

WASTE RECYCLING GROUP LTD  
EASTCROFT ENERGY FROM WASTE  
PLANT THIRD LINE EXTENSION  
AIR QUALITY ASSESSMENT

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[appendix 11-1 air quality assessment](#)

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## 1 INTRODUCTION

### 1.1 Background

Waste Recycling Group Ltd operates a two stream energy from waste plant, processing municipal waste, at their Eastcroft site in Nottingham. This air quality assessment has been carried out to accompany a planning application for the installation of a third stream. There is also a clinical waste incinerator on the site, operated by White Rose Environmental Ltd.

The only source of continuous emissions to atmosphere is the main chimney, containing two flues. Both of the existing municipal waste lines and the clinical waste line discharge into one of the two flues, with the second flue being reserved for the future third line.

In addition, the impact of traffic associated with the plant on air quality has also been assessed.

### 1.2 Methodology

The assessment contains the following sections:

- A statement of the current air quality standards, objectives and guidelines which apply to the pollutants which will be released from the plant.
- An assessment of the current air quality in the vicinity of the site.
- An assessment of the traffic emissions.
- A description of the methodology used in the air dispersion modelling, including assumptions and data used.
- A description of the results of the air dispersion modelling, including dispersion diagrams.
- Conclusions

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## 2 AIR QUALITY OBJECTIVES AND GUIDELINES

In the UK, air quality standards and objectives for the major pollutants are described in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2000 (The National Air Quality Strategy, or NAQS)<sup>1</sup>. An Addendum to NAQS was published in 2003, leading to some tighter air quality objectives. The Government published a consultation on the NAQS in April 2006<sup>2</sup>, in which there were no recommendations for tightening air quality objectives for the protection of human health.

The NAQS makes a clear distinction between “standards” and “objectives”. Paragraphs 107 to 109 are reprinted below

*107. For the purposes of the Strategy:*

- *standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups; and*
- *objectives are policy targets generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences, within a specified timescale.*

*108. We have set standards for minimum or zero risk levels of pollutants purely with regard to scientific and medical evidence on the effects on health or, in the appropriate context, on the wider environment. However, when we set objectives, we also have to consider economic efficiency, practicability, technical feasibility and timescales.*

*109. It is the definition of objectives which drives air quality policy and, in particular, the implementation of Part IV of the Environment Act 1995....*

The air quality objectives are implemented in a series of Statutory Instruments:

- The Air Quality (England) Regulations 2000 (SI 2000/928), as amended by The Air Quality (England) (Amendment) Regulations 2002 (SI 2002/3043).
- The Air Quality Standards Regulations 2007 (SI 2007/64)

For other pollutants, the Environment Agency (EA) set Environmental Assessment Levels (EALs) in Appendix D to Technical Guidance Note H1: Environmental Assessment and Appraisal of BAT (“TGN H1”). The long term and short term EALs from this document have been used when the NAQS does not contain relevant objectives.

### 2.1 Nitrogen Dioxide

All combustion processes produce nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), known by the general term of NO<sub>x</sub>. In general, the majority of the NO<sub>x</sub> released is in the form of NO, which then reacts with ozone in the atmosphere to form NO<sub>2</sub>. Of the two compounds, nitrogen dioxide is associated with adverse effects on human health, principally relating to respiratory illness.

The major sources of NO<sub>x</sub> in the UK are road transport and power stations. According to the most recent annual report from the National Atmospheric Emissions Inventory (NAEI), road transport accounted for 46% of UK emissions, with power stations accounting for a further 21%. High levels of NO<sub>x</sub> in urban areas are almost always associated with high traffic densities.

<sup>1</sup> *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Working Together for Clean Air. January 2000. Cm 4548, SE 2000/3 and NIA 7. The Stationery Office Ltd.*

<sup>2</sup> *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. A Consultation Document on options for further improvements in air quality. April 2006. DEFRA*

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The NAQS includes two objectives to be achieved by 31 December 2005:

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

## 2.2 Sulphur Dioxide

Sulphur dioxide is predominantly released by the combustion of fuels containing sulphur. 66% of UK emissions are associated with power stations, with much of the remainder associated with other combustion processes. Emissions of  $\text{SO}_2$  have reduced by 75% since 1970, due to the reduction in coal combustion and the installation of flue gas desulphurisation plants on a number of large coal-fired power stations.

Sulphur dioxide is an irritant when inhaled, with people with asthma being particularly affected. The NAQS contains three objectives for the control of  $\text{SO}_2$ :

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

## 2.3 Particulate matter

Concerns over the health impact of solid matter suspended in the atmosphere tend to focus on particles with a diameter of less than  $10 \mu\text{m}$ , known as  $\text{PM}_{10\text{s}}$ . These particles have the ability to enter and remain in the lungs. Various epidemiological studies have shown increases in mortality associated with high levels of  $\text{PM}_{10\text{s}}$ , although the underlying mechanism for this effect is not yet understood.

Significant sources of  $\text{PM}_{10\text{s}}$  are road transport (25%), quarrying (14%), power stations (14%) and other industrial combustion (10%). The NAQS includes two objectives for  $\text{PM}_{10\text{s}}$  to be achieved by the end of 2004 and two objectives to be achieved by 2010:

- An annual limit of  $40 \mu\text{g}/\text{m}^3$ , to be achieved by 2004.
- An annual limit of  $20 \mu\text{g}/\text{m}^3$ , to be achieved by 2010.
- A daily limit of  $50 \mu\text{g}/\text{m}^3$ , not to be exceeded more than 35 times a year (the 90.4<sup>th</sup> percentile) to be achieved by 2004.
- A daily limit of  $50 \mu\text{g}/\text{m}^3$ , not to be exceeded more than 7 times a year (the 98.1<sup>st</sup> percentile) to be achieved by 2010.

The 2010 objectives have not yet been included in legislation.

At both a National and European level, air quality standards for different fractions of particulate matter are being considered, with the main focus being on  $\text{PM}_{2.5\text{s}}$ . No conclusions have yet been reached on this issue. A discussion on the relative contribution of incineration plants to  $\text{PM}_{2.5\text{s}}$  emissions can be found in section 5.6.3.

## 2.4 Carbon Monoxide

Carbon Monoxide is produced by the incomplete combustion of fuels containing carbon. By far the most significant source is road transport, which produces 73% of the UK's emissions. Carbon monoxide can interfere with the processes that transport oxygen around the body, which can prove fatal at very high levels.

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Concentrations in the UK are well below levels at which health effects can occur. The NAQS includes the following objectives for the control of carbon monoxide:

- A limit for the 8-hour running mean of 11.6 mg/m<sup>3</sup>, to be achieved by 31 December 2003.
- A limit for the 8-hour running mean of 10 mg/m<sup>3</sup>, to be achieved by 1 January 2005.

## 2.5 Hydrogen Chloride

There are no standards or objectives for hydrogen chloride, but the Environment Agency regulates the emissions of HCl. Technical Guidance Note H1 defines the short-term EAL as 800 µg/m<sup>3</sup> and the long-term EAL as 20 µg/m<sup>3</sup>. EPAQS<sup>3</sup> have recommended a short term EAL of 750 µg/m<sup>3</sup>.

## 2.6 Hydrogen Fluoride

There are no standards or objectives for hydrogen fluoride, but the Environment Agency regulates the emissions of HF. Technical Guidance Note H1 defines the short-term EAL as 250 µg/m<sup>3</sup> but there is no long-term EAL. EPAQS have recommended a short term EAL of 160 µg/m<sup>3</sup>.

## 2.7 Lead

Lead is the only metal included in the NAQS objectives. Lead can have many health effects, including effects on the synthesis of haemoglobin, the nervous system and the kidneys. Emissions of lead in the UK declined by 86% between 1970 and 1998, due principally to the virtual elimination of leaded petrol. In 1998, road transport still accounted for 57% of lead emissions, but this is likely to be much reduced now.

The NAQS included objectives to limit the annual mean to 0.5 µg/m<sup>3</sup> by the end of 2004 and to 0.25 µg/m<sup>3</sup> by the end of 2008.

## 2.8 Other Metals

Heavy metals can have various health impacts, and some are carcinogenic. In most cases, the principal sources of releases in the UK are metal industries and coal combustion.

Emission limits will be set for a number of heavy metals which do not have air quality standards associated with them. The EALs for these metals are summarised in [Table 2.1](#) below.

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**Table 2.1 Environmental Assessment Levels (EALs) for Metals**

Metal	Daughter Directive Target Level (µg/m <sup>3</sup> )	Environmental Assessment Levels	
		Long-term (µg/m <sup>3</sup> )	Short-term (µg/m <sup>3</sup> )
Arsenic	0.006	0.2	15
Antimony	-	5	150
Cadmium	0.005	0.005	1.5
Chromium (II & III)	-	5	150
Chromium (VI)	-	0.1	3
Cobalt	-	0.2	6

<sup>3</sup> "Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects", Expert Panel on Air Quality Standards (EPQAS), February 2006

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Metal	Daughter Directive Target Level ( $\mu\text{g}/\text{m}^3$ )	Environmental Assessment Levels	
		Long-term ( $\mu\text{g}/\text{m}^3$ )	Short-term ( $\mu\text{g}/\text{m}^3$ )
Copper	-	10	200
Lead	-	0.25	-
Manganese	-	1	1500
Mercury	-	0.25	7.5
Nickel	0.020	1	30
Thallium	-	1	30
Vanadium	-	5	1

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

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

And paragraph (6) states:

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

The application of the target values would not have an effect on the design or operation of the plant. The plant will be designed in accordance with BAT and will include cost effective methods for the abatement of arsenic, cadmium and nickel, including the injection of activated carbon and a fabric filter. Therefore, although the target values have been considered in the assessment, the focus has remained on the EALs.

## 2.9 Volatile Organic Compounds (VOCs)

A variety of VOCs could be released from the plant, of which benzene and 1,3-butadiene are included in the National Air Quality Strategy and monitored at various sites around the UK. The NAQS includes two objectives to be achieved by 2003 and the addendum introduced one objective to be achieved by 2010:

- 1,3-butadiene 2.25  $\mu\text{g}/\text{m}^3$  as a running annual mean, to be achieved by the end of 2003
- Benzene 16.25  $\mu\text{g}/\text{m}^3$  as a running annual mean, to be achieved by the end of 2003
- Benzene 5  $\mu\text{g}/\text{m}^3$  as an annual mean, to be achieved by the end of 2010

The 2010 objective has not yet been included in legislation.

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## 2.10 Polycyclic Aromatic Hydrocarbons

Low levels of Polycyclic Aromatic Hydrocarbons (PAHs) may be released by the plant. PAHs are members of a large group of organic compounds widely distributed in the atmosphere. The best known PAH is benzo[a]pyrene (B[a]P). The addendum to the NAQS included an objective to limit the annual mean to 0.25 ng/m<sup>3</sup> by the end of 2010. This objective has not yet been included in legislation.

The fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes a target value for benzo(a)pyrene of 1 ng/m<sup>3</sup> as an annual mean. Since the UK provision AQO is lower than this target value, the UK provisional AQO has been used in this assessment.

## 2.11 Dioxins and Furans

Dioxins and furans are a group of organic compounds with similar structures, which are formed as a result of combustion in the presence of chlorine. Principal sources include steel production, power generation, coal combustion and uncontrolled combustion, such as bonfires. Waste incineration used to be a major source of dioxins, but the Municipal Waste Incineration Directive and UK legislation imposed strict limits on dioxin emissions in 1995, with the result that current emissions from energy from waste plants are less than 0.5% of the emissions in 1994. The new Waste Incineration Directive imposes even lower limits, reducing the limit to one tenth of the current permitted level.

One dioxin, 2,3,7,8-TCDD, is a definite carcinogen, and a number of other dioxins and furans are considered to be possible carcinogens. There are no air quality guidelines for dioxins, but the World Health Organisation (WHO) recommends a tolerable daily intake (TDI) for dioxins of 1-4 pg I-TEQ per kg bodyweight per day. It should be noted that the daily intake of virtually all people in the UK currently exceeds the lower value.

Dioxins are not normally compared with set EALs, but the probable ingestion rates of dioxins by different groups of people is considered as part of the health risk assessment.

## 2.12 Summary

The table below summarises the air quality objectives and guidelines used in the air quality assessment. The sources for each of the values can be found in the preceding sections. Where more than one objective exists for a given averaging period for a given pollutant, the most stringent objective has been used.

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Table 2.2 Air Quality Objectives (AQO) and Environmental Assessment Levels (EALs)

Pollutant	Limit Value ( $\mu\text{g}/\text{m}^3$ )	Averaging Period	Frequency of exceedence
Nitrogen Dioxide	200	1 hour	18 times per year (99.79 <sup>th</sup> %ile)
	40	Annual	-
Sulphur Dioxide	266	15 minutes	35 times per year (99.9 <sup>th</sup> %ile)
	350	1 hour	24 times per year (99.73 <sup>rd</sup> %ile)
	125	24 hours	3 times per year (99.18 <sup>th</sup> %ile)
Particulate matter (PM <sub>10</sub> )	50	24 hours	7 times per year (98.1 <sup>st</sup> %ile)
	20	Annual	-
Carbon Monoxide	10,000	8 hours, running	-
Hydrogen chloride	750	1 hour	-
	20	Annual	-
Hydrogen fluoride	180	1 hour	-
Lead	0.25	Annual	-
Benzene	5	Annual	-
1,3-butadiene	2.25	Annual, running	-
PAHs	0.25 ng/m <sup>3</sup>	Annual	-

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### 3 BACKGROUND AIR QUALITY

The air quality in the area around the plant has been reviewed by identifying the monitoring stations around the site. These are generally operated by the local authority.

#### 3.1 Automatic Monitoring Stations

There is an automatic monitoring station in Nottingham, operated by DEFRA and located about 1.1 km north-west of the site.

The results from this monitoring station for 2004-2006 are summarised in the table below.

**Table 3.1 Automatic Monitoring Results, Nottingham**

Pollutant	Quantity (in $\mu\text{g}/\text{m}^3$ )	Nottingham City			EAL
		2004	2005	2006	
Nitrogen Dioxide	Annual Average	35.1	32.6	33.6	40
	Hourly peak	138	149	136	-
	99.8 <sup>th</sup> %ile of hourly means	94	113	107	200
Carbon monoxide	Annual Average	470	390	250	-
	Peak 8-hour mean	2,160	3,140	2,190	10,000
Sulphur dioxide	Annual Average	16.7	10.5	2.5	-
	99.73 <sup>rd</sup> %ile of hourly means	59	37.3	24.0	350
	15 minute peak	178	69	154	-
	99.9 <sup>th</sup> %ile of 15 minute means	77	51	48	266
Particulate matter	Annual Average	22.5	23.1	23.9	40 (by 2004) 20 (by 2010)
	Daily peak	56.6	83.7	69.3	
	90.41 <sup>st</sup> %ile of daily means	36.2	34.8	35.9	50 (by 2004)
	98.1 <sup>st</sup> %ile of daily means	48.3	44.9	51.3	50 (by 2010)

It can be seen that none of the current or future air quality objectives for nitrogen dioxide, carbon monoxide and sulphur dioxide were breached in Nottingham in 2004, 2005 or 2006. The short term future air quality objective for particulate matter was slightly breached in 2006.

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### 3.2 National Diffusion Tube

There are three non-automatic diffusion tube sites in Nottingham, measuring nitrogen dioxide. These measured monthly averages in 2005 and 2006.

**Table 3.2 Diffusion Tube Monitoring Results, Nottingham**

Site	Location (relative to stack)	Nitrogen Dioxide monthly averages ( $\mu\text{g}/\text{m}^3$ )	
		Maximum	Average
Nottingham 1N	Roadside, 2.8 km NW	45	32.8
Nottingham 3N	Background, 3.7 km NE	40	27.6
Nottingham 4N	Background, 3.3 km NE	20	10.9

*“Roadside” sites are 1-5 metres away from a major road and so show the high levels in the near vicinity of heavy traffic.*

*“Background” sites are at least 50 metres away from a major road and so give a better representation of the levels experienced by local people.*

It can be seen that the air quality objective for the annual average concentration of nitrogen dioxide,  $40 \mu\text{g}/\text{m}^3$ , was recorded as being achieved at all three of the sites.

### 3.3 Other Pollutants

#### 3.3.1 Volatile Organic Compounds

The concentration of benzene and 1,3-butadiene are measured at a number of locations across the UK, including a site in Nottingham for benzene. The results for 2004-2006 for those sites in the North of England are shown below.

**Table 3.3 VOC Monitoring Results, North of England ( $\mu\text{g}/\text{m}^3$ )**

Site	Benzene			1,3-butadiene		
	2004	2005	2006	2004	2005	2006
Barnsley Gawber	1.35	4.50	0.78			
Birmingham Roadside	3.19	3.04	2.17	0.20	0.15	0.07
Coventry Memorial Park	1.23	0.93	0.7			
Hull Freetown	1.26	1.36	1.22			
Leamington Spa	1.35	1.26	0.91			
Leeds Centre	1.42	1.27	1.15	0.08	0.05	0.05
Leeds Roadside	3.13	2.71	1.94	0.19	0.11	0.17
Leicester Centre	1.47	1.21	1.00			
Liverpool Speke	1.55	1.40	1.21			
Manchester Piccadilly	1.47	1.34	1.02			
Middlesbrough	1.91	3.03	1.60	0.07	0.04	0.09

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Site	Benzene			1,3-butadiene		
	2004	2005	2006	2004	2005	2006
Newcastle Centre	1.13	0.96	0.84			
Northampton	1.14	0.98	0.83			
Norwich Centre	1.35	1.24	0.97			
Nottingham Centre	1.64	1.55	1.08			
Sheffield Centre	1.48	1.57	n/a			
Stockton-on-Tees Yarm	3.24	2.70	2.00			
Stoke-on-Trent Centre	1.55	1.75	1.32			
Wigan Centre	1.82	1.05	0.81			
<b>Maximum</b>	<b>3.24</b>	<b>4.50</b>	<b>2.17</b>	<b>0.20</b>	<b>0.15</b>	<b>0.17</b>
<b>Air Quality Objective</b>		<b>5</b>			<b>2.25</b>	

It can be seen that none of the air quality objectives are exceeded at any of the monitoring sites for both benzene and 1,3-butadiene.

- The highest benzene reading was measured in 2005 at Barnsley, and was 90% of the air quality objective. The concentration in Nottingham was well below this level
- The highest reading of 1,3-butadiene was measured 2004 at the Birmingham Roadside site, and was 8.9% of the air quality objective.

### 3.3.2 Metals

There are no monitoring sites for heavy metals in Nottingham – the only national multi-element urban sites in England are in London (three sites), Leeds, Manchester and Newcastle. The monitoring results for 2005 and 2006 for these sites are shown below.

**Table 3.4 Heavy Metal Monitoring Results, National**

Metal	EAL	Central London		London Brent		London Cromwell Road	
		2005	2006	2005	2006	2005	2006
(concs in ng/m <sup>3</sup> )							
Arsenic	200	1.26	0.95	1.41	1.08	1.14	0.98
Cadmium	5	0.37	0.28	0.55	0.22	0.36	0.24
Chromium	5000	2.37	3.16	4.32	4.17	5.53	5.27
Copper	10,000	22.4	18.74	24.12	25.14	41.8	47.61
Manganese	1000	6.4	6.30	7.56	8.39	10.1	11.31
Mercury	250	0.16	0.20	0.62	0.29	0.81	0.36
Nickel	1000	3.47	2.07	3.45	2.18	4.46	2.14
Vanadium	5000	3.69	4.15	4.19	3.64	6.34	4.65
Lead	250	15.9	14.1	23.5	14.7	14.6	17.3

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Metal (concs in ng/m <sup>3</sup> )	EAL	Leeds		Manchester		Newcastle	
		2005	2006	2005	2006	2005	2006
Arsenic	200	1.15	0.89	1.01	0.80	0.75	0.94
Cadmium	5	0.38	0.25	0.31	0.28	0.23	0.29
Chromium	5000	3.29	6.13	5.30	5.73	1.87	3.46
Copper	10,000	11.46	10.21	52.99	43.18	8.89	9.09
Manganese	1000	8.28	9.30	11.66	11.23	4.41	7.31
Mercury	250	0.90	0.26	0.34	0.46	0.92	0.51
Nickel	1000	2.61	1.77	3.86	2.41	2.75	2.33
Vanadium	5000	3.72	2.00	3.01	2.22	2.43	3.11
Lead	250	18.2	16.9	12.6	10.3	9.1	12.2

It can be seen that none of the EALs are close to being breached at any of the recording sites. The concentrations are generally around 1% of the EAL or lower, with the exception of lead and cadmium for which the concentrations are around 10% of the EAL.

The target values for arsenic (6 ng/m<sup>3</sup>) and nickel (20 ng/m<sup>3</sup>) under the Fourth Daughter Directive are also not breached at any of the recording sites.

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### 3.3.3 Dioxins and Furans

Dioxins and Furans are monitored on a quarterly basis at a number of sites in the UK, although not near Nottingham. The latest data available is for 2005, although some sites only have data available until 2001. The monitoring data for 1996-2001 and 2002-2005 is shown in the table below.

**Table 3.5 Dioxin Monitoring Results, National**

Site	1996-2001		2002-2005	
	Average Concentration (fg TEQ/m <sup>3</sup> )	Maximum Quarterly Concentration (fg TEQ/m <sup>3</sup> )	Average Concentration (fg TEQ/m <sup>3</sup> )	Maximum Quarterly Concentration (fg TEQ/m <sup>3</sup> )
Hazelrigg	10.1	33.4	8.9	17.7
High Muffles	5.4	11.2	5.4	11.8
London 1	26.3	98.8	-	-
London 2a	23.3	41.8	18.8	27.7
Manchester	68	169.2	63.6	134.3
Middlesborough	38.3	114.7	33.4	58.0
Stoke Ferry	14.6	30.6	-	-
<b>All Sites</b>	<b>26.6</b>	<b>169.2</b>	<b>26.0</b>	<b>134.3</b>
<b>Rural Sites</b>	<b>10.1</b>	<b>33.4</b>	<b>7.2</b>	<b>7.7</b>
<b>Urban Sites</b>	<b>39.0</b>	<b>106.1</b>	<b>38.6</b>	<b>134.3</b>

The variation in concentration between sites is due to the fact that some sites (Hazelrigg, High Muffles, Stoke Ferry) are in rural areas while the other sites are in cities. There are no air quality standards for dioxins.

### 3.3.4 Polycyclic Aromatic Hydrocarbons (PAHs)

The concentration of PAHs is measured at a number of sites across England, although none of the sites are close to Nottingham. For the purposes of this assessment, the most important PAH is benzo(a)pyrene, as this is the PAH for which an air quality objective is set. The highest annual average concentrations of benzo(a)pyrene at urban sites in England in 2003-2006 were as follows:

- Birmingham 0.12 ng/m<sup>3</sup>
- Brent 0.14 ng/m<sup>3</sup>
- Bromley 0.21 ng/m<sup>3</sup>
- Leeds 0.21 ng/m<sup>3</sup>
- London 0.12 ng/m<sup>3</sup>
- Manchester 0.24 ng/m<sup>3</sup>
- Middlesborough 0.24 ng/m<sup>3</sup>
- Newcastle 0.16 ng/m<sup>3</sup>

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- Speke 0.14 ng/m<sup>3</sup>
- These are all below the air quality objective of 0.25 ng/m<sup>3</sup>.

### 3.4 Summary of Background Air Quality

For the purposes of the air quality modelling, the following long term background concentrations will be used.

- 1) For those pollutants measured by the automatic monitoring stations, the highest recorded annual average concentration will be used, i.e.
  - a) **Nitrogen Dioxide** 35.1 µg/m<sup>3</sup>
  - b) **Sulphur dioxide** 16.7 µg/m<sup>3</sup>
  - c) **Particulate matter** 23.9 µg/m<sup>3</sup>
  - d) **Carbon Monoxide** 470 µg/m<sup>3</sup>
- 2) For VOCs, the highest annual average concentrations in Nottingham will be used for benzene and the highest annual average concentration in Birmingham will be used for 1,3-butadiene, i.e.
  - a) **Benzene** 1.64 µg/m<sup>3</sup>
  - b) **1,3-butadiene** 0.20 µg/m<sup>3</sup>
- 3) For metals, the highest concentration recorded nationally will be used, as shown in [Table 3.4](#).

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4 IMPACT OF TRAFFIC

4.1 Traffic Flows

The traffic assessment has identified the following traffic flows associated with the plant:

- 100 HGVs per weekday, increasing to 167 HGVs with the extension. Since all lorries go in and out of the plant, this gives a total of 200 HGV movements per day at present, increasing to 334 HGV movements per day with the extension.
- There will also be a total flow of 40 light vehicles per day, or 80 vehicle movements. This will barely change with the extension.

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These traffic flows are very small in the context of local traffic flows. The total traffic flow along the A6011 was measured as around 16,654 vehicle movements, so that the extended plant would contribute around 2.5% of this flow.

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4.2 Method Used

The assessment was carried out using the screening method outlined in Section 3 of Volume 11 of the Design Manual for Roads and Bridges (DMRB), produced by the Highways Agency. A software tool is available to implement this method. The following assumptions were made:

- Emission factors for typical vehicles in 2011 were selected. Traffic emissions are expected to reduce over time, so the selection of 2011 will be a worst case scenario.
- Two receptors were considered, at 4 metres and 10 metres from the centre of the road.
- The average vehicle speed was taken as 30 km/h.
- The following traffic flows were used:

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	Cars	LGVs	Buses	Rigid HGVs	Total
Baseline	12,819	2,703	25	1,107	16,654
Current plant	60	20	0	200	280
Extension	0	0	0	134	134

- As explained in the transport assessment, the HGV movements associated with the plant were distributed as follows:
  - 59% of inward movements arriving from the A6011 Cattle Market Road (E), with the remaining 41% arriving from the A6011 County Road (W)
  - 43% of outward movements travelling along the A6011 Cattle Market Road (E), with the remaining 57% travelling along the A6011 County Road (W)

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This means that the HGV movements are split, with 102 of the current movements on Cattle Market Road and 98 on the County Road. This split has also been applied to the HGV movements associated with the extension.

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4.3 Results

The results of the assessment are shown in [Table 4.1](#). All figures are annual average ground level concentrations [along the Cattle Market Road \(A6011 E\)](#).

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Table 4.1 Results of Assessment of Traffic Emissions

Receptor Pollutant		4 metres from road		10 metres from road	
		Nitrogen dioxide	Particulate matter	Nitrogen dioxide	Particulate matter
Contribution of baseline traffic	µg/m <sup>3</sup>	<u>8.14</u>	<u>3.12</u>	<u>7.43</u>	<u>2.81</u>
Contribution of current plant	µg/m <sup>3</sup>	<u>0.37</u>	<u>0.13</u>	<u>0.25</u>	<u>0.11</u>
Contribution of extension	µg/m <sup>3</sup>	<u>0.24</u>	<u>0.08</u>	<u>0.23</u>	<u>0.08</u>
Total predicted concentration	µg/m <sup>3</sup>	<u>8.75</u>	<u>3.33</u>	<u>8.07</u>	<u>3.00</u>
Air Quality Objective	µg/m <sup>3</sup>	<u>40</u>	<u>40</u>	<u>40</u>	<u>40</u>
Total plant contribution as percentage of AQO		<u>1.5%</u>	<u>0.5%</u>	<u>1.2%</u>	<u>0.5%</u>
<u>Extended</u> plant contribution as percentage of <u>AQO</u>		<u>0.6%</u>	<u>0.2%</u>	<u>5.7%</u>	<u>0.2%</u>

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The results show that the traffic from the plant makes a noticeable contribution to [nitrogen dioxide concentrations](#) in the vicinity of the A6011. This is because the plant is associated with a high proportion of the HGVs which travel along the A6011. [However, the additional traffic associated with the extension leads to an insignificant contribution to concentrations of nitrogen dioxide and particulate matter.](#)

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[Traffic emissions are not predicted to lead to any breaches of air quality standards. The background concentrations \(discussed in section 3\) measured by the automatic monitoring station in the centre of Nottingham already include the impact of existing traffic. If the contribution of the current plant and the extension is added to the background concentrations, the results are as follows:](#)

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- For nitrogen dioxide, the background concentration is 35.1 µg/m<sup>3</sup> and the traffic contribution is 0.61 µg/m<sup>3</sup>, giving a total predicted concentration of 35.71 µg/m<sup>3</sup>. This is less than the air quality objective of 40 µg/m<sup>3</sup>.
- For particulates, the background concentration is 23.9 µg/m<sup>3</sup> and the traffic contribution is 0.48 µg/m<sup>3</sup>, giving a total predicted concentration of 24.38 µg/m<sup>3</sup>. This is less than the air quality objective of 40 µg/m<sup>3</sup>.

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4.4 Sensitivity

[Since the routing of the HGVs associated with the extension is uncertain, a worst case sensitivity assessment was carried out, assuming that all of the HGVs associated with the extension travels down the same section of the A6011. The results were as follows:](#)

- [The contribution of extension traffic to nitrogen dioxide concentrations at a distance of 4 metres from road increased from 0.24 µg/m<sup>3</sup> to 0.43 µg/m<sup>3</sup>, which is slightly more than 1% of the air quality objective. The total predicted concentration increased from 35.71 µg/m<sup>3</sup> to 35.90 µg/m<sup>3</sup>, so no breach is predicted.](#)

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- The contribution of extension traffic to particulate concentrations at a distance of 4 metres from road increased from 0.08  $\mu\text{g}/\text{m}^3$  to 0.14  $\mu\text{g}/\text{m}^3$ , which is less than 1% of the air quality objective. The total predicted concentration increased from 24.38  $\mu\text{g}/\text{m}^3$  to 24.44  $\mu\text{g}/\text{m}^3$ , so no breach is predicted.

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## 5 IMPACT OF STACK EMISSIONS

The air quality modelling was carried out for a number of cases. The base case, which was anticipated to give the highest concentrations, was for all three lines. The results of other cases, using various combinations of one and two lines, are also presented in this section.

### 5.1 Stack Height Calculation

The first stage of the assessment of the impact on air quality is to select a suitable stack height for the plant. This was done using the method detailed in Technical Guidance Note (Dispersion) D1<sup>4</sup>. The calculation is attached in Annex 1, and gives a recommended stack height of 61 metres. This compares with the actual stack height of 91.5 metres, which was used for the modelling.

### 5.2 Model Inputs

#### 5.2.1 Selection of Model

The detailed flue gas dispersion modelling was carried out using the computer model ADMS 3.3, developed and supplied by Cambridge Environmental Research Consultants (CERC). This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the Monin-Obukhov length and the boundary layer depth. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. Modules within the model take account of the effect of complex terrain and nearby buildings.

ADMS 3.3 is one of the few dispersion models accepted by the Environment Agency for the prediction of emissions for planning and PPC (Pollution Prevention and Control) purposes.

#### 5.2.2 Chemistry

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

ADMS 3.3 includes a chemistry module, which models the progress of this reaction in the atmosphere. This module requires the background concentrations of NO<sub>2</sub>, NO and ozone to be provided, but background concentrations are not available for all years. Therefore, the chemistry module has not been used and it has been assumed that all of the NO<sub>x</sub> released by the plant is converted to NO<sub>2</sub> by the time it reaches the ground. This is a very pessimistic assumption and the sensitivity of the results to this assumption is examined later.

#### 5.2.3 Source and Emissions Data

The principal inputs to the model with respect to the releases from the three MSW lines are shown in [Table 5.1](#) below.

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<sup>4</sup> Her Majesty's Inspectorate of Pollution, "Technical Guidance Note (Dispersion) D1, Guidelines on Discharge Stack Heights for Polluting Emissions", 1993

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Table 5.1 Source and Emissions Data

Item	Unit	Line 1	Lines 1&2	Line 3	Lines 1,2&3
Stack Height	m		91.5		
Internal Stack Diameter	m	2.085	2.085	1.7	2.69
Stack Position (E,N)	m, m	458220, 339120			
Stack Flue Gas Exit Velocity	m/s	7.8	15.5	15.5	15.5
Flue Gas Conditions					
Temperature	°C	140	140	140	140
Oxygen	% v/v, dry	7.99%	7.99%	7.99%	7.99%
Moisture Content	% v/v	15.85%	15.85%	15.85%	15.85%
Vol at reference conditions	Nm <sup>3</sup> /s	19.2	38.3	25.6	63.9
	Nm <sup>3</sup> /h	69,018	138,036	92,024	230,059
Vol at discharge conditions	Am <sup>3</sup> /s	26.5	53.0	35.3	88.3
	Am <sup>3</sup> /h	95.394	190,789	127,192	317,981
<b>Emissions</b>	<b>Conc. (mg/m<sup>3</sup>)</b>	<b>Rate (g/s)</b>	<b>Rate (g/s)</b>	<b>Rate (g/s)</b>	<b>Rate (g/s)</b>
Nitrogen oxides (as NO <sub>2</sub> )	200	3.834	7.669	5.112	12.781
Sulphur dioxide	50	0.959	1.917	1.278	3.195
Carbon monoxide	50	0.959	1.917	1.278	3.195
Particulates (PM <sub>10</sub> )	10	0.192	0.383	0.256	0.639
Hydrogen Chloride	10	0.192	0.383	0.256	0.639
Hydrogen Fluoride	1	0.019	0.038	0.0256	0.064
VOCs	10	0.192	0.383	0.256	0.639
Mercury	0.05	0.96 mg/s	1.92 mg/s	1.28 mg/s	3.20 mg/s
Cadmium and Thallium	0.05	0.96 mg/s	1.92 mg/s	1.28 mg/s	3.20 mg/s
Other Metals	0.5	0.0096	0.019	0.013	0.032
PAHs (as B[a]P)	0.001	19.2 µg/s	38.3 µg/s	25.6 µg/s	63.9 µg/s
Dioxins and Furans	0.1 ng/m <sup>3</sup>	1.92 ng/s	3.83 ng/s	2.56 ng/s	6.39 ng/s
<i>Notes:</i>					
<ul style="list-style-type: none"> <li>• The flue is actually a D-shape, with a cone at the top to increase the exit velocity. The stack diameter shown is the equivalent diameter for a circular flue.</li> <li>• Emission concentrations are for dry flue gas, 11% oxygen. Emission rates are corrected to the actual flue gas conditions.</li> <li>• "Other Metals" are Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel, Vanadium</li> <li>• The PAH concentration is based on the most recent monitoring at Eastcroft.</li> </ul>					

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5.2.4 Terrain Data

The impact of the local terrain was taken into account by using Ordnance Survey Landform PANORAMA digital contour data.

A surface roughness length of 1 m was used, which is representative of cities.

5.2.5 Meteorological Data

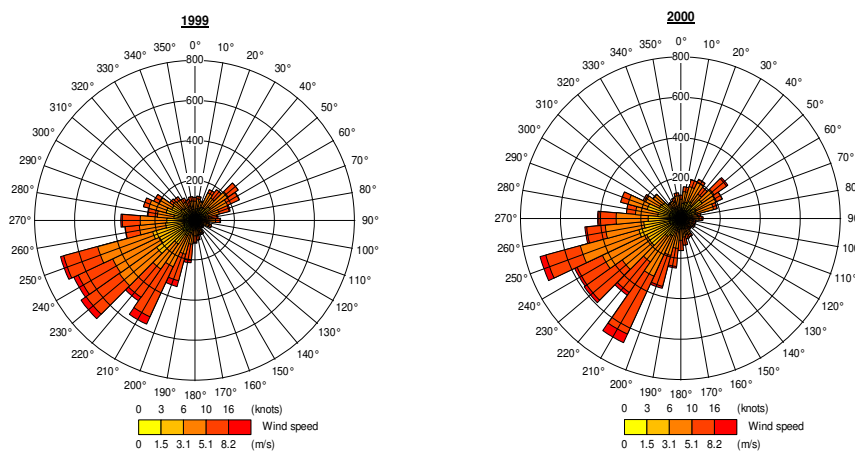
The impact of weather data was taken into account by using data from the Meteorological Office for the years 1999-2006 from the weather station at Watnall. This weather station is located around 10 km from the site and the Met. Office consider that this is the most representative weather station for the Eastcroft site.

Normally, five years of data would be used to ensure that fluctuations in weather conditions would be accounted for. In the air quality assessment submitted with the planning application, weather data for 1999-2003 was used. Since then, weather data for 2004-2006 has become available and so this has been used in this assessment, but the original weather data was also used since the weather data from earlier years led to higher predicted ground level concentrations.

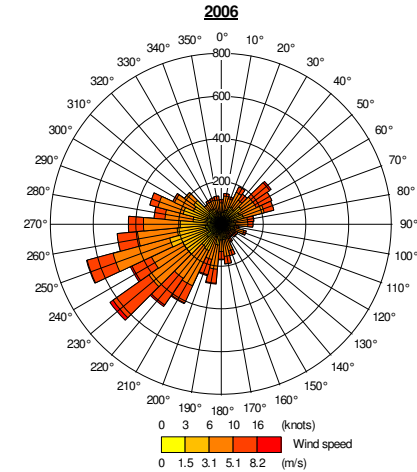
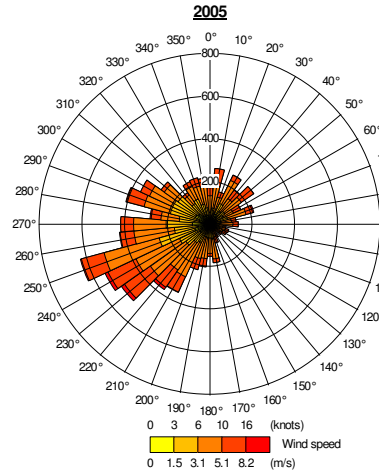
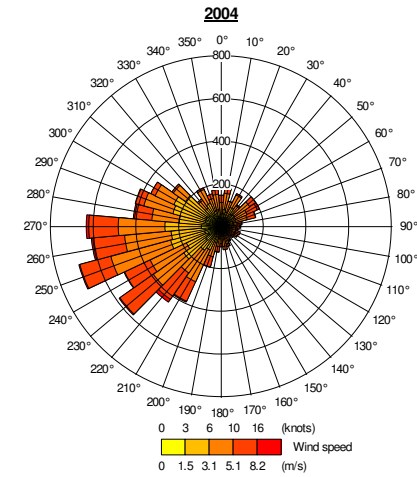
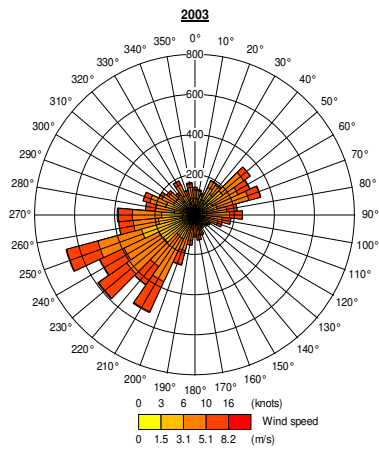
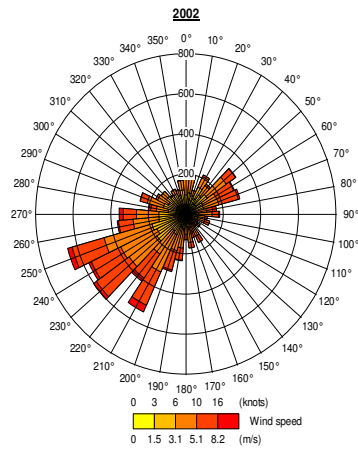
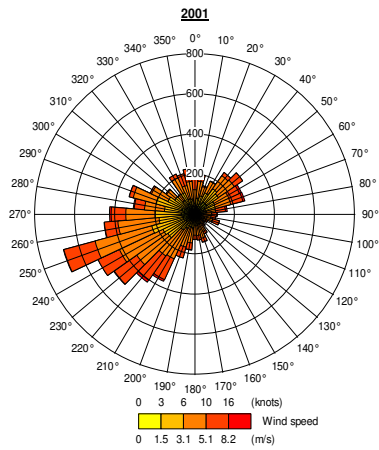
The wind roses for each year are shown in [Figure 5.1](#). These diagrams show the spread of wind direction, with most wind coming from the south-west. The length of each section is proportional to the frequency of that wind direction and the coloured sections show the spread of wind speeds.

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Figure 5.1 Windroses for Watnall Met Station, 1999-2003



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### 5.2.6 Buildings

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

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

The only building in the vicinity of the stack which is significant is the complicated building associated with the municipal energy from waste plant itself. This building has been modelled as four sections, as shown in [Table 5.2](#) below, and the relative locations of the stack and buildings are shown in [Figure 5.2](#). The “Extended Boiler Hall” is only used for those cases after the third line has been installed.

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**Table 5.2 Building Parameters**

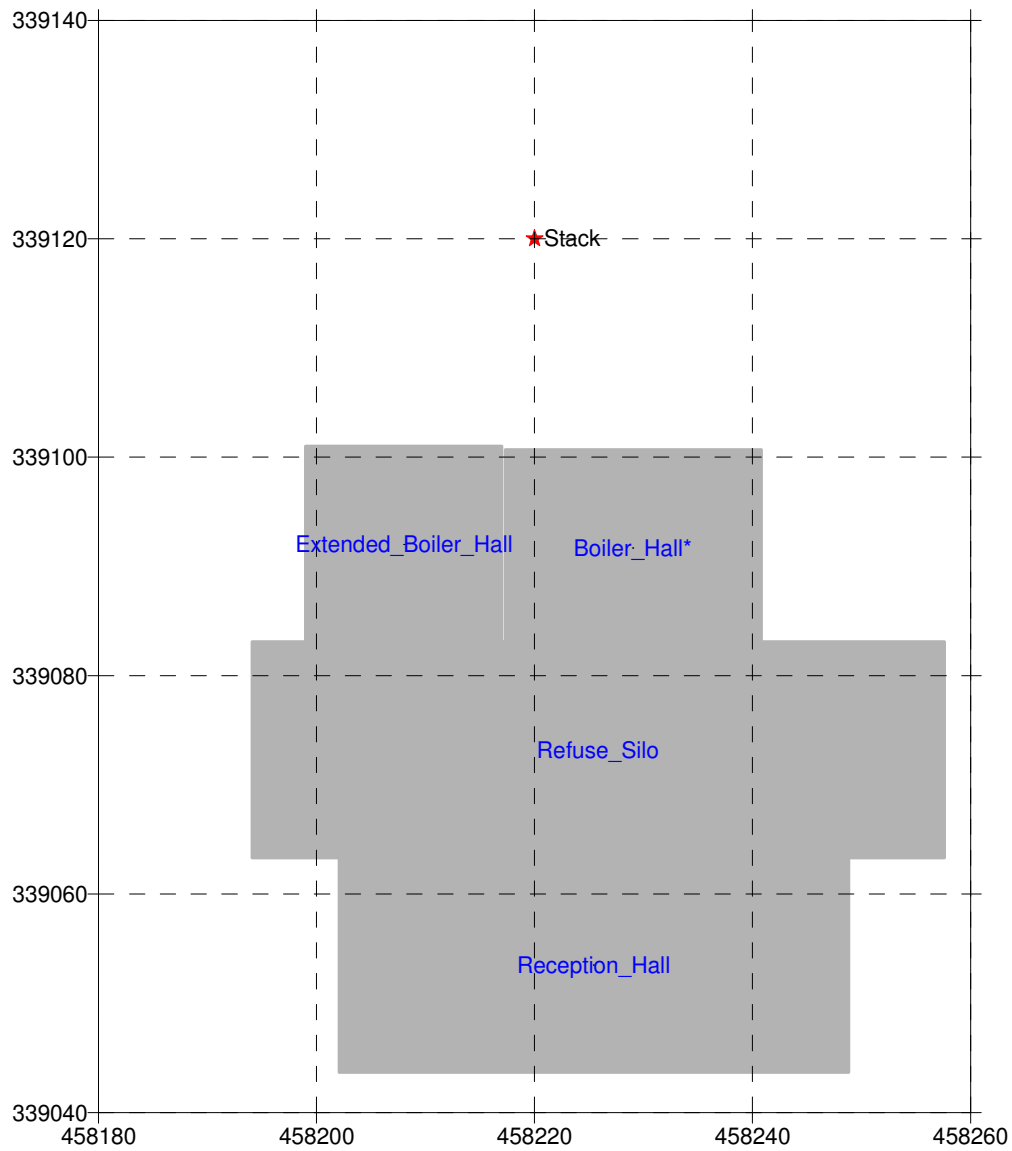
Item	Unit	Boiler Hall	Refuse Silo	Reception Hall	Extended Boiler Hall
Building Height	m	28.65	28.65	14.85	40*
Building Length	m	18	19.75	19.70	18
Building Width	m	23.50	63.50	46.70	18
Position of building centre (Eastings, Northings)	m, m	458229, 339092	458224, 339073	458223, 339053	458208, 339092
Angle of building to north (clockwise)	°	0	0	0	0

*\* The extended boiler hall is likely to be smaller than this, but the greatest possible height was used to give the most pessimistic results.*

It is generally accepted that building effects are only significant for buildings which are taller than one third of the stack height. This means that these buildings are likely to have only a minor effect on the results of the dispersion modelling in this case.

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Figure 5.2 Representation of Stack and Buildings in the Dispersion Model



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### 5.3 Dispersion Modelling Results

The results of the dispersion modelling for the main case, with all three municipal waste lines running, are shown in [Table 5.3](#).

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**Table 5.3 Dispersion Modelling Results, Lines 1,2 and 3**

Pollutant	Quantity	Ground Level Concentration at point of greatest impact ( $\mu\text{g}/\text{m}^3$ unless stated)			Year of Weather Data for Max	Max as % of limit
		Min	Average	Max		
Nitrogen dioxide	Annual Mean	0.79	0.90	1.03	1999	2.57%
	99.8 <sup>th</sup> %ile of hourly means	13.93	14.84	15.68	1999	7.84%
Sulphur dioxide	99.9 <sup>th</sup> %ile of 15 minute means	4.11	4.41	4.77	1999	1.79%
	99.73 <sup>rd</sup> %ile of hourly means	3.34	3.52	3.67	2004	1.04%
	99.18 <sup>th</sup> %ile of daily means	1.31	1.42	1.67	2000	1.34%
Particulate matter	Annual mean	0.04	0.04	0.05	1999	0.29%
	98.1 <sup>st</sup> %ile of daily means	0.23	0.24	0.27	2000	0.53%
Carbon monoxide	Annual mean	0.20	0.23	0.26	1999	
	Highest 8-hour running mean	3.26	3.95	5.01	1999	0.05%
Hydrogen chloride	Annual mean	0.04	0.04	0.05	1999	0.26%
	Hourly mean	1.13	1.20	1.26	2003	0.16%
Hydrogen fluoride	Hourly mean	0.11	0.12	0.13	2003	0.05%
VOCs	Annual mean	0.04	0.04	0.05	1999	2.28%
Mercury ( $\text{ng}/\text{m}^3$ )	Annual mean	0.20	0.22	0.26	1999	0.10%
	Hourly mean	5.66	6.00	6.32	2003	0.08%
Cd & Tl ( $\text{ng}/\text{m}^3$ )	Annual mean	0.20	0.22	0.26	1999	5.13%
	Hourly mean	5.66	6.00	6.32	2003	0.42%
Other metals ( $\text{ng}/\text{m}^3$ )	Annual mean	1.98	2.24	2.57	1999	1.28%
	Hourly mean	56.56	60.00	63.19	2003	6.32%
PAHs ( $\text{pg}/\text{m}^3$ )	Annual mean	3.96	4.48	5.13	1999	2.05%
Dioxins ( $\text{fg}/\text{m}^3$ )	Annual mean	0.40	0.45	0.51	1999	

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A number of other cases were run. [Table 5.4](#) shows the results for cases which assume that the third line has been installed, including the extended boiler building. For reference, the results from the base case (lines 1,2 and 3) are included and the results for the other cases are expressed as a percentage of the results for the base case. It can be seen that operating with all three lines gives rise to the highest ground level concentrations.

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**Table 5.4 Dispersion Modelling Results, Other Cases following installation of third line**

Pollutant	Quantity	Lines 1,2&3	Line 3		Lines 2&3		Lines 1&2	
		Conc. ( $\mu\text{g}/\text{m}^3$ )	Conc. ( $\mu\text{g}/\text{m}^3$ )	% of base	Conc. ( $\mu\text{g}/\text{m}^3$ )	% of base	Conc. ( $\mu\text{g}/\text{m}^3$ )	% of base
Nitrogen dioxide	Annual Mean	1.03	0.59	57.1%	0.84	82.1%	0.76	74.0%
	99.8 <sup>th</sup> %ile of hourly means	15.68	11.03	70.3%	14.42	91.9%	13.29	84.7%
Sulphur dioxide	99.9 <sup>th</sup> %ile of 15 minute means	4.77	3.73	78.2%	4.27	89.5%	4.06	85.2%
	99.73 <sup>rd</sup> %ile of hourly means	3.56	2.59	72.8%	3.24	91.2%	3.03	85.2%
	99.18 <sup>th</sup> %ile of daily means	1.41	0.79	56.1%	1.15	81.2%	1.03	72.9%
Particulate matter	Annual mean	0.05	0.03	57.2%	0.04	82.1%	0.04	73.9%
	98.1 <sup>st</sup> %ile of daily means	0.259	0.136	52.7%	0.20	77.6%	0.18	68.5%
Carbon monoxide	Annual mean	0.261	0.149	57.3%	0.21	81.9%	0.19	73.8%
	Highest 8-hour running mean	5.01	3.95	78.9%	4.78	95.5%	4.51	90.0%
Hydrogen chloride	Annual mean	0.051	0.029	57.2%	0.042	82.1%	0.038	73.9%
	Hourly mean	1.210	0.957	79.0%	1.147	94.7%	1.09	90.3%
Hydrogen fluoride	Hourly mean	0.121	0.096	79.0%	0.115	94.7%	0.109	90.3%
VOCs	Annual mean	0.051	0.029	57.2%	0.042	82.1%	0.04	73.9%
Mercury ( $\text{ng}/\text{m}^3$ )	Annual mean	0.257	0.147	57.2%	0.211	82.1%	0.19	73.9%
	Hourly mean	6.051	4.783	79.0%	5.733	94.7%	5.467	90.3%
Cd & Tl ( $\text{ng}/\text{m}^3$ )	Annual mean	0.257	0.147	57.2%	0.211	82.1%	0.19	73.9%
	Hourly mean	6.051	4.783	79.0%	5.733	94.7%	5.467	90.3%
Other metals ( $\text{ng}/\text{m}^3$ )	Annual mean	2.566	1.467	57.2%	2.106	82.1%	1.90	73.9%
	Hourly mean	60.51	47.83	79.0%	57.33	94.7%	54.67	90.3%
PaHs ( $\text{pg}/\text{m}^3$ )	Annual mean	5.13	2.93	57.2%	4.21	82.1%	3.79	73.9%
Dioxins ( $\text{fg}/\text{m}^3$ )	Annual mean	0.513	0.293	57.2%	0.421	82.1%	0.379	73.9%

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Table 5.5 shows the peak results for cases which model the current situation before the third line is installed. Again, the results for the base case are shown for reference. These results do not include the influence of the extended boiler building and use the worst case weather conditions from 1999-2003, so that the results for lines 1 and 2 in the table below are slightly different from the results for lines 1 and 2 in the table above.

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**Table 5.5 Dispersion Modelling Results, Other Cases prior to installation of third line**

Pollutant	Quantity	Lines 1,2&3	Line 1		Lines 1&2		Lines 1&2 + CWI	
		Conc. ( $\mu\text{g}/\text{m}^3$ )	Conc. ( $\mu\text{g}/\text{m}^3$ )	% of base	Conc. ( $\mu\text{g}/\text{m}^3$ )	% of base	Conc. ( $\mu\text{g}/\text{m}^3$ )	% of base
Nitrogen dioxide	Annual Mean	1.03	0.49	48.0%	0.76	74.0%	0.78	75.9%
	99.8 <sup>th</sup> %ile of hourly means	15.68	9.46	60.3%	13.29	84.7%	13.52	86.2%
Sulphur dioxide	99.9 <sup>th</sup> %ile of 15 minute means	4.77	3.32	69.7%	4.06	85.2%	4.00	83.9%
	99.73 <sup>rd</sup> %ile of hourly means	3.63	2.29	643.1%	3.03	83.6%	3.03	83.6%
	99.18 <sup>th</sup> %ile of daily means	1.41	0.68	48.4%	1.10	77.7%	1.15	81.2%
Particulate matter	Annual mean	0.05	0.02	48.1%	0.04	74.1%	0.04	75.9%
	98.1 <sup>st</sup> %ile of daily means	0.267	0.113	42.4%	0.19	71.3%	0.20	73.6%
Carbon monoxide	Annual mean	0.261	0.126	48.2%	0.19	73.8%	0.20	75.6%
	Highest 8-hour running mean	5.01	3.74	74.6%	4.51	90.0%	4.52	90.3%
Hydrogen chloride	Annual mean	0.051	0.025	48.1%	0.038	74.1%	0.039	75.9%
	Hourly mean	1.264	0.856	67.7%	1.096	86.7%	1.09	86.0%
Hydrogen fluoride	Hourly mean	0.126	0.086	67.7%	0.110	86.7%	0.109	86.0%
VOCs	Annual mean	0.051	0.025	48.1%	0.038	74.1%	0.04	75.9%
Mercury ( $\text{ng}/\text{m}^3$ )	Annual mean	0.257	0.123	48.1%	0.190	74.1%	0.19	75.9%
	Hourly mean	6.319	4.280	67.7%	5.481	86.7%	5.434	86.0%
Cd & Tl ( $\text{ng}/\text{m}^3$ )	Annual mean	0.257	0.123	48.1%	0.190	74.1%	0.19	75.9%
	Hourly mean	6.319	4.280	67.7%	5.481	86.7%	5.434	86.0%
Other metals ( $\text{ng}/\text{m}^3$ )	Annual mean	2.566	1.235	48.1%	1.901	74.1%	1.95	75.9%
	Hourly mean	63.19	42.80	67.7%	54.81	86.7%	54.34	86.0%
PaHs ( $\text{pg}/\text{m}^3$ )	Annual mean	5.13	2.47	48.1%	3.80	74.1%	3.90	75.9%
Dioxins ( $\text{fg}/\text{m}^3$ )	Annual mean	0.513	0.247	48.1%	0.380	74.1%	0.390	75.9%

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It can be seen that maximum concentration for the case with two lines is always greater than the maximum concentration for the case with 1 line and that both cases give lower concentrations than the future case with three lines. It can also be seen that the inclusion of the clinical waste incinerator combined with the two existing municipal waste lines leads to very similar ground level concentrations, with short term concentrations generally increasing slightly and long term concentrations generally decreasing slightly. The incremental impact of the CWI is not considered in this air quality assessment.

The remainder of the discussion in this section is based on the main case, including all three municipal waste lines. The incremental impact of the third line is considered in section 6.

## 5.4 Discussion of Results

The results for each pollutant are considered individually below. As the weather impacts different pollutants in different ways, the peaks quoted in the text below can vary between different years due to the different weather conditions.

### 5.4.1 Nitrogen dioxide

The highest contribution of the plant to the annual average ground level concentration is predicted to be  $1.03 \mu\text{g}/\text{m}^3$ , based on 1999 weather data. This peak is 2.6% of the air quality objective. If the peak contribution is added to the background concentration of  $35.1 \mu\text{g}/\text{m}^3$ , the total predicted ground level concentration is  $36.1 \mu\text{g}/\text{m}^3$ , which is less than the air quality objective of  $40 \mu\text{g}/\text{m}^3$ .

The highest contribution of the plant to the 99.79<sup>th</sup> percentile of hourly average ground level concentrations is predicted to be  $15.7 \mu\text{g}/\text{m}^3$ , based on 1999 weather data. This peak occurs about 550 metres north-east of the stack and is 7.8% of the air quality objective.

It would not be correct to add the peak short-term contribution from the plant to the highest recorded background concentration, since the two peaks would not be coincident in time or space. Instead, Technical Guidance Note H1 recommends that the short-term process contribution should be added to twice the long-term ambient concentration. If the short-term peak is added to two times the highest annual average concentration measured in central Nottingham, the total predicted ground level concentration is  $85.9 \mu\text{g}/\text{m}^3$ , which is less than half of the AQO of  $200 \mu\text{g}/\text{m}^3$ .

The concentrations from the dispersion model assume that all of the  $\text{NO}_x$  released from the plant is oxidised to  $\text{NO}_2$  immediately. In reality, at the distances from the stack at which the peaks occur, the atmospheric oxidation process will not be completed, so that the actual concentrations of  $\text{NO}_2$  will be lower than those predicted above. This issue is considered in more detail in section 5.5.1 below.

The distribution of the annual average is shown in figure 5.3, based on 1999 weather data. The distribution of the 99.79<sup>th</sup> percentile of hourly averages is shown in figure 5.4, also based on 1999 weather data.

### 5.4.2 Sulphur Dioxide

The highest contribution of the plant to the annual average ground level concentration is predicted to be  $0.26 \mu\text{g}/\text{m}^3$ , based on 1999 weather data. This peak occurs about 900 metres north-east of the stack and is 1.9% of the background level. If the peak contribution is added to the highest recorded annual average in central Nottingham of  $16.7 \mu\text{g}/\text{m}^3$ , the maximum predicted ground level concentration is  $16.96 \mu\text{g}/\text{m}^3$ .

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The highest contribution of the plant to the 99.73<sup>rd</sup> percentile of hourly average ground level concentrations is predicted to be 3.67 µg/m<sup>3</sup>, based on 2004 weather data. This peak occurs about 600 metres east of the stack and is 1.0% of the air quality objective. If the peak contribution is added to twice the highest recorded annual average in central Nottingham of 16.7 µg/m<sup>3</sup>, the maximum predicted ground level concentration is 38.1 µg/m<sup>3</sup>, which is much less than the AQO of 350 µg/m<sup>3</sup>.

The highest contribution of the plant to the 99.9<sup>th</sup> percentile of 15 minute average ground level concentrations is predicted to be 4.77 µg/m<sup>3</sup>, based on 1999 weather data. This peak occurs about 470 metres north-east of the stack and is 1.8% of the air quality objective. If the peak contribution is added to twice the highest recorded annual average in central Nottingham of 16.7 µg/m<sup>3</sup>, the maximum predicted ground level concentration is 38.2 µg/m<sup>3</sup>, which is much less than the AQO of 266 µg/m<sup>3</sup>.

The highest contribution of the plant to the 99.18<sup>th</sup> percentile of daily average ground level concentrations is predicted to be 1.67 µg/m<sup>3</sup>, based on 2000 weather data. This peak occurs about 900 metres north-east of the stack and is 1.3% of the air quality objective. If the peak contribution is added to twice the highest recorded annual average in central Nottingham of 16.7 µg/m<sup>3</sup>, the maximum predicted ground level concentration is 35.1 µg/m<sup>3</sup>, which is much less than the AQO of 125 µg/m<sup>3</sup>.

The distribution of the 99.9<sup>th</sup> percentile of 15 minute averages is shown in figure 5.5, based on 1999 weather data. The distribution of the 99.18<sup>th</sup> percentile of daily averages is shown in figure 5.6, based on 2000 weather data.

#### 5.4.3 Particulate Matter

The highest contribution of the plant to the annual average ground level concentration is predicted to be 0.051 µg/m<sup>3</sup>, based on 1999 weather data. This peak occurs about 900 metres north-west of the stack and is 0.29% of the air quality objective.

The highest contribution of the plant to the 98.1<sup>st</sup> percentile of daily average ground level concentrations is predicted to be 0.27 µg/m<sup>3</sup>, based on 2000 weather data. This peak occurs about 800 metres north-west of the stack and is 0.53% of the air quality objective.

It can be seen that the plant will not make a significant contribution to particulate levels in the atmosphere. Since the contribution of the plant to particulate levels in the atmosphere is so low, no dispersion diagrams have been included.

#### 5.4.4 Carbon Monoxide

The highest contribution of the plant to the 8-hour running mean of ground level concentrations is predicted to be 5.01 µg/m<sup>3</sup>, based on 1999 weather data. This is less than 0.05% of the air quality objective of 10,000 µg/m<sup>3</sup>. Therefore, the plant will not make a significant contribution to carbon monoxide levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

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#### 5.4.5 Hydrogen Chloride

The highest contribution of the plant to the annual average ground level concentration is predicted to be  $0.051 \mu\text{g}/\text{m}^3$ , based on 1999 weather data. This is less than 0.3% of the EAL of  $20 \mu\text{g}/\text{m}^3$ . The highest contribution of the plant to the hourly average ground level concentration is predicted to be  $1.26 \mu\text{g}/\text{m}^3$ , based on 2003 weather data. This is less than 0.2% of the EAL of  $750 \mu\text{g}/\text{m}^3$ . Therefore, the plant will not make a significant contribution to hydrogen chloride levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

#### 5.4.6 Hydrogen Fluoride

The highest contribution of the plant to the hourly average ground level concentration is predicted to be  $0.13 \mu\text{g}/\text{m}^3$ , based on 2003 weather data. This is 0.08% of the EAL of  $160 \mu\text{g}/\text{m}^3$ . Therefore, the plant will not make a significant contribution to hydrogen fluoride levels in the atmosphere.

#### 5.4.7 Volatile Organic Compounds (VOCs)

The highest contribution of the plant to the annual average ground level concentration is predicted to be  $0.051 \mu\text{g}/\text{m}^3$ , based on 1999 weather data. If this is assumed to be all benzene, this concentration would be 1% of the air quality objective. Alternatively, if this is assumed to be entirely 1,3-butadiene, this would only be 2.3% of the air quality objective. In reality, only a small fraction of the VOCs released from the plant will be benzene and 1,3-butadiene. Therefore, the plant will not make a significant contribution to VOC levels in the atmosphere.

#### 5.4.8 Cadmium and Thallium

The highest contribution of the plant to the annual average ground level concentration of Cadmium and Thallium combined is predicted to be  $0.26 \text{ ng}/\text{m}^3$ , based on 1999 weather data. If it is assumed that the whole of this release is accounted for by a single metal, then the ground level concentration would be 5.1% of the long-term EAL for cadmium or 0.03% of the long-term EAL for thallium.

On the same basis, the highest contribution of the plant to the hourly average ground level concentration of each metal is predicted to be  $6.32 \text{ ng}/\text{m}^3$ , based on 2003 weather data. This concentration is 0.4% of the short-term EAL for cadmium or 0.02% of the short-term EAL for thallium.

The approach used is very much a worst case, since the plant will not continuously release cadmium and thallium compounds at the limit level. Recent emission monitoring tests at the current plant indicated that the total concentration of cadmium and thallium was less than  $0.003 \text{ mg}/\text{m}^3$ , or less than 1% of the emission limit. Therefore, the contribution of the plant to long-term cadmium levels in the atmosphere is likely to be well below 1% of the EAL.

#### 5.4.9 Mercury

The contribution of the plant to the concentrations of mercury are predicted to be the same as for cadmium and thallium, since the emission limit is the same in each case. The maximum hourly average ground level concentration of  $6.32 \text{ ng}/\text{m}^3$  is 0.08% of the short-term EAL and the peak annual average ground level concentration of  $0.26 \text{ ng}/\text{m}^3$  is 0.1% of the long-term EAL. Therefore, the emissions of mercury are not predicted to have a significant impact.

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#### 5.4.10 Other Metals

In assessing the impact of the other metals, it is assumed that the combined emission comprises a single metal. This will overestimate the impact, since in reality the combined concentration will include a fraction of each of the metals and the plant will not continuously emit metal compounds at the limit level.

With this assumption, the highest contribution of the plant to the annual average ground level concentration is predicted to be  $2.57 \text{ ng/m}^3$ , based on 1999 weather data. The most stringent long-term EAL is  $0.2 \text{ } \mu\text{g/m}^3$  (for nickel, cobalt and arsenic), so the annual average concentration is no more than 1.3% of the long-term EAL for any metal. In reality, the highest concentration will be many times lower than this value.

If the target values in the Fourth Daughter Directive are considered, the highest contribution of the plant to the annual average ground level concentration of nickel and arsenic is predicted to be 13% and 43% of the respective target values. However, this is a significant overestimate of the actual situation. The periodic emissions testing at the current Eastcroft facility show that arsenic is released at a level of less than 0.25% of the emission limit and nickel is released at less than 5% of the emissions limit. At these levels:

- For nickel, the highest contribution of the plant to the annual average ground level concentration is predicted to be  $0.13 \text{ ng/m}^3$ , which is less than 1% of the target value of  $20 \text{ ng/m}^3$ ; and
- For arsenic, the highest contribution of the plant to the annual average ground level concentration is predicted to be  $0.006 \text{ ng/m}^3$ , which is 0.1% of the target value of  $6 \text{ ng/m}^3$ .

The highest contribution of the plant to the hourly ground level concentration is predicted to be  $63.2 \text{ ng/m}^3$ , based on 2003 weather data. The most stringent short-term EAL is  $1 \text{ } \mu\text{g/m}^3$  for vanadium, so that if the facility operated at its limit for other metals and only released vanadium, the peak contribution from the plant would be 6.3% of the limit for vanadium. In reality, the contribution from the facility to vanadium concentrations would be many times smaller than this.

The next most stringent EAL is  $6 \text{ } \mu\text{g/m}^3$  (for nickel, cobalt and arsenic), for which the hourly ground level concentration would be no more than 1% of the short-term EAL, even if all of the other metals released from the plant were one of nickel, cobalt or arsenic.

Chromium (VI) should be considered separately. It can be assumed that no more than 10% of chromium released from the facility will be Chromium (VI). Therefore, if it is assumed that the facility operated at its limit for other metals and only released Chromium, the highest annual average ground level concentration of Chromium (VI) would be  $0.26 \text{ ng/m}^3$  and the peak hourly ground level concentration would be  $6.32 \text{ ng/m}^3$ . These concentrations are 0.26% of the long term EAL and 0.21% of the short term EAL respectively.

The distribution of the annual average concentration of the combined metals using 1999 weather data is shown in Figure 5.7. The concentrations of mercury and the combined concentration of cadmium and thallium are one tenth of the concentration of other metals, so Figure 5.7 can be used to see the distribution of all metals.

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#### 5.4.11 Polycyclic Aromatic Hydrocarbons (PAHs)

The highest annual average ground level concentration of benzo(a)pyrene from the plant is predicted to be 5.13  $\mu\text{g}/\text{m}^3$ , using weather data from 1999. This is around 2% of the air quality objective of 0.25  $\text{ng}/\text{m}^3$  (250  $\mu\text{g}/\text{m}^3$ ). However, this assumes that all PAHs are released as benzo(a)pyrene whereas recent monitoring at Eastcroft suggests that benzo(a)pyrene only contributes around 1-2% of total PAHs. Therefore, the plant will not make a significant contribution to benzo(a)pyrene levels in the atmosphere.

#### 5.4.12 Dioxins and Furans

The highest annual average ground level concentration of dioxins from the plant is predicted to be 0.51  $\text{fg}/\text{m}^3$ , using weather data from 1999. This is around 1.9% of the average urban background concentration in the UK.

As the key health risk due to dioxins is due to ingestion via the food chain, peaks in dioxin emissions are not considered to be a problem. It is the accumulated annual emission which must be assessed.

Inhalation of dioxins from the air is a relatively minor exposure route for humans. In order to assess the true impact of the facility on human health, it is necessary to consider all possible exposure pathways. This has been done in the Health Risk Assessment section later in this document by following the methodology given by the HMIP in 1996<sup>5</sup>.

#### 5.4.13 Summary

The results are summarised in [Table 5.6](#) below, which includes the pollutants which are most significant.

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**Table 5.6 Summary of Impact of Three Line Plant**

Substance Assessed	Background ( $\mu\text{g}/\text{m}^3$ )	EAL ( $\mu\text{g}/\text{m}^3$ )	PC ( $\mu\text{g}/\text{m}^3$ )	PEC ( $\mu\text{g}/\text{m}^3$ )	%PC of EAL	%PEC of EAL
<b>Long Term Impacts</b>						
Nitrogen dioxide	35.1	40	1.03	36.13	2.6	90.3
Sulphur dioxide	16.7	125	1.67	18.37	1.3	14.7
1,3 butadiene	0.20	2.25	0.051	0.25	2.3	11.1
Cadmium	0.00055	0.005	0.00026	0.00081	5.2	16.2
<b>Short Term Impacts</b>						
Nitrogen dioxide	70.2	200	15.68	85.88	7.8	42.9
Sulphur dioxide	33.4	267	4.77	38.2	1.8	14.3
<i>EAL = Environmental Assessment Level</i>						
<i>PC = Process Contribution</i>						
<i>PEC = Predicted Environmental Concentration</i>						

<sup>5</sup> Her Majesty's Inspectorate of Pollution, "Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes", 1996.

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According to the Environment Agency's Technical Guidance Note H1, which provides guidance on environmental assessment under the IPPC regime, emissions are unlikely to lead to significant environmental impacts where:

- The contribution to long term ground level concentrations is less than 1% of the air quality objective; and
- The contribution to short term ground level concentrations is less than 20% of the air quality objective.

It can be seen that the emissions from the plant are unlikely to lead to significant environmental impacts on a short term basis for any of the pollutants. On a long term basis,

- Nitrogen dioxide exceeds the 1% criterion on an annual basis, under the pessimistic assumption that all of the NO<sub>x</sub> is released as NO<sub>2</sub>.
- If all the emissions of VOCs are assumed to be 1,3-butadiene, these would slightly exceed the 1% criterion. This is a very pessimistic assumption.
- If the emissions of Cadmium are assumed to be at the combined limit of cadmium and thallium for the entire year, these would exceed the 1% criterion. As discussed above, emissions of cadmium are actually around 1% of the emission limit.

## 5.5 Sensitivities

### 5.5.1 Chemistry

The chemistry module in ADMS3.2 was used to assess the impact of the pessimistic assumption that all of the NO<sub>x</sub> released by the plant is released as NO<sub>2</sub>. According to the periodic testing carried out at other energy from waste plants, less than 5% of the NO<sub>x</sub> is actually released as NO<sub>2</sub>, with the rest released as NO.

Two additional model runs were used to assess this.

- Both included emissions from two MSWI lines and the CWI.
- Both used weather data from 1999.
- Both used background concentrations of NO<sub>2</sub>, NO<sub>x</sub> and ozone from the Nottingham City monitoring station.
- One run used a total NO<sub>x</sub> release rate of 3.694 g/s with 5% of this as NO<sub>2</sub>. The second run used a total NO<sub>x</sub> release rate of 0.001 g/s, to act as a base background case.

The results of the base background case were subtracted from the main chemistry case in order to show the impact of the plant on ground level concentrations of NO<sub>2</sub>. The results were as follows:

- 1) The highest contribution of the plant to the annual average ground level concentration was predicted to be 0.234 µg/m<sup>3</sup>. This is about 30% of the predicted concentration from the non-chemistry run of 0.78 µg/m<sup>3</sup>.
- 2) The highest contribution of the plant to the 99.79<sup>th</sup> percentile of ground level hourly average concentrations was predicted to be 0.727 µg/m<sup>3</sup>. This is about 5% of the predicted concentration from the non-chemistry run of 13.52 µg/m<sup>3</sup>.

These results demonstrate that the assumption that all NO<sub>x</sub> is released as NO<sub>2</sub> leads to a significant overestimation of the contribution of the plant to NO<sub>2</sub> levels in the atmosphere.

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### 5.5.2 Chimney Height

The sensitivity of the ground level concentrations to different stack heights has been assessed by running the dispersion model with a number of stack heights, using 1999 weather data and emissions from two MSWI lines and the CWI line. The results for three lines would show a similar trend. The ground level concentration of nitrogen dioxide predicted by the model for each stack height is shown in [Table 5.7](#).

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**Table 5.7 Impact of Stack Height on Peak Nitrogen Dioxide Ground Level Concentrations**

Stack Height (m)	Annual Average ( $\mu\text{g}/\text{m}^3$ )		99.79 <sup>th</sup> percentile of hourly averages ( $\mu\text{g}/\text{m}^3$ )	
	Process Contribution	Total Concentration	Process Contribution	Total Concentration
71	1.50	36.10	17.18	81.65
81	1.02	35.78	14.75	80.03
<b>91.5</b>	<b>0.78</b>	<b>35.62</b>	<b>13.53</b>	<b>79.22</b>
101	0.63	35.51	11.66	77.97
111	0.51	35.44	10.20	77.00
AQO		40		200

Notes: The total annual average concentration is calculated by adding the background concentration of  $35.1 \mu\text{g}/\text{m}^3$  to the process contribution.

The total 99.79<sup>th</sup> percentile of the hourly means is calculated by adding twice the annual average background concentration of  $35.1 \mu\text{g}/\text{m}^3$  to the process contribution.

All calculations assume that all  $\text{NO}_x$  is released as  $\text{NO}_2$ .

The results demonstrate that

- Even the concentrations from a 71 metre stack would not cause any breaches of air quality objectives in the vicinity of the stack.
- Increasing the stack height from 91.5 metres to 101 metres would reduce the total annual average ground level concentration of nitrogen dioxide by 0.3% and the 99.79<sup>th</sup> percentile of hourly averages by 1.6%.

Therefore, increasing the stack height further cannot be justified on environmental grounds.

### 5.5.3 Weather Conditions

The sensitivity of the results to different weather data sets has been assessed by running the model with eight years of data from the Watnall weather station. The results, shown in [Table 5.3](#) above, show that, over the eight years.

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- The highest annual average concentration can be as much as 30% higher than the lowest annual average concentration. (e.g. For  $\text{NO}_2$ , the highest figure was  $1.03 \mu\text{g}/\text{m}^3$  in 1999 and the lowest was  $0.79 \mu\text{g}/\text{m}^3$  in 2005.)
- The variation is lower for short-term peaks. (e.g. for  $\text{NO}_2$ , the highest figure for the 99.79<sup>th</sup> percentile of hourly means was  $15.68 \mu\text{g}/\text{m}^3$  in 1999 and the lowest figure was  $13.93 \mu\text{g}/\text{m}^3$  in 2005, a 12% difference.)

These results illustrate the importance of using a number of years of weather data.

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## 5.6 Health Impact Assessment

For most substances released from the plant, the most significant effects on human health would arise by inhalation. The air quality objectives discussed above have been set by the various authorities at a level which is considered to present minimum or zero risk to human health. It is widely accepted that, if the concentrations in the atmosphere are less than the air quality objectives, then the pollutant is unlikely to have an adverse effect on human health.

Rather than attempting to identify the location of the most sensitive groups of people, the approach has been to predict the highest contribution of the plant at any point. The contribution of the plant to the most sensitive people is likely to be significantly lower than the highest contribution.

Therefore, since the highest contribution of the plant to ground level concentrations of any substance is less than 8% of the air quality objective, even under the most adverse conditions, it can be seen that the plant is highly unlikely to have an adverse effect on human health.

### 5.6.1 **Dioxins**

The key risk to health from dioxins is not be inhalation, but by ingestion. Therefore, dioxins are assessed differently from other pollutants to take account of potential levels of intake by ingestion. A health risk assessment was carried out for dioxins using the assumptions and methodology in HMIP 1996. This methodology considers all pathways for transmission of dioxins from the atmosphere to humans, including direct inhalation and the consumption of animals and plants which have absorbed dioxins through the food chain, ultimately from the soil and air. The following site specific assumptions were made:

- Average rainfall of 700 mm per year, ambient temperature of 10°C and windspeed of 3.72 m/s, based on Watnall weather data from 2000.

The incremental exposure to dioxins and furans was assessed for a number of groups of people. In particular, the Hypothetical Maximally Exposed Individual (HMEI) was considered, who only consumes locally-produced food and spends his or her whole life living near to the plant. The results are shown below, and are compared with the Tolerable Daily Intake (TDI) recommended by the WHO of 1 pg/kg bodyweight/day (1000 fg/kg bodyweight/day)

**Table 5.8 Exposure to Dioxins and Furans**

Group of People	Incremental Intake (fg TEQ/kg bodyweight/day)	Percentage of Tolerable Daily Intake
Adult resident	2.97	0.3%
Local child aged 1-6	5.45	0.55%
Local child aged 6-11	5.28	0.53%
Local child aged 11-16	3.34	0.33%
Local breast-feeding infant	8.73	0.87%
Local farmer	8.66	0.87%
Local child of a farmer	15.64	1.56%
Local farmer's baby	25.2	2.52%
HMEI	22.2	2.22%

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It can be seen that the contribution from the plant to the dioxin intake is not significant. Even for the HMEI, it is less than 2.3% of the TDI.

### 5.6.2 Sensitive Environmental Receptors

The English Nature website was used to identify all sensitive environmental areas within 10 km of the plant. The impact of air emissions on more distant sites is considered to be negligible.

In total, eleven Sites of Special Scientific Interest (SSSIs) have been identified with 10 km of the site. These are listed below.

**Table 5.9 Location of SSSIs within 10 km of the site**

Site	Eastings	Northings	Distance from site(km)
Colwick Cutting	460200	339700	2.06
Wilford Claypits	457100	335500	3.79
Wilwell Cutting	456700	334800	4.58
Holme Pit	453600	334500	6.53
Normanton Pastures	462500	333200	7.31
Attenborough Gravel Pits	452200	334100	7.84
Sellers Wood	452300	345500	8.70
Robbinetts	449200	342100	9.50
Bulwell Wood	451800	346300	9.63
Gotham Hill Pasture	453200	330700	9.80
Kimberley Railway Cutting	450600	345400	9.87

The relative location of the four closest SSSIs is shown on Figure 5.8, along with the distribution of the contribution of the plant to the annual average ground level concentrations of nitrogen dioxide, based on 1999 weather data.

At Colwick Cutting, the annual average ground level concentration of nitrogen dioxide is  $0.5 \mu\text{g}/\text{m}^3$  and the annual average ground level concentration of sulphur dioxide is about  $0.12 \mu\text{g}/\text{m}^3$ . In all other cases, the annual average ground level concentration of nitrogen dioxide is below  $0.2 \mu\text{g}/\text{m}^3$  and the annual average ground level concentration of sulphur dioxide is below  $0.05 \mu\text{g}/\text{m}^3$ . These concentrations can be compared with the National Objectives for the Protection of Vegetation and Ecosystems from the Air Quality Strategy, which are:

- $30 \mu\text{g}/\text{m}^3$  for nitrogen dioxide as an annual mean
- $20 \mu\text{g}/\text{m}^3$  for sulphur dioxide as an annual mean

It can be seen that the plant will make a contribution of less than 1.7% of the National Objective for nitrogen dioxide and less than 0.6% of the National Objective for sulphur dioxide. Therefore, the plant will not have a significant impact on the SSSIs.

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### 5.6.3 PM2.5s

Concerns have been raised by various groups about the potential impact of PM<sub>2.5s</sub> on human health. In particular, the CAFÉ Working Group has recommended “the use of PM<sub>2.5</sub> rather than PM<sub>10</sub> as the principle metric for assessing exposure to particulate matter”.<sup>6</sup> It should be noted, however, that the Expert Panel on Air Quality Standards (EPAQS) responded to this draft and “questioned whether there would be any additional benefit from changing the metric when PM<sub>10</sub> continues to serve as a very good surrogate for PM<sub>2.5</sub>.”<sup>7</sup> As a result, it is possible that air quality standards will be set for PM<sub>2.5s</sub> at both a European and National level.

An analysis of the size distribution of particulate matter released from a municipal energy from waste plant is shown in [Table 5.10](#) below.<sup>8</sup> This illustrates that only 33% of the particles released by the plant were less than 2.8 microns in size. In other words, the PM<sub>2.5</sub> fraction was less than 33% of the PM<sub>10</sub> fraction. In contrast, it is reported that 90% of the particulates in vehicle emissions are in the sub PM<sub>2.8</sub> size range.<sup>9</sup>

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**Table 5.10 Size Distribution of Particles in Flue Gas from UK Energy from Waste Plant**

Size range microns	% in range	% <range
<0.36	0%	0%
0.36 - 0.55	9.5%	9.5%
0.55 - 0.85	4.8%	14.3%
0.85 - 1.75	4.8%	19.1%
1.75 - 2.8	14.3%	33.4%
2.8 - 4.1	14.3%	47.7%
4.1 - 6.0	33.3%	81.0%
6.0 - 9.2	9.5%	90.5%
>9.2	9.5%	100.0%

Also, the dispersion of particulate matter depends on the size of the particles. Smaller particles released from the stack will disperse more widely than larger particles and will be removed from the plume more rapidly, so that the concentration of smaller particles will be lower than would be obtained by simply assuming that the particle size distribution is unaffected by the dispersion.

<sup>6</sup> Source: Clean Air For Europe (CAFE) Working Group on Particulate Matter, “Second Position Paper on Particulate Matter”, Dec 2004, available at [http://europa.eu.int/comm/environment/air/cale/pdf/working\\_groups/2nd\\_position\\_paper\\_pm.pdf](http://europa.eu.int/comm/environment/air/cale/pdf/working_groups/2nd_position_paper_pm.pdf).

<sup>7</sup> Source: Letter to Co-chairs of CAFE Particulate Matter Working Group from Chair of EPAQS, expressing the views of the Panel, available at <http://www.defra.gov.uk/environment/airquality/aqs/pdf/cale-pmwg.pdf>.

<sup>8</sup> Source: SELCHP stream 1, carried out by AEA Technology August 2000 and reported in the Environment Agency's decision document for the Chineham Energy from Waste plant

<sup>9</sup> Source: Table 3.1 on P12 of Report of the Airborne Particles Expert Group ‘Source Apportionment of Airborne Particulate Matter in the United Kingdom, January 1999

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For these reasons, the contribution of the plant to ground level concentrations of PM<sub>2.5</sub> is likely to be less than 30% of the contribution of the plant to ground level concentrations of PM<sub>10</sub>s. Conversely, the contribution from traffic emissions to PM<sub>2.5</sub> concentrations is likely to be more than 75% of the contribution to PM<sub>10</sub> concentrations. Therefore, it can be seen that it is more conservative to focus on PM<sub>10</sub> emissions from the plant. If these are found to be insignificant, then the PM<sub>2.5</sub> emissions are likely to be even more insignificant.

**5.7 Combination of stack and traffic emissions**

The peak concentrations from traffic and stack emissions have been combined with background concentrations in [Table 5.11](#), below. It can be seen that no breaches of air quality objectives are predicted, even if it is assumed that the peak concentrations occur at the same place.

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However, it is important to emphasise that the peak concentrations due to traffic emissions are predicted to occur in a different place from the peak concentrations due to emissions from the stack. Figure 5.3 shows that the highest annual average ground level concentrations of nitrogen dioxide resulting from traffic emissions are predicted to occur to the north-east of the plant, whereas peak concentrations due to traffic emissions are predicted to occur along the A6011 to the south and south-west of the plant.

**Table 5.11 Combined Traffic and Stack Emissions**

Pollutant	Contribution from Stack Emissions	Contribution from Traffic Emissions	Background Concentration	Total Concentration	Air Quality Objective
Nitrogen dioxide	1.03	0.61	36.3	37.94	40
PM <sub>10</sub> s	0.051	0.48	19.8	20.3	40

*All figures are annual average ground level concentrations in µg/m<sup>3</sup>.*

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**5.8 Plume Visibility**

A plume visibility assessment was carried out, with a water content in the flue gases of 15.9% by volume, or 0.1125 kg water per kg dry gas. The results for the current plant are shown in [Table 5.12](#), and the results for the extended plant are shown in [Table 5.13](#).

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**Table 5.12 Plume Visibility Results – Current Plant**

Year	Percentage of time plume is visible	Longest Visible Plume Length (m)	Average Visible Plume Length (m)	Percentage of time there is a visible plume over 91 metres
1999	40.7%	475	49.6	4.7%
2000	44.5%	1328	59.1	7.6%
2001	46.4%	936	65.4	10.5%
2002	41.5%	775	59.8	8.0%
2003	41.6%	1133	56.6	7.1%

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Table 5.13 Plume Visibility Results – Extended Plant

Year	Percentage of time plume is visible	Longest Visible PlumeLength (m)	Average Visible Plume Length (m)	Percentage of time there is a visible plume over 91 metres
1999	40.5%	573	58.3	7.0%
2000	44.3%	1663	69.1	9.8%
2001	45.8%	1157	77.1	14.0%
2002	40.7%	947	71.0	10.8%
2003	41.2%	1416	66.4	9.8%

It can be seen that the plume is visible for around 40-45% of the time in both cases, with the percentage reducing with the extended plant. However, the visible plume is only longer than the stack height for around 8% of the time with the current plant and 10% of the time with the extended plant, with the longest plumes occurring at night.

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## 6 INCREMENTAL IMPACT OF LINE 3

While the main aim of this assessment is to assess the impact of the entire Eastcroft installation, it is also important to consider the change in environmental impact which will occur as a result of installing the third line. This can be done by comparing the results for the main base case, with all three lines running, with the case with only two lines running.

The results of this comparison are shown in [Table 6.1](#). This shows:

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- the highest ground level concentration predicted using 1999 weather data for the two cases;
- the difference between these peak concentrations;
- the highest incremental concentration, which is the largest difference between the concentrations at any point; and
- the highest incremental concentration as a percentage of the relevant air quality objective or environmental assessment level.

The “highest incremental concentration” shows the highest increase in concentration which will be experienced as a result of the operation of line 3. This increment does not necessarily occur at the same place as the highest absolute concentration. Considering the 99.79<sup>th</sup> percentile of hourly ground level concentrations for nitrogen dioxide:

- The peak value resulting from the emissions for all three lines is 15.68  $\mu\text{g}/\text{m}^3$ . This occurs 560 metres from the stack at a bearing of 60°.
- The peak value resulting from the emissions from lines 1 and 2 is 13.29  $\mu\text{g}/\text{m}^3$ . This occurs 470 metres from the stack at a bearing of 54°. (The value at the location of the peak value from the emissions for all three lines is 12.57  $\mu\text{g}/\text{m}^3$ .)
- The difference in peak values is 2.39  $\mu\text{g}/\text{m}^3$ . This doesn't occur at any particular point, since the two peaks occur at different places.
- The highest incremental value is 3.87  $\mu\text{g}/\text{m}^3$ . This occurs 735 metres from the stack at a bearing of 68°.

It can be seen from the table that the incremental impact of line 3 is small. The long term incremental impact is less than 1% of the limit for all substances except Cadmium, while the short term incremental impact is less than 2% of the limit for all substances.

The incremental impact is illustrated in Figure 6.1, which shows the incremental annual average of nitrogen dioxide, and Figure 6.2, which shows the incremental 99.79<sup>th</sup> percentile of hourly averages of nitrogen dioxide.

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Table 6.1 Dispersion Modelling Results, 1999 Weather Data

Pollutant	Quantity	Peak Concentration. ( $\mu\text{g}/\text{m}^3$ )		Difference in Peak Conc. ( $\mu\text{g}/\text{m}^3$ )	Peak Incremental Conc. ( $\mu\text{g}/\text{m}^3$ )	Increment as % of Limit
		Lines 1,2&3	Lines 1&2			
Nitrogen dioxide	Annual Mean	1.03	0.76	0.267	0.28	0.7%
	99.8 <sup>th</sup> %ile of hourly means	15.68	13.29	2.393	3.87	1.9%
Sulphur dioxide	99.9 <sup>th</sup> %ile of 15 minute means	4.77	4.06	0.706	1.13	0.4%
	99.73 <sup>rd</sup> %ile of hourly means	3.56	3.03	0.525	0.95	0.3%
	99.18 <sup>th</sup> %ile of daily means	1.41	1.03	0.383	0.45	0.4%
Particulate matter	Annual mean	0.05	0.04	0.013	0.01	0.08%
	98.1 <sup>st</sup> %ile of daily means	0.259	0.18	0.081	0.084	0.2%
Carbon monoxide	Annual mean	0.261	0.19	0.068	0.071	
	Highest 8-hour running mean	5.01	4.51	0.501	1.15	0.01%
Hydrogen chloride	Annual mean	0.051	0.038	0.013	0.014	0.07%
	Hourly mean	1.210	1.09	0.117	0.307	0.04%
Hydrogen fluoride	Hourly mean	0.121	0.109	0.012	0.031	0.01%
VOCs	Annual mean	0.051	0.04	0.013	0.014	0.6%
Mercury ( $\text{ng}/\text{m}^3$ )	Annual mean	0.257	0.19	0.067	0.070	0.03%
	Hourly mean	6.051	5.467	0.585	1.536	0.02%
Cd & Tl ( $\text{ng}/\text{m}^3$ )	Annual mean	0.257	0.19	0.067	0.070	1.4%
	Hourly mean	6.051	5.467	0.585	1.536	0.1%
Other metals ( $\text{ng}/\text{m}^3$ )	Annual mean	2.566	1.90	0.670	0.696	0.3%
	Hourly mean	60.51	54.67	5.848	15.36	1.5%
PaHs ( $\text{pg}/\text{m}^3$ )	Annual mean	0.513	0.379	0.134	0.139	0.06%
Dioxins ( $\text{fg}/\text{m}^3$ )	Annual mean	0.513	0.379	0.134	0.139	

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## 7 CONCLUSIONS

- 1) The methodology used in this assessment of the impact on air quality of the Eastcroft plant uses a number of conservative assumptions. These include the following:
  - a) It is assumed that the Eastcroft plant will continually operate at the maximum emission limits allowed under the Waste Incineration Directive. In practice, this will not be the case and actual emissions will be less than the limits.
  - b) For heavy metals, emission limits for individual metals have been taken as the maximum limit for the group of metals to which the individual metals belong. This will tend to further overestimate the emissions of these metals.
  - c) For nitrogen dioxide, it is assumed that all oxides of nitrogen are released as nitrogen dioxide.
  - d) The maximum ground level concentrations are considered in each case. These concentrations occur in small areas; in general, the concentration will be much lower.
  - e) For comparison with the air quality objectives, the highest background concentration in Nottingham is added to the maximum ground level concentration from the Eastcroft plant. In reality, these two peaks will not occur at the same time or in the same place, so the combined maximum concentration will be an overestimate.
- 2) Even with these conservative assumptions, the concentration of most pollutants is less than 1% of the long term air quality objective or guideline and less than 20% of the short term air quality objective or guideline. The principal exceptions are:
  - a) The contribution to the annual average concentration of nitrogen dioxide is predicted to be 2.6% of the air quality objective. However, this assumes that all oxides of nitrogen are released as nitrogen dioxide.
  - b) The contribution to the daily average concentration of VOCs is predicted to be 2.3% of the air quality objective for 1,3-butadiene. However, VOCs are a mixture of organic compounds and 1,3-butadiene will only comprise a small fraction of the total VOCs.
  - c) The contribution to the long-term peak concentration of cadmium is predicted to be 5.1% of the air quality guideline. This prediction assumes that the cadmium emissions are at the emission limit for a combination of cadmium and thallium, whereas recent emission monitoring shows that they are actually around a hundred times lower than this.
- 3) A full health risk assessment was carried out for dioxins, including all exposure pathways. This concluded that the contribution from the Eastcroft plant would be only 2.2% of the Tolerable Daily Intake for the Hypothetical Maximally Exposed Individual. For the local and general population, the impact would be insignificant.
- 4) It can therefore be concluded that the impact on either the local community or the general population from the atmospheric emissions from the Eastcroft plant is negligible.
- 5) The incremental impact of the proposed third line has been evaluated and has been shown to be insignificant.

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Annex 1 Stack Height Calculation

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Annex 2 Dispersion Modelling Diagrams

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