre Resource Recovery Centre that the key concern for Westbury Dairies in relation to bio-aerosols relates to the potential to affect existing air filtration system leading to increased operational and maintenance costs. This system is currently serviced on an annual basis, when the filters are replaced [3]. Given that the filters are replaced on an annual basis it is the annual average concentration of bio-aerosols that is of concern to the dairy.

It was reported in the 2008 assessment that Westbury Dairies have indicated that an increase in levels of bio-aerosols within 1 order of magnitude (ie a factor of 10) of existing backgrounds is broadly acceptable. Therefore, as existing background levels in the area have been measured at an average of 50 cfu m^{-3}, the assessment criteria at the location of the air intakes for the dairy is 500 cfu m^{-3}. Given that it is annual average loading that is of concern that criteria of 500 cfu m^{-3} is an annual average concentration.

2.5 SIGNIFICANCE CRITERIA

The Environment Agency's risk assessment guidance includes a test for insignificance. The risk assessment guidance states that the process contribution (PC) can be considered as insignificant if:

- the long term PC is <1% of the assessment criteria
- the short term PC is < 10% of the assessment criteria

This is not to say that if these thresholds are exceeded the process contribution (PC) is significant, just that it cannot be ruled out as being insignificant.

The Environment Agency (EA) does not provide guidance on what is an acceptable level of impact, so it is necessary to resort to alternative sources to determine if the predicted impacts are significant or not.

2.5.1 AIR QUALITY

The impact refers to the change that is predicted to take place to the prevailing environment as a result of the proposed development (ie the incremental increase or decrease in pollutant concentration).

The significance of an impact is generally determined by the combination of the 'sensitivity' and/or 'value' of the affected environmental receptor and the

(1) Environment Agency (2007) Policy Number 405_07 Our position on composting and potential health effects from bio-aerosols.
(2) Environment Agency (2003) M17; Technical Guidance Document Monitoring of Particulate Matter in Ambient Air Around Waste Facilities.
(3) SLR (December 2008) Northacre Resource Recovery Centre (RCC) Detailed Assessment of Air Quality.

predicted “extent” and/or “magnitude” of the impact or change. The impact descriptors used in this assessment are taken from the IAQM/EPUK guidance for planning and air quality (1). The assessment of significance ultimately relies on professional judgement, although comparing the extent of the impact with criteria and standards specific to each environmental topic can guide this judgement.

Details of impact descriptors used in this assessment are shown in **Table 2.3** It should be noted that the IAQM/EPUK impact descriptors refer to permanent changes in air quality brought about by a development and not short term or temporary changes. They also refer to locations where there is relevant exposure and not therefore necessarily the location of the maximum impact. The criteria therefore are only appropriate for changes to annual average concentrations at locations where there is relevant exposure; ie not generally the point of maximum impact.

Table 2.3 IAQM/EPUK Air Quality Impact Descriptors for Individual Receptors

Long Term Average Concentration at Receptor in Assessment Year	% Change in Concentration Relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
102%-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial
Note: Changes less than 0.5% are Negligible.				

The IAQM guidance on significance shown in **Table 2.3** is only applicable to long term/annual average impacts.

IAQM provides the following guidance for peak short-term concentrations from an elevated source, as shown below.

Magnitude of Impact (percentage of relevant Air Quality Assessment Level, AQAL):

- 10-20% Small
- 20-50% Medium
- >50% Large

The corresponding severity of these impacts can be described as slight, moderate and substantial without the need to make reference to background or baseline concentration.

(1) Environmental Protection UK/IAQM (January 2017) Land-Use Planning& Development Control: Planning for Air Quality.

The Environment Agency's (EA) risk assessment guidance includes a test for insignificance of short term impacts [1]. The guidance states that the process contribution (PC) can be considered as insignificant if:

- the long term PC is <1% of the assessment criteria
- the short term PC is < 10% of the assessment criteria

This is not to say that if these thresholds are exceeded the process contribution (PC) is significant, just that it cannot be ruled out as being insignificant.

For the assessment of significance, this assessment uses the IAQM guidance.

2.5.2 ODOUR

The Institute of Air Quality Management (IAQM) has published guidance on the assessment of odour for planning [2]. As with air quality, the assessment of significance ultimately relies on professional judgement.

The IAQM guidance suggests three categories for receptor sensitivity and odour effect descriptors based on the sensitivity of the receptor and the magnitude of the impact.

Table 2.4 provides details of the receptor sensitivity and **Table 2.5** the odour effect descriptors.

Table 2.4 IAQM Receptor Sensitivity

Sensitivity	Description
High	Surrounding land where: • users can reasonably expect enjoyment of a high level of amenity; and • people would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.
Medium	Surrounding land where: • users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or • people wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreation fields.
Low	Surrounding land where: • the enjoyment of amenity would not reasonably be expected; or • there is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Examples may include industrial use, farms, footpaths and roads.

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

(2) Institute of Air Quality Management (IAQM, May 2014) Guidance on the assessment of odour for planning.

Table 2.5 IAQM Odour Effect Descriptors

Odour Exposure (C_{98}, $OU_e\ m^{-3}$) [(a)]	Receptor Sensitivity		
	Small	Medium	High
>10	Moderate	Substantial	Substantial
5-10	Moderate	Moderate	Substantial
3-5	Slight	Moderate	Moderate
1.5-3	Negligible	Slight	Moderate
0.5-1.5	Negligible	Negligible	Slight
<0.5	Negligible	Negligible	Negligible
(a) 98th percentile of hourly averages.			

The IAQM guidance on odours states: Where the overall effect is greater than 'slight adverse', the effect is likely to be considered significant. This is a binary judgement: either it is 'significant' or 'not significant'. Therefore, if the overall effect is not worse than 'slight adverse' then the impact is 'not significant'. Given that the IAQM approach for judging significance for odours is the same as air quality the test for significance is valid for both air quality and odours.

3 AMBIENT AIR QUALITY DATA

3.1 INTRODUCTION

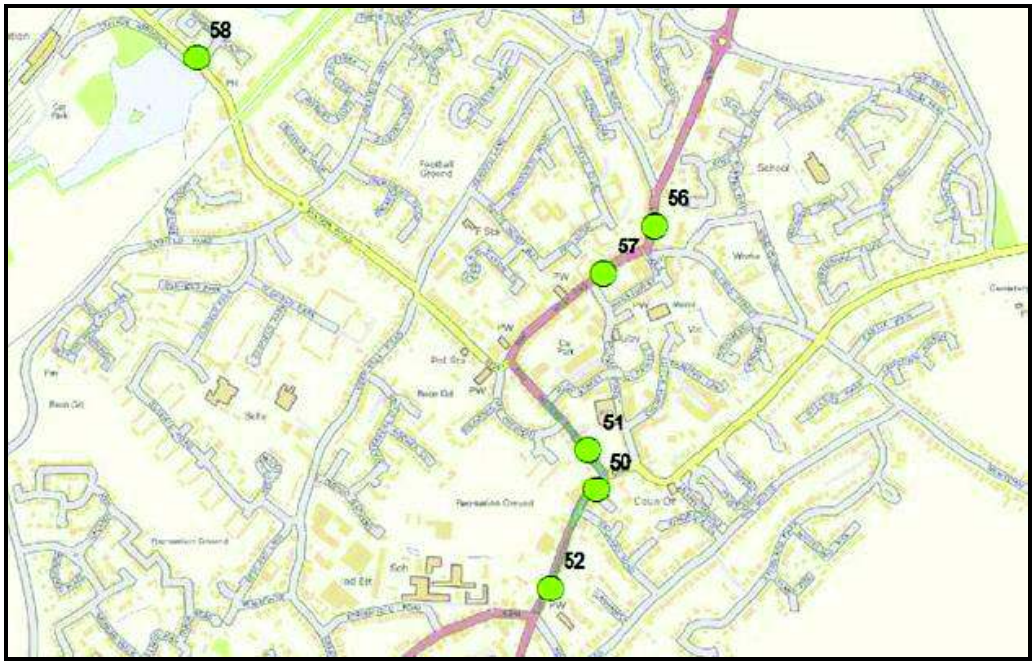
This section presents a description of the ambient air quality in the region of the proposed facility. Given the large degree of variation in pollutant concentrations, both with time and location, it is desirable to have measurements over a period of time that is long enough to ensure that a complete range of meteorological conditions and emissions have been experienced.

The criteria used throughout this assessment are compared to the incremental increase occurring due to emissions to atmosphere from the proposed facility and therefore an accurate determination of the prevailing concentration is not necessary. However, estimates of the prevailing background concentrations are presented for completeness.

3.2 MEASURED CONCENTRATION OF NITROGEN DIOXIDE (NO_2)

As part of on-going requirements to continually review and assess air quality, Wiltshire Council operates a monitoring network that includes both passive and continuous sampling. The closest locations where pollutant concentrations are measured is at road side locations in Westbury. **Figure 3.1** shows the location and where measurements of annual average road side concentration of nitrogen dioxide (NO_2) are made. There are no measurements made close to the location of the proposed facility.

Figure 3.1 Location of Nitrogen Dioxide (NO_2) Diffusion Tubes



Source: Wiltshire Council (May 2015) 2015 Updating and Screening Assessment

Table 3.1 provides details of the nitrogen dioxide (NO_2) diffusion tube monitoring sites shown in **Figure 3.1**.

Table 3.1 Details of Diffusion Tubes in the Locality of the Proposed Facility

Tube Number	Description	OS Grid Reference (m)	Distance from Site (km)
50	71 Warminster Road	387255 151087	1.8
52	76 Warminster Road	387157 150901	1.8
51	41 Haynes Road	387240 151164	1.7
57	23 West End	387269 151507	1.6
56	12 Fore Street	387369 151600	1.7
58	Primmers Place	386470 151928	0.7

Source: Wiltshire Council (June 2014) 2014 Progress Report

Table 3.2 provides details of the measured annual average concentration of nitrogen dioxide (NO_2) at each monitoring site; data are available for 2012 to 2016, the values presented are the bias adjusted values.

Table 3.2 Diffusion Tube Measured Annual Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3})

No.	Description	2012	2013	2014	2015	2016	Average
50	71 Warminster Rd	**50**	**45**	**45**	39	**49**	**46**
52	76 Warminster Rd	35	40	32	35	38	36
51	41 Haynes Road	38	**41**	27	40	**45**	38
57	23 West End	36	36	33	35	36	35
56	12 Fore Street	40	40	37	39	40	39
58	Primmers Place	-	28	-	-	-	28
Assessment Criteria				**40**			

Table 3.2 shows that there are two locations where the measured annual average concentration exceeds the Air Quality Strategy (AQS) objective for nitrogen dioxide (NO_2) which is an annual average of 40 µg m^{-3}, the exceedences are marginal.

3.3 ESTIMATED BACKGROUND CONCENTRATIONS

Defra estimate the background concentration for a number of pollutants for a number of years on a 1 km grid resolution for the whole of the UK.

Table 3.3 shows the Defra estimated background concentration closest to the proposed site for 2018.

Table 3.3 Estimated Annual Average Background Concentrations for 2018 at OS Grid Reference 385500, 152500 (µg m^{-3})

Pollutant	Defra Estimated Background	Assessment Criteria
Nitrogen Dioxide (NO_2)	9.9	40
Oxides of Nitrogen (NO_x)	13.3	30
Particulate Matter (PM_{10})	12.8	40
Particulate Matter ($PM_{2.5}$)	8.3	20
Sulphur dioxide (SO_2) [(a)]	2.6	10-20

(a) Data from 2001 which is most recent year available. Data for Wiltshire is unavailable so the average for North Somerset is used.

Table 3.3 shows that the Defra estimated background concentration of nitrogen dioxide (NO_2) for 2018 of 9.9 µg m^{-3}, 13.3 µg m^{-3} for PM_{10} and 8.3 µg m^{-3} for $PM_{2.5}$ are all less than the Air Quality Strategy (AQS) objectives. It is considered that the background levels shown in **Table 3.3** provide a reasonable estimate of current concentrations in the region of the proposed facility. These values are used when assessing the impact of the proposed facility at its point of maximum impact.

3.4 SUMMARY OF AMBIENT POLLUTANT CONCENTRATIONS

Table 3.4 provides a summary of all the relevant background measured and estimated annual average pollutant concentration used in this assessment and the source of the data.

Table 3.4 Measured and Estimated Annual Average Background Pollutant Concentrations

Pollutant	Background Concentration	Unit	Data Source
Nitrogen dioxide (NO_2)	9.9	µg m^{-3}	Defra 2018 estimate
Oxides of Nitrogen (NO_x)	13.3	µg m^{-3}	Defra 2018 estimate
Particulate matter (PM_{10})	12.8	µg m^{-3}	Defra 2018 estimate
Particulate matter ($PM_{2.5}$)	8.3	µg m^{-3}	Defra 2018 estimate
Sulphur dioxide (SO_2)	2.6	µg m^{-3}	Defra 2001 estimate
Carbon monoxide (CO)	0.3	mg m^{-3}	Defra 2001 estimate
Hydrogen chloride (HCl)	0.07	µg m^{-3}	Measured 2013 Harwell
Hydrogen fluoride (HF)	3	ng m^{-3}	Slooff et al 1988
Antimony (Sb)	0.82	ng m^{-3}	Measured 2013 Harwell
Arsenic (As)	0.61	ng m^{-3}	Measured 2013 Harwell
Cadmium (Cd)	0.096	ng m^{-3}	Measured 2013 Harwell
Chromium (Cr)	0.96	ng m^{-3}	Measured 2013 Harwell
Chromium (Cr, VI)	0.19	ng m^{-3}	EA guidance upto 20% of Cr is Cr (VI)
Cobalt (Co)	0.06	ng m^{-3}	Measured 2013 Harwell
Copper (Cu)	2.7	ng m^{-3}	Measured 2013 Harwell
Lead (Pb)	4.7	ng m^{-3}	Measured 2013 Harwell
Manganese (Mn)	2.2	ng m^{-3}	Measured 2013 Harwell
Mercury (Hg)	1.1	ng m^{-3}	Measured 2013 Harwell
Nickel (Ni)	0.77	ng m^{-3}	Measured 2013 Harwell
Vanadium (Vn)	0.92	ng m^{-3}	Measured 2013 Harwell
Benzene (C_6H_6)	0.2	µg m^{-3}	Defra 2001 estimate
Dioxins	16.8	fg m^{-3}	Weybourne 2010
Ammonia (NH_3)	1.9	µg m^{-3}	Measured 2013 Harwell
Bio-aerosols	50	cfu m^{-3}	Measured 2008 [(a)]
(a) SLR (December 2008) Northacre Resource Recovery Centre (RRC), Detailed Assessment of Air Quality. Measurements were undertaken in April and May 2008.			

Table 3.5 shows the measured/estimated background concentrations as a percentage of the assessment criteria.

Table 3.5 Measured and Estimated Annual Average Background Pollutant Concentrations Compared to Assessment Criteria for Human Health

Pollutant	Background Concentration	Assessment Criteria	Unit	Percentage of Assessment Criteria (%)
Nitrogen dioxide (NO_2)	9.9	40	µg m^{-3}	25%
Particulate matter (PM_{10})	12.8	40	µg m^{-3}	32%
Particulate matter ($PM_{2.5}$)	8.3	20	µg m^{-3}	42%
Sulphur dioxide (SO_2)	2.6	10-20	µg m^{-3}	13% to 26%
Carbon monoxide (CO)	0.3	-	mg m^{-3}	-
Hydrogen chloride (HCl)	0.07	-	µg m^{-3}	-
Hydrogen fluoride (HF)	3	16	µg m^{-3}	19%
Antimony (Sb)	0.82	5	ng m^{-3}	16%
Arsenic (As)	0.61	3	ng m^{-3}	20%
Cadmium (Cd)	0.096	5	ng m^{-3}	2%
Chromium (Cr)	0.96	5,000	ng m^{-3}	0%
Chromium (Cr VI)	0.19	0.20	ng m^{-3}	96%
Cobalt (Co)	0.06	-	ng m^{-3}	-
Copper (Cu)	2.65	10,000	ng m^{-3}	0%
Lead (Pb)	4.7	250	ng m^{-3}	2%
Manganese (Mn)	2.2	150,000	ng m^{-3}	0%
Mercury (Hg)	1.07	250	ng m^{-3}	0%
Nickel (Ni)	0.77	20	ng m^{-3}	4%
Vanadium (Vn)	0.92	5,000	ng m^{-3}	0%
Benzene (C_6H_6)	0.2	3.25	µg m^{-3}	6%
Dioxins	16.8	-	TEQ fg m^{-3}	-
Ammonia (NH_3)	1.9	180	µg m^{-3}	1%
Bioaerosols	50	1,000	cfu m^{-3}	5%

Table 3.5 shows that all the estimate/measured background annual average concentrations are less than the assessment criteria. It should be noted that the estimated background concentration of Chromium VI is derived from the measured concentration of total chromium using EA guidance. The EA suggest that, as a worst case, up to 20% of total Chromium can be assumed for screening to be Chromium VI (1). However, Defra guidance for metal and metalloids in ambient air for protection of human health suggest that the Chromium VI constitutes between 3% and 8% of total airborne chromium (2). Use of this estimated range suggests that the ambient concentration of Chromium VI in the range of 14% to 38% of the assessment criteria.

(1) Environment Agency (September 2012) Guidance to applicants on impact assessment for group 3 metals stack.
(2) Defra (May 2008) Consultation on guidelines for metals and metalloids on ambient air for the protection of human health.

4 METHODOLOGY

4.1 INTRODUCTION

This section describes the methodology and assumptions made for the air quality assessment. Also described are the emissions data used.

4.2 EMISSIONS DATA

The facility employs thermal decomposition to generate synthetic gas known as 'syngæs'. The syngas is combusted at a temperature greater than 850 deg C with a residence time of more than 2 seconds, to comply with the requirements of the Industrial Emissions Direction (IED)) (1) (2). The heat generated from thermal decomposition is used to generate steam which drives a steam turbine.

The products of combustion pass through an air pollution control system which removes pollutants and ensures that the emissions to atmosphere comply with the requirements of IED. The emissions are released to atmosphere via a twin flue 75 m high stack.

Table 4.1 and Table 4.2 show the parameters which describe the physical properties of emissions from the stack, as required for definition of the emissions in dispersion modelling terms. These data are conservative estimates of the emission rates with the facility operating continuously at full load, in practice the installation is expected to operate for about 7,500 hours per year (85% of the time). Data are presented for each flue and for the combined emissions from the two flues.

Table 4.1 Emissions and Physical Properties, Main Stack

Parameter	Value		
Number of stacks	1		
Number of flues	2		
OS Grid Reference (m)	385774 152070		
Release height above ground level (m)	75		
	Flue 1	**Flue 2**	**Combined**
Exhaust gas flow rate ($Am^3 hr^{-1}$)	99,720	99,720	199,440
Actual volumetric flow rate ($Am^3 s^{-1}$)	27.7	27.7	55.4
Exhaust gas oxygen content (% v/v wet)	4.8	4.8	4.8
Exhaust gas water content (% v/v)	15.1	15.1	15.1
Flue diameter (m)	1.40	1.40	1.98 (a)
Exit velocity ($m s^{-1}$)	18.0	18.0	18.0
Flue gas emission temperature (deg C)	125	125	125
Normalised volumetric flow ($Nm^3 s^{-1}$) (b)	24.9	24.9	49.9

(a) Effective diameter of two flues.
(b) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 11% v/v O_2.

(1) Directive 2010/75/EU (24 November 2010) on Industrial Emissions.
(2) Directive 2000/76/EC of the European Parliament and of the Council (4 December 2000) on the incineration of waste. The requirements of WID are now maintained under Chapter IV and Annex VI of the Industrial Emissions Directive (IED) 2010/75/EC

Table 4.2 shows both the pollutant emissions concentrations and emission rates.

Table 4.2 Pollutant Emission Concentration and Rates

Pollutant	Concentration [(a)]			Emission Rate (total for two flues)	
Oxides of nitrogen (NO_x as NO_2)	200	mg Nm^{-3}		9.98	g s^{-1}
Sulphur dioxide (SO_2)	50	mg Nm^{-3}		2.49	g s^{-1}
Particulate matter (PM_{10})	10	mg Nm^{-3}		0.50	g s^{-1}
Particulate matter ($PM_{2.5}$)	10	mg Nm^{-3}	(b)	0.50	g s^{-1}
Carbon monoxide (CO)	50	mg Nm^{-3}		2.49	g s^{-1}
Hydrogen chloride (HCl)	10	mg Nm^{-3}		0.50	g s^{-1}
Hydrogen fluoride (HF)	1	mg Nm^{-3}		0.05	g s^{-1}
Ammonia (NH_3)	10	mg Nm^{-3}		0.50	g s^{-1}
Benzene (C_6H_6)	1	mg Nm^{-3}		0.05	g s^{-1}
Cadmium (Cd)	0.025	mg Nm^{-3}	(c)	1.25	mg s^{-1}
Mercury (Hg)	0.05	mg Nm^{-3}		2.49	mg s^{-1}
Antimony (Sb)	0.056	mg Nm^{-3}		2.79	mg s^{-1}
Lead (Pb)	0.056	mg Nm^{-3}	(d)	2.79	mg s^{-1}
Chromium (Cr)	0.056	mg Nm^{-3}	(d)	2.79	mg s^{-1}
Cobalt (Co)	0.056	mg Nm^{-3}	(d)	2.79	mg s^{-1}
Copper (Cu)	0.056	mg Nm^{-3}	(d)	2.79	mg s^{-1}
Manganese (Mn)	0.056	mg Nm^{-3}	(d)	2.79	mg s^{-1}
Nickel (Ni)	0.056	mg Nm^{-3}	(d)	2.79	mg s^{-1}
Vanadium (Vn)	0.056	mg Nm^{-3}	(d)	2.79	mg s^{-1}
Arsenic (As)	0.0007	mg Nm^{-3}	(e)	0.035	mg s^{-1}
Chromium (VI)	0.000035	mg Nm^{-3}	(e)	0.0017	mg s^{-1}
Dioxins & furans (I-TEQ)	0.1	ng Nm^{-3}		4.99	ng s^{-1}
PAHs	0.1	ng Nm^{-3}		4.99	ng s^{-1}
PCBs	0.0026	ng Nm^{-3}	(f)	0.13	ng s^{-1}

(a) Corrected for: Temperature; 273 K; Pressure; 101.3 kPa (1 atmosphere); dry; 11% v/v O_2.
(b) Conservatively assumes all PM_{10} is $PM_{2.5}$.
(c) Assumes that cadmium is 50% of the total of cadmium plus thallium (tl).
(d) The IED limit for nine metals is 0.5 mg Nm^{-3} this assessment assumes that these metals are no more than 1/9 of this limit.
(e) Environment Agency Guidance (September 2012); Mean measured concentration from 20 WID plants used.
(f) Environment Agency (30 April 2014) personal communication.

Measures will be incorporated into the design and operation of the facility to minimise the potential for emissions of odours. These measures will include fast acting doors to the waste handling facility with the doors normally closed during operation. Also, there will be an air handling unit ensuring adequate ventilation. Air from the waste handling building is released to atmosphere from a 40 m high stack.

Table 4.3 shows the emissions data used to model emissions of odour to atmosphere from the waste handling building.

Table 4.3 Emissions and Physical Properties, Ventilation Stack

Parameter	Value
Number of stacks	1
Number of flues	1
OS Grid Reference (m)	385682 152003
Release height above ground level (m)	40.0
Exhaust gas flow rate ($Am^3 hr^{-1}$)	120,000
Actual volumetric flow rate ($Am^3 s^{-1}$)	33.3
Flue diameter (m)	1.68
Exit velocity ($m s^{-1}$)	15.0
Flue gas emission temperature (deg C)	20
Odour Concentration ($OU_e m^{-3}$)	2,000
Odour emission rate ($OU_e s^{-1}$)	66,600
Bio-aerosol concentration ($cfu m^{-3}$)	1,000
Bio-aerosol emission rate ($cfu s^{-1}$)	33,300

4.3 RECEPTORS

To determine the maximum ground level concentrations occurring due to emissions to atmosphere from the proposed facility and the distribution of impacts, predictions are made of ground level concentrations for a grid of receptors. Concentrations for receptor R1 are relevant for the height of the intake but for simplicity, are all referred to as 'ground level concentrations' throughout this report. The receptor grid is 6,000 m by 5,000 m with spacing of 100 m. Making predictions for a grid of receptors also allows the predicted ground level concentrations to be presented as contour plots.

The specific receptors used in this assessment can be divided into three groups

- Monitoring locations, this allows for the predicted impacts to be directly compared and added to measured concentrations.
- Locations where there is relevant exposure such as residential properties.
- Statutory and non-statutory sites of ecological importance: The Environment Agency (EA) H1 guidance states that Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar Sites within 10 km together with Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs), Local Nature Reserves (LNRs), Local Wildlife sites and ancient woodland within 2 km need to be considered.

For the purpose of Local Air Quality Management (LAQM) the Air Quality Strategy Objectives (AQS) only apply where there is relevant exposure. This is defined as being where members of the public are regularly present and are likely to be exposed for a period of time, appropriate to the averaging period of the objective. For the annual average objective, locations of relevant exposure include residential properties, schools and hospitals.

Table 4.4 presents details of the specific receptors included in the modelling which have been selected because of the potential for relevant exposure,

ecological importance. The air intake for the dairy has been included as a receptor to allow the potential for tainting to be assessed.

Table 4.4 Receptor Locations

No.	Description	Distance (km)	OS Grid Reference (m)
R1	Dairy, air intake	0.1	385617 152060
R2	Storridge Farm	0.8	385267 152609
R3	Brook Farm	1.6	385178 153494
R4	Court Farm	1.6	385915 153613
R5	Property on Hawkeridge Road	1.6	386134 153574
R6	Hawkeridge Farm	1.4	386442 153199
R7	Hawkeridge Park	0.6	386151 152405
R8	Hawkeridge Park	0.8	386367 152583
R9	Grenmore Farm	1.0	386477 152747
R10	Storridge Road	0.4	386022 152256
R11	Bramble Drive	1.3	387050 152190
R12	Oldfield Road	0.8	386370 151576
R13	Penleigh Farm	1.1	385625 150947
R14	Brook Lane	0.2	385905 152060
R15	Orchard House	0.3	385504 151808
R16	Brook Cottage	0.7	385029 151867
R17	Lambert's farm	1.2	384905 151214
R18	Dairy Farm	1.3	384524 151709
R19	Bremeridge Farm	1.5	384904 150785
R20	School	1.1	386506 151280
M1	P13/58 Primmers Place	0.7	386470 151928
M2	P13/51 41 Haynes Road	1.7	387240 151164
M3	P13/56 12 Fore Street	1.7	387369 151600
E1	Salisbury Plain SAC (Max)	4.2	389588 150300
E2	Salisbury Plain SAC (Representative)	7.3	392043 148353
E3	River Avon SAC	8.6	388191 143736
E4	Picket and Clanger Wood SSSI (Max)	2.4	387257 153817
E5	Picket and Clanger Wood SSSI (Representative)	2.9	387564 154240

Figure 4.1 shows the locations of the receptors, also shown is the location of the main stack.

Figure 4.1 Location of Human Heath Receptors and Stack (Blue Spot)

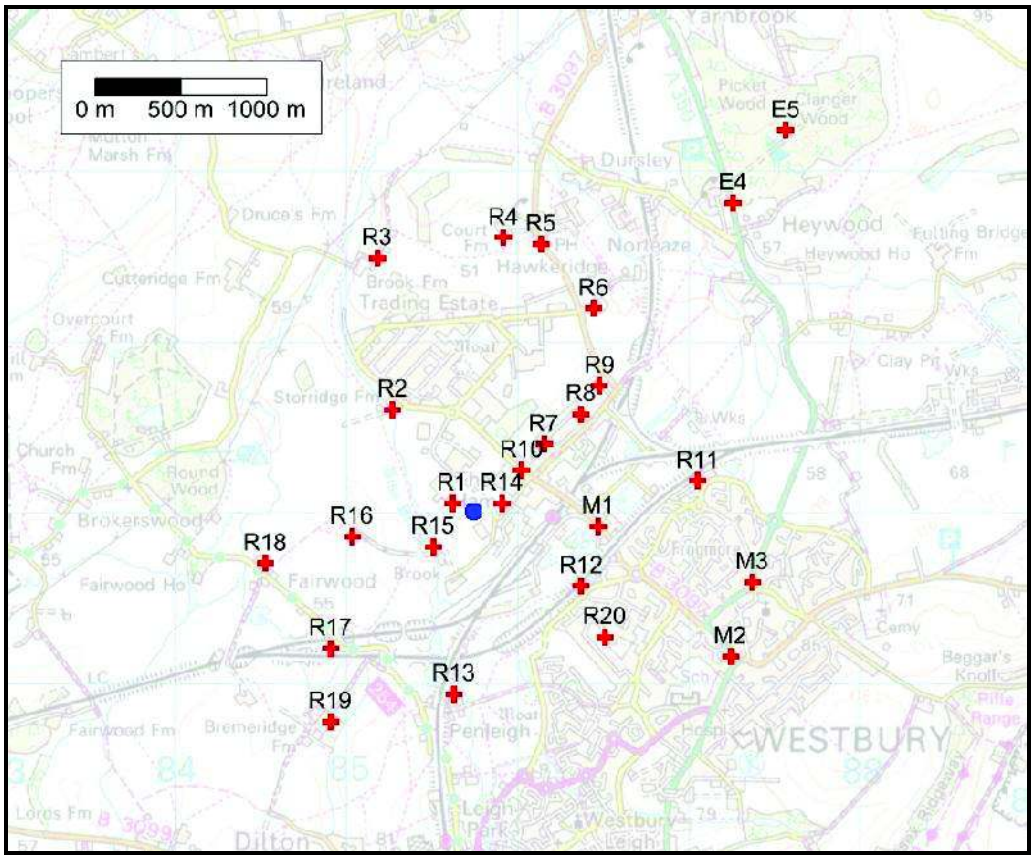
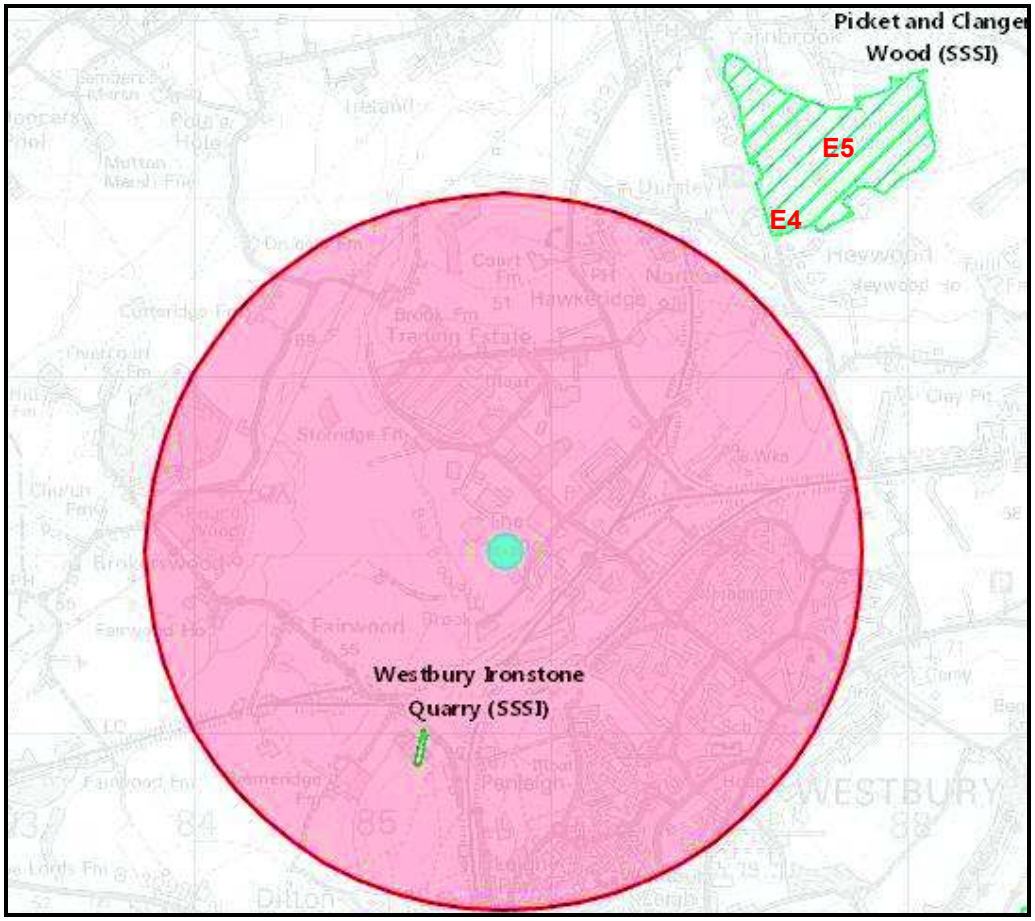


Figure 4.2 shows the location of statutory and non-statutory ecological sites within 2 km of the proposed facility used to assess the impacts of the proposed facility on vegetation and eco systems. Also shown are the receptor locations.

Figure 4.2 shows that there are no statutory or non-statutory ecological sites within 2 km. Given that 2 km is the screening distance detailed in the Environment Agency's H1 guidance it would be reasonable to disregard sites outside this distance (unless they are SAC, Ramsar or SPAs). However, given that the Picket and Clanger SSSI is located to the north east which is in the direction that the prevailing wind will transport emissions from the facility assessment of the impacts on this SSSI have been included in this assessment.

The Westbury Ironstone Quarry SSSI has been designated a SSSI for geological reasons and therefore is not relevant to this assessment.

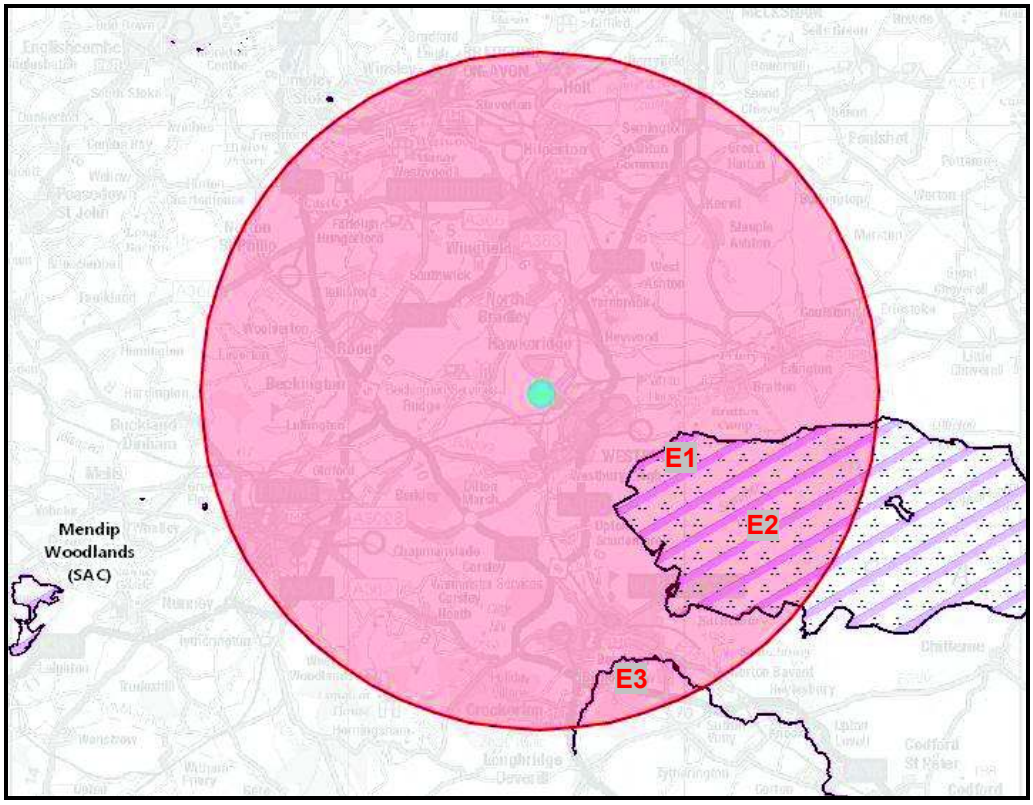
Figure 4.2 **Location of Proposed Facility and Statutory and Non Statutory Sites (Red Circle Radius is 2 km)**



Source: www.magic.defra.gov.uk

Figure 4.3 shows the location of statutory ecological sites within 10 km of the proposed facility used to assess the impacts of the proposed facility on vegetation and eco systems. Also shown are the receptor locations.

Figure 4.3 **Location of Proposed Facility and Statutory Sites (Red Circle Radius is 10 km)**



Source: www.magic.defra.gov.uk

4.4 FACTORS AFFECTING DISPERSION

There are a number of factors that will affect how emissions disperse once released to atmosphere. The four factors having the greatest effect on dispersion are:

- physical characteristics of the emissions
- climate
- terrain
- building downwash

4.4.1 PHYSICAL CHARACTERISTICS OF THE EMISSIONS

Provided that the exhaust gases have sufficient velocity at stack exit to overcome the effects of stack tip downwash, which is almost certainly the case for velocities of 15 m s^{-1} or more, the physical characteristics of the flue gases will determine the amount of plume rise and hence the effect on ground level pollutant concentrations. The degree of plume rise usually depends on the greater of the thermal buoyancy or momentum effects.

4.4.2 CLIMATE

The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind speed, wind direction and atmospheric stability.

- **Wind direction** determines the broad transport of the plume and the sector of the compass into which the plume is dispersed.

- **Wind speed** can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise.

- **Atmospheric stability** is a measure of the turbulence of the air, particularly of the vertical motions present. For dispersion modelling purposes, one method of classifying stability is by the use of Pasquill Stability categories, A to F. Another is by reference to the surface heat flux present at the ground.

Dispersion models, such as ADMS and AERMOD, do not allocate the degree of atmospheric turbulence into six discrete categories. These models use a parameter known as the Monin-Obukhov length which, together with the wind speed, describes the stability of the atmosphere.

4.4.3 BUILDING DOWNWASH

The presence of buildings can significantly affect the dispersion of the atmospheric emissions. Wind blowing around a building distorts the flow and creates zones of turbulence that are greater than if the building were absent. Increased turbulence causes greater plume mixing; the rise and trajectory of the plume may be depressed generally by the flow distortion. For elevated releases such as those from stacks, building downwash leads to higher ground level concentrations closer to the stack than those present if a building was not there. The effects of building down wash are usually only significant where the buildings are more than 40% of the stack height.

Table 4.5 shows the dimensions of the buildings included in the modelling. The buildings of the proposed waste transfer station will not affect dispersion and have not been included.

Table 4.5 Dimensions of Buildings Included in the Modelling

Building	Centre (m)		Height (m) [(a)]	Length (m)	Width (m)	Angle (deg) [(b)]
1	385706	152024	37.8	39.4	36.9	57
2	385731	152044	26.1	24.9	29.4	57
3	385714	152064	21.5	31.4	21.5	57
4	385689	152044	16.0	32.3	14.9	57
5	385681	152017	35.1	9.1	51.8	57
6	385657	151985	30.1	27.4	62.0	57
7	385590	152110	40 [(c)]	50	25	43

(a) Height above ground level.
(b) Angle building length makes to north.
(c) Approximate height of highest building of the dairy.

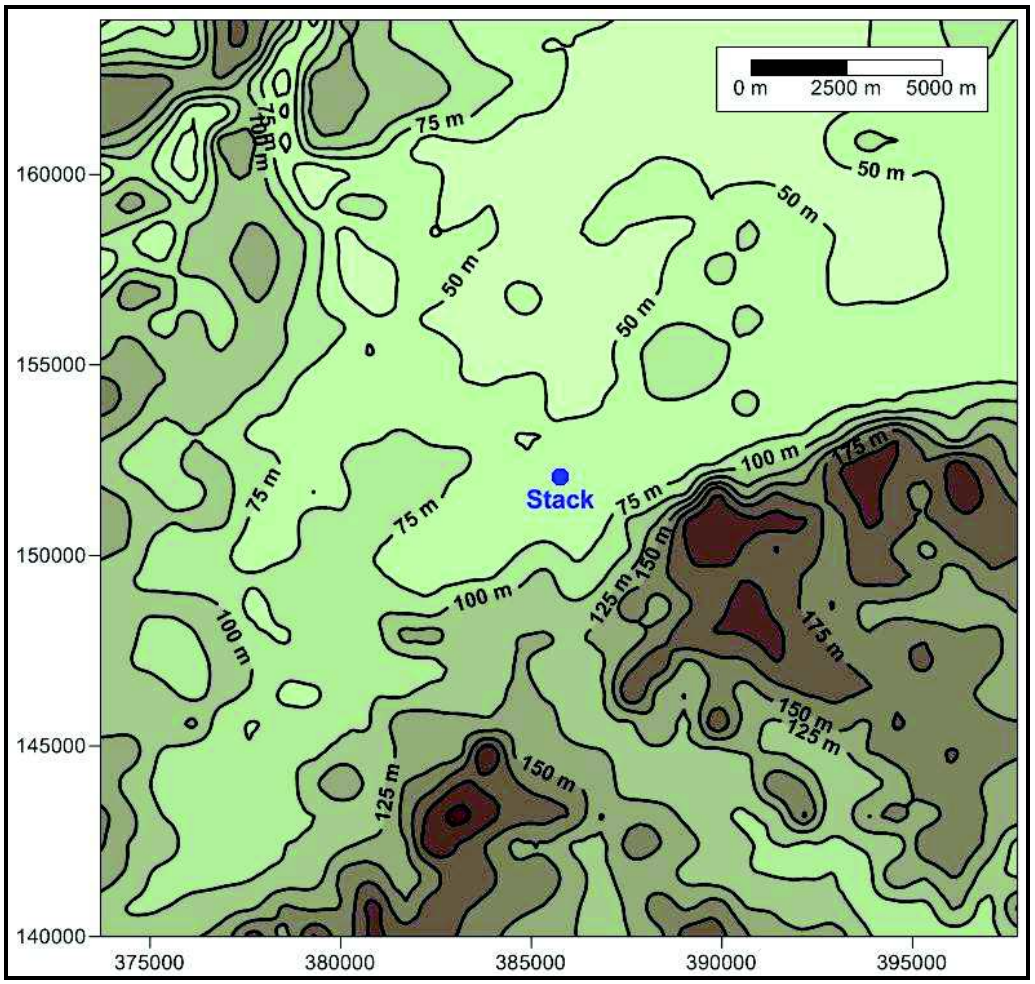
The sensitivity of model predicted concentrations to the effects of building downwash are presented in **Section 7.**

4.4.4 NATURE OF THE SURFACE

Terrain

The effects of elevated terrain can affect dispersion. **Figure 4.4** shows the terrain elevations that have been included in the modelling.

Figure 4.4 Terrain Elevations in Region of the Proposed Facility



The sensitivity of model predicted concentrations to the inclusion of terrain effects is presented in **Section 7**.

Roughness

The nature of the surface can have a significant influence on dispersion by affecting the vertical velocity profile (ie the rate of increase in wind speed for increasing heights above ground level). Also affected is the amount of atmospheric turbulence. To account for the surrounding nature of the proposed site, a surface roughness length of 0.3 m has been assumed for the dispersion modelling. It is assumed that this roughness length is also representative of Lyneham which is the source of the meteorological data. The sensitivity of model predicted concentrations to roughness length are presented in **Section 7**.

4.4.5 PLUME GROUNDING

Plume grounding is usually the description given when a plume can be observed to impact on the ground or elevated terrain. Plumes are usually only visible if they contain smoke, which is not the case here, or if water vapour in the plume has condensed to form a visible vapour plume.

Whether visible or not, all plumes will ground; the dispersion model used for this assessment calculates the frequency and intensity of plume grounding events to predict the resulting ground level concentrations.

The assessment of the frequency of visibility vapour plumes presented in **Section 5.6** shows that visible vapour plumes longer than 100 m will only occur for 0.5% of the year and therefore the frequency of visible plume grounding events will be significantly less that 0.5% for locations more than 100 m from the proposed facility. It should be noted that for the majority of the time when a plume is visible (eg 0.5% for plumes more than 100 m) the visible part of plume will not be coming to ground and therefore there will not be a visible plume grounding event.

4.5 SELECTION OF SUITABLE DISPERSION MODEL

The dispersion models which are widely used to predict ground level pollutant concentrations are based on the concept of the time averaged lateral and vertical concentration of pollutants in a plume being characterised by a Gaussian (1) distribution and the atmosphere is characterised by a number of discrete stability classes. So-called ‘ new generation' dispersion models have been developed which replace the description of the atmospheric boundary layer as being composed of discrete stability classes with an infinitely variable measure of the surface heat flux, which in turn influences the turbulent structure of the atmosphere and hence the dispersion of a plume.

(1) A Gaussian distribution has the appearance of a bell-shaped curve. The maximum concentration occurs on the centre line.

There are two commercially available dispersion models that are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources (ie stacks), and are described by the Environment Agency (EA) as being ‘ new generation’.

- AERMOD: The US **A**merican Meteorological Society and **E**nvironmental Protection Agency **R**egulatory Model Improvement Committee developed the dispersion **MOD**del called AERMOD which incorporates the latest understanding of the atmospheric boundary layer.

- Atmospheric Dispersion Modelling System (ADMS): This dispersion model was developed by the UK consultancy CERC. The model allows for the skewed nature of turbulence within the atmospheric boundary layer.

In many respects the models are quite similar and in some situations, generate similar predictions of ground level concentrations. Two intercomparison studies commissioned by the Environment Agency however found there to be significant differences in calculated concentrations between the models [(1)]. These reports highlight modelling uncertainties and do not suggest that any one of the models is considered to be the most accurate.

ADMS 5.2 was selected as the model for use in this assessment because it has been extensively used for assessment work of this nature.

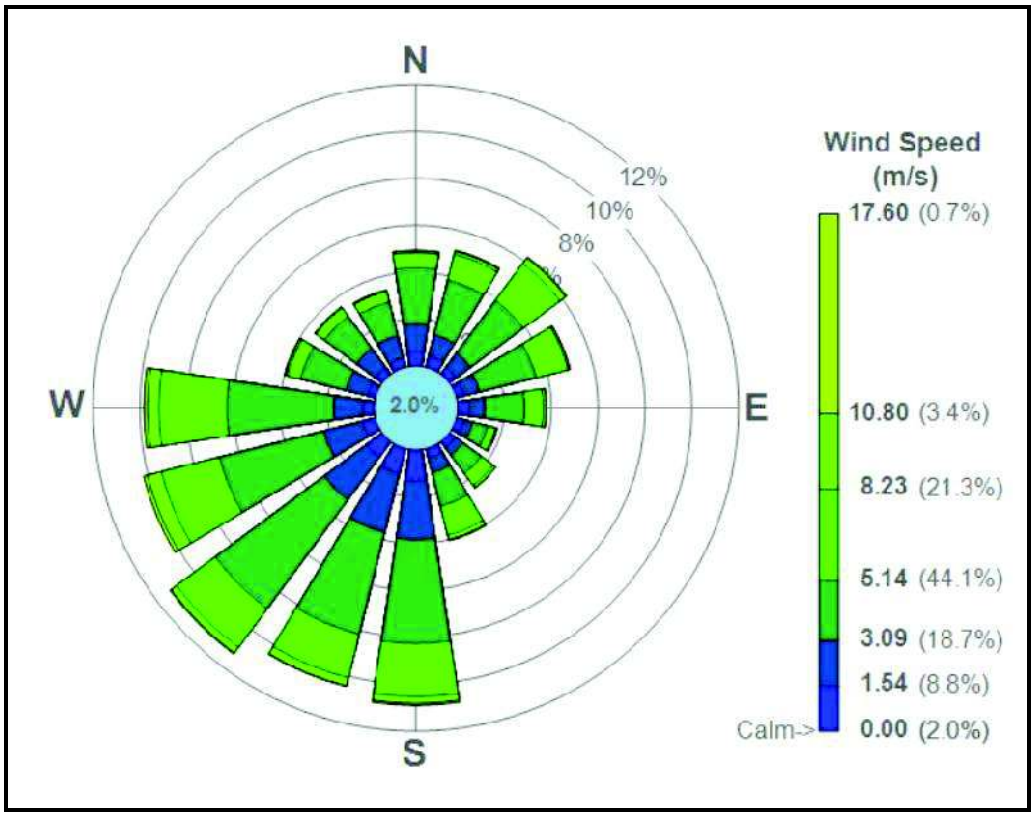
4.6 METEOROLOGICAL DATA

An important input to the dispersion model is the meteorological data. These data are important in determining the location of the maximum concentrations and their magnitude.

The closest observing station where data is available is RAF Lyneham which is 30 km away. Five years of hourly meteorological data for 2012-2016 have been used in this assessment. **Figure 4.5** shows the windrose for RAF Lyneham for 2012-2016, used in this assessment, which shows that the prevailing wind is from the south west, which will transport emissions to the north east.

(1) R&D Technical Report P353: **A review of dispersion model intercomparison studies using ISC, R91, AERMOD and ADMS** (ISBN 1 85705 276 5) and R&D Technical Report P362: An intercomparison of the AERMOD, ADMS and ISC dispersion models for regulatory applications (ISBN 1 85705 340 0).

Figure 4.5 Wind Rose RAF Lyneham (2012-2016)



4.7 PERCENTAGE OXIDATION OF NITRIC OXIDE (NO) TO NITROGEN DIOXIDE (NO_2)

Oxides of nitrogen (NO_x) emitted to atmosphere as a result of gas combustion will consist largely of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, nitric oxide is oxidised to nitrogen dioxide (NO_2), which is of concern with respect to health and other impacts. The proportion of nitric oxide oxidised to nitrogen dioxide depends on a number of factors and the oxidation is limited by the availability of oxidants, such as ozone (O_3).

An oxidation of 35% has been assumed for oxidation of nitric oxide (NO) to nitrogen dioxide (NO_2) for short-term concentrations. For predictions of annual averages, it is assumed that 70% of the oxides of nitrogen (NO_x) are in the form of nitrogen dioxide (NO_2). These assumptions are recommended by the Environment Agency (EA) [(1)].

(1) Environment Agency (AQMAU): Conversion Ratios for NO_x and NO_2.

5 PREDICTIONS AND ASSESSMENT OF IMPACTS ON HUMAN HEALTH

5.1 INTRODUCTION

This section presents the incremental increase in ground level concentrations predicted to occur as a consequence of emissions to atmosphere from the operation of the proposed facility. Predictions are presented, and assessment made of the routine emissions to atmosphere assuming that the facility is operating continuously at full load.

The focus of the assessment is on impacts of nitrogen dioxide (NO_2) as this is the pollutant of most concern both in terms of the existing prevailing concentration and the incremental impacts from the proposed facility.

This section also presents an assessment of the impacts of all the pollutants released to atmosphere from the proposed facility as well as predictions of the potential for emissions of odour to cause annoyance and bio-aerosols to affect the dairy.

Also considered are impacts during construction.

5.2 IMPACTS DURING CONSTRUCTION

No demolition or site clearance is required for the proposed development.

The impacts on air quality along the routes that will be used by construction traffic will be negligible as the number of movements will not exceed the EPUK threshold for requiring an assessment, which is an increase of more than 200 HDV movements per day of a 5% increase in traffic through an AQMA. Construction vehicle traffic movements will therefore have no impact on the Air AQMA.

The closest residential properties to the proposed development are Brookfield and Crosslands off Brook Lane approximately 75 m to the east of the site. There is also the dairy immediately to the north of the site.

The Institute of Air Quality Management (IAQM) published guidance on how to assess impacts of emissions of dust from demolition and construction sites (1). This guidance has been followed in **Table 5.1** which shows the steps undertaken to determine the risk of dust from construction giving rise to annoyance.

(1) IAQM (February 2014) Guidance on the Assessment of the Impacts of Construction on Air Quality and the Determination of their Significance.

Table 5.1 IAQM Dust Risk Assessment Methodology

Step	Outcome
Step 1: Need for Detailed Assessment	Assessment required due to proximity of sensitive receptors within 350 m.
Step 2: Assess the Risk of Dust Effect	Low risk site due to receptors because on the small number of receptors.
Step 3: Identify the Need for Site-Specific Mitigation	The IAQM guidance stipulates that for Low Risk sites the Low Risk mitigation measures are appropriate. The guidance however states that professional judgement should be employed. Given the close proximity of the air intakes to the dairy it is considered that Medium Risk mitigation measures should be followed. These are detailed in the IAQM guidance
Step 4: Define Effects and their Significance	Low impact (following mitigation)

Following the implementation of appropriate mitigation measures the significance of the impacts is considered to be low.

The effect on air quality of emissions to atmosphere from construction vehicles will be negligible.

5.3 EMISSIONS FROM VEHICLES

Currently, Solid Recovered Fuel (SRF) from Northacre Resource Recovery Centre destined for Germany passes through the Westbury AQMA resulting in 718 trips per year; these movements will cease on the opening of the proposed development. Waste material imports to the proposed development will result in 2,343 trips per year through the Westbury AQMA, therefore the net change in HGV traffic is an additional 1,625 trips per year. On the basis of 7,500 hours operation per year this equates to no more than an additional 6 HGV movements per days through the Westbury AQMA.

Emissions to atmosphere from 6 HGV movements per day will have a negligible impact on air quality as the numbers of HGVs are significantly below the EPUK/IAQM threshold for requiring an assessment which is 100 HGV movements per day. The additional 6 HGVs movements can also be put into context by comparison to the current annual average daily traffic (AADT) of 17,310 which passes through the AQMA (1). The extra HGVs represent a negligible increase in the AADT of 0.03%.

The effect of emissions to atmosphere from vehicles during operation has therefore not been considered further.

5.4 EMISSIONS FROM THE MAIN STACK

The assessment is undertaken for continuous full load emissions. It should be noted that the installation is expected to operate for 7,500 hours per year so all predicted annual average concentrations are conservative.

(1) AMEC (September 2014) Land North of Bitham Park, Westbury, Air Quality Assessment.

5.4.1 NITROGEN DIOXIDE (NO_2)

The principal pollutant released to atmosphere from the proposed facility is the oxides of nitrogen (NO_x) which will progressively oxidise to nitrogen dioxide (NO_2) in the atmosphere. **Table 5.2** shows the maximum predicted ground level concentration of nitrogen dioxide (NO_2) occurring as a consequence of emissions to atmosphere from the facility for each of the five years of meteorological data. The predictions include the effects of terrain and building downwash.

Table 5.2 ADMS 5.2 Maximum Predicted (Process Contribution) Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3}) [(a)]

Year	Annual Average	99.8th Percentile of Hourly Averages
2012	1.03	8.0
2013	0.74	7.7
2014	0.83	10.1
2015	0.94	8.4
2016	0.64	8.5
Background Concentration	9.9 [(b)]	-
Background + Maximum Impact (PEC) [(c)]	10.9	29.9 [(d)]
Assessment Criteria	**40**	**200**

(a) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.
(b) Defra estimate background concentration, appropriate for point of maximum impact.
(c) Predicted Environmental Concentration.
(d) Environment Agency (H1) guidance; 99.8th + 2 x annual average background.

For determining the total annual average concentration, it is correct to add the predicted increment to the prevailing background. This is not the case for the 99.8th percentile.

The Environment Agency's H1 Technical Guidance also states:

$$PEC_{short\ term} = PC_{short\ term} + (2 \times Background_{long\ term})$$

where PC is the Process Contribution and PEC is the Predicted Environmental Concentration.

Table 5.2 shows that 2012 meteorological data gives rise to the highest predicted increment to annual average ground level concentrations and 2014 is the highest 99.8th percentile of hourly averages.

For 2012 meteorological data, at the point of maximum predicted impact, the incremental increase in annual average ground level concentration is 1.03 µg m^{-3} which can be compared to the air quality strategy objective of 40 µg m^{-3}. When added to the prevailing background concentration of 9.9 µg m^{-3}, the resulting total concentration of 10.9 µg m^{-3} is less than the Air Quality Strategy (AQS) objective.

The maximum predicted 99.8th percentile of 10.1 µg m^{-3} is small compared to the Air Quality Strategy (AQS) objective of 200 µg m^{-3}. To determine the incremental increase to background occurring due to the proposed facility, the H1 guidance is used. The resulting total 99.8th percentile is 29.9 µg m^{-3}.

Table 5.3 shows the predicted annual average concentration at the specific receptors for human exposure and at the monitoring locations using 2012 meteorological data.

Table 5.3 ADMS 5.2 Predicted Annual Average Concentrations of Nitrogen Dioxide (NO_2) at Specific Receptors, 2012 Meteorological Data (NO_2, µg m^{-3}) [(a)]

No.	Description	Predicted Increment (Process Cont., PC)	Prevailing Conc.	Predicted Increment + Prevailing (Predicted Environmental Conc. PEC)	Increment (PC) as Percentage of Objective (%)
R1	Dairy, air intake	0.0	9.9	9.9	0.0%
R2	Storridge Farm	0.1	9.9	10.0	0.3%
R3	Brook Farm	0.1	9.9	10.0	0.3%
R4	Court Farm	0.2	9.9	10.1	0.6%
R5	Hawkeridge Road	0.3	9.9	10.2	0.6%
R6	Hawkeridge Farm	0.5	9.9	10.4	1.2%
R7	Hawkeridge Park	0.8	9.9	10.7	2.0%
R8	Hawkeridge Park	0.9	9.9	10.8	2.2%
R9	Grenmore Farm	0.8	9.9	10.7	1.9%
R10	Storridge Road	0.3	9.9	10.2	0.7%
R11	Bramble Drive	0.3	9.9	10.2	0.7%
R12	Oldfield Road	0.2	9.9	10.1	0.5%
R13	Penleigh Farm	0.2	9.9	10.1	0.4%
R14	Brook Lane	0.0	9.9	9.9	0.0%
R15	Orchard House	0.1	9.9	10.0	0.3%
R16	Brook Cottage	0.2	9.9	10.1	0.4%
R17	Lambert's farm	0.3	9.9	10.2	0.7%
R18	Dairy Farm	0.1	9.9	10.0	0.3%
R19	Bremeridge Farm	0.2	9.9	10.1	0.5%
R20	School	0.2	9.9	10.1	0.4%
M1	58 - Primmers	0.2	28 [(b)]	28.2	0.6%
M2	51 - 41 Haynes	0.1	38 [(b)]	38.1	0.3%
M3	56 - 12 Fore St	0.1	39 [(b)]	39.1	0.3%
Assessment Criteria			**40**		

(a) Assumes 70% oxidation.
(b) Measured values.

The EPUK significance criteria are applicable to locations where there is relevant exposure and are only applicable to annual average concentration. Defra TG16) guidance gives the following examples of where there is relevant exposure to annual average objectives

- Building facades of residential properties
- School
- Hospital
- Care homes

Examples given of where there is not relevant exposure to annual average objectives include; gardens of residential properties, hotels and kerbside sites.

Table 5.4 shows the EPUK significance criteria.

Table 5.4 EPUK Significance Criteria; Nitrogen Dioxide (NO_2, µg m^{-3})

No.	Description	Predicted Increment (PC)	Increase %age of Objective (%)	Back ground	PEC	PEC %age of Objective	Impact Descriptor
R1	Dairy, air intake	0.0	0%	9.9	9.9	24.8%	Negligible
R2	Storridge Farm	0.1	0%	9.9	10.0	25.0%	Negligible
R3	Brook Farm	0.1	0%	9.9	10.0	25.1%	Negligible
R4	Court Farm	0.2	1%	9.9	10.1	25.3%	Negligible
R5	Hawkeridge Road	0.3	1%	9.9	10.2	25.4%	Negligible
R6	Hawkeridge Farm	0.5	1%	9.9	10.4	26.0%	Negligible
R7	Hawkeridge Park	0.8	2%	9.9	10.7	26.7%	Negligible
R8	Hawkeridge Park	0.9	2%	9.9	10.8	27.0%	Negligible
R9	Grenmore Farm	0.8	2%	9.9	10.7	26.7%	Negligible
R10	Storridge Road	0.3	1%	9.9	10.2	25.4%	Negligible
R11	Bramble Drive	0.3	1%	9.9	10.2	25.5%	Negligible
R12	Oldfield Road	0.2	0%	9.9	10.1	25.2%	Negligible
R13	Penleigh Farm	0.2	0%	9.9	10.1	25.1%	Negligible
R14	Brook Lane	0.0	0%	9.9	9.9	24.8%	Negligible
R15	Orchard House	0.1	0%	9.9	10.0	25.0%	Negligible
R16	Brook Cottage	0.2	0%	9.9	10.1	25.2%	Negligible
R17	Lambert's farm	0.3	1%	9.9	10.2	25.5%	Negligible
R18	Dairy Farm	0.1	0%	9.9	10.0	25.1%	Negligible
R19	Bremeridge Farm	0.2	1%	9.9	10.1	25.3%	Negligible
R20	School	0.2	0%	9.9	10.1	25.2%	Negligible
M1	58 - Primmers	0.2	1%	28	28.2	70.6%	Negligible
M2	51 - 41 Haynes	0.1	0%	38	38.1	95.3%	Negligible
M3	56 - 12 Fore St	0.1	0%	39	39.1	97.8%	Negligible

Table 5.4 shows that the impact description is 'negligible' at all the receptor locations. This includes the receptors M1 M2 and M3 which are in the Air Quality Management Area (AQMA).

Table 5.5 shows the predicted 99.8th percentile concentration at the specific receptors using 2014 meteorological data.

Table 5.5 ADMS 5.2 Predicted 99.8th Percentile Concentrations of Nitrogen Dioxide (NO_2) at Specific Receptors, 2014 Meteorological Data (NO_2, µg m^{-3}) [(a)]

No.	Description	Predicted Increment (PC)	Predicted Increment + Prevailing (PEC)[(b)]	Increment as Percentage of Objective (%)
R1	Dairy, air intake	0.1	19.9	0.0%
R2	Storridge Farm	4.0	24.0	2.0%
R3	Brook Farm	3.0	23.1	1.5%
R4	Court Farm	3.0	23.2	1.5%
R5	Hawkeridge Road	3.0	23.3	1.5%
R6	Hawkeridge Farm	3.7	24.6	1.8%
R7	Hawkeridge Park	7.6	29.2	3.8%
R8	Hawkeridge Park	6.5	28.2	3.2%
R9	Grenmore Farm	5.4	26.9	2.7%
R10	Storridge Road	5.0	25.5	2.5%
R11	Bramble Drive	3.5	24.0	1.8%
R12	Oldfield Road	5.6	25.7	2.8%
R13	Penleigh Farm	3.7	23.7	1.8%
R14	Brook Lane	0.2	20.0	0.1%
R15	Orchard House	3.9	23.9	1.9%
R16	Brook Cottage	5.1	25.3	2.6%
R17	Lambert's farm	4.1	24.5	2.1%
R18	Dairy Farm	3.5	23.6	1.8%
R19	Bremeridge Farm	3.0	23.3	1.5%
R20	School	4.1	24.1	2.0%
M1	58 - Primmers	6.0	62.5	3.0%
M2	51 - 41 Haynes	2.5	78.7	1.3%
M3	56 - 12 Fore St	2.8	81.1	1.4%
	Assessment Criteria		**200**	

(a) Assumes 35% oxidation.
(b) Defra guidance (TG4(00)); NO_2 99.8th + 2 x annual average NO_2 background.

Table 5.5 shows that the maximum predicted 99.8th percentile of hourly average nitrogen dioxide (NO_2) concentrations is 7.6 µg m^{-3} at any of the specific receptors which is only 3.8% of the objective. It is not appropriate to use the EPUK significance criteria on short term concentrations of nitrogen dioxide (NO_2).

The short term impacts can be screened out as being insignificant using the Environment Agency's H1 guidance of 10%.

Tables 5.2 to 5.5 show that at the specific receptors, the predicted incremental increase in concentrations of nitrogen dioxide (NO_2) occurring due to emissions from the proposed facility are small compared to the assessment criteria and are not of concern to human health.

The following figures are presented to illustrate the distribution of concentrations of the nitrogen dioxide (NO_2). Predictions are presented for 2012 and 2014 meteorological data and are the Process Contributions (PC).

- **Figure 5.1;** Annual Average
- **Figure 5.2**; 99.8th percentile of hourly averages

The figures show that peak predicted increments to ground level concentrations occur within about 750 m of the facility.

Figure 5.1 ADMS 5.2 Predicted Annual Average Ground Level Concentrations of the Nitrogen Dioxide (NO_2); 2012 Meteorological Data (µg m^{-3}); Assuming 70% Oxidation

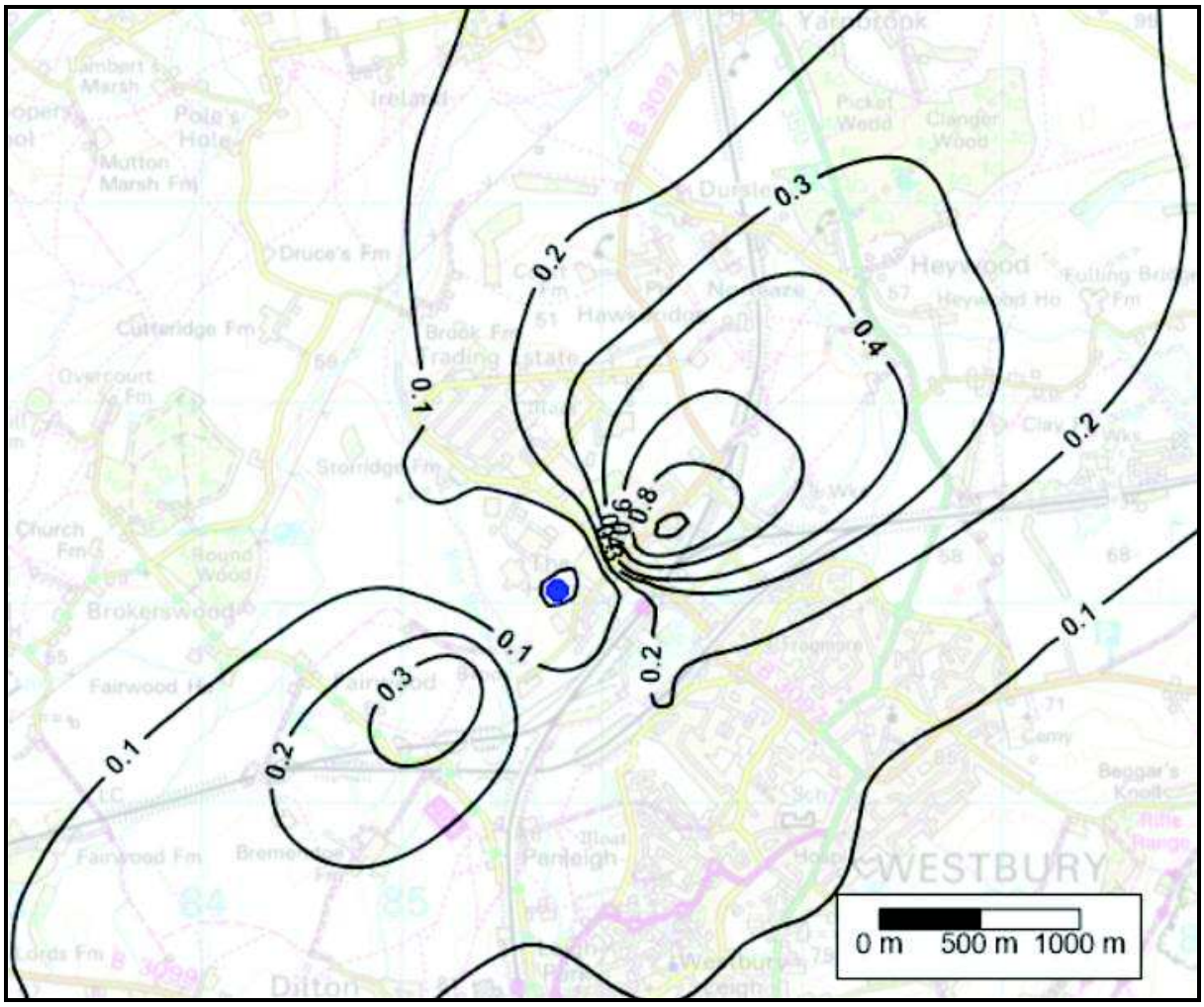
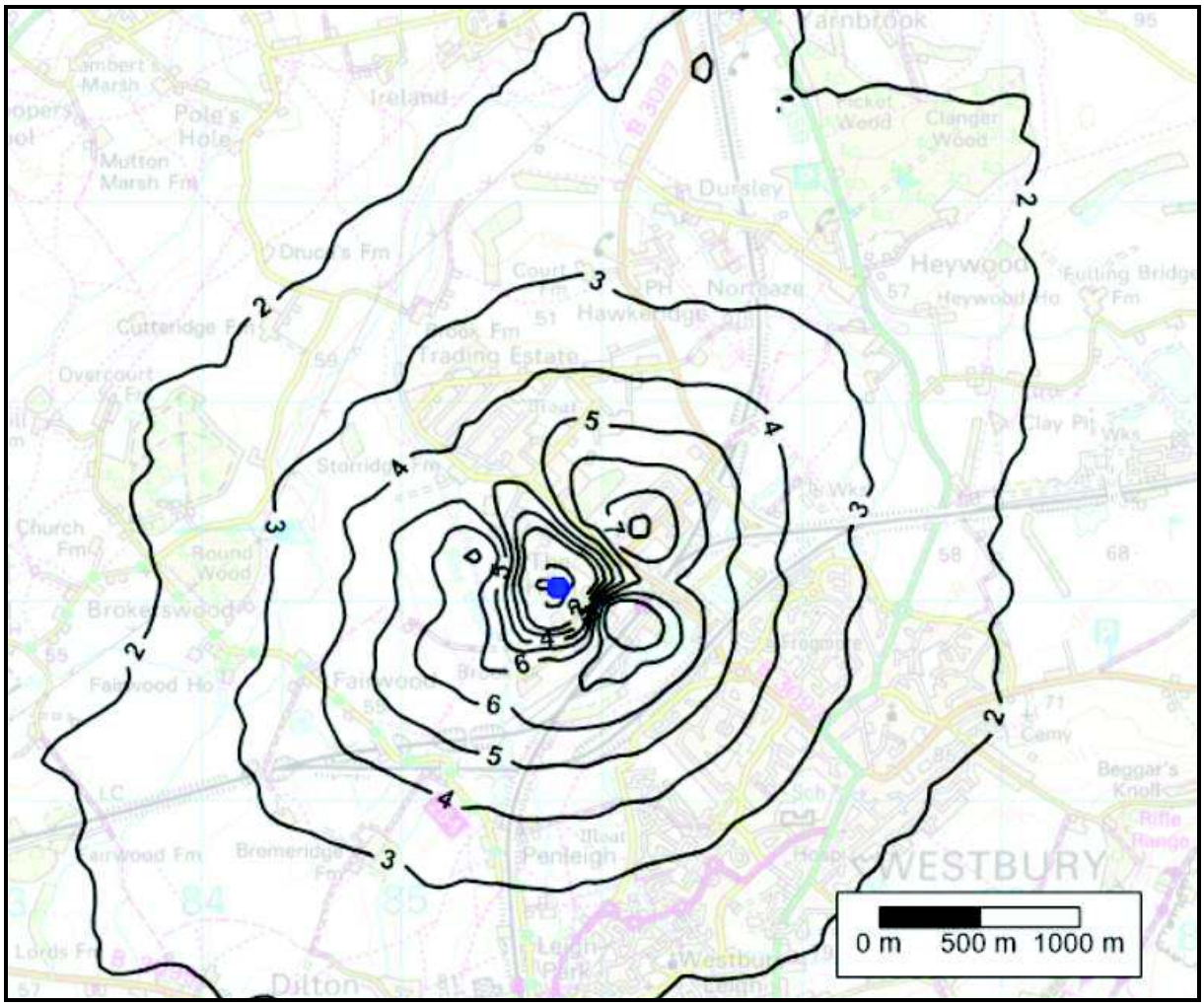


Figure 5.2 ADMS 5.2 Predicted 99.8th Percentile of Hourly Average Ground Level Concentrations of Nitrogen Dioxide (NO_2); 2014 Meteorological (µg m^{-3}); Assuming 35% Oxidation



5.4.2 REMAINING POLLUTANTS

The assessment of nitrogen dioxide (NO_2) and the remaining pollutants assumes full load continuous operation at the IED limits. The assessment uses 2012 meteorological data because this gives rise to the largest increment to annual average concentrations. The distribution of all the predicted ground level pollutant concentrations will be the same as those for nitrogen dioxide (NO_2) and therefore have not been presented.

Table 5.6 shows the maximum predicted increments to ground level concentrations (Process Contribution, PC) using emission data which are in the most part the emission limits. Also shown are the estimates of background concentrations and the Predicted Environmental Concentration (PEC).

Table 5.6 ADMS 5.2 Maximum Predicted Incremental Concentrations due to Emissions to Atmosphere (µg m^{-3}, 2012 Meteorological Data)

Pollutant	Averaging Period	Allowable Number of Exceedence	PC (µg m^{-3})	Background (µg m^{-3})	PEC (µg m^{-3})	Assessment Criteria (µg m^{-3})	Percentage of Assessment Criteria (%)	PEC as Percentage Assessment Criteria
Nitrogen dioxide (NO_2)	1 hour	18	8.0	-	27.8	200	4.0%	13.9%
	Annual	-	1.03	9.9	10.9	40	2.6%	27.3%
Particulate matter (PM_{10})	24 hour	35	0.25	-	8.2	50	0.5%	16.5%
	Annual	-	0.07	12.8	12.9	40	0.2%	32.2%
$PM_{2.5}$	Annul	-	0.07	8.3	8.4	20	0.4%	42.0%
Sulphur dioxide (SO_2)	15 Min	35	6.5	-	11.7	266	2.4%	4.4%
	1 hour	24	5.5	-	10.7	350	1.6%	3.1%
	24 hour	3	2.7	-	7.9	125	2.2%	6.4%
Carbon monoxide (CO)	8 Hour	-	5.3	-	605	10,000	0.1%	6.1%
Hydrogen chloride (HCl)	1 Hour	-	3.0	-	3.1	750	0.4%	0.4%
Hydrogen fluoride (HF)	Annual	-	0.007	0.003	0.010	16	0.0%	0.1%
	1 Hour	-	0.30	-	6.3	160	0.2%	3.9%
Benzene (C_6H_6)	Annual	-	0.007	0.2	0.21	5.0	0.1%	4.1%
	1 Hour		0.30	-	3.1	195	0.2%	0.4%
Ammonia (NH_3)	Annual	-	0.073	1.9	1.97	180	0.0%	1.1%
	1 Hour	-	2.95	-	6.8	2,500	0.1%	0.3%
Antimony (Sb)	Annual	-	0.0004	0.0008	0.0012	5	0.0%	0.0%
	1 Hour	-	0.017	-	0.018	150	0.0%	0.0%
Arsenic (As)	Annual	-	0.000005	0.00061	0.00062	0.003	0.2%	20.5%
Cadmium (Cd)	Annual	-	0.00018	0.00010	0.00028	0.005	3.7%	5.6%
Chromium (Cr)	Annual	-	0.0004	0.0010	0.0014	5	0.0%	0.0%
	1 Hour	-	0.017	-	0.018	150	0.0%	0.0%
Chromium (Cr, VI)	Annual	-	0.0000003	0.00019	0.00019	0.0002	0.1%	95.1%
Cobalt (Co)	Annual	-	0.0004	0.0001	0.0005	0.2	0.2%	0.2%
Copper (Cu)	Annual	-	0.0004	0.0027	0.0031	10	0.0%	0.0%
	1 Hour	-	0.017	-	0.022	200	0.0%	0.0%
Lead (Pb)	Annual	-	0.0004	0.0047	0.0051	0.25	0.2%	2.0%
Manganese (Mn)	Annual	-	0.0004	0.0022	0.0026	150	0.0%	0.0%
	1 Hour	-	0.017	-	0.021	1,500	0.0%	0.0%
Mercury (Hg)	Annual	-	0.0004	0.0011	0.0015	0.25	0.1%	0.6%
	1 Hour	-	0.015	-	0.017	7.5	0.2%	0.2%
Nickel (Ni)	Annual	-	0.0004	0.0008	0.0012	0.02	2.1%	5.9%
Vanadium (Vn)	Annual	-	0.0004	0.0009	0.0013	5	0.0%	0.0%
	1 Hour	-	0.017	-	0.018	1	1.7%	1.8%
Dioxins	Annual	-	0.73 [(a)]	16.80	17.5	-	-	-
PAHs	Annual	-	0.73 [(a)]	-	-	0.00025	0.0%	-
PCB	Annual	-	0.02 [(a)]	-	-	0.2	0.0%	-
	1 Hour	-	0.77 [(a)]	-	-	6	0.0%	-

(a) Units are fg m^{-3} ($x10^{-15}$).

Table 5.6 shows that, as a percentage of the short term assessment criteria, it is the 99.8th percentile of hourly average concentration of nitrogen dioxide (NO_2) which is 4.0% of the assessment criteria that has the largest impact. When combined with the background concentration the PEC (Predicted Environmental Concentration) of 27.8 µg m^{-3} is 13.90% of the assessment criteria and not considered to be of concern to human health.

For annual average impacts the increment to annual average concentration of cadmium (Cd) is predicted to give rise to the largest percentage of the assessment criteria of 3.7%. It should be noted that the assessment criteria of 0.005 µg m^{-3} is from the World Health Organisation Air Quality guidelines (2000) which state that the guideline is set to 'prevent any further increase of cadmium in agricultural soils'. Given that the maximum predicted concentration is substantially less than the assessment criteria and that the location of maximum impact is predominantly urban, it is considered that there is no concern to human health.

Dioxins and furans are a group of organic compounds that are formed as a result of incomplete combustion in the presence of chlorine. Sources include vehicles, domestic and industrial coal burning, power generation and incinerators. There are no regulatory air quality standards set for dioxins and furans. The maximum predicted ground level concentration of dioxin of 0.73 fg I-TEQ m^{-3} is small compared to the prevailing dioxin concentration and not of concern to human health as demonstrated by the health risk assessment (1).

5.5 ODOUR AND BIO-AEROSOLS IMPACTS FROM VENTILATION STACK

5.5.1 ODOURS

Table 5.7 shows the ADMS 5.2 predicted 98th percentile of hourly average odour concentrations at receptors.

(1) ADM Ltd (February 2018) Appendix A: Health Risk Assessment of Emissions to Atmosphere from Northacre Renewable Energy Westbury.

Table 5.7 ADMS 5.2 Prediction of 98th Percentile of Hourly Average Odour Concentrations ($OU_e\ m^{-3}$)

No.	Description	Predicted Odour Concentration for each Year of Met Data					Receptor Sensitivity [(a)]	Magnitude of Impact
		2012	2013	2014	2015	2016		
R1	Dairy, air intake	0.07	0.10	0.09	0.02	0.02	-	-
R2	Storridge Farm	0.2	0.2	0.2	0.2	0.2	High	Negligible
R3	Brook Farm	0.1	0.1	0.1	0.1	0.1	High	Negligible
R4	Court Farm	0.1	0.1	0.2	0.1	0.1	High	Negligible
R5	Hawkeridge Road	0.2	0.1	0.2	0.2	0.1	High	Negligible
R6	Hawkeridge Farm	0.2	0.2	0.2	0.2	0.2	High	Negligible
R7	Hawkeridge Park	0.5	0.4	0.5	0.5	0.5	High	Slight
R8	Hawkeridge Park	0.3	0.3	0.3	0.4	0.4	High	Negligible
R9	Grenmore Farm	0.2	0.2	0.3	0.3	0.3	High	Negligible
R10	Storridge Road	0.7	0.7	0.7	0.8	0.8	High	Slight
R11	Bramble Drive	0.1	0.1	0.1	0.1	0.1	High	Negligible
R12	Oldfield Road	0.2	0.2	0.2	0.2	0.2	High	Negligible
R13	Penleigh Farm	0.1	0.1	0.1	0.1	0.1	High	Negligible
R14	Brook Lane	1.2	1.2	1.2	1.3	1.3	High	Slight
R15	Orchard House	1.0	1.0	1.1	1.1	1.2	High	Slight
R16	Brook Cottage	0.2	0.2	0.2	0.3	0.3	High	Negligible
R17	Lambert's farm	0.1	0.1	0.2	0.2	0.2	High	Negligible
R18	Dairy Farm	0.1	0.1	0.1	0.1	0.1	High	Negligible
R19	Bremeridge Farm	0.1	0.1	0.1	0.1	0.1	High	Negligible
R20	School	0.1	0.1	0.1	0.1	0.2	High	Negligible
M1	P13/58 Primmers	0.2	0.2	0.2	0.2	0.3	High	Negligible
M2	P13/51 41 Haynes	0.1	0.1	0.1	0.1	0.1	High	Negligible
M3	P13/56 12 Fore St	0.1	0.1	0.1	0.1	0.1	High	Negligible
Assessment Criteria				**3.0**				

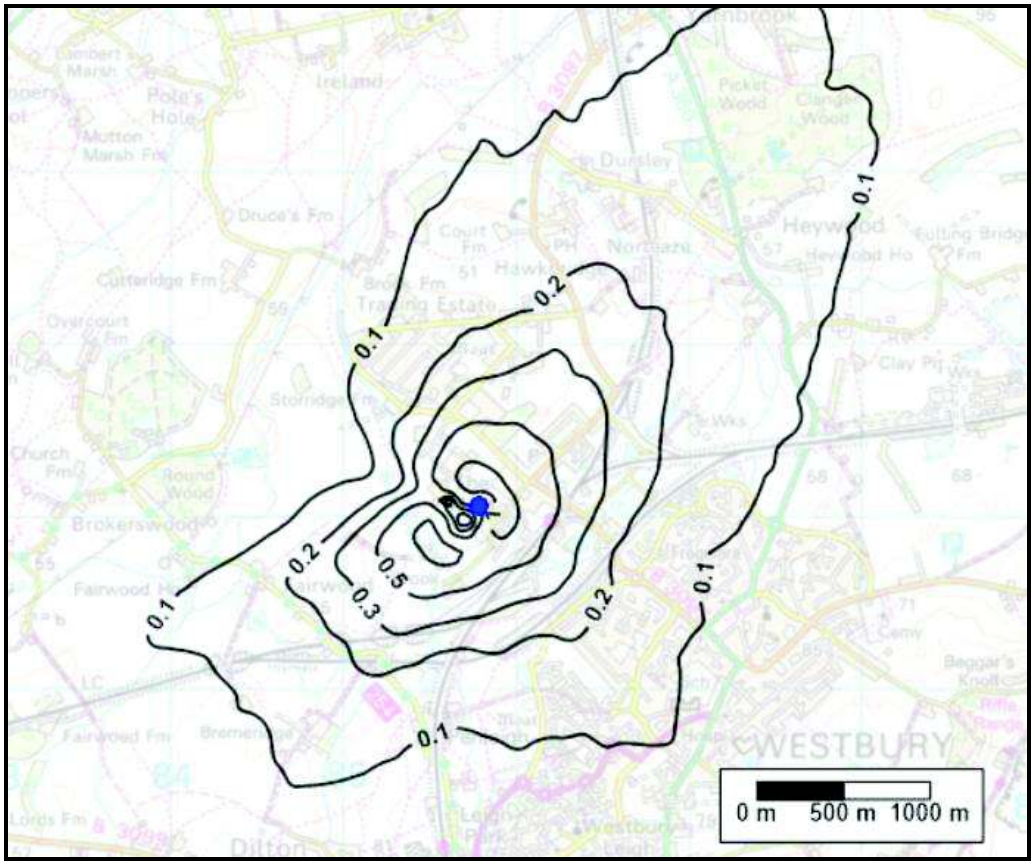
(a) The IAQM odour significance guidance is intended to determine the likelihood of annoyance and is not appropriate for use for the air intake of the dairy where tainting is the concern.

Table 5.7 shows that the predicted odour impacts are significantly below the level that would give rise to annoyance of 3.0 $OU_e\ m^{-3}$ and therefore can be screen out as having an impact of negligible significance.

There are four locations where the IAQM magnitude of change descriptor is slight. The IAQM guidance on odours states: Where the overall effect is greater than 'slight adverse', the effect is likely to be considered significant. This is a binary judgement: either it is 'significant' or 'not significant'. Therefore, in this case, the overall impact is 'not significant'.

Figure 5.3 shows the predicted distribution of odour concentration for emissions from the ventilation stack for 2016 which is the year that gives rise to the largest impact.

Figure 5.3 ADMS 5.2 Predicted 98th Percentile of Hourly Average Odour Concentrations (OU_e m^{-3}); 2016 Meteorological Data



Predictions have been made at the location of the air intake to the dairy because there is the potential for odour to taint the dairy products. The maximum predicted 98th percentile odour concentration at the dairy air intake is 0.10 OU_e m^{-3}. Even though this is only 3% of the threshold for annoyance there is still the possibility of detectable odours from time to time, but not at an intensity or duration likely to cause annoyance. .The potential for odour to cause tainting is considered in the next section.

The following are the widely accepted odour thresholds (1):

- 1 OU_e m^{-3} is the point of detection in a laboratory
- 3 OU_e m^{-3} is the recognition threshold
- 5 OU_e m^{-3} is a faint odour
- 10 OU_e m^{-3} is a distinct odour

For 2013 meteorological data the maximum one hour average odour concentrations at the location of the dairy air intakes is 2.3 OU_e m^{-3} which is less than the recognition odour threshold. During this hour there will be periods where odour concentration will be higher and lower than the average for the hour. The predictions show that the odours at the location of the air intakes will be undetectable over an averaging period of one hour. It should

(1) Environment Agency (March 2007) Review of odour character and thresholds.

also be noted that the prevailing background odour is likely to be in the range of 5 to 40 $OU_e\,m^{-3}$ ie considerably higher than the incremental increase predicted to occur due to emissions from the proposed facility (1).

5.5.2 BIOAEROSOLS

Bio-aerosols are assessed to determine the potential affect the dairy air filtration system.

Table 5.8 shows the predicted annual average concentrations of bio-aerosols for each of five years of meteorological data at the location of the dairy air intake (receptor R1).

Table 5.8 ADMS 5.2 Predicted Annual Average Bio-Aerosol Concentration at Dairy Air Intake (cfu m^{-3})

Meteorological Data Year	Annual Average (cfu m^{-3})
2012	0.0041
2013	0.0047
2014	0.0059
2015	0.0037
2016	0.0037
Maximum	0.0059
Assessment Criteria	500
Max as %age of Assessment Criteria	0.0%

Table 5.8 shows that the maximum predicted annual average concentration of bio-aerosols at the location of the dairy air intake is negligible.

5.5.3 TASTE, ODOUR AND HEALTH TAINT

Detailed work on the potential of emissions from the Northacre Resource Recovery Centre (RRC) to cause food, odour and health tainting of the products from the dairy was undertaken in 2008 (2). The conclusion of the assessment was that the risk of odour and taste tainting is negligible. The assessment found that (only) one compound (1,2-dichloroethane) exceeded the health taint threshold and that was by a factor of 3. The report stated that the assessment methodology was 'highly conservative' and that the risk present by 1,2-dichloroethane was 'low'.

The results of this study can be used to assess the risk of odour, taste and health tainting from the proposed facility.

Emissions from the ventilation stack are the most significant source of compounds that have the potential to cause tainting. Modelling of the concentration of bio-aerosols presented above shows a maximum concentration of 0.0059 cfu m^{-3} for an emission concentration of 1,000 cfu m^{-3}

(1) Environment Agency (March 2007) Review of odour character and thresholds.
(2) SLR (December 2008) Northacre Resource Recovery Centre (RCC) Detailed Assessment of Air Quality.

The concentration would be would be 0.059 cfu m^{-3} for an emissions concentration of 10,000 cfu m^{-3}. The concentration of 0.059 cfu m^{-3} can be compared to the concentration of ~2 cfu m^{-3} predicted for the MBT facility in SLR's 2008 report. Therefore, given that the same bio-aerosol source concentration is used, if emissions of VOCs with the potential to cause tainting are present in the same concentration for the proposed facility as for the MBT plant, the potential for tainting would be about 30 less for the proposed facility (ie ~0.059/~2). This is sufficient to conclude that the potential for odour, taste and health tainting from the proposed facility is negligible.

It should be noted that the only compound of significance (1,2 dichloroethane) was found to be present at a higher concentration in the air leaving the bio-filter than in the air entering it (ie the compound was being emitted from the bio-filters). Given that the proposed facility is not using bio-filters the source concentration of 1,2-dichloroethane will be lower than the MBT plant, further reducing the potential for tainting.

It should also be noted that this assessment very conservatively assumed continuous emissions from the ventilation stack.

5.6 PLUME VISIBILITY

5.6.1 INTRODUCTION

The water content of the emissions to atmosphere from the stack is 15.1% (v/v) which equates to a mixing ratio of 0.094 kg/kg (1). The temperature of the emissions on release to atmosphere is 125 deg C.

Once released to atmosphere the emissions will dilute, cool, and depending on the prevailing ambient temperature and relative humidity, may condense to form a visible vapour plume. The frequency and extent of any visible plume depends on the ambient temperature and relative humidity and the rate of plume dilution.

The ADMS 5.2 dispersion model has been used to predict the frequency and extent of a visible vapour plume.

5.6.2 PREDICTIONS OF VISIBLE VAPOUR PLUME

Predictions of the frequency and extent of a visible vapour plume have been made with the ADMS 5.2 plume visibility module. **Table 5.9** summarises the predictions of visible vapour plume length and frequency for each year of metrological data.

(1) www.humidity-calculator.com.

Table 5.9 Summary of ADMS 5.2 Predictions for Visible Vapour Plume

Year of Meteorological Data	2012	2013	2014	2015	2016	Average
%age occurrence of visible plume (%)	4.4%	6.3%	2.1%	2.4%	3.2%	**3.7%**
%age visible plume length > 250 m (%)	0.0%	0.1%	0.0%	0.0%	0.0%	**0.0%**
%age visible plume length > 100 m (%)	0.5%	1.1%	0.5%	0.3%	0.3%	**0.5%**
%age visible plume length > 50 m (%)	1.2%	2.7%	0.9%	0.8%	0.9%	**1.3%**
Maximum length of visible plume (m)	231	345	179	217	236	**-**
Average length of vapour plume (m)	44	59	57	45	42	**-**

Table 5.9 shows that for the year that gives rise to the highest frequency occurrence of visible vapour plumes (2013) the predicted occurrence is 6.3% of the time. The average percentage occurrence for the five years of meteorological data is 3.7%. It should be noted that these percentages are for all hours including night time hours where a higher frequency will occur due to lower ambient temperatures. The predictions of visible vapour plume shown in **Table 5.9** are less than those predicted and presented in the 2014 assessment due to improvements in the ADMS dispersion model.

5.6.3 DEPOSITION RATES

Presented in this section are the deposition rates for the pollutants released to atmosphere from the proposed facility where the Environment Agency's risk assessment guidance provides maximum deposition rates (1).

The Environment Agency H1 guidance states that the process contribution of air emissions deposited to land can be calculated by:

$PC_{ground} = (PC_{air} \times RR \times DV \times 3 \times 86{,}400)/1000$

Where:

PCground = process contribution to daily deposition rate (mg m^{-2} day^{-1})
RR = release rate (g s^{-1})
DV = deposition velocity (taken to be 0.01 m s^{-1})
PC_{air} = process contribution to air base on maximum annual average ground level concentration per unit mass release rate (µg m^{-3}/g s^{-1})

Value of 3 is nominal factor to convert dry deposition to total deposition.

Table 5.10 shows the estimated deposition rate at the point of maximum impact for the year that give rise to the largest impact (2012).

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#calculate-pc-for-substance-deposition.

Table 5.10 Deposition Rate

Pollutant	Emission Rate (mg s^{-1})	Deposition Rate (mg m^{-2} day^{-1})		Deposition Rate as a Percentage of the Max (%)
		Process Contribution	Maximum Rate [(a)]	
Arsenic (As)	0.035	0.000013	0.02	0.07%
Cadmium (Cd)	1.25	0.000475	0.009	5.3%
Chromium (VI)	0.0017	0.000001	1.5	0.0%
Copper (Cu)	2.79	0.001065	0.25	0.43%
Lead (Pb)	2.79	0.001065	1.1	0.10%
Mercury (Hg)	2.49	0.000951	0.004	23.8%
Nickel (Ni)	2.79	0.001065	0.11	0.97%
(a) Environment Agency H1 Guidance.				

The deposition rates presented in **Table 5.10** shows that the maximum rate is not exceeded by the process contribution. It should be noted that the modelling assumes the facility is operating continuously at full load and the impact at the point of maximum impact for the year that gives rise to the largest impact. Deposition rates at all other locations and years of metrological data will be less than the values shown.

Given the conservative nature of the assessment, it is considered that the deposition rates presented here show an acceptable impact.

6 PREDICTIONS AND ASSESSMENT OF IMPACTS ON VEGETATION AND ECOSYSTEMS

6.1 INTRODUCTION

So far, this assessment has focused on the potential impacts to human health of emissions to atmosphere from the proposed facility. There is also the potential for the facility to affect vegetation and ecosystems.

The impacts are assessed in the context of their critical levels and critical loads. The critical levels and critical loads are defined as follows (1).

Critical Loads are a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge

Critical Levels are the concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge.

6.2 ASSESSMENT OF CRITICAL LEVEL

The assessment on the effects on vegetation and eco systems conservatively assumes that emissions to atmosphere of the oxides of nitrogen (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3) are all at their respective emissions limits as detailed in **Table 4.2**.

Table 6.1 shows the predicted annual average concentration (Process Contribution, PC) of the oxides of nitrogen (NO_x) at the five receptors of ecological importance and the percentage of the critical level which for the oxides of Nitrogen (NO_x) is 30 µg m^{-3}.

Table 6.1 ADMS 5.2 Predicted Incremental (Process Contribution) to Annual Average Concentrations of Oxides of Nitrogen (NO_x) at Ecological Receptors

No.	Description	Predicted Increment (NO_x, µg m^{-3}) for each year of Met Data						Percentage of Critical Level (% of 30 µg m^{-3})
		2012	2013	2014	2015	2016	Max	
E1	Salisbury SAC (Max)	0.06	0.06	0.06	0.06	0.08	**0.08**	0.3%
E2	Salisbury SAC (Rep)	0.04	0.04	0.04	0.05	0.05	**0.05**	0.2%
E3	River Avon SAC	0.04	0.04	0.03	0.03	0.04	**0.04**	0.1%
E4	Picket & Clanger (Max)	0.51	0.37	0.44	0.47	0.31	**0.51**	1.7%
E5	Picket & Clanger (Rep)	0.42	0.31	0.36	0.37	0.26	**0.42**	1.4%

Table 6.1 shows that the predicted increments to annual average concentrations of the oxides of nitrogen (NO_x) are less than Environment

(1) www.apis.ac.uk.

Agency's 1% level of insignificance for all the ecological sites except Picket and Clanger Wood SSSI where the maximum impact is 1.7% and the impact at a representative location is 1.4%. Although the predicted impact at Picket and Clanger Wood is close to 1% because it is not less than 1% it requires further assessment.

Table 6.2 shows the Predicted Environmental Concentration (predicted increment + background concentration, PEC) of annual average concentration of the oxides of nitrogen (NO_x) at the five receptors of ecological importance and the percentage of the critical level which for the oxides of Nitrogen (NO_x) is 30 µg m^{-3}. Background is assumed to be 13.3 µg m^{-3}.

Table 6.2 ADMS 5.2 Predicted Environmental Concentration (PEC) of Annual Average Concentrations of Oxides of Nitrogen (NO_x) at Ecological Receptors

No.	Description	PEC (NO_x, µg m^{-3}) for each year of Met Data						Percentage of Critical Level (% of 30 µg m^{-3})
		2012	2013	2014	2015	2016	Max	
E1	Salisbury SAC (Max)	13.4	13.4	13.4	13.4	13.4	**13.4**	44.6%
E2	Salisbury SAC (Rep)	13.3	13.3	13.3	13.3	13.4	**13.4**	44.5%
E3	River Avon SAC	13.3	13.3	13.3	13.3	13.3	**13.3**	44.5%
E4	Picket & Clanger (Max)	13.8	13.7	13.7	13.8	13.6	**13.8**	46.0%
E5	Picket & Clanger (Rep)	13.7	13.6	13.7	13.7	13.6	**13.7**	45.7%

Table 6.2 shows that the PEC is less than the critical level at all the receptors.

Table 6.3 shows the predicted maximum 24-hour average concentration (Process Contribution, PC) of the oxides of nitrogen (NO_x) at the five receptors of ecological importance and the percentage of the critical level which for the oxides of Nitrogen (NO_x) is 75 µg m^{-3}.

Table 6.3 ADMS 5.2 Predicted Maximum 24-Hour Average Concentration (Process Contribution) of Oxides of Nitrogen (NO_x) at Ecological Receptors

No.	Description	Predicted Increment (NO_x, µg m^{-3}) for each year of Met Data						Percentage of Critical Level (% of 75 µg m^{-3})
		2012	2013	2014	2015	2016	Max	
E1	Salisbury SAC (Max)	0.98	1.21	0.91	0.95	0.72	**1.21**	1.6%
E2	Salisbury SAC (Rep)	0.79	1.28	0.74	0.62	0.52	**1.28**	1.7%
E3	River Avon SAC	0.55	1.05	0.39	0.39	0.52	**1.05**	1.4%
E4	Picket & Clanger (Max)	3.16	3.37	3.63	4.35	2.54	**4.35**	5.8%
E5	Picket & Clanger (Rep)	2.69	3.06	2.91	3.33	2.07	**3.33**	4.4%

Table 6.3 shows that the predicted 24-hour average concentration of the oxide of nitrogen (NO_x) are less than the Environment Agency's test for short term impacts for insignificance of 10% and therefore is insignificant.

Table 6.4 shows the predicted annual average concentration of sulphur dioxide (SO_2) at the five receptors of ecological importance and the percentage of the critical level which for the sulphur dioxide (SO_2) is 10 to 20 µg m^{-3} (10 µg m^{-3} for sensitive lichen and bryophytes and 30 µg m^{-3} for all higher plants).

Table 6.4 ADMS 5.2 Predicted Incremental (Process Contribution) to Annual Average Concentrations of Sulphur Dioxide (SO_2) at Ecological Receptors

No.	Description	Predicted Increment (SO_2, µg m^{-3}) for each year of Met Data						Percentage of Critical Level (% of 10-20 µg m^{-3})
		2012	2013	2014	2015	2016	Max	
E1	Salisbury SAC (Max)	0.02	0.01	0.01	0.02	0.02	**0.02**	0.1% - 0.2%
E2	Salisbury SAC (Rep)	0.01	0.01	0.01	0.01	0.01	**0.01**	0.0% - 0.1%
E3	River Avon SAC	0.01	0.01	0.01	0.01	0.01	**0.01**	0.0% - 0.1%
E4	Picket & Clanger (Max)	0.13	0.09	0.11	0.12	0.08	**0.13**	0.4% - 1.3%
E5	Picket & Clanger (Rep)	0.11	0.08	0.09	0.09	0.06	**0.11**	0.4% - 1.1%

Table 6.4 shows that the predicted increments to annual average concentrations of sulphur dioxide (SO_2) are less than the Environment Agency's test for insignificance of 1% (ie less than 1.5%) and therefore are insignificant. There would therefore be justification not to consider the impact of sulphur dioxide (SO_2) further. However, for completeness, the deposition rates and contribution to acidification are assessed.

Table 6.5 shows the Predicted Environmental Concentration (ie predicted increment + background concentration, PEC) of annual average concentration of sulphur dioxide (SO_2) at the five receptors of ecological importance and the percentage of the critical level which for sulphur dioxide (SO_2) is 10 to 20 µg m^{-3}. Background is assumed to be 2.6 µg m^{-3}.

Table 6.5 ADMS 5.2 Predicted Environmental Concentration (PEC) of Annual Average Concentrations of Sulphur Dioxide (SO_2) at Ecological Receptors

No.	Description	PEC (SO_2, µg m^{-3}) for each year of Met Data						Percentage of Critical Level (% of 10-20 µg m^{-3})
		2012	2013	2014	2015	2016	Max	
E1	Salisbury SAC (Max)	2.62	2.61	2.61	2.62	2.62	2.62	8.7% - 26.2
E2	Salisbury SAC (Rep)	2.61	2.61	2.61	2.61	2.61	2.61	8.7% - 26.1
E3	River Avon SAC	2.61	2.61	2.61	2.61	2.61	2.61	8.7% - 26.1
E4	Picket & Clanger (Max)	2.73	2.69	2.71	2.72	2.68	2.73	9.1% - 27.3
E5	Picket & Clanger (Rep)	2.71	2.68	2.69	2.69	2.66	2.71	9.0% - 27.1

Table 6.5 shows that the critical level for sulphur dioxide (SO_2) is not predicted to be exceeded.

Table 6.6 shows the predicted annual average concentration of ammonia (NH_3) at the eight receptors of ecological importance and the percentage of the critical level which for the ammonia (NH_3) 1 µg m^{-3} for sensitive lichen and bryophytes and 3 µg m^{-3} for all higher plants.

Table 6.6 ADMS 5.2 Predicted Incremental (Process Contribution) to Annual Average Concentrations of Ammonia (NH_3) at Ecological Receptors

No.	Description	Predicted Increment (NH_3, µg m^{-3}) for each year of Met Data						Percentage of Critical Level (% of 1-3 µg m^{-3})
		2012	2013	2014	2015	2016	Max	
E1	Salisbury SAC (Max)	0.003	0.003	0.003	0.003	0.004	**0.004**	0.1% - 0.4%
E2	Salisbury SAC (Rep)	0.002	0.002	0.002	0.002	0.003	**0.003**	0.1% - 0.3%
E3	River Avon SAC	0.002	0.002	0.001	0.001	0.002	**0.002**	0.1% - 0.2%
E4	Picket & Clanger (Max)	0.026	0.019	0.022	0.023	0.016	**0.026**	0.9% - 2.6%
E5	Picket & Clanger (Rep)	0.021	0.015	0.018	0.019	0.013	**0.021**	0.7% - 2.1%

Table 6.6 shows that, at the most, the predicted annual average concentrations of ammonia are 0.9% to 2.6% of the Critical Level and therefore not at a level that is of concern.

Table 6.7 shows the Predicted Environmental Concentration of annual average concentration of ammonia (NH_3) at the five receptors of ecological importance and the percentage of the critical level. Background is assumed to be 1.9 µg m^{-3}.

Table 6.7 ADMS 5.2 Predicted Environmental Concentration (PEC) of Annual Average Concentrations of Ammonia (NH_3) at Ecological Receptors

No.	Description	PEC (NH_3, µg m^{-3}) for each year of Met Data						Percentage of Critical Level (% of 1-3 µg m^{-3})
		2012	2013	2014	2015	2016	Max	
E1	Salisbury SAC (Max)	1.90	1.90	1.90	1.90	1.90	**1.90**	63% - 190%
E2	Salisbury SAC (Rep)	1.90	1.90	1.90	1.90	1.90	**1.90**	63% - 190%
E3	River Avon SAC	1.90	1.90	1.90	1.90	1.90	**1.90**	63% - 190%
E4	Picket & Clanger (Max)	1.93	1.92	1.92	1.92	1.92	**1.93**	64% - 193%
E5	Picket & Clanger (Rep)	1.92	1.92	1.92	1.92	1.91	**1.92**	64% - 192%

Table 6.7 shows that the PEC exceeds the critical level at all the receptors as a direct consequence of the prevailing background concentration if there are sensitive lichen communities or bryophytes present, otherwise the critical level is not exceeded. Any exceedence is a direct consequence of the prevailing background concentration and not the contribution from the proposed facility.

There are no critical levels for hydrogen chloride (HCl).

6.3 ASSESSMENT OF CRITICAL LOAD

There are critical loads for eutrophication (ecosystem response to the addition of artificial or natural substances) and for acidification.

Assessment of critical load has not been undertaken for the Salisbury and River Avon SACs because the impacts for these locations are negligible (less than 1% of critical levels).

Nitrogen Deposition

The Picket and Clanger SSSI contains both coniferous and broad leaf woodland.

Table 6.8 shows the habitat descriptions that are relevant to atmospheric deposition and the critical load range for nitrogen deposition (Kg N ha^{-1} $year^{-1}$) which were obtained from the APIS web site [(1)].

Table 6.8 Site Description, Habitat and Nitrogen Deposition Critical Load Range (Kg N ha^{-1} $year^{-1}$)

No.	Description	Habitat	Critical Load Range	
			Min	Max
E4 and E5	Picket & Clanger SSSI	Coniferous Woodland	5	15
		Broadleaved, mixed and yew woodland	10	20

Table 6.9 shows the annual average process contribution (PC) at each ecological receptor for ammonia (NH_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and hydrogen chloride (HCl).

Table 6.9 ADMS 5.2 Predicted Annual Average Ground Level Concentrations, 2012 Meteorological Data (µg m^{-3})

No.	Description	NH_3	NO_2	SO_2	HCl
E4	Picket & Clanger (Max)	0.03	0.36	0.13	0.026
E5	Picket & Clanger (Representative)	0.02	0.30	0.09	0.021

Table 6.10 shows the Environment Agency (EA) dry deposition velocities used in this assessment [(2)].

(1) Air Pollution Information System (APIS) www.apis.ac.uk.
(2) Environment Agency (March 2014); AQTAG06; Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air.

Table 6.10 Dry Deposition Velocities (m s^{-1})

Pollutant	Forest
Nitrogen Dioxide (NO_2)	0.003
Sulphur Dioxide (SO_2)	0.024
Ammonia (NH_3)	0.030
Hydrogen Chloride (HCl)	0.060

Table 6.11 shows the annual average deposition rates at each ecological receptor for ammonia (NH_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and hydrogen chloride (HCl). For sulphur dioxide (SO_2), ammonia (NH_3) and nitrogen dioxide (NO_2) it is assumed that wet deposition is insignificant. For hydrogen chloride (HCl) the Environment Agency's factor of 3 is used to convert from dry deposition to total (wet + dry).

Table 6.11 Estimated Annual Average Deposition Rate (µg m^{-2} s^{-1})

No.	Description	NH_3	NO_2	SO_2	HCl
E4	Picket & Clanger (Max)	0.00077	0.00108	0.0031	0.0046
E5	Picket & Clanger (Rep)	0.00064	0.00089	0.0021	0.0038

Table 6.12 shows the nutrient nitrogen deposition rates (kg N ha^{-1} $year^{-1}$) at each ecological receptor for nitrogen from ammonia (NH_3), nitrogen dioxide (NO_2) and the total.

Table 6.12 Estimated Nutrient Nitrogen Deposition Rate (kg N ha^{-1} $year^{-1}$) [(a)]

No.	Description	From NH_3	From NO_2	Total
E4	Picket & Clanger (Max)	0.200	0.103	0.304
E5	Picket & Clanger (Rep)	0.166	0.086	0.251
(a) Factor used; NH_3 260, NO_2 95.9.				

Table 6.13 shows the calculated nitrogen deposition rates (Process Contribution) as a percentage of the critical load range and the total load (ie baseline + additional load).

Table 6.13 Nitrogen Deposition Rate and Critical Loads (Kg N ha^{-1} $year^{-1}$)

No.	Habit (Location)	Critical Load Range		Additional Load (PC)	%age of Critical Load	Baseline Deposition [(a)]	%age of Baseline	Total (PEC)
		Min	Min					
E4	Coniferous (Max)	5	15	0.304	2.0% - 6.1%	39.06	0.8%	39.36
E5	Coniferous (Rep)	5	15	0.251	1.7% - 5.0%	39.06	0.6%	39.31
E4	Broad leaf (Max)	10	20	0.304	1.5% - 3.0%	39.06	0.8%	39.36
E5	Broad leaf (Rep)	10	20	0.251	1.3% - 2.5%	39.06	0.6%	39.31
(a) Baseline deposition from www.apis.ac.uk								

Table 6.13 shows that as a percentage of the Critical Load the Process

Contribution (PC) is in the range of 1.3% to 6.1%. As a percentage of the existing baseline deposition the Process Contribution (PC) is less than 1%.

Although ammonia (NH_3) is an alkali it can have an acidifying effect on soils and freshwaters. This is because acid protons can be released through transformations in the soil or on leaf surfaces, eg via oxidation, nitrification, mediated by microbes and nitrifying bacteria. For this reason, the acidification potential of ammonia (NH_3) is added to that of nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and hydrogen chloride (HCl) to determine the over acidifying potential of emissions from the facility.

Table 6.14 shows the annual acid deposition rates (keq ha^{-1} $year^{-1}$) at each ecological receptor for ammonia (NH_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and hydrogen chloride (HCl).

Table 6.14 Estimated Annual Average Acid Deposition Rate (keq ha^{-1} $year^{-1}$) [(a)]

No.	Description	NH_3	NO_2	SO_2	HCl
E4	Picket & Clanger (Max)	0.014	0.007	0.030	0.040
E5	Picket & Clanger (Rep)	0.012	0.006	0.021	0.033
(a) Factor used; NH_3 18.5, NO_2 6.84, SO_2 9.84, HCl 8.63.					

As per EA guidance 'The acid contribution from HCl should be added to the S contribution and treated as S'.

Table 6.15 shows the total N and S deposition rates (keq ha^{-1} $year^{-1}$).

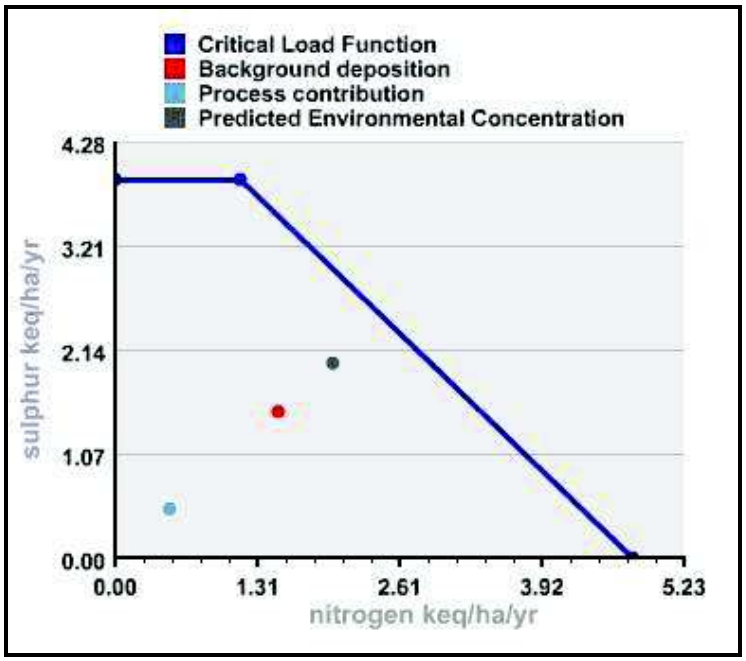
Table 6.15 ADMS 5.2 Total Nitrogen (N) and Sulphur (S) Acid Deposition Rates (Keq ha^{-1} $year^{-1}$)

No.	Description	S	N
E4	Picket & Clanger (Max)	0.070	0.022
E5	Picket & Clanger (Rep)	0.054	0.018

The critical load function for acidification is defined by three quantities CLmaxS, CLmaxN and CLminN. **Figure 6.1** illustrates how it is possible to compare acid deposition with the critical load function. In this case, both the background and the background plus Process Contribution (PC) are below the critical load function line and therefore there is no exceedence.

For acidification, the nitrogen (N) and sulphur (S) deposition rates are expressed as 'equivalents' which is a measure of how acidifying a substance can be. The units for N and S deposition are Keq ha^{-1} $year^{-1}$.

Figure 6.1 Illustration of Critical Load Function



Source: www.apis.ac.uk

The critical load function for each habitat and at each ecological receptor is available from the APIS web site and have been used in this assessment together with the tool to compare the acidification with the critical load function [(1)].

Table 6.16 shows the CLmaxS, CLmaxN and CLminN which define the critical load function and the baseline deposition rates.

Table 6.16 Critical Load Function and Baseline Deposition Rates (Keq N ha^{-1} $year^{-1}$)

No.	Description	Critical Load Function			Baseline Deposition Rate		
		CLmaxS	CLminN	CLmaxN	N	S	Total
E4	Picket & Clanger (Max)	2.7	0.36	3.06	2.79	0.22	3.01
E5	Picket & Clanger (Rep)	2.7	0.36	3.06	2.79	0.22	3.01

Table 6.17 shows the process contribution/additional loading, the Predicted Environmental Concentration (PEC) and the percentages of these compared to the critical load function for expected emissions. The calculations are made using the APIS critical load function tool.

(1) Air Pollution Information System (APIS) www.apis.ac.uk.

Table 6.17 Deposition and Deposition as Percentage of Critical Load Function (keg ha^{-1} year^{-1})

No.	Description	Process Contribution (PC)		PEC	PC (Percentage of CL Function, %)	PEC (Percentage of CL Function, %)
		S	N			
E4	Picket & Clanger (Max)	0.070	0.022	3.10	2.9	101.3
E5	Picket & Clanger (Rep)	0.054	0.018	3.08	2.3	100.7

Table 6.17 shows that the acid deposition is at most 2.9% of the critical load. It is considered that the impacts at the levels predicted are not of concern to habitats and ecosystems.

Figure 6.2 shows the full details for the calculation of the Critical Load Function for the point of maximum impact.

Figure 6.2 Critical Load Function for Point of Maximum Impact, E4

Critical Load Function Deposition data

CLmaxS:	2.7
CLminN:	0.36
CLmaxN:	3.06

Source	keq/ha/yr		
	Sulphur Deposition	Nitrogen Deposition	Total Acid Deposition (S+N)
Process Contribution (PC)	0.07	0.022	0.09
Background	0.22	2.79	3.01
Predicted Environmental Concentration (PEC)	0.29	2.81	3.1

Results - exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	2.9
Background	no exceedance of CL function	98.4
Predicted Environmental Concentration (PEC)	0.04	101.3

* % of CL function is calculated after the value of PEC relative to CL minN is taken into account. See detailed explanation for further information and justification.

Source: www.apis.ac.uk

7 SENSITIVITY ANALYSIS

7.1 INTRODUCTION

This section considers the sensitivity of model predicted concentrations to the following:

- Meteorological data
- Roughness length
- Grid spacing
- Building downwash
- Terrain
- Stack height
- Part-load operation
- Peak emissions

7.2 BUILDING DOWNWASH AND TERRAIN

The modelling presented in this assessment includes the effects of both building downwash and terrain. **Table 7.1** shows the predicted maximum ground level concentration of nitrogen dioxide (NO_2) both with and without the effects of building downwash and terrain using 2012 meteorological data.

Table 7.1 ADMS 5.2 Maximum Predicted Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3}) [(a)]

Building Downwash	Terrain	Annual Average	99.8^{tn} Percentile of Hourly Averages
Yes	Yes	1.03	8.0
No	Yes	0.60	7.1
Yes	No	1.04	8.0
No	No	0.57	6.2
Assessment Criteria		**40**	**200**

(a) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.

Table 7.1 shows that building downwash and terrain effects are predicted to have only a small effect on the maximum predicted ground level concentration.

7.3 METEOROLOGICAL DATA

The assessment presented in this report is based on predictions made using five years (2012-2016) of meteorological data from Lyneham.

To illustrate the year to year variation in meteorological data, **Table 7.2** shows the maximum predicted ground level concentration of nitrogen dioxide (NO_2) for each of the five years of meteorological data from Lyneham together with predictions made with 2016 meteorological data from Boscombe Down which is an alternative choice for source of meteorological data.

Table 7.2 ADMS 5.2 Maximum Predicted Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3}) (a)

Year and Source	Annual Average	99.8th Percentile of Hourly Averages
Lyneham 2012	1.03	8.0
Lyneham 2013	0.74	7.7
Lyneham 2014	0.83	10.1
Lyneham 2015	0.94	8.4
Lyneham 2016	0.64	8.5
Boscombe Down 2016	0.71	7.5
Assessment Criteria	**40**	**200**

(a) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.

Table 7.2 shows that there is some year to year variation in predicted concentrations although the variation is not considered to be significant. The maximum predicted concentration using meteorological data from Boscombe Down is a little lower than using data from Lyneham. This shows that the selection of metrological data is conservative.

7.4 ROUGHNESS LENGTH

The roughness length of 0.3 m used in this assessment was selected using professional judgement because roughness length is not something that can be directly measured. In practice, there is no one unique roughness that fits a given wind speed profile. Roughness length will also vary depending on wind direction and other factors such as the season of the year.

It is therefore of interest to see how sensitive the model predictions are to roughness length.

Table 7.3 shows the maximum predicted ground level concentration of nitrogen dioxide (NO_2) for roughness lengths in the range of 0.1 m to 0.5 m using 2012 meteorological data.

Table 7.3 ADMS 5.2 Maximum Predicted Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3}) (a)

Roughness Length (m)	Annual Average	99.8th Percentile of Hourly Averages
0.1	0.75	7.9
0.3	1.03	8.0
0.5	1.22	8.0
Assessment Criteria	**40**	**200**

(b) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.

Table 7.3 shows that in this modelling situation, increasing the roughness length increases the maximum predicted annual average concentrations but has little effect on the maximum predicted 99.8th percentile.

7.5 GRID SPACING

If the grid spacing is too large then it is possible that the reported maximum concentrations will not be the actual maxima. This assessment uses a grid spacing of 100 m. One way to demonstrate that the grid spacing is adequate is to model with smaller grid spacing and if the maximum concentration is not significantly different then one can be confident that the grid spacing is adequate.

Table 7.4 shows the maximum predicted ground level concentration of nitrogen dioxide (NO_2) for the grid spacing of 100 m used in this assessment together with 60 m and 150 m grid spacing. Predictions are made using 2012 meteorological data.

Table 7.4 ADMS 5.2 Maximum Predicted Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3}) [(a)]

Grid Spacing (m)	Annual Average	99.8th Percentile of Hourly Averages
60	1.04	8.2
100	1.03	8.0
150	1.01	7.8
Assessment Criteria	**40**	**200**

(c) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.

Table 7.4 shows that reducing grid spacing does not have a significant effect on the maximum predicted concentrations.

7.6 STACK HEIGHT

Table 7.5 shows the ADMS 5.2 maximum predicted annual average and 99.8th percentile of hourly average concentrations of nitrogen dioxide (NO_2) for stack heights in the range of 65 m to 85 m. Predictions are made for 2012 meteorological data.

Table 7.5 ADMS 5.2 Maximum Predicted Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2 µg m^{-3}) Effect of Stack Height [(a)]

Stack Height (m)	Annual Average	99.8th Percentile
65	1.78	12.2
70	1.31	9.6
75	1.03	8.0
80	0.84	7.0
85	0.68	6.2

(a) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.

Table 7.5 shows that the benefits in terms of reduction in the maximum ground level concentration of nitrogen dioxide (NO_2) for stack heights above the proposed height of 75 m are minimal.

7.7 PART-LOAD OPERATION

When the facility is operating at part-load both the exit velocity and pollutant emission rates will be lower. It is possible that the impacts will be higher during part-load operation is the effect of the reduced plume ruse caused by the lower exit velocity if not fully off-set by reduced pollutant emission rate occurring because of the reduced flow rate.

To determine the sensitivity of the predicted presented in this assessment to part load operation, modelling has been undertaken at both 100% and 75% load

Table 7.6 shows the emissions data used in the assessment (100%) and those used to determine the impacts for 75% operation.

Table 7.6 Emissions and Physical Properties, Main Stack (Combined for Two Flues)

Parameter	Value	
Number of stacks	1	
Number of flues	2	
OS Grid Reference (m)	385774 152070	
Release height above ground level (m)	75	
Flue diameter (m)	1.98 [(a)]	
Percentage of Maximum	**100%**	**75%**
Actual volumetric flow rate ($Am^3 s^{-1}$)	55.4	41.6
Exhaust gas oxygen content (% v/v wet)	4.8	4.8
Exhaust gas water content (% v/v)	15.1	15.1
Exit velocity ($m s^{-1}$)	18.0	13.5
Flue gas emission temperature (deg C)	125	125
Normalised volumetric flow ($Nm^3 s^{-1}$) [(b)]	49.9	37.4
Oxides of nitrogen ($mg Nm^{-3}$) NO_x as NO_2)	200	200
Oxides of nitrogen ($g s^{-1}$) NO_x as NO_2)	10.0	7.5

(c) Effective diameter of two flues.
(d) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 11% v/v O_2.

Table 7.7 shows the maximum predicted annual average and 99.8th percentile concentration of nitrogen dioxide (NO_2) for both the 100% and 75% case for each of five years of meteorological data.

Table 7.7 ADMS 5.2 Maximum Predicted (Process Contribution) Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, µg m^{-3}) for Both Full Load (100%) and 75% Load [(a)]

Year	Annual Average		99.8th Percentile of Hourly Averages	
	100%	75%	100%	75%
2012	1.03	0.94	8.0	7.1
2013	0.74	0.67	7.7	6.9
2014	0.83	0.77	10.1	8.8
2015	0.94	0.86	8.4	7.6
2016	0.64	0.60	8.5	7.7
Assessment Criteria	**40**		**200**	

(e) Assumes 70% oxidation for annual average and 35% for 99.8th percentile.

Table 7.7 shows that the impacts are lower when the facility is operating at 75% load than at 100% load and therefore the 100% load scenario modelled in the assessment is the one that gives rise to the highest impact.

7.8 PEAK EMISSIONS

The assessment has assumed that the pollutant emission concentration are either at their long term emission limit and assumes that these occur for the year of meteorological data that gives rise to the highest impact (out of five years). It is considered that this approach is robust and conservative.

It is however, theoretically possible that the short term impacts could be higher than those presented. For example, for the oxides of nitrogen (NO_x) an emission concentration of 200 mg Nm^{-3} has been used in the assessment as the emission concentration for both long and short term impact. There is a short term emission limit which states that 97% of the half hourly concentrations are no more than 200 mg Nm^{-3} and that the maximum half hour concentration is no more than 400 mg Nm^{-3}. Therefore, if the proposed facility were to operate at its very maximum permissible short term emission levels, the emission concentration could be more than 200 mg Nm^{-3} for 3% of the time and at a maximum concentration of 400 mg Nm^{-3} for 30 minutes. It is considered that making the assumption that the emission concentration will be at 400 mg Nm^{-3} for the 18 hours of the year that gives rise to the worst dispersion (this is the value that makes up the 99.8th sort term objective) is illogical as it could never occur.

However, as part of the sensitivity analysis, predictions are presented making the assumption that the facility is operating at its short term emissions limits for the hours that give rise to the worst dispersion and for the frequency and duration of the ambient air quality assessment criteria..

Table 7.8 shows the short term emissions concentrations, also shown are the long term emission concentration used in the assessment for reference.

Table 7.8 Pollutant Emission Concentration [(a)]

Pollutant	Long Term	Short Term		
Oxides of nitrogen (NO_x as NO_2)	200	400	mg Nm^{-3}	
Sulphur dioxide (SO_2)	50	200	mg Nm^{-3}	
Particulate matter (PM_{10})	10	30	mg Nm^{-3}	
Carbon monoxide (CO)	50	50	mg Nm^{-3}	
Hydrogen chloride (HCl)	10	60	mg Nm^{-3}	
Hydrogen fluoride (HF)	1	4	mg Nm^{-3}	
Ammonia (NH_3)	10	10	mg Nm^{-3}	
Benzene	1	1	mg Nm^{-3}	
Cadmium (Cd)	0.025	0.25	mg Nm^{-3}	(b)
Mercury (Hg)	0.05	0.05	mg Nm^{-3}	
Antimony (Sb)	0.056	0.056	mg Nm^{-3}	
Lead (Pb)	0.056	0.056	mg Nm^{-3}	(c)
Chromium (Cr)	0.056	0.056	mg Nm^{-3}	(c)
Cobalt (Co)	0.056	0.056	mg Nm^{-3}	(c)
Copper (Cu)	0.056	0.056	mg Nm^{-3}	(c)
Manganese (Mn)	0.056	0.056	mg Nm^{-3}	(c)
Nickel (Ni)	0.056	0.056	mg Nm^{-3}	(c)
Vanadium (Vn)	0.056	0.056	mg Nm^{-3}	(c)
Arsenic (As)	0.0007	0.0007	mg Nm^{-3}	(d)
Chromium (VI)	0.000035	0.000035	mg Nm^{-3}	(d)
Dioxins & furans (I-TEQ)	0.1	0.1	ng Nm^{-3}	
PAHs	0.1	0.1	ng Nm^{-3}	
PCBs	0.0026	0.0026	ng Nm^{-3}	(e)

(a) Corrected for: Temperature; 273 K; Pressure; 101.3 kPa (1 atmosphere); dry; 11% v/v O_2.
(b) Assumes that cadmium is 50% of the total of cadmium plus thallium (tl).
(c) The IED limit for nine metals is 0.5 mg Nm^{-3} this assessment assumes that these metals are no more than 1/9 of this limit.
(d) Environment Agency Guidance (September 2012); Mean measured concentration from 20 WID plants used.
(e) Environment Agency (30 April 2014) personal communication).

Table 7.9 shows the emission rates which are the totals for both flues.

Table 7.9 Pollutant Emission Rate

Pollutant	Long Term	Short Term	
Oxides of nitrogen (NO_x as NO_2)	9.98	19.95	g s^{-1}
Sulphur dioxide (SO_2)	2.49	9.98	g s^{-1}
Particulate matter (PM_{10})	0.50	1.50	g s^{-1}
Carbon monoxide (CO)	2.49	2.49	g s^{-1}
Hydrogen chloride (HCl)	0.50	2.99	g s^{-1}
Hydrogen fluoride (HF)	0.05	0.20	g s^{-1}
Ammonia (NH_3)	0.50	0.50	g s^{-1}
Benzene (C_6H_6)	0.05	0.05	g s^{-1}
Cadmium (Cd)	1.25	12.47	mg s^{-1}
Mercury (Hg)	2.49	2.49	mg s^{-1}
Antimony (Sb)	2.79	2.79	mg s^{-1}
Lead (Pb)	2.79	2.79	mg s^{-1}
Chromium (Cr)	2.79	2.79	mg s^{-1}
Cobalt (Co)	2.79	2.79	mg s^{-1}
Copper (Cu)	2.79	2.79	mg s^{-1}
Manganese (Mn)	2.79	2.79	mg s^{-1}
Nickel (Ni)	2.79	2.79	mg s^{-1}
Vanadium (Vn)	2.79	2.79	mg s^{-1}
Arsenic (As)	0.035	0.035	mg s^{-1}
Chromium (VI)	0.0017	0.0017	mg s^{-1}
Dioxins & furans (I-TEQ)	4.99	4.99	ng s^{-1}
PAHs	4.99	4.99	ng s^{-1}
PCBs	0.13	0.13	ng s^{-1}

Table 7.10 shows short term predictions made using the short term emission rates. This is an extremely conservative assumption as it assumes that the facility will be operating at its maximum half hour emission value for the whole hour (or number of hours) of the year that give rise to the worst dispersion. The table only shows predictions where there is a short term ambient air quality standard and uses the year of meteorological data that give rise to the highest impact.

Table 7.10 ADMS 5.2 Maximum Predicted Incremental Concentrations due to Emissions to Atmosphere from the Proposed Facility (µg m^{-3}, Using Short Term Emission Limits), 2012 Meteorological Data

Pollutant	Period	Allowable Number of Exceedences per year	Predicted Concentration (µg m^{-3})	Assessment Criteria (µg m^{-3})	Percentage of Assessment Criteria (%)
Nitrogen dioxide (NO_2)	1 hour	18	16.0	200	8.0%
Particulate matter (PM_{10})	24 hour	35	0.74	50	1.5%
Sulphur dioxide (SO_2)	15 min	35	25.9	266	9.7%
	1 hour	24	22.0	350	6.3%
	24 hour	3	11.0	125	8.8%
Carbon monoxide	8 Hour	-	5.30	10,000	0.1%
Hydrogen chloride	1 Hour	-	17.7	750	2.4%
Hydrogen fluoride (HF)	1 Hour	-	1.18	160	0.7%
Benzene (C_6H_6)	1 Hour	-	0.30	195	0.2%
Antimony (Sb) [(a)]	1 Hour	-	0.017	150	0.0%
Chromium (Cr) [(b)]	1 Hour	-	0.017	150	0.0%
Copper (Cu)	1 Hour	-	0.017	200	0.0%
Manganese (Mn)	1 Hour	-	0.017	1,500	0.0%
Mercury (Hg)	1 Hour	-	0.015	7.5	0.2%
Vanadium (Vn)	1 Hour	-	0.017	1	1.7%
PCBs (TEQ, fg/m^{-3})	1 Hour		0.77	6	0.0%

(a) Antimony and compounds (as Sb) except antimony trisulphide and antimony trioxide.
(b) Chromium, chromium (II) compounds and chromium (III) compounds (as Cr).

Table 7.10 shows that even with the very conservative assumption of using the maximum half hour average emission rate for the short term predictions, the assessment criteria are not approached and are considered to be insignificant.

8 MITIGATION AND RESIDUAL IMPACTS

8.1 INTRODUCTION

The assessment presented in this report assumes appropriate levels of mitigation and therefore the predicted impacts are those following mitigation and can be considered to be the residual impacts.

This section outlines the mitigation measures that are inherent in the design, construction and operation of the facility.

8.2 CONSTRUCTION

Emissions of dust generated during construction can be almost entirely abated by mitigation measures should these be necessary. The mitigation measures that will be employed during construction will be those set out in the IAQM dust guidance for medium risk site. The measures will be discussed and agreed with the Wiltshire Council prior to construction.

8.3 OPERATION

The assessment presented in this report shows that the dispersion provided by a 75 m main stack and 40 m ventilation stack is sufficient to render the emissions harmless at ground level and therefore no further mitigation measures are required.

9 SUMMARY AND CONCLUSIONS

Hills Waste Solutions Ltd has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality assessment of emissions to atmosphere from Northacre Renewable Energy, to be located to the north of Westbury, Wiltshire.

This assessment is an update of the previous assessment that was submitted to support the 2015 planning application (1).

Emissions to atmosphere will occur from the following sources:

- twin flue 75 m high stack
- 40 m high ventilation stack

The ADMS 5.2 dispersion model has been used to make predictions of ground level concentrations of the pollutants released to atmosphere from the proposed facility.

The following are the principal conclusions that can be drawn from this assessment, which has been undertaken using the emissions data provided and the assumptions specified:

- Emission to atmosphere from the 75 m main stack is predicted to not significantly affect air quality at ground level and the impact is considered to be insignificant.

- Potential for annoyance due to emissions of odours from the ventilation stack is predicted to be negligible.

- Potential for emissions of bio-aerosols from the ventilation stack to affect the operation of dairy is predicted to be negligible.

- Potential for emissions of volatile organic compounds (VOCs) from the ventilation stack to taint food products at the dairy is considered to be negligible.

- It is considered that the overall impact on air quality of emissions to atmosphere from the proposed facility can be described as of **minor significance**. This conclusion is based on all the impacts presented in the assessment and takes account of the localised nature of the area of maximum impact.

- This assessment, which is an update of the previous assessment that was submitted to support the 2015 planning application, shows that the impacts of emissions to atmosphere are similar or less than those predicted for the approved 2015 application.

(1) ADM (16 December 2014) Air Quality Assessment of Emissions to Atmosphere from Northacre Renewable Energy, Westbury.

Appendix A:

Health Risk Assessment of Emissions to Atmosphere from Northacre Renewable Energy, Westbury

P1713

A Report Prepared for
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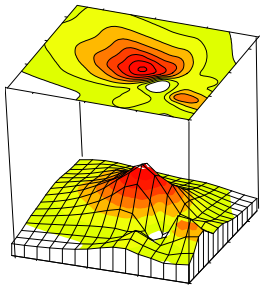

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Client: Hills Waste Solutions Ltd

Version/File	Issue Date
File=Northacre HRA v1.doc	12 Nov 2014
File=Northacre HRA v2.doc	14 Nov 2014
File=Northacre HRA v4.doc	22 Feb 2018

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A1. INTRODUCTION

A1.1 SCOPE OF THE ASSESSMENT

Hills Waste Solutions Ltd has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake a health risk assessment (HRA) of dioxin, furan and PCB emissions to atmosphere from the approved Northacre Renewable Energy facility at Westbury in 2014. The HRA is limited to consideration of dioxins, furans and PCBs. The assessment of all other substances including metals, benzene, oxides of nitrogen and particulate matter are included in the air quality assessment which shows that the impacts are not of concern to human health. There are no ambient air quality standards for dioxins/furans and so their impact cannot easily be assessed in the same way.

Consideration is also given to emissions of Polychlorinated Biphenyls (PCBs) because the Environment Agency (EA) routinely requests its inclusion in HRAs because they are similar in nature to dioxins and furans in terms of human health impact.

This report also updates the emissions data and is based on the updated air dispersion modelling which also uses more recent meteorological data (2012-2016).

The HRA is based on outputs from the latest air quality assessment [(1)].

The assessment considers the human health impact of emissions on an adult Hypothetical Maximum Exposed Individual (HMEI). Hence, this assessment is an assessment of the incremental additional risk resulting from the operation of the proposed facility (see *Section A3.2* for further explanation).

The HMEI exposure represents a highly unrealistic situation in which all exposure assumptions are set at their maximum value. While high-end individual pathway exposure estimates may represent actual exposure possibilities (albeit at very low likelihood), the possibility of all the high-end exposure assumptions made in this assessment accumulating in one individual is, for practical purposes, never realised. Therefore, HMEI intakes should be regarded with caution and should not be taken as representative of actual exposures. Several scenarios for emissions of dioxins/furans have been considered (see *Section A2.3* for further explanation).

(1) ADM Ltd (February 2018), **Air Quality Assessment of Emissions to Atmosphere from Northacre Renewable Energy, Westbury (P1713)**.

A1.2 APPROACH TO THE ASSESSMENT

The risk assessment process follows a structured approach as set out in HMIP's (one of the predecessors to the Environment Agency) 1996 report [(1)].

The approach consists of four major steps:

A) Hazard identification: The hazard identification process determines whether human exposure to a substance could cause an increase in adverse health effects. It involves characterising the nature and quantity of the stack emissions, selecting *indicator* chemicals, evaluating data on the types of health injury or disease and identifying the conditions of exposure under which injury or disease may occur.

B) Dose-response evaluation: The dose-response evaluation involves the quantification of the relationship between the degree of exposure to a substance and the extent of a potential health effect, generally based upon data derived from animal experimental studies or, less frequently, from studies of exposed human populations.

C) Quantification of the exposure: An exposure evaluation determines the dose and intake of key indicator chemicals of a hypothetically exposed person or population. The dose is defined as the amount of a substance contacting body boundaries (in the case of inhalation, the lungs) and intake is the amount of the substance absorbed into the body. The evaluation is based upon worst-case, conservative scenarios, with respect to the following:

- location of the exposed individual and duration of exposure;
- exposure rate;
- emission rate from the source.

D) Risk characterisation: Following the above steps, the risk is characterised by examining the toxicity of the chemicals to which the individual has been exposed, and evaluating the significance of the calculated dose.

(2) DOE (1996) **Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes** Contract No. HMIP/CPR2/41/1/181.

A2. METHODOLOGY FOR ESTIMATING EXPOSURE TO EMISSIONS

A2.1 INTRODUCTION

A risk assessment for the purposes of characterising the health impact of the dioxin, furan emissions from the facility can be divided into the following steps.

(1) Measure or estimate emissions from the source.

(2) Model the transport and fate of the emissions through the relevant pathways, such as the atmosphere and through soil, water and biota following deposition onto land. Estimate concentrations of the emitted chemicals in the environmental media at the point of exposure.

(3) Calculate uptake of the emitted chemicals into humans coming into contact with the affected media.

(4) Assess the significance of the absorbed dose in terms of a likely health impact.

With regard to Step (3), the exposure assessment considers the uptake of PCDD/Fs (dioxins/furans) by an adult Hypothetical Maximum Exposed Individual (HMEI). Step (4) involves comparison with an acceptable dose and this is specified as a tolerable daily intake (TDI) as a lifetime average and hence cannot be used to assess the specific intake during childhood. The TDI used for the assessment includes the period for which the person was a child.

A2.2 POTENTIAL EXPOSURE PATHWAYS

There are potentially six exposure pathways of concern following the introduction of substances into the atmosphere:

- inhalation of air;
- ingestion of food;
- ingestion of drinking water;
- dermal (skin) contact with soil;
- intentional ingestion of soil;
- dermal (skin) contact with water.

A2.3 EXPOSURE PATHWAYS CONSIDERED IN THE ASSESSMENT

Dermal contact with soil and intentional ingestion of soil (known as *pica)* are screened out as significant exposure pathways on the basis of the infrequent and sporadic nature of the events and the very low dermal and ingestion absorption factors for these exposure routes, coupled with the low plausible total dose which might be experienced (when considered over the lifetime of an individual). Health risk assessments of similar emissions (Pasternach (1989) ***The Risk Assessment of Environmental and Human Health Hazards***, John Wiley, New York) have concluded that dermal absorption and ingestion of soil

are at least one order of magnitude less efficient than lung absorption. Additionally, in the case of soil ingestion, the possible levels of soil contamination are estimated, at worst, to be no more than the contamination of food. The contamination in soil is also likely to be less bioavailable than that in food. Therefore, it is considered that the risk from soil ingestion is adequately covered by considering the risk of an exposed individual from ingesting contaminated food.

Similar arguments are relevant with respect to the elimination of aquatic pathways from consideration; swimming, fishing and other recreational activities are also sporadic and unlikely to lead to significant exposures or uptake of any contamination into the human body. Exposure via drinking water requires contamination of drinking water sources local to the point of consumption. The likelihood of contamination reaching a level of concern in the local water sources and ground water supplies is extremely low, making this pathway insignificant in terms of the total potential uptake.

On the basis of the assessment of the potential significance of the exposure pathways the key exposure pathways which are relevant to the assessment and, hence, subject to examination in detail are as follows:

- inhalation;
- ingestion of food.

The exposures arising due to the consumption of food are assessed with reference to the following food groups:

- milk and dairy produce;
- eggs;
- beef;
- lamb;
- pork;
- chicken;
- fish;
- root vegetables;
- leafy vegetables;
- potatoes;
- legumes;
- fruit; and
- cereals.

The inclusion of all food groups in the assessment conservatively assumes that both arable and pasture land and suitable rivers/lakes (for edible fish) are present in the vicinity of the predicted maximum annual average ground level concentration. It is assumed in the method that all of these food groups are grown/harvested locally(1). This is, in reality, a very unlikely scenario, but it has been included as a means of building a high degree of conservatism into the

(1) There is a dairy just to the north of the site. However, the method of assessment presented here already assumes that all milk and dairy products consumed are from cows that are continuously present at the point of maximum impact from the facility.

assessment and, hence, reducing the possibility of exposures being underestimated.

The substances which have been considered in the assessment are a range of dioxins and furans (PCDD/Fs) as shown in **Table A2.3**.

The emissions from the proposed facility have been previously discussed in detail in the air quality assessment as have the predicted maximum ground level concentrations resulting from these emissions. The *Worst Case* scenario for emissions of dioxins and furans (and hence increments to ground level concentrations resulting from the facility) have been used in this assessment, i.e. emissions at one hundred (100) times the emission limit (10 ng Nm^{-3}) for 60 hours of the year and at the emission limit (0.1 ng Nm^{-3}) for the remainder of the year (8700 hours). The data are summarised in **Table A2.1**. The base case (emissions at the emission limit for 100% of the year) is not included in this assessment but results would be 40% lower than those reported here for the *Worst Case*.

Table A2.1 Dioxins/furans (I-TEQ) Emitted from the Proposed Stack

Scenario	Annual Mean Concentration (ng Nm^{-3}) [(a) (b)]	Annual Mean Emission Rate (ng s^{-1}) [(b)]
Worst Case	0.1678	8.37
(a) Corrected for: Temperature; 273 K; Pressure; 101.3 kPa (1 atm); dry; 11% v/v O_2		
(b) ng = nano gram = 10^{-9} g = 0.000 000 001 g		

These emission rates from the proposed facility result in the maximum annual mean ground level concentrations shown in **Table A2.2**.

Table A2.2 *Worst Case* Annual Mean Ground Level Concentrations resulting from the Dioxins/furans (I-TEQ) Emissions from the Proposed Facility

Met Year	Concentration (µg m^{-3})
2012	1.2314 x 10^{-9} µg m^{-3} (or 1.2314 fg m^{-3}) [(a)]
2013	0.8832 x 10^{-9} µg m^{-3} (or 0.8832 fg m^{-3}) [(a)]
2014	0.9963 x 10^{-9} µg m^{-3} (or 0.9963 fg m^{-3}) [(a)]
2015	1.1287 x 10^{-9} µg m^{-3} (or 1.1287 fg m^{-3}) [(a)]
2016	0.7669 x 10^{-9} µg m^{-3} (or 0.7669 fg m^{-3}) [(a)]
Minimum	0.7769 x 10^{-9} µg m^{-3} (or 0.7769 fg m^{-3}) [(a)]
Mean	1.0013 x 10^{-9} µg m^{-3} (or 1.0013 fg m^{-3}) [(a)]
Maximum	1.2314 x 10^{-9} µg m^{-3} (or 1.2314 fg m^{-3}) [(a)]
(a) fg is a femtogram equivalent to 10^{-15} grams.	

The values presented are for each of the years of met data modelled. In order to contribute to the *Worst Case* (hypothetical maximum) scenario the maximum result of the five years modelled has been used in this assessment (*i.e.* the results for 2012 met data).

The exposure methodology determines the fate and transport of PCDD/Fs on a congener specific basis. Therefore, information regarding the PCDD/F annual

mean ground level concentrations on a congener specific basis is required. For the purposes of the exposure assessment, the congener profile for the Base Case operation (*i.e.* emissions are at the emission limit of 0.1 ng (ITEQ)/ Nm^3) plant is presented in **Table A2.3**. This is a standard profile derived by HMIP, one of the predecessors of the Environment Agency. **Table A2.4** presents the congener profile pro-rated for the *Worst Case* emissions scenario.

Table A2.3 Base Case PCDD/F Congener Profile [a]

Congener	Annual Mean Emission Concentration (non I-TEQ ng Nm^{-3}) [b] [c]	I-TEF [b]	Annual Mean Emission Concentration (ng I-TEQ Nm^{-3}) [b]
2,3,7,8-TCDD	0.0031	1.000	0.0031
1,2,3,7,8-PeCDD	0.0245	0.500	0.0123
1,2,3,4,7,8-HxCDD	0.0287	0.100	0.0029
1,2,3,7,8,9-HxCDD	0.0205	0.100	0.0021
1,2,3,6,7,8-HxCDD	0.0258	0.100	0.0026
1,2,3,4,6,7,8-HpCDD	0.1704	0.010	0.0017
OCDD	0.4042	0.001	0.0004
2,3,7,8-TCDF	0.027	0.100	0.0028
2,3,4,7,8-PeCDF	0.0535	0.500	0.0268
1,2,3,7,8-PeCDF	0.0277	0.050	0.0014
1,2,3,4,7,8-HxCDF	0.2179	0.100	0.0218
1,2,3,7,8,9-HxCDF	0.0042	0.100	0.0004
1,2,3,6,7,8-HxCDF	0.0807	0.100	0.0081
2,3,4,6,7,8-HxCDF	0.0871	0.100	0.0087
1,2,3,4,6,7,8-HpCDF	0.4395	0.010	0.0044
1,2,3,4,7,8,9-HpCDF	0.0429	0.010	0.0004
OCDF	0.3566	0.001	0.0004
Total (ng I-TEQ Nm^{-3}) [c]			**0.100**

(a) Congener profile from *Table 7.2a* DOE (1996) **Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes** Contract No. HMIP/CPR2/41/1/181.

(b) I-TEF is the international toxic equivalent factor. 2,3,7,8-TCDD the most toxic of the congeners is allocated a toxicity of 1.0. The toxicities of the other congeners are therefore related to the toxicity of 2,3,7,8-TCDD and by application of the I-TEF to the measured emission concentrations the international toxic equivalent (I-TEQ) can be determined. Hence the emissions of the different congeners stated above is equivalent (in terms of toxicity) to an emission concentration of 0.1 ng m^{-3} of 2,3,7,8-TCDD.

(c) Corrected for: Temperature; 273 K; Pressure; 101.3 kPa (1 atm); dry; 11% v/v O_2

Table A2.4 *Worst Case* PCDD/F Congener Profile

Congener	Annual Mean Emission Concentration (ng (I-TEQ) Nm^{-3})
2,3,7,8-TCDD	0.00520
1,2,3,7,8-PeCDD	0.02055
1,2,3,4,7,8-HxCDD	0.00481
1,2,3,7,8,9-HxCDD	0.00433
1,2,3,6,7,8-HxCDD	0.00344
1,2,3,4,6,7,8-HpCDD	0.00286
OCDD	0.00068
2,3,7,8-TCDF	0.00465
2,3,4,7,8-PeCDF	0.00232
1,2,3,7,8-PeCDF	0.04487
1,2,3,4,7,8-HxCDF	0.03655
1,2,3,7,8,9-HxCDF	0.00070
1,2,3,6,7,8-HxCDF	0.01354
2,3,4,6,7,8-HxCDF	0.01461
1,2,3,4,6,7,8-HpCDF	0.00737
1,2,3,4,7,8,9-HpCDF	0.00072
OCDF	0.00060
Total (ng I-TEQ Nm^{-3})	**0.1678**

A2.4 ESTIMATION OF DOSES

Exposure of an individual to a chemical may occur either by inhalation, oral intake (including food, water and soil), or where the chemical is absorbed through the skin (via water or soil). Of interest is the total dose of the chemical received by the individual through these three routes, and the model has been developed to estimate the dose at the point of entry into the body, often referred to as the external dose.

Exposure to PCDD/Fs is a function of the estimated concentration of the substance in the environmental media with which individuals may come into contact (*i.e.* exposure point concentrations) and the duration of contact. Exposure equations have been developed which combine exposure factors (*eg* exposure duration, frequency and medium intake rate) and exposure point concentrations. The dose equations therefore facilitate estimation of the received dose and are clearly dependent on the route of exposure, *i.e.* ingestion, inhalation and dermal contact. Detailed inputs to and outputs from the HMIP model are given in Attachment 1.

A3. EXPOSURE ASSESSMENT

A3.1 INTRODUCTION

Uptake of PCDD/Fs has been based on the maximum of the five annual mean ground level concentrations predicted to arise as a result of emissions from the proposed facility (*i.e.* the modelling estimated five maximum annual means based on the five met years 2012-2016, the value used was the maximum of these five values) for the *Worst Case* emissions scenario (See *Section A2.3* for further explanation).

Intakes have been calculated for an adult HMEI, assuming that HMEI is exposed for a total of 30 years (constituted of the likely lifetime of the facility (20-25 years) plus a period (5-10 years) to allow for the persistence of the compounds in the environment after the facility has ceased operation). The assessment assumes that the exposure is the same throughout this period of 30 years which is an overestimation as once the facility ceases operation the presence of the compounds resulting from the facility will decrease). However, it should be stressed that the calculations for the HMEI represents a worst case exposure assumption, leading to what might be regarded as an absolute upper limit of PCDD/F intake.

In order to predict the health effects of PCDD/F emissions from the proposed facility, the calculated intakes have been compared to the World Health Organization (WHO) Tolerable Daily Intake (TDI) and the UK COT (see *Section A3.2*).

The calculations presented represent the incremental intake from the operation of the proposed facility, operating at maximum capacity and emitting pollutants at the likely maximum permitted rates for most of the year but at much higher (x100) rates for 60 hours per year (*Worst Case* scenario).

A3.2 ASSESSMENT CRITERIA

A3.2.1 PCDD/Fs

International and national bodies have studied the effects of PCDDs/Fs on animals and humans and proposed a variety of metrics by which to evaluate impact or exposure to these compounds. The science is accepted as complex and the effects of relatively low exposures tend to take decades to show up in epidemiological studies. For this reason a precautionary approach is taken by these bodies and the largest observed effects on humans at the lowest doses are taken into account. Several bodies based their proposals on non-carcinogenic effects such as the development of the reproductive systems of male foetuses via the maternal body burden.

At the latest World Health Organisation (WHO) expert meeting (held in 2001) a revised Provisional Tolerable Monthly Intake (PTMI) of 70 pg I-TEQ/kg (body

weight (bw))/month was proposed(1). This supersedes the previous TDIs proposed.

The USEPA(2) have proposed a no-effect level / reference dose (RfD) of 7 x 10^{-10} mg/kg (body weight)/day.

The UK Committee on Toxicity (COT, 2001)(3) also proposed a TDI of 2 pg I-TEQ/kg(body weight)/day.

The background intake of PCDD/Fs for an adult from the ingestion of food products has been reducing significantly over the past two decades. When the HRA method was devised the Ministry of Agriculture, Fisheries and Foods (MAFF)(4) estimated annual food ingestion doses to be 69 pg I-TEQ/day in 1992 (240 pg I-TEQ/day in 1982).

COT (6) estimated intakes are 1.8 pg I-TEQ/kg(bw)/day for the average adult.

A summary of the various tolerable intakes/background estimates is given in the table below and to enable comparison have been converted to the same units as used by the WHO.

Table A3.1 Summary of Assessment Criteria

Organisation	Metric	Proposed Value	WHO Units[a]
WHO	Provisional Tolerable Monthly Intake	70 pg I-TEQ/ kg/ month	70 pg I-TEQ/ kg(bw)/month
USEPA	Mean daily reference dose (no effect level)	7 x 10^{-10} mg/kg (bw)/day	21 pg I-TEQ/kg (bw)/month
UK COT	Tolerable daily intake	2 pg I-TEQ/kg(bw)/day	60 pg I-TEQ/kg (bw)/month
UK Intake	Per person in 1982	240 pg I-TEQ/day	103 pg I-TEQ/kg (bw)/month
UK Intake	Per person in 1992	69 pg I-TEQ/day	30 pg I-TEQ/kg (bw)/month
UK Intake	Average consumer	1.8 pg I-TEQ/kg(bw)/day	56 pg I-TEQ/kg (bw)/month
(a) Approximate conversion based on 30 day month, 70kg / adult			

A3.3 ESTIMATED DOSES

The total intake of PCDD/Fs as a result of emissions from the proposed facility for the two scenarios assessed, are presented in the following tables.

(1) WHO (2010) **Fact Sheet 225 Dioxins and Their Effects on Human Health**
www.who.int/mediacentre/factsheets/fs225/en/ (accessed March 2013)
(2) USEPA, **Integrated Risk Information System** (IRIS) www.epa.gov/iris/subst/1024.htm (accessed March 2013)
(3) UK COT (2001) http://cot.food.gov.uk/pdfs/cot-diox-full.pdf (accessed March 2013)
(4) http://archive.food.gov.uk/maff/archive/food/infsheet/1995/no71/table1.htm (accessed March 2013)

Table A3.2 Estimated Total PCDD/Fs Intake (pg I-TEQ/kg (body weight)/month) including the Contribution of Inhalation and Ingestion for a HMEI Presented in Units for Comparison to the WHO PTMI

Scenario	Inhalation	Ingestion	Total Intake
Worst Case	0.011	1.392	1.403
WHO PTMI	**-**	**-**	**70**

Table A3.3 Estimated Total PCDD/Fs Intake (pg I-TEQ/kg (body weight)/day) including the Contribution of Inhalation and Ingestion for a HMEI Presented in Units for Comparison to the UK COT TDI

Scenario	Inhalation	Ingestion	Total Intake
Worst Case	0.0004	0.0464	0.0468
UK COT TDI	**-**	**-**	**2**

A3.4 ASSESSMENT OF HEALTH EFFECTS

Even for the extremely conservative exposure assumptions adopted for the HMEI, the predicted incremental intake is estimated to be small for both the *Worst Case* in comparison to the TDI and typical UK dietary intakes.

Table A3.4 shows the estimated intake (see **Table A3.3**) as a percentage of the assessment criteria for the three scenarios considered.

Table A3.4 Estimated Total PCDD/F (Dioxin/Furan) Intake as Percentage of Assessment Criteria (%)

Assessment Criteria	*Worst Case* Scenario
WHO (PTMI)	2.0%
US EPA (RfD)	6.7%
UK COT (TDI)	2.3%
UK Average intake (COT, 2001)	2.6%

The assessment demonstrates that the Hypothetical Maximum Exposed Individual (HMEI) is not subject to a significant additional risk arising from exposures via both inhalation and the ingestion of foods.

A4. POLYCHLORINATED BIPHENYLS (PCBS)

A4.1 BACKGROUND

The HMIP methodology (1996) used for the assessment of human health risks arising from emissions of dioxins and furans does not include pathways or factors to enable PCBs to be included in the assessment.

The EA [(1)] have advised that the US Environmental Protection Agency (EPA) Human Health Risk Assessment Protocol (HHRAP) indicates that the primary intake route for humans for PCBs is via the fish route. The EA advise that if the dietary fish route can be screened out of the assessment (e.g. because the location of the plant is not sited close to an area where fishing is a common source of food) the consideration of PCB intake to humans can also be excluded from the assessment. For this facility this is the case and so modelling of PCBs in the food chain is not required [(2)].

A4.2 EMISSIONS OF PCBS

It is also possible to examine the likely effects of including PCBs in the overall assessment, without having to apply the detailed and complex HHRAP methodology. The EA also provided information relating to emissions of PCBs (personal communication 2014). They state that emissions from 44 measurements taken by operators of 24 municipal waste incinerators (MWIs) between 2008 and 2010 resulted in a mean stack gas PCB concentration of 0.0026 ng [TEQ] Nm^{-3} (range of 0.000056 to 0.0092 ng [TEQ] Nm^{-3}).

Taking the mean value (0.0026 ng [TEQ] Nm^{-3}) as a representative emission rate for PCBs when the plant is operating within its dioxin/furan emission limit of 0.1 ng [TEQ] Nm^{-3} would give an emission rate under the *Worst Case* emission scenario of:

0.0044 ng [TEQ] Nm^{-3} (i.e. 0.0026*0.1678/0.1 ng [TEQ] Nm^{-3}).

This can be added to the assumed emission concentration of dioxins/furans of 0.1678 ng [TEQ] Nm^{-3} (*Worst Case* scenario) giving an emission rate for dioxins/furans plus PCB-like dioxins of:

0.1722 ng [TEQ] Nm^{-3} (i.e. 0.0044+0.1678 ng [TEQ] Nm^{-3}).

A4.3 FOOD CHAIN ASSESSMENT OF PCBS

Assuming that the behaviour of PCBs in the food chain is broadly similar to dioxins and furans (some PCBs are known to be dioxin-like in their behaviour) the results from the dioxin and furan assessment can be pro-rated to give an indication of what the possible impact would be on the HMEI.

(1) Personal communication, Adam Dawson (Environment Agency) and Carl Hawkings (ADM Ltd), 28 April 2014.
(2) Fish ingestion has been included in the assessment of dioxins and furans because the methodology is based on the HMEI (hypothetically maximum exposed individual).

UK COT states that PCBs, if relevant should be included in the tolerable daily intake (COT-TDI), used for the dioxin assessment, of 2 pg [TEQ] kg [BW]$^{-1}$ day^{-1} as a lifetime exposure.

The following table shows percentage the plant would contribute at most to the COT-TDI as a result of emissions of PCDDs/Fs, PCBs and the total.

Table A4.1 Estimated Total PCDD/Fs and PCBs Intake (pg I-TEQ/kg (body weight)/day) including the Contribution of Inhalation and Ingestion for a HMEI Presented as a Percentage of the UK COT TDI

Scenario	PCDD/Fs	PCBs	PCDD/Fs+PCBs
Worst Case	2.3%	0.1%	2.4%

Adding PCBs to the calculation results in a negligible increase and makes the very pessimistic assumption that all fish consumed by the individual (HMEI) comes from water bodies (sea and freshwater) at the point of maximum air quality impact.

A4.4 ASSESSMENT OF AMBIENT CONCENTRATIONS OF PCBS

The air modelling estimated that the *Worst Case s*cenario maximum ground level concentration, (GLC) of dioxins/furans ranged (depending on the year of meteorological data used in the modelling) between 0.7669 and 1.2314 fg m^{-3} (mean = 1.0013 fg m^{-3}).

Based on the likely emission rate of dioxin-like PCBs this GLC (for dioxins/furans) can be prorated to estimate the maximum GLC of PCBs, i.e.: 0.0199-0.0320 fg m^{-3} (mean = 0.0260 fg m^{-3}).

This is insignificant compared to the long term EAL of 200,000,000 fg m^{-3} (stated as 0.2 µg m^{-3} in H1 Guidance Annex F(1) but converted to fg for ease of comparison).

(3) www.gov.uk/government/uploads/system/uploads/attachment_data/file/298239/geho0410bsil-e-e.pdf

A5. HEALTH RISK ASSESSMENT - SUMMARY AND CONCLUSIONS

The possible impacts on human health arising from PCDD/F emitted from the proposed facility have been assessed under the *Worst Case* scenario. The proposed facility is assumed to be continually operating at maximum permitted emission limits for most of the year and at one hundred (100) times these limits for 60 (*Worst Case* scenario) hours per year. These predicted effects are also for the location at which **maximum** ground level concentrations arising from the facility's emissions occur and therefore estimates of the magnitude or risk of any effects at other locations will be lower than these. Further, the estimates apply to a Hypothetical Maximum Exposed Individual (HMEI) who is exposed to dioxins/furans for 30 years at this location and who eats food only from produce grown locally.

The study also assessed exposures via the ***ingestion*** of food. The possible impact of dioxins is discussed by comparison with a range of tolerability criteria. The assessment shows that for the HMEI the intake would equate to 2.0%-6.7% of the tolerability criteria (the range derives from using the criteria from the three organisations). The intake would also equate to 2.6% (*Worst Case* scenario) of the current daily intake of an average adult individual.

The risk assessment methodology used in this assessment has been structured so as to create worst case estimates of risk. A number of features in the methodology give rise to this degree of conservatism, including:

- The proposed facility continually operates at the maximum permissible air emissions limits for most of the year and 100 times these limits for 60 hours (*Worst Case* scenario). In practice this is unlikely to be the case and actual emissions would be lower than those for which the assessment was conducted.

- Doses of contaminants are calculated for a hypothetical maximum exposed individual (HMEI) who lives at the point of maximum impact and consumes all of his/her animal, fish, dairy, vegetable and cereal products from this point.

- Modelling parameters are such that they will tend to over-estimate the levels of substances in foods.

The methodology for dioxins and furans has been adapted to estimate the likely risk that may arise from emissions of polychlorinated biphenyls (PCBs) emitted from the facility.

The assessment demonstrates that the Hypothetical Maximum Exposed Individual (HMEI) is not subject to a significant additional risk arising from exposures to emissions of dioxins, furans or PCBs via both inhalation and the ingestion of foods.

Attachment 1

HMIP Dioxins/Furans Model
Detailed Inputs and Outputs: *Worst Case* Emissions Scenario

Typical Exposure

Northacre Renewable Energy (P1418) - Worst Case Scenario

Population Subgroup: Adult MEI (Increment)

Constituent	INH Intake via Inhalation	DERM Intake via Dermal Contact	INGsoil Intake via Soil Ingestion	INGwater Intake via Water Ingestion	INGplant Intake via Plant Ingestion	INGanimal Intake via Meat/meat prod	INGmilk Intake via eggs/ Milk/dairy prod	INGtotal Total Intake via Ingestion	INTAKEtotal Total Intake via all pathways
TEQ (ng/kg-day)	3.52E-07	0.00E+00	0.00E+00	0.00E+00	1.52E-05	3.13E-05			
TEQ (ng/day)	2.46E-05	0.00E+00	0.00E+00	0.00E+00	1.06E-03	2.19E-03			
TEQ (pg/day)	2.46E-02	0.00E+00	0.00E+00	0.00E+00	1.06E+00	1.62E+00	*5.66E-01*	3.25E+00	3.27E+00

Media concentrations	
TEQ Total airborne concentration (µg/m3)	1.23E-09
TEQ Soil Concentration (ng/kg)	7.40E-02
TEQ Waterbody concentration (ng/L)	1.10E-06

Inhalation pathway-specific parameters	Indoors	Outdoors
INHair (inhalation rate, m3/hr)	0.000	0.833
ET (exposure time, hr/day)	0	24

Dermal pathway-specific parameters	
Adherence factor (mg/cm2-event)	0
ABS (Absorption factor)*	0.03
Exposed surface area (cm2)	5000

Soil ingestion pathway-specific parameters	Mean Annual Rainfall (mm/year)
INGsoil (mg/day)	0
BIO (Bioavaillability)	1
Exposure frequency for soil ingestion (day/yr)	365

Water ingestion pathway-specific parameters	
INGwater (L/day)	0

General Exposure Parameters	
Exposure frequency (day/yr)	365
Exposure duration (yr)	30
Body weight (kg)	70
Averaging time - carcinogenic (day)	10,950
Ratio of MEI to resident air concentration	1.00
Ratio of MEI to water air concentration	1.00

Plant ingestion pathway-specific parameters

	Cp (Consumption rate of plants, g FW/kg-day)	P (TEQ plant conc., ng/kg FW)	Fraction plants locally grown	Intake pg/day
Potatoes	1.580	3.53E-05	1.00	3.90E-03
Leafy Veg	3.000	6.01E-04	1.00	1.26E-01
Legumes	0.260	7.91E-04	1.00	1.44E-02
Root Vegetables	0.380	3.21E-05	1.00	8.54E-04
Fruit	1.830	9.33E-04	1.00	1.19E-01
Fruit Vegetables	1.070	9.62E-04	1.00	7.21E-02
Cereals products	3.300	3.14E-03	1.00	7.24E-01
Total Plants				**1.06E+00**

Animal tissue ingestion pathway-specific parameters

	Ca (Consumption rate of an. tissue, g FW/kg-day)	A (TEQ animal tissue concen., ng/kg FW)	Fraction animals locally raised	Intake pg/day
Beef	0.530	2.16E-03	1.00	8.03E-02
Offal	0.000	2.16E-02	1.00	0.00E+00
Lamb	0.120	6.58E-03	1.00	5.52E-02
Pork	0.640	1.23E-03	1.00	5.51E-02
Poultry	0.530	8.36E-04	1.00	3.10E-02
Milk	3.400	1.09E-03	1.00	2.60E-01
Eggs	0.280	8.88E-04	1.00	1.74E-02
Dairy Products	0.700	5.89E-03	1.00	2.89E-01
Meat Products	0.000	2.45E-03	1.00	0.00E+00
Fats, Oils, Cereals	1.000	1.86E-02	1.00	1.30E+00
Fish	1.100	1.25E-03	1.00	9.61E-02
Total Animals				**2.19E+00**
			Total (Animals + Plants)	**3.25E+00**