Plymouth City Council

Preliminary Air Quality Assessment

For A Proposed Thermal Processing Plant, University Of Plymouth Playing Fields, Ernesettle

Final Report

February 2008

Entec UK Limited

Report for

Plymouth City Council

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Executive Summary

This assessment has used atmospheric dispersion modelling to determine the potential air quality constraints associated with a proposed thermal treatment facility at Ernesettle. The assessment considered the contribution of site emissions of pollutants covered under the Waste Incineration Directive (WID). For the purposes of the assessment, two scenarios have been considered based upon a 80,000 tonnes per annum (tpa) facility and a 180,000 tpa facility.

Emissions from three stack heights (50m, 70m and 90m for the 80,000 tpa facility; and 80, 100 and 120m for the 180,000 facility) were considered. It was determined that, as to be expected, the maximum impacts at the sensitive receptors were from emissions from a 50m stack and 80m stack resulting from 80,000 and 180,000 tpa facilities, respectively.

The dispersion modelling predicts that maximum environmental concentrations of all pollutants comfortably satisfy the appropriate Air Quality Objective, with the vast majority of pollutant concentrations being less than 50% of the objectives, when combined with background levels.

Based upon guidance in the Civil Aviation Authority's (CAA) CAP168 document, it has been determined that the proposed stack would not infringe upon the lateral extents of the critical precision approach and take-off climb obstacle avoidance surfaces of the runway of greatest concern at Plymouth Airport, some 6km NNE of the site.

None of the stack heights would infringe upon the vertical extents of a conical surface surrounding the entire airport. However, consideration still may have to be given to the potential obstacle hazard of the stack and precautionary measures, such as high-visibility lighting, may require installation on the stack.

An assessment of the impacts of atmospheric inversions and aircraft generated vortices from the nearby airport on plume behaviour, revealed ground level concentrations of pollutants that still easily satisfied the appropriate objectives. From an air quality perspective, given that predicted concentrations from all stack heights are considerably less than the objectives, there are no concerns as to which stack height is chosen.

In conclusion, maximum environmental concentrations of all pollutants comfortably satisfy the appropriate Air Quality Objectives, with the vast majority of pollutant concentrations being <50% of the objectives when combined with background levels. An assessment of the potential for dry and wet deposition of nitrogen onto sensitive ecological sites in the area has indicated that the potential addition to existing background levels would be so small as to be insignificant.

It is recommended that, should development of a facility on the site be pursued, the following additional work should be considered;

- undertaking an ambient air quality monitoring survey in the vicinity of the site to better characterise background air quality; and
- consultation with Plymouth City Airport and the CAA on the obstacle limitation surface.

Abbreviations

AQO	Air Quality Objective
AQMA	Air Quality Management Area
AQS	The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (as amended)
AUN	Automatic Urban Air Quality Monitoring Network
CERC	Cambridge Environmental Research Consultants
CO	Carbon Monoxide
Defra	Department for Environment, Food and Rural Affairs
DETR	The (former) Department of the Environment, Transport and the Regions
EAL	Environmental Assessment Level
EfW	Energy from Waste
EPAQS	Expert Panel on Air Quality Standards
EU	European Union
fg m^{-3}	Femtograms per Cubic Metre
LAQM	Local Air Quality Management
MBT	Mechanical and Biological Treatment
mg m^{-3} or mg m-3	Milligrams per Cubic Metre
m s^{-1}	Metres per second
ng m^{-3}	Nanogram per Cubic Metre
NETCEN	The National Environmental Technology Centre
NMVOC	Non-Methane Volatile Organic Compounds
NNR	National Nature Reserve
NO_2 or NO_2	Nitrogen Dioxide
NO_X	Oxides of Nitrogen
PC	Process Contribution
PEC	Predicted Environmental Concentration
PM	Suspended Particulate Matter
PM_{10} or PM10	Particulate Matter of Aerodynamic Diameter greater than 10 µm
Ramsar	Ramsar sites are designated under the International Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention)
RDF	Refuse Derived Fuel
SAC	Special Area of Conservation
SO_2 or SO2	Sulphur Dioxide
SPA	Special Protection Area

SSSI	Site of Special Scientific Interest
TOC	Total Volatile Organic Compounds
TOMPS	Toxic Organic Micro Pollutants
tpa	Tonnes per annum
VOC	Volatile Organic Compound

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1. Introduction

Entec UK Limited has been commissioned by Plymouth City Council to identify waste management sites as part of the Waste Strategy Development Document. Following an assessment of sites within the Council's administrative boundaries, the former University of Plymouth playing fields at Ernesettle were identified as a potential strategic waste facility.

Although no definitive technology has been identified, this report aims to assess the impacts on local air quality due to atmospheric emissions from an indicative 80,000 tpa thermal processing plant and a 180,000 tpa joint regional facility thermal processing plant. A stack height will be proposed that will limit the air quality impacts arising from dispersion of residual emissions, but will not cause an obstacle for aircraft movements at the local airport, as defined in the Civil Aviation Authority's CAP 168 document.

1.1 Aims and Objectives

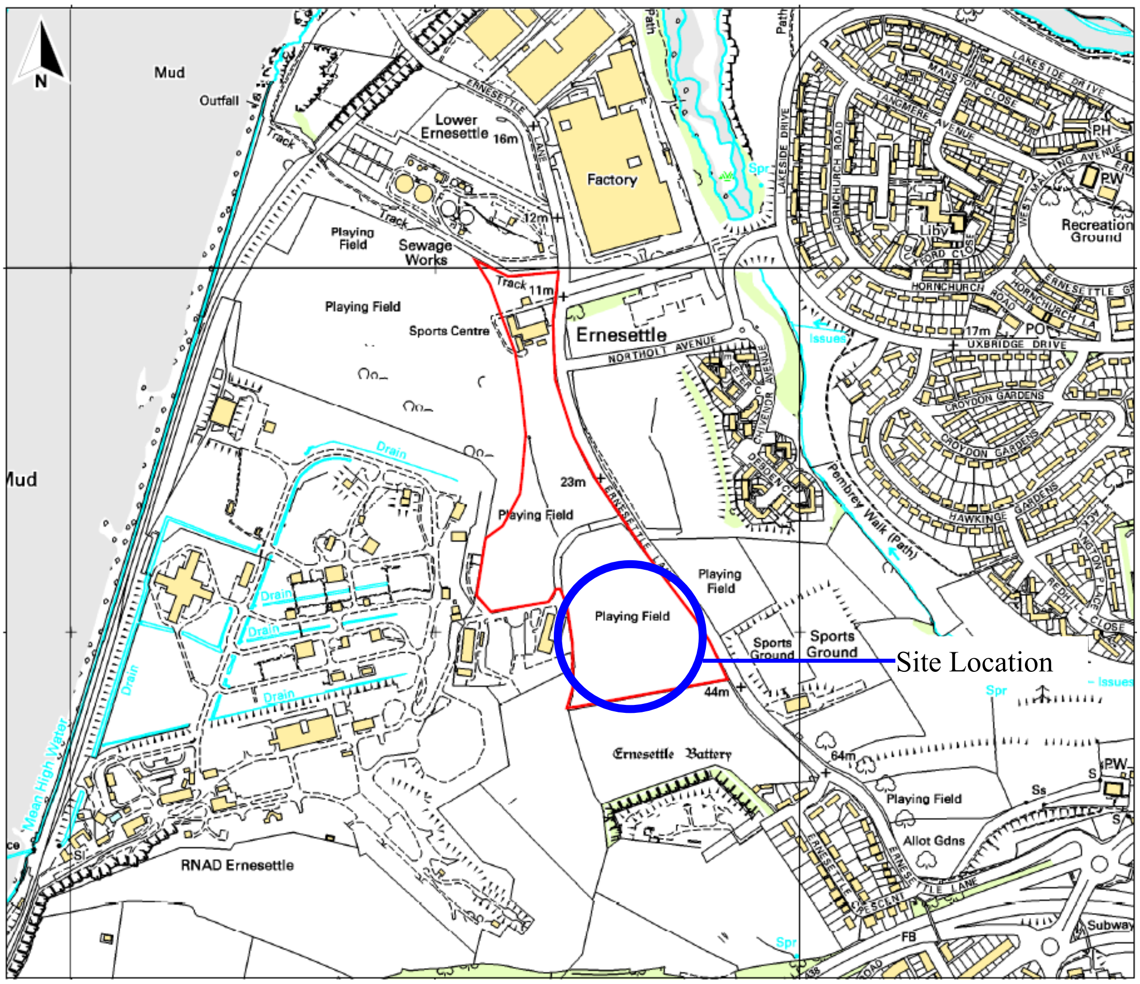
At the request of Plymouth City Council, Entec UK Limited has assessed the likely required stack height for the proposed thermal treatment facility with emission concentrations of key potential pollutants at the emission limits set under the Waste Incineration Directive 2000/76/EC.

In determining a suitable stack height, this air quality assessment considers the impact of the process emissions on local background air quality and the obstruction impacts of such a stack on aircraft utilising Plymouth City Airport.

The dispersion of emissions is predicted using an appropriate dispersion model, with results presented in graphical format. The assessment considers both short and long-term effects in relation to the air quality standards set in legislation and in Government and international guidance. The evaluation criteria used to assess the results of the modelling are based on The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DEFRA, 2000, as amended 2007).

The location of the possible site is shown in Figure 1.1 overleaf.

Figure 1.1 Proposed Site Location



1.2 Sources of Information

The information used to assess air quality includes:

- Emissions data calculated by Entec UK Limited based on supplied process data, WID emission limits and operating data;
- Site locations from Plymouth City Council and Ordnance Survey mapping;
- Baseline air quality data from surveys undertaken by Government bodies, Local Authorities and third parties;
- Ordnance Survey (OS) maps of the local area; and
- Meteorological data supplied by Atmospheric Dispersion Modelling Ltd.

1.3 Structure of the Assessment

The remainder of the report is set out as follows:

Table 1.2 Report Structure

Section	Aims and Objectives
Section 2	Sets out standards and guidelines used to assess the air quality impacts of the process
Section 3	Describes the ambient air quality in the area
Section 4	Describes the dispersion model, assessment methodology, model inputs and assumptions used in the assessment
Section 5	Presents an assessment of the potential impacts arising from the site emissions
Section 6	Summarises the findings of the assessment

2. Assessment Criteria

2.1 Air Quality Impacts of the Process

The atmospheric emissions of eleven classes of pollutants have been identified as requiring detailed dispersion modelling based on the pollutants covered by the Waste Incineration Directive 2000/76/EC.

The emitted pollutants of primary concern to the local environment are:

- Carbon Monoxide (CO);
- Oxides of Nitrogen (NO_X as NO_2);
- Particulate matter of diameter less than 10 µm (PM_{10});
- Sulphur Dioxide (SO_2);
- Total Organic Compounds (TOC);
- Hydrogen Chloride (HCl);
- Hydrogen Fluoride (HF);
- Group 1 Metals (e.g. Cadmium);
- Group 2 Metals (e.g. Mercury);
- Group 3 Metals (e.g. Lead); and
- Dioxins and furans, including dioxin-like polychlorinated biphenyls (PCBs)

A brief description of each pollutant is given in Table 2.1.

Table 2.1 Summary of Pollutants Assessed

Pollutant	Description And Effect On Human Health And The Environment	Principal Sources
Carbon Monoxide[B, C] (CO)	The toxicity of CO results in it binding avidly to haemoglobin and thus reducing the oxygen-carrying capacity of the blood. In very high doses, the restriction of oxygen to the brain and heart can be fatal. At lower concentrations, CO can affect higher cerebral function, heart function and exercise capacity.	The principal source of CO is emissions from petrol vehicles, accounting for 98% of CO emissions within urban areas and 73% of total UK emissions in 1998.

Table 2.1 (continued) Summary of Pollutants Assessed

Pollutant	Description And Effect On Human Health And The Environment	Principal Sources
Dioxins and furans	The term dioxins and furans are used to refer to polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. These compounds have been shown to possess a number of toxicological properties. The major concern is centred on their possible role in immunological and reproductive effects. They can potentially arise from any thermal process where chlorine, in any form, is present.	Waste incineration (73%), domestic combustion (5%)
Hydrogen Chloride (HCl)[D, E]	Hydrogen chloride is a toxic gaseous compound. It produces protein denaturation and hence cell death. Exposure to inhalation of HCl can affect the alveolar cells. Pulmonary oedema may develop after two to twelve hours. Other symptoms can include: • Cough; • Dyspnoea; and • Chest pain. Also, it can damage the cornea causing intense ocular irritation[D].	The majority of HCl emissions in the UK are from public power installations (83%). The remaining emissions are from other fuel combustion and waste incineration.
Hydrogen Fluoride[C] (HF)	HF is an extremely corrosive chemical and is rapidly absorbed into the body where it acts on all cells as a direct poison. It permeates and dissolves most surfaces. This compound may cause: • Disturbance of calcium and magnesium metabolism; • Pulmonary fibrosis; • Cardiac arrhythmias; and • Bone damage.	Some uses of HF include: • Etching and glass cleaning in the manufacture of glass; • Semiconductors (computer chips), and ceramics; • Rust removal; • Metallurgy laboratories; • Petroleum exploration, refining (alkylation units); • Electroplating; • Ceramic cleaning; • Aluminium brighteners; • Various chemical industries.
Metals	These are present as solids and liquids associated with particulate matter. The metals considered have a range of toxic and carcinogenic effects including increased risk of lung cancer, renal disease and effects on the nervous system and kidneys.	Fuel combustion and industrial processes.
Oxides of Nitrogen[A, B, C] (NO_X)	Nitrogen dioxide (NO_2) and Nitric Oxide (NO) are both collectively referred to as oxides of Nitrogen (NO_X). It is NO_2 that is associated with adverse effects on human health. Most atmospheric emissions are in the form of NO which is converted to NO_2 in the atmosphere through reactions with Ozone. The oxidising properties of NO_2 theoretically could damage lung tissue, and exposure to very high concentrations of NO_2 can lead to inflammation of lung tissue, affect the ability to fight infection. The greatest impact of NO_2 is on individuals with asthma or other respiratory conditions.	All combustion processes produce NO_X emissions, and the principal source of NO_X is road transport, which accounted for 49% of total UK emissions in 2000.

Table 2.1 (continued) Summary of Pollutants Assessed

Pollutant	Description And Effect On Human Health And The Environment	Principal Sources
Particulate Matter (PM)	Particulate matter is the term used to describe all suspended solid matter. Particulate matter with an aerodynamic diameter of less than 10 µm (PM_{10}) is the subject of health concerns because of its ability to penetrate and remain deep within the lungs. The health effects of particles are difficult to assess, and evidence is mainly based on epidemiological studies. Evidence suggests that there may be associations between increased PM_{10} concentrations and increased mortality and morbidity rates, changes in symptoms or lung function, episodes of hospitalisation or doctors consultations.	Road transport, industrial processes and electricity generation. Other pollutants, including NO_2 and SO_2, have the potential to form secondary particulates which are often smaller than PM_{10}.
Sulphur dioxide (SO_2)[B]	At high concentrations SO_2 is a potent bronchoconstrictor, and asthmatic individuals are more susceptible. It is likely that SO_2 contributes to respiratory symptoms, reduced lung function and rises in hospital admissions. Exposure to high levels of SO_2 over a long period can result in structural changes in the lungs and may enhance sensitisation to allergens.	The principal source of SO_2 is the combustion of fossil fuels containing Sulphur, and in the UK this is primarily through the combustion of coal in power stations. Industry and domestic combustion and transport also emit SO_2.

A DEFRA, 2003, Part IV of the Environment Act 1995 Local Air Quality Management: Technical Guidance LAQM.TG(03).
B Harrison, R.M., *Air Pollution: Sources, Concentrations and Measurements*. In: Harrison, R.M., 2000, *Pollution: Causes, Effects and Controls*, 4th Edition Royal Society of Chemistry.
C Walters, S. and Ayers, J., *The Health Effects of Air Pollution*. In: Harrison, R.M., 2000, *Pollution: Causes, Effects and Controls*, 4th Edition Royal Society of Chemistry.
D GP Notebook, *Hydrogen Chloride*, http://www.gpnotebook.co.uk/cache/-1502937008.htm
E NETCEN, UK Emissions of Hydrogen Chloride 1994 and 1970, http://www.aeat.com/netcen/airqual/emissions/hcl.html, Last updated 28 October 1998

2.2 Air Quality Standards

Details of the ambient air quality standards and criteria used in this assessment are included in Appendix A. In summary, the criteria used are drawn from the following sources;

- EU Directives and the corresponding UK regulations;
- UK Air Quality Objectives (AQOs);
- WHO air quality guidelines for Europe; and
- UK Environment Agency Environmental Assessment Levels (EALs – derived from occupational exposure standards)

The numerical values and averaging periods for these air quality criteria are given in section 2.4, together with an indication of status (statutory/non-statutory).

2.3 Local Authority Review and Assessment

Part IV of the Environment Act 1995 requires that Local Authorities in England and Wales periodically review air quality within their individual areas. This process of Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQOs.

To carry out an air quality Review and Assessment under the LAQM process, the Government recommends a three-stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified to be at potential risk of exceeding the objectives in the Regulations.

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's air quality objectives by the required dates.

For the purposes of determining the focus of Review and Assessment, Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an Air Quality Management Area (AQMA). The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP), to reduce air pollution concentrations so that the required AQOs are met.

2.4 Air Quality Assessment Criteria

A summary of the relevant air quality standards that relate to the substances included in this assessment is given in **Table 2.2**.

Table 2.2 Air Quality Standards, Objectives and Guideline Values

Substance	Source	Statutory or Non-statutory	Averaging Period	Value ($\mu g\ m^{-3}$)	Date to be achieved
Cadmium (Group 1 Metal)	EAL	N	Annual mean	0.005	-
	EAL	N	1-hour Maximum	1.5	-
Carbon Monoxide	AQS	S	Maximum daily running 8-hour mean (equivalent of 100 percentile)	10 mg m^{-3}	31 Dec 2003
	EAL	N	Annual Mean	350	-
Hydrogen Chloride	EAL	N	Annual mean	20	-
	EAL	N	1-hour Maximum	800	-
Hydrogen Fluoride	EAL	N	Annual mean	-	-
	EAL	N	1-hour Maximum	350	-
Lead (Group 3 Metal)	AQS	S	Annual Mean	0.25	31 Dec 2008
Mercury (Group 2 Metal)	EAL	N	Annual mean	0.25	-
	EAL	N	1-hour Maximum	7.5	-
Nitrogen Dioxide	AQS	S	Annual mean	40	31 Dec 2005
	AQS	S	1-hour mean, not more than 18 exceedences a year (equivalent of 99.79 percentile)	200	31 Dec 2005
Nitrogen Oxides	AQS	N	Annual mean For the protection of vegetation	30	31 Dec 2000
PM_{10}	AQS	S	Annual mean	40	31 Dec 2004
	AQS	N	Annual mean (England and Wales, not London)	20	31 Dec 2010
	AQS	S	24-hour mean, not more then 35 exceedences a year	50	31 Dec 2004
	AQS	N	24-hour mean, not more than 7 exceedences a year (England and Wales, not London)	50	31 Dec 2010
Sulphur dioxide	AQS	S	1-hour mean, not to be exceeded more than 24 times a year	350	31 Dec 2004
	AQS	S	24-hour mean, not to be exceeded more than 3 times a year	125	31 Dec 2004
	AQS	S	15-min mean, not to be exceeded more than 35 times a year	266	31 Dec 2005

3. Existing Ambient Air Quality

3.1 Continuous Monitoring Data

A network of continuous air quality monitoring stations is sponsored by Defra in the UK. The nearest such station to the site is situated approximately 6 km away in Plymouth city centre. However, this station is designated as an urban centre monitoring location and, as such, would not best represent background concentrations in the area. Consequently, this data has been excluded from consideration in the assessment.

3.2 Passive Monitoring Data

There are a number of passive monitoring locations within the Plymouth City Council (CC) area, operated as part of the National Diffusion Tube Network. The closest to the site are located in Saltash, approximately 10km to the west. Recent monitoring data is given in **Table 3.1**.

Table 3.1 National NO_2 Diffusion Tube Monitoring Results – Annual Means (µg m^{-3})

	SALTASH 3N	SALTASH 7N
Location	Background	Roadside
2001	16.2	43.7
2002	Insufficient Data Capture	Insufficient Data Capture
2003	17.2	42.7
2004	No Data	35.2

Monitoring of NO_2 is also undertaken directly by Plymouth City Council as part of its responsibilities under LAQM. The latest QA/QC verified data is contained within the Council's 2004 detailed assessment report.

Table 3.2 Plymouth CC NO_2 Diffusion Tube Monitoring Results – 2003 Annual Means (µg m^{-3})

Site	Classification	Bias Adjusted Concentration
Mutley Plain	Roadside	52.71
Exeter Street	Roadside	45.42
Plymouth Road	Roadside	31.36
Embankment Road	Roadside	33.22

The diffusion tube results indicate that there are occurrences of the annual mean objective being exceeded at certain roadside locations. However, individuals are unlikely to be exposed for the full duration of the averaging period at such locations.

3.3 Estimated Ambient Concentrations

The National Environmental Technology Centre (NETCEN) has made estimates of background pollution concentrations on a 1 km^2 grid for the UK for seven of the main pollutants, with a 2001 base year. For NO_2 and PM_{10} an updated version is available with a 2004 base year.

The background mapped concentrations for the 1 km^2 covering the site are given in Table 3.3. Where data is unavailable for the year considered, the concentrations have been predicted from the nearest year based on methodology set out in Local Air Quality Management technical guidance (Defra, 2003). There is no methodology to forecast sulphur dioxide to future years. Consequently, data for 2001 only is presented.

Table 3.3 Estimated Mapped Background Concentrations

	PM_{10} Annual Mean µg m^{-3}	NO_2 Annual Mean µg m^{-3}	SO_2 Annual Mean µg m^{-3}	CO Annual Mean mg m^{-3}
2001	-	-	1.81	0.233
2003	-	-	-	-
2004	15.8	8.54	-	-
2005	15.7	8.22	-	-
2007 [A]	15.1	7.82	-	-
2010	14.6	6.61	-	-

Note
A Concentrations calculated using guidance outlined in LAQM TG.(03)

3.4 Toxic Organic Micro Pollutants (TOMPS) Network

Nine sites in the UK measure dioxin concentration as part of the TOMPS Network. Samples are collected over two week periods, bulked together and analysed every six months for dioxins. Concentrations of the most potent dioxin, 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (2, 3, 7, 8-TCDD), from the TOMPS Network, are presented in the table below;

Table 3.4 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin Annual Means

Site	Year	Annual Mean Concentration (fg m^{-3})
Hazelrigg (semi-rural)	2002	1
	2003	2
	2004	2
London 2a (urban)	2002	2
	2003	2
	2004	2
Manchester (urban)	2002	2
	2003	5
	2004	2
Middlesbrough (urban)	2002	2
	2003	6
	2004	2
Stoke Ferry (rural)	2002	-
	2003	2
	2004	2

Note: 1 fg = $1x10^{-15}$ g

It is considered that concentrations at Hazelrigg would be most representative of those at the Ernesettle site, due to the similar semi-rural surroundings.

3.5 Lead and Trace Metals Monitoring Network

Lead and other trace metals are currently measured at 25 sites around the UK as part of Defra's trace element survey. However, the nearest site is located in North Petherton, Somerset, approximately 110km to the north-east. The ratified 2004 data indicates that metal concentrations, averaged across the entire network are low, accounting for less than 5% of the relevant standard in all cases.

Table 3.5 Annual Metal Concentrations Averaged over the UK Network (ng m^{-3})

Year	As	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Pt	V	Zn	Hg
2004	1.12	0.65	6.76	20.76	463	10.02	5.38	24.69	<0.06	2.12	105.3	0.71

As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Fe = Iron; Mn = Manganese; Ni = Nickel; Pb = Lead; Pt = Platinum; V = Vanadium; Zn = Zinc; Hg = Mercury

3.6 Acid Monitoring Networks

Hydrogen chloride and hydrogen fluoride concentrations are not routinely measured in the UK. The United Kingdom Review Group on Acid rain measured rural concentrations at Harwell between 1984 and 1986. The peak short-term concentration measured during this time was 2.5 µg m^{-3} which is much less than the derived standards for both the annual mean (20 µg m^{-3}) and maximum hourly concentration (800 µg m^{-3}).

Although concentrations measured at Harwell in 1986 are not relevant to the site, there is no reason to believe that concentrations at the site would be much higher than these since there are no significant sources of hydrogen chloride or hydrogen fluoride emissions close to the proposed site.

3.7 Local Air Quality Management

Following the first stage of review and assessment under LAQM in 2000, Plymouth City Council recommended a combined stage two and three assessment for NO_2 and PM_{10}, due to concerns of potential exceedences of the objectives at busy road junctions, within the city centre.

The subsequent Update and Screening Assessment (USA) in May 2003 highlighted four locations within the city where monitoring data indicated potential exceedences of the annual mean NO_2 objective by 2005. Concern was also expressed as to the potential PM_{10} threats posed to residents living near to ports handling dusty cargo.

The Council undertook a detailed assessment of air quality in 2004. Based upon the results of this assessment, the Council declared two AQMAs for NO_2 at separate road junctions in the city centre. An isolated point source emission of benzene from a petrol station was also highlighted and, due to the station being located only 10m away from a school, a third AQMA for benzene was declared, encompassing the area surrounding the station. However, the need for a PM_{10} AQMA was revoked as a result of the detailed assessment.

The AQMAs are approximately 5km to the south-west of the proposed site, within the city centre. Due to the prevailing wind direction (section 4.3) and distance to the AQMAs, it is not expected that site emissions will have a great influence on concentrations within the AQMAs.

4. Assessment Methodology

4.1 The Dispersion Model

The model used in this assessment is the ADMS 4 advanced atmospheric dispersion model that has been developed and validated by Cambridge Environmental Research Consultants (CERC). The model was used to predict the ground level concentrations of compounds emitted from the proposed EfW plant at the University of Plymouth's playing fields, Ernesettle. The model has been used extensively throughout the UK for regulatory compliance purposes and is accepted as a permissible air quality modelling tool by the Environment Agency and local authorities.

The model uses a range of input parameters including, among others, data describing the local area, meteorological measurements, emissions data and stack flow rate parameters. The data used in modelling the plant emissions are given in the following sections of this chapter.

4.2 Plant Emissions

Details of the plant emissions to atmosphere arising from the proposed plant, under normal operating conditions, are based on capacity information provided by Plymouth City Council and process data derived by Entec during previous modelling studies for plants of a similar capacity[1]. Emission rates and process parameters are calculated for two scenarios:

- 80,000 tpa thermal processing; and
- 180,000 tpa thermal processing.

As no specific technology has been identified, it has been assumed that the plant will handle bulk municipal waste as a worst-case assumption. The combustion of municipal waste is less efficient than refuse derived fuel (RDF). This ultimately results in a greater volume of waste flue gas per mass of throughput.

Emission rates have been derived based upon emission limits given in IPPC Sector Guidance Note S5.01[2], which contains emission limits implemented by the Waste Incineration Directive (WID) 2000/76/EC. These emission concentrations are given in Appendix B.

Details of the stack parameters and emission rates used in the modelling can be found in **Tables 4.1** and **4.2.**

[1] Entec (2001), Capel Energy from Waste Plant Air Quality and Health Risk Assessment

[2] Environment Agency (2001), Sector Guidance Note IPPC S5.01 – Sector Guidance for the Incineration of Waste and Fuel Manufactured from or Including Waste

Table 4.1 Stack Parameters Used in the Modelling

Parameter	Value	
	80,000 TPA Capacity	180,000 TPA Capacity
Location (X)	244855	244855
Location (Y)	59390	59390
Stack Height (m)	To be determined by this assessment	To be determined by this assessment
Stack Diameter (m)	1.48	2.22
Efflux Velocity (ms^{-1})	18	18
Volumetric Flux at Actual conditions (Am^3s^{-1})	25.70	57.83
Efflux Temperature (°C)	157	157

Table 4.2 Emission Rates Used in the Modelling

	80,000 TPA Capacity		180,000 TPA Capacity	
Pollutant	**Long-term Emission Rate (gs^{-1})**	**Short-term Emission Rate (gs^{-1})**	**Long-term Emission Rate (gs^{-1})**	**Short-term Emission Rate (gs^{-1})**
CO	1.13	2.26	2.55	5.09
NO_X	4.53	9.05	10.19	20.37
SO_2	1.13	4.53	2.55	10.19
PM_{10}	0.23	0.68	0.51	1.53
HCl	0.23	1.36	0.51	3.06
HF	0.02	0.09	0.05	0.20
TOC	0.23	0.45	0.51	1.02
Group 1 Metals	0.01	0.01	0.03	0.03
Group 2 Metals	1.13×10^{-3}	1.13×10^{-3}	2.55×10^{-3}	2.55×10^{-3}
Group 3 Metals	1.13×10^{-3}	1.13×10^{-3}	2.55×10^{-3}	2.55×10^{-3}
Dioxins and furans	2.26×10^{-9}	2.26×10^{-9}	5.09×10^{-9}	5.09×10^{-9}

The WID contains three emission limit averaging periods – a daily average and two short-term 10-30min averages at the 97^{th} and 100^{th} percentile. For this assessment, the daily average has been used in calculating long-term means and the 100^{th} percentile average 10-30 min average for short-term means

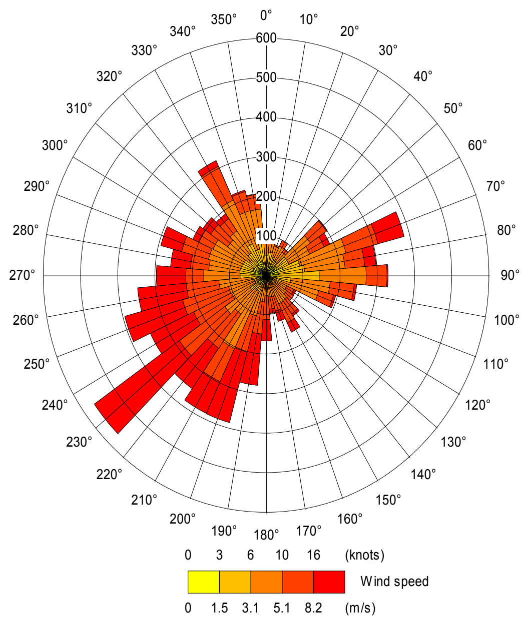
4.3 Meteorology

Plymouth Mount Batten meteorological station is situated approximately 6 km to the south-east of the site. This station measures meteorological parameters on an hourly basis and, therefore, provides data suitable for input to the dispersion model. Meteorogical data measured at Plymouth-Mountbatten meteorogical station for 2002 to 2006 inclusive has been used in this assessment.

The following figures illustrate the frequency of wind directions and wind speeds recorded in each of the years considered. The wind roses depict a prevailing south-westerly wind with a frequent easterly component. 2003 and 2005, in particular, had greater frequencies of easterly wind. Winds are generally moderate, with a significant proportion of the wind speeds in the range 3 to 8 m s^{-1}. Due to the close proximity of the meteorogical station to the site, these winds are considered to be representative of those occurring at the site.

It should be noted that cloud cover measurements were discontinued at this site in 1996. Therefore, where appropriate, the Plymouth meteorogical data has been supplemented with cloud cover measurements taken at Culdrose meteorogical station.

Figure 4.1 Plymouth 2002 Wind Rose



Entec

Figure 4.2 Plymouth 2003 Wind Rose

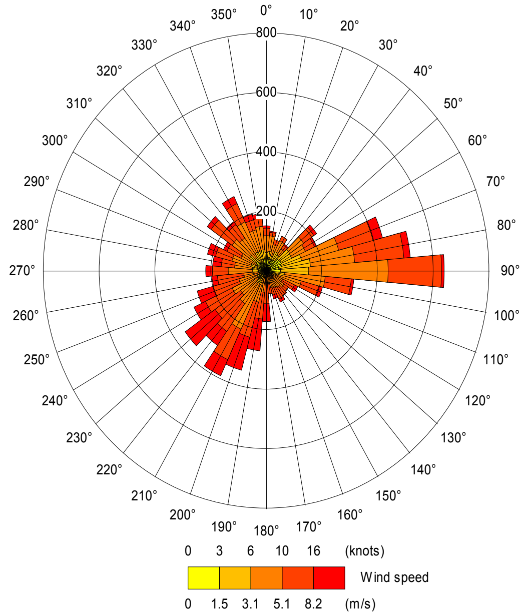
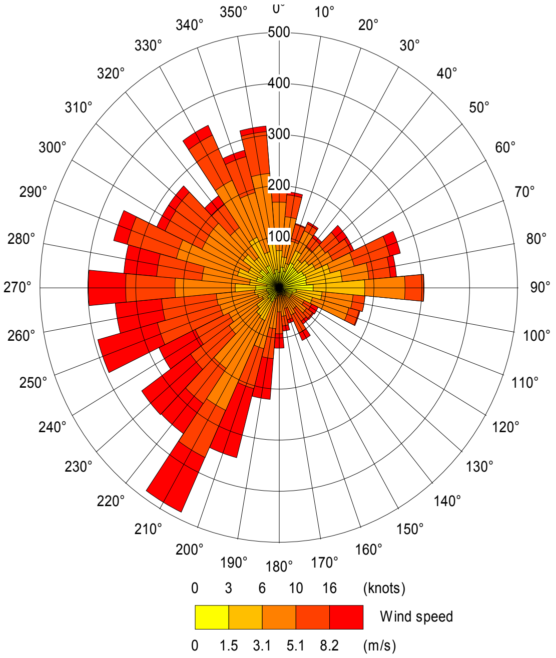


Figure 4.3 Plymouth 2004 Wind Rose



Entec

Figure 4.4 Plymouth 2005 Wind Rose

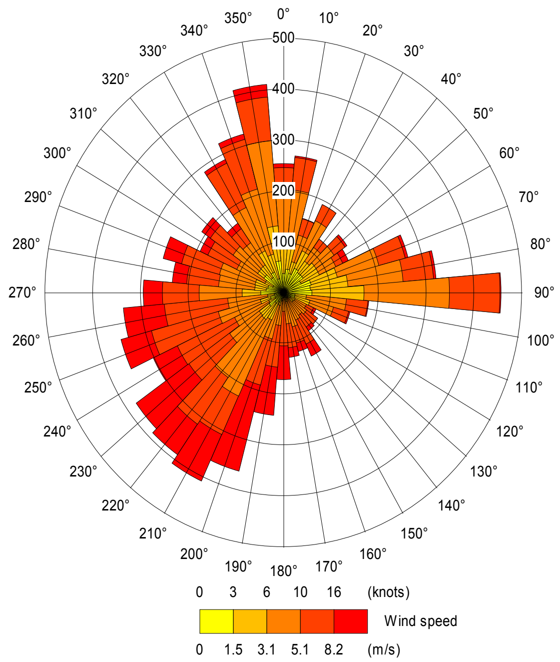
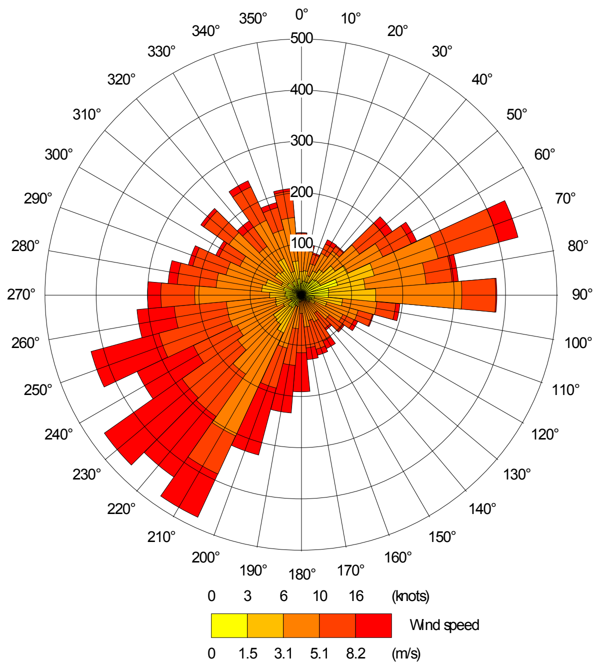


Figure 4.5 Plymouth 2006 Wind Rose



4.4 Surface Characteristics

4.4.1 Land Characteristics

The predominant characteristics of land use in an area provides a measure of the vertical mixing and dilution that takes place in the atmosphere due to factors such as surface roughness and albedo, a measure of the amount of radiation reflected from a surface.

Examination of 1:25,000 Ordnance Survey maps has shown that the area surrounding the site is predominantly open with isolated buildings. However, to incorporate the effect of existing buildings at the site and localised terrain, an increased surface roughness length of 0.7 m was used to represent the land characteristics.

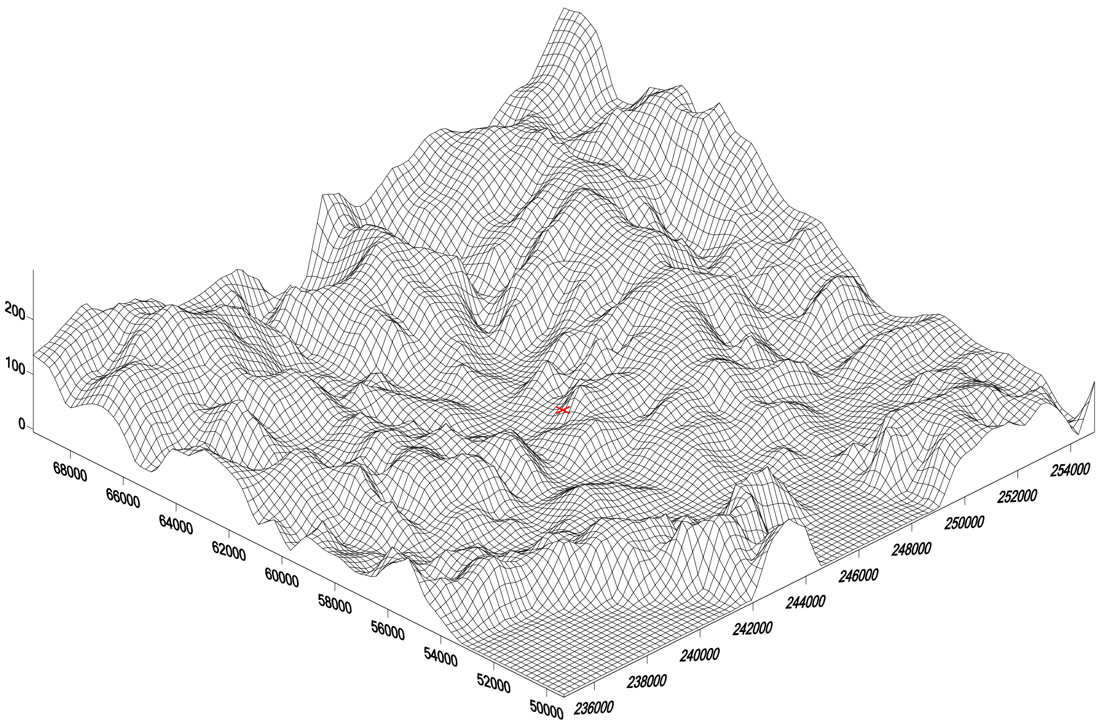
4.4.2 Terrain

Topographical features such as hills can have a significant effect on the dispersion of pollutants, generally when the ground level within 1 km of the sources varies by more than 100m (1 in 10).

The site is located within a valley and in order to best represent the dispersion process, digital terrain mapped data supplied by emapsite.com was included in the model.

Figure 4.6 visually depicts the terrain surrounding the site.

Figure 4.6 Terrain Map of the Local Area



4.4.3 Treatment of Buildings

Air passing over a building tends to move towards the ground in its lee; an effect known as downwash. The potential for downwash to affect plume dispersion is an important consideration, particularly where the stack is less than 2.5 times the height of nearby buildings.

The following assumed building has been included in the dispersion model.

Table 4.3 Buildings Included in the Model

Building	X (m)	Y (m)	Height (m)	Length (m)	Width (m)	Angle (°)
Waste Processing Building	244855	59390	25	30	45	0

4.5 Modelled Domain and Receptors

4.5.1 Modelled Domain

A 4 x 4 km square grid centred on the site was modelled, with a grid receptor point resolution of 50 m, to assess the impact of atmospheric emissions from the site on local air quality.

4.5.2 Sensitive Human Receptors

The receptors considered in this assessment are not an exhaustive list, but include the nearest residential properties and other receptors selected according to distance and direction from the site.

The human receptors considered were chosen based on locations where people may be present, the likely duration of their exposure to odour and proximity to the site. Details of the locations of human receptors considered in this assessment are given in

Table 4.4, as identified from Ordnance Survey plans and site visits.

Table 4.4 Modelled Sensitive Human Receptors

Receptor Name	Easting (m)	Northing (m)
Ernesettle Lane Houses	245090	59234
Ernesettle Crescent Houses	254016	59192
Agaton Road Houses	245057	58994
Bickham Road Houses	244887	58838
Waverley Road Houses	244596	58689
Kinsale Road Houses	245567	59317
Russet Wood School	245888	59797
Kenley Gardens School	245672	59714
Debden Close Houses	244959	59663
Redhill Close Houses	245327	59516
Rochford Crescent Houses	245685	60144
Old Ferry Road Houses	243241	59013

4.5.3 Sensitive Ecological Receptors

IPPC guidance (Environment Agency, 2003) requires detailed dispersion modelling to be carried out based on local receptors. In ecological terms, the sensitive receptors to be considered include,

> *"A site of special scientific interest (SSSI), a special protection area (SPA) or a special area of conservation (SAC) within 10 km of the installation".*

A survey was carried out of the various sites of ecological designation within 10 km of the site; the following designations were considered:

- Sites of special scientific interest (SSSI);
- Special areas of conservation (candidate and potential/proposed) (cSAC and pSAC);
- Special protection areas (SPA); and
- Ramsar sites.

The following ecological designated sites, as detailed in **Table 4.5**, were identified within 10 km of the site.

Table 4.5 Modelled Ecological Receptors

Name	Designation	Grid Ref.	Area (ha)	Status
Tamar-Tavy Estuary	SSSI	244918 , 60041	1422.33	Listed
South Dartmoor Woods	SAC	253288 , 63629	2157.15	Listed
Plymouth Sound and Estuaries	SAC	244918 , 60041	6402.03	Listed
Tamar Estuaries Complex	SAC	244918 , 60041	6402.03	Listed

Table 4.6 below gives more detail of the SPA/SAC sites.

Table 4.6 Reasons for Designation of SPA/SAC Sites

Name of Site	Reason for Designation
Plymouth Sound & Estuaries SAC	Sandbanks which are slightly covered by sea water all the time.
	Estuaries.
	Atlantic Salt Meadows
	Mudflats and sandflats not covered by seawater at low tide.
	Large shallow inlets and bays.
	Reefs.
	Shore dock.
	Allis shad.
Tamar Estuaries Complex SPA	Internationally important populations of Avocet & Little Egret
South Dartmoor Woods SAC	Old sessile oak woodlands Ilex and Blechnum in the British Isles
	European dry heath

4.6 Special Treatments

4.6.1 Deposition

The predominant route by which emissions will affect the land in the vicinity of the process is by deposition of atmospheric emissions. The model used to predict local air quality has the capability of incorporating both dry and wet deposition based on the gas type or particle size and density. For the purposes of this assessment, dry deposition of NO_2 is considered to be the predominant mechanism by which nutrient enrichment of ecological sites and habitats could be affected by emissions from the proposed plant at Ernesettle. NO_2 is sparingly soluble in water and will be washed out of the atmosphere by rainfall. As a worst-case assumption, the total NOx burden of the flue gases was assumed to consist of NO_2. A dry deposition velocity of 0.02 m s^{-1} was used and a washout factor of 0.003.

4.6.2 Other Treatments

Specialised model treatments, for short-term (puff) releases, coastal models, fluctuations or photochemistry were not used in this assessment.

4.7 Conversion of NO to NO_2

Emissions of oxides of Nitrogen (NO_X) from combustion processes are predominantly in the form of Nitric oxide (NO). Excess Oxygen in the combustion gases and further atmospheric reactions cause the oxidation of NO to Nitrogen dioxide (NO_2). Given the short travel time to the areas of maximum concentration and the rate of reaction to convert NO to NO_2, it is unlikely that more than 30% of the NO_X is present at ground level as NO_2. This conversion factor is based on comparison of ambient NO and NO_2 continuous measurements evaluated over recent years.

Ground level NO_X concentrations have been predicted by the atmospheric dispersion modelling. NO_2 concentrations reported in the results section assume 100 % conversion from NO_X to NO_2 for the long-term, annual averages and a 50 % conversion for short-term (hourly) averages. When assessing the predicted concentrations, it should be noted that these predictions are therefore, pessimistic and the concentrations are likely to be an overestimation of the actual plant contributions.

4.8 Background Concentrations

For NO_2, SO_2, PM_{10} and CO, conservative short-term ambient levels have been derived from the estimated annual mean data shown in **Table 3.2**.

The annual average process contribution for each pollutant is added to the annual average ambient background concentration, to give a total concentration at each receptor location. This total concentration can then be compared against the relevant AQO and the likelihood of an exceedence determined. It is not technically rigorous to add predicted short-term or percentile concentrations to ambient background concentrations not measured over the same averaging period, since peak contributions from different sources would not necessarily coincide in time or location. Without hourly ambient background monitoring data available it is difficult to make an assessment against the achievement or otherwise of the short-term AQOs. For the current assessment, conservative short-term ambient levels have been derived from the annual mean data. The short-term ambient background concentration of NO_2 has been determined by doubling the annual mean ambient concentration. For CO, the running 8-hour mean ambient concentration has been determined by multiplying the annual mean concentration, as shown in **Table 3.2**, by a factor of 10.

Background concentrations included within the modelling assessment are detailed in **Table 4.7** below.

Table 4.7 Short-Term and Long-Term Ambient Background Concentrations

Pollutant	Short-term mean	Long-term (annual) mean
NO_2 (µg m^{-3})	15.64	7.82
CO (mg m^{-3})	2.33	0.233
PM_{10} (µg m^{-3})	30.2	15.1
SO_2 (µg m^{-3})	3.62	1.81

Note: Concentrations are forecasted to the latest year that methodology is available for

There are no TOMPS monitoring stations located within south-west England. However, concentrations at the site are expected to be low. There is no background concentration data available for HF, HCl, TOC or any of the Group metals considered for a location representative of the site. It has therefore been assumed that the ambient concentrations of these compounds are zero.

Current background nitrogen deposition levels at the South Dartmoor Woods SAC are estimated (from the Air Pollution Information System web site - APIS) to be 16.9 kg ha^{-1} $year^{-1}$, against a Critical Load range of 10-20. For the Tamar Estuaries Complex and Plymouth Sound and Estuary areas, the estimated background deposition levels are 19.2 kg N ha^{-1} $year^{-1}$, against a Critical Load range of 30 - 40.

5. Assessment of Potential Impacts

This section sets out the results of the dispersion modelling and compares predicted ground level concentrations to ambient air quality standards for the proposed thermal processing plant at University of Plymouth's playing fields, Ernesettle.

When interpreting the results in this section, it should be remembered that the AQS objectives and other air quality standards apply,

> *"In non-occupational near ground level outdoor locations where a person might reasonably be expected to be exposed over the relevant averaging period"* (DETR, 2000).

For long-term average concentrations, this has been interpreted to mean at the nearest residential properties; for short-term average concentrations, this has been interpreted to mean at any location outside the site boundary.

The predicted concentrations resulting from the process are presented with background concentrations and the percentage contribution that the process concentrations would make towards the relevant AQS. The background concentrations of each of the pollutants are discussed in section 3.3.

The impact of the plant has been modelled for the emission conditions described in section 4.2 and on a 4 x 4 km square receptor grid.

Results are presented for the meteorological year resulting in the highest ground level concentrations as a worst case assumption. The worst-case was determined separately for long- and short-term concentrations based on NO_2.

5.1 80,000 TPA Capacity

Table 5.1 Determination of Worst-Case Meteorological Year – 80,000 T Per Annum Capacity

Year	Predicted Ground Level Concentration due to Process Emissions (μgm^{-3})	
	NO_2 Annual Mean	NO_2 99.79 Percentile of 1-Hour Mean
2002	**2.91**	24.95
2003	2.35	25.22
2004	2.54	26.04
2005	2.48	**27.04**
2006	2.83	25.75

Note these concentrations are based on emissions from a 50m stack and at the receptor experiencing the greatest concentration

From the above predicted ground level concentrations, it can be seen that 2002 meteorology results in the highest predicted concentrations for long-term and 2005 meteorology results in the highest predicted concentrations for short-term means. However, in guidance Defra (2003) guidance issued to local authorities, it can be ‘confidently assumed’ that short-term (1-hour) objective will not be exceeded if the annual mean objective is achieved. Therefore, as a worst case assumption, results for 2002 are presented for long and short-term means respectively.

5.1.1 NO2 Impacts

Figures 5.1 and **5.2** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (50m, 70m, 90m).

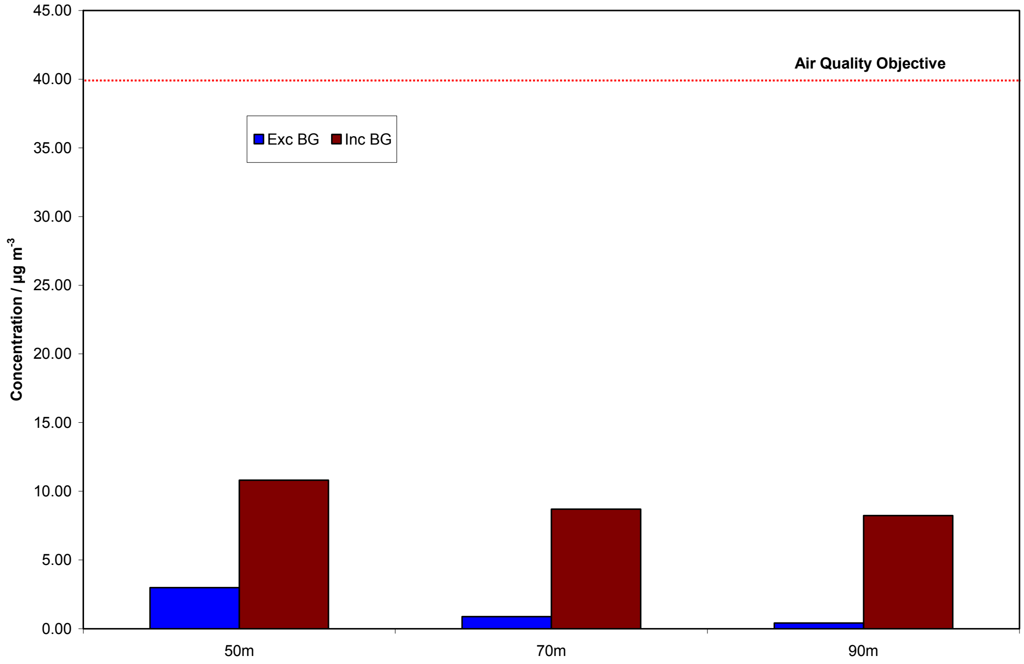
Long-term Annual Concentrations

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.2). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~25%, in the case of emissions from a 50m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the plant being approximately 1% of the AQO.

At this level, the process contributions infringe the Environment Agency’s insignificance test for the annual metric. However, this is a common occurrence across the spectrum of combustion processes in the UK. The critical test is that of complying with the AQO, and retaining a reasonable margin, and all stack height scenarios achieve this target.

Figure 5.1 Long Term NO_2 Concentrations

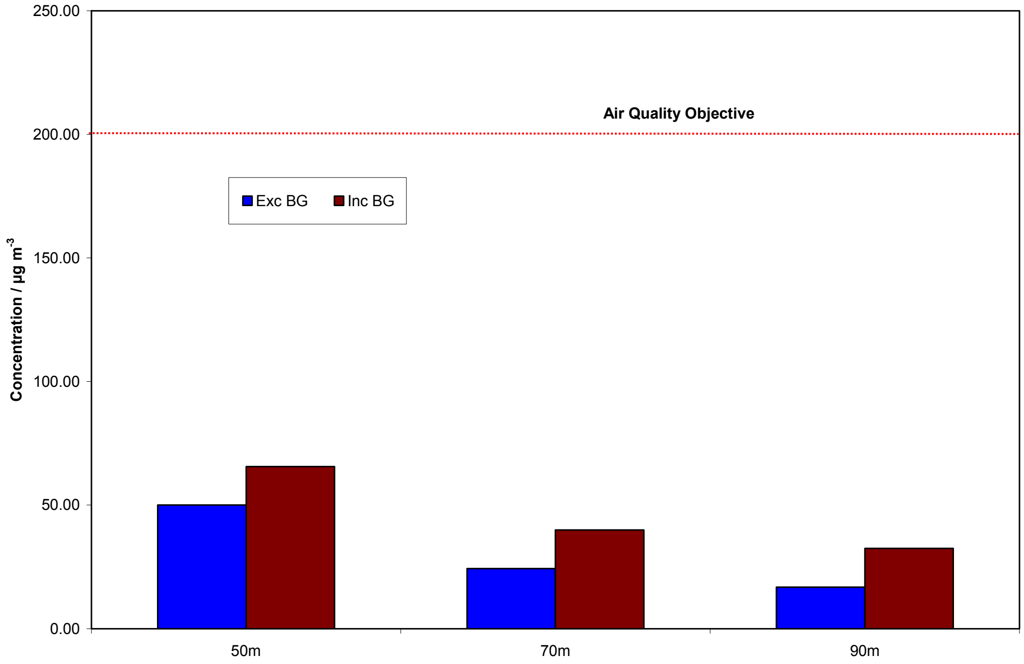


Short-term 1-hour Concentrations

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.2). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~30%, in the case of emissions from a 50m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the EfW plant reducing to 8.5% of the AQO. This does not infringe the short-term test for insignificance and, therefore, short-term process contributions can be considered insignificant for all stack heights.

Figure 5.2 NO_2 Short-term Concentrations



5.1.2 NOx Impacts on Ecological Receptors

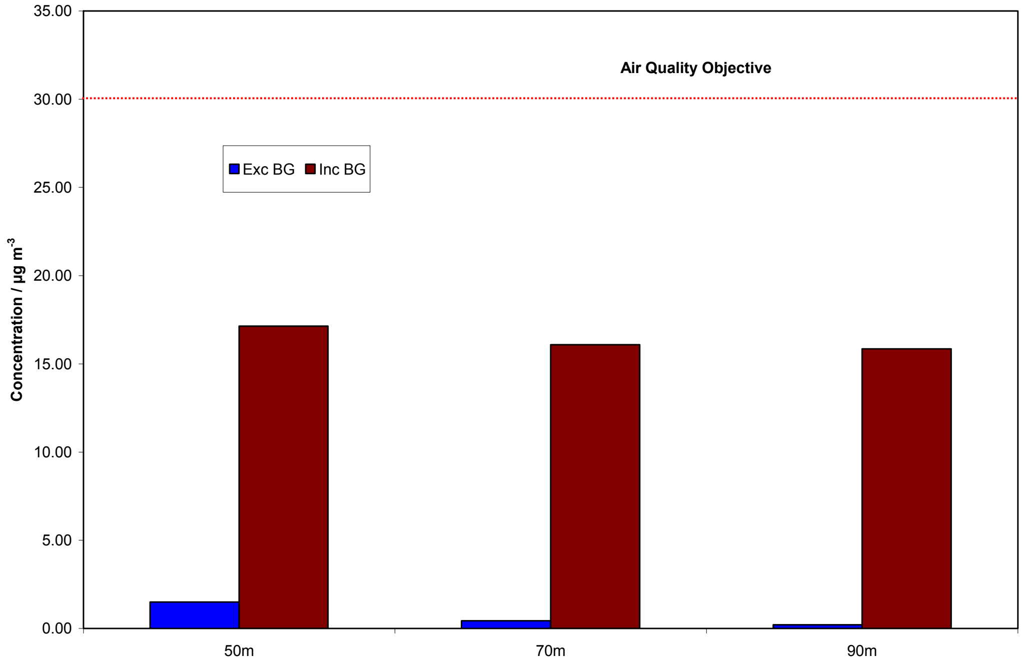
Figure 5.3 contains the summarised results of the dispersion modelling for the Ernesettle site, where annual mean ground-level concentrations at the ecological receptor experiencing the greatest levels are included for each of the three stack heights (50m, 70m, 90m).

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.3). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~55%, in the case of emissions from a 50m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the plant dropping to approximately 1% of the AQO at the greatest stack height.

At this level, the process contributions infringe the Environment Agency's insignificance test for the annual metric. However, this is a common occurrence across the spectrum of combustion process in the UK. The critical test is that of complying with the AQO, and retaining a reasonable margin, and all stack height scenarios achieve this target. It should also be noted that this objective remains non-statutory.

Figure 5.3 NOx Long-term Concentrations (Ecological Receptors)



5.1.3 PM_{10} Impacts

Figure 5.4 and **5.5** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (50m,70m,90m). Currently, there is no objective for ecological receptors from particulates.

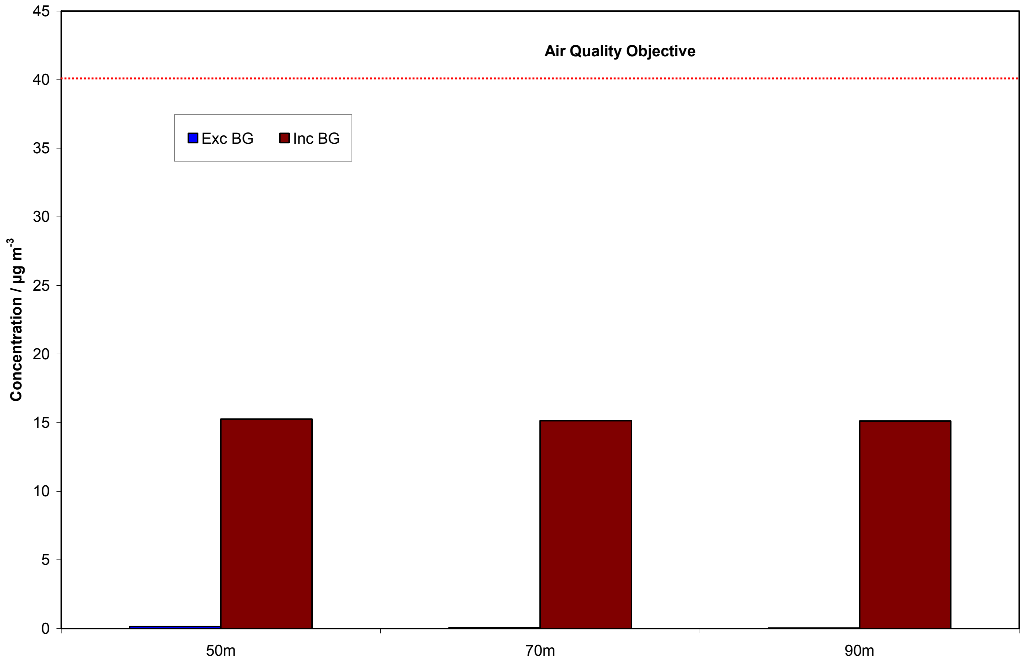
Long-term Annual Concentrations

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.4). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~38%, in the case of emissions from a 50m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the plant accounting for less than 0.1% of the AQO.

This does not infringe the short-term test for insignificance and, therefore, long-term process contributions can be considered insignificant for all stack heights.

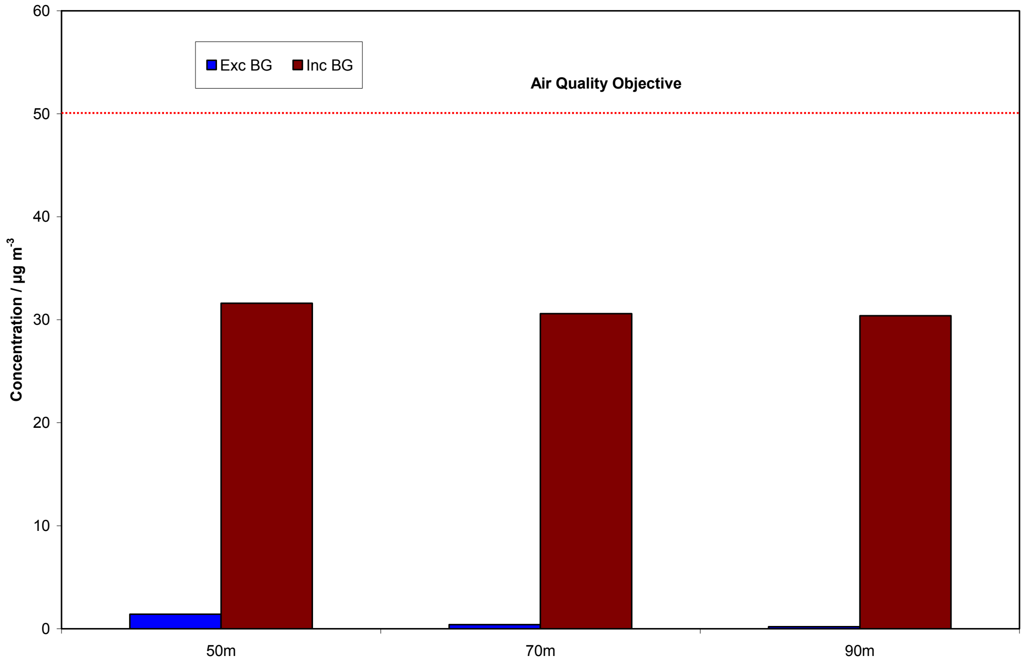
Figure 5.4 PM_{10} Long-term Concentrations



Short-term 24-hour Concentrations

The short-term impacts are similar when compared to the annual affects, with the background concentrations being the dominating factor in the comparison against the AQO (Figure 5.5). The maximum process contribution to the AQO from any stack height is approximately 1.5% and, therefore, short-term emissions can therefore be considered insignificant. Furthermore, there are no exceedances of the AQO for any stack height scenario.

Figure 5.5 PM_{10} Short-term Concentrations



5.1.4 SO_2 Impacts

Long-term Annual Average

Maximum concentrations of SO_2 at human receptors are predicted to be significantly less than the relevant EAL in each stack height scenario. Maximum long term predicted environmental concentrations at human receptors account for approximately 20% of the AQO, with site specific contributions representing 15% of this value

Maximum concentrations of SO_2 at ecological receptors are also expected to comply with the non-statutory 20 µg m^{-3} objective for the protection of vegetation and ecosystems, accounting for less than 27% of the AQO, with site specific emissions contributing 0.6% of this value.

Owing to the small site contributions predicted by the modelling, it has not been possible to produce graphical results as the scale of the predicted concentrations is significantly less than the EAL/AQO.

Short-term Averages

Figure 5.6, 5.7 and **5.8** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (50m,70m,90m).

SO_2 impacts against all of the AQOs (15-minute, 1-hour and 24-hour) and stack heights considered are predicted to be insignificant, with maximum percentage site contributions to the AQOs (13.4%) occurring from a 50m stack and for an averaging period of 24-hours.

The site contributions combined with background concentrations for all stack heights considered easily satisfy each of the AQOs, with the maximum value being 16.3% of the AQO. This was achieved for a stack height of 50m and averaging period of 24-hours.

Figure 5.6 SO_2 15-minute Mean Concentrations

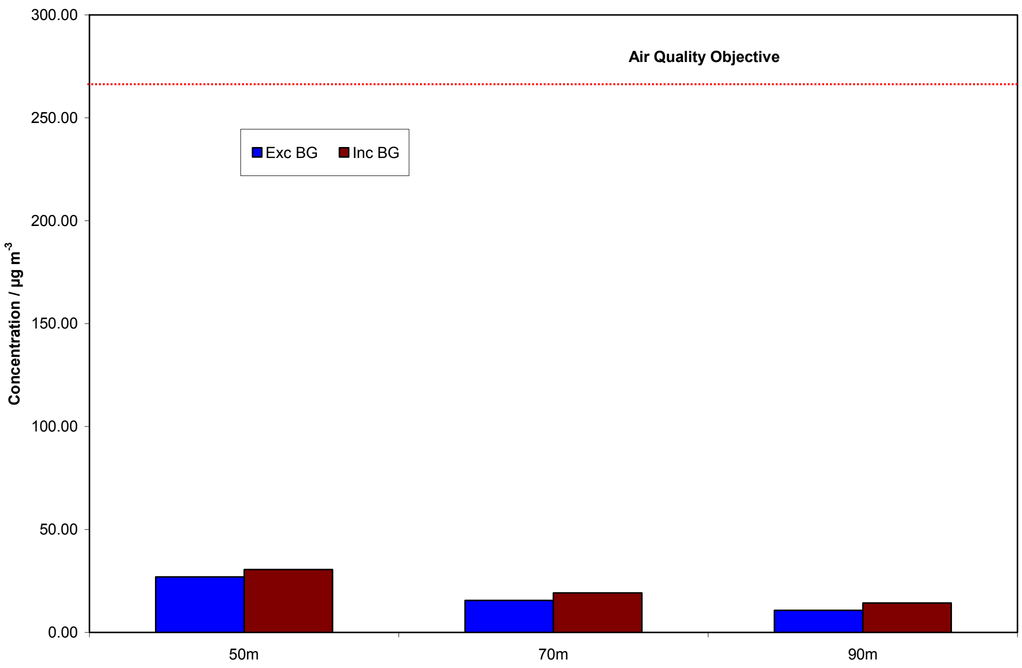


Figure 5.7 SO_2 1-hour Mean Concentration

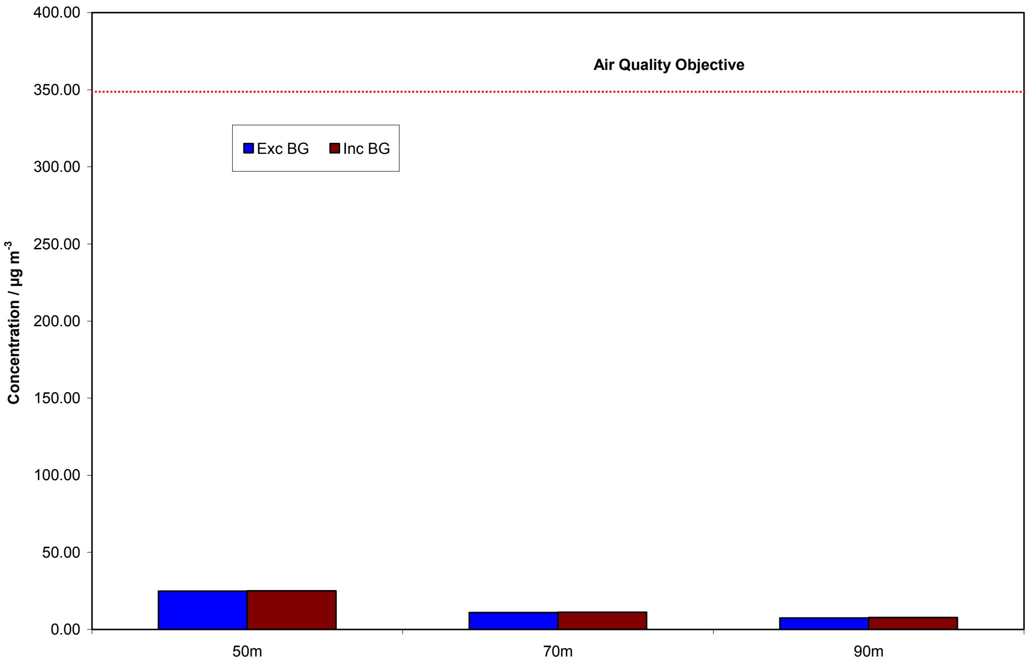
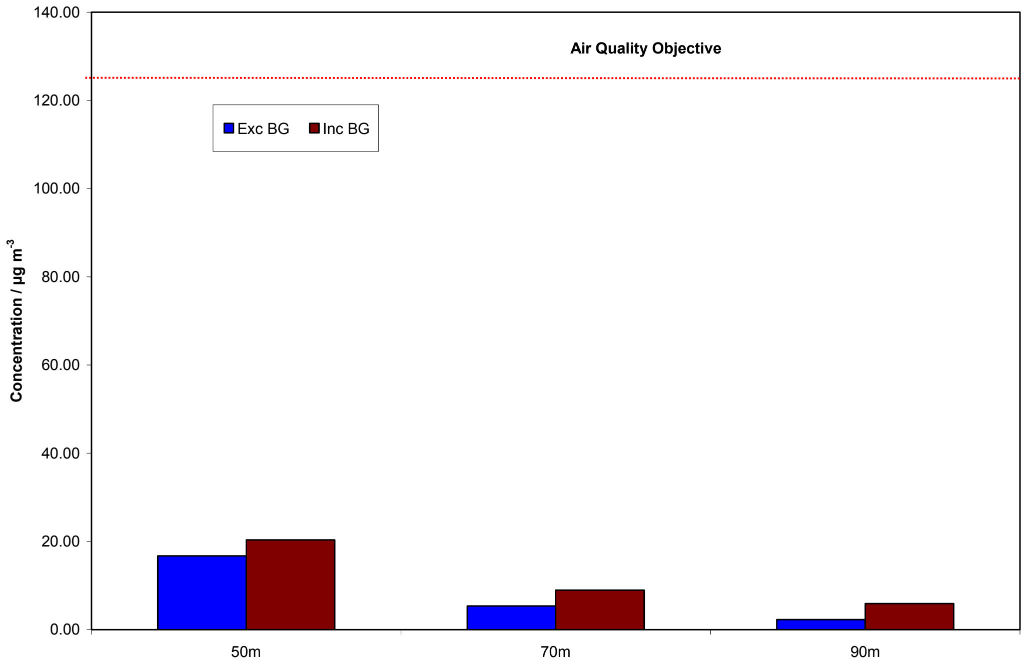


Figure 5.8 SO_2 24-hour Mean Concentrations



5.1.5 CO Impacts

Figure 5.9 and **5.10** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (50m,70m,90m). Currently, there is no objective for ecological receptors from CO.

It is evident from both figures that CO percentage contributions towards the AQO/EAL, arising from site processes during each stack height scenario are minimal, with the existing background concentration being the major factor in addressing any exceedence of the AQO.

Maximum long-term predicted environmental concentrations represent 67% of the EAL, with site processes accounting for less than 0.1% of this value. Maximum short-term predicted environmental concentrations represent 11% of the AQO with site processes contributing less than 0.1% of this value.

Figure 5.9 CO Long-term Concentrations

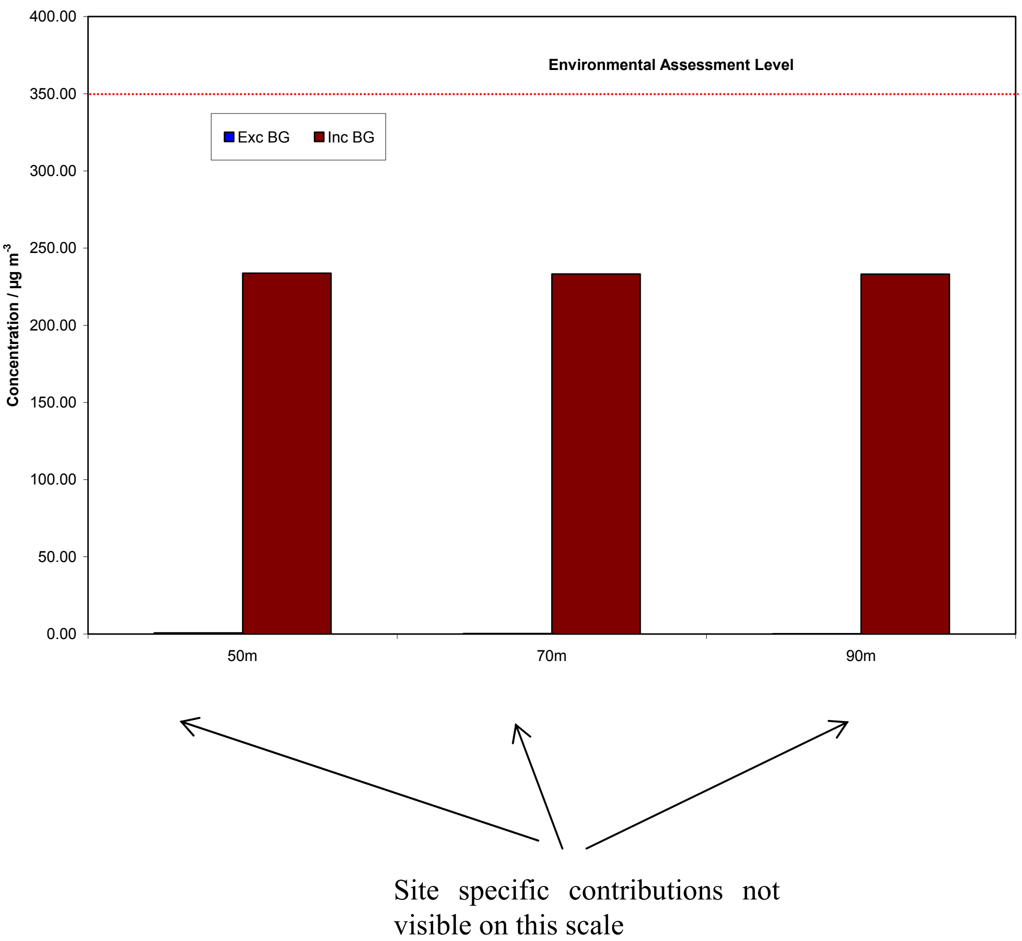
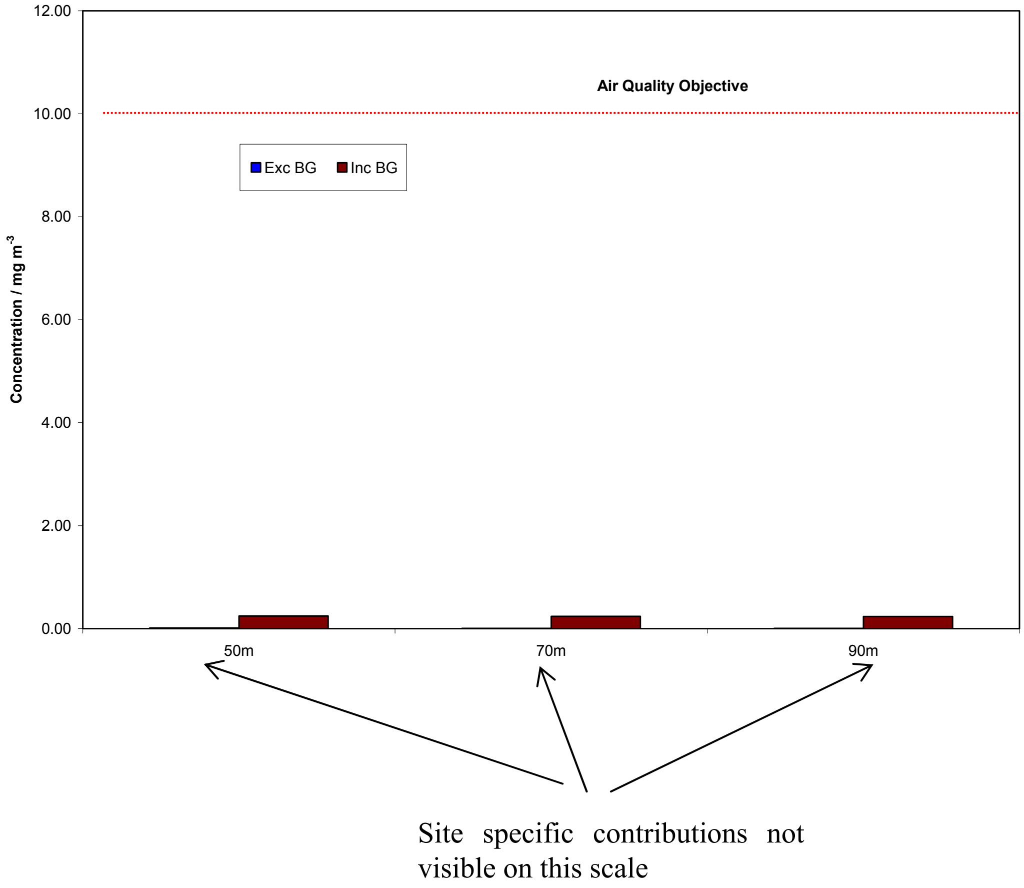


Figure 5.10 CO Short-term Concentrations



5.1.6 Acid Gas Impacts

This section summarises the maximum impacts at any of the human receptors considered. Currently, there is no AQO/EAL for ecological receptors from HCl and HF.

Maximum concentrations of HCl and HF are predicted to be significantly less than the relevant EAL in each stack height scenario. Maximum long and short-term predicted environmental concentrations of HCl represent 0.75% and 1.1% of the EAL, respectively. Maximum short-term HF predicted environmental concentrations are less than 0.25% of the EAL. There is no long-term standard for HF.

Owing to the small concentrations predicted by the modelling, it has not been possible to produce graphical results as the scale of the predicted concentrations is significantly less than the EAL.

5.1.7 Metals Impacts

This section summarises the maximum impacts at any of the human receptors considered. Currently, there is no AQO/EAL for ecological receptors from any of the group metals considered.

The emission limit values implemented in the WID are for total metals in each Group. In order to quantify the impacts of the emissions, each metal group concentration has been compared against the standard for a specific metal in each group. For Group 1 metals this was the cadmium standard, for Group 2 metals the mercury standard and for Group 3 metals the lead standard, being the standards of lowest concentration for any of the metals within the relevant Group.

It should therefore be noted that this results in a highly conservative estimate of the impacts. If the Group metals were speciated and, compared against the relevant standard, the predicted impacts will be less significant.

Group 1 Metals

Maximum long-term predicted environmental concentrations from any stack height scenario account for less than 15% of the cadmium EAL, whilst maximum short-term concentrations account for less than 0.5% of the short-term standard. At these levels, the risk to human health is minimal. Furthermore, speciation of the Group will reduce impacts further.

Group 2 Metals

Maximum long-term and short-term predicted environmental concentrations from any stack height scenario account for less than 0.1% of the relevant mercury EAL. At these levels, the risk to human health is minimal. Furthermore, speciation of the Group will reduce impacts further.

Group 3 Metals

Maximum long-term predicted environmental concentrations from any stack height scenario account for less than 1% of the statutory lead AQO. Currently, there is no short-term objective for lead. Site emissions can therefore be considered insignificant under Environment Agency definitions of significant releases.

5.1.8 Dioxin and TOC Impacts

There are no ambient air quality standards for dioxins or TOCs. Therefore, results cannot be presented with quantification of impact. However, it should be noted that predicted concentrations are low during each stack height scenario (Table 5.2).

Table 5.2 Maximum Dioxin and TOC Concentrations at Human Receptors (µg m^{-3})

Dioxin Annual Mean	Dioxin 1-hour Mean	TOC Annual Mean	TOC 1-hour Mean
1.49×10^{-9}	9.35×10^{-9}	0.15	2.95

These values were obtained from a 50m stack height

5.2 180,000 TPA Capacity

Table 5.3 Determination of Worst-Case Meteorological Year –180,000 T Per Annum Capacity

Year	Predicted Ground Level Concentration due to Process Emissions (µgm^{-3})	
	NO_2 Annual Mean	NO_2 99.79 Percentile of 1-Hour Mean
2002	**4.85**	**46.24**
2003	3.64	45.70
2004	3.87	45.54
2005	3.85	45.68
2006	4.44	46.11

Note these concentrations are based on emissions from an 80m stack and at the receptor experiencing the greatest concentration

From the above predicted ground level concentrations, it can be seen that 2002 meteorology results in the highest predicted concentrations for long- and short-term means. Therefore, as a worst case assumption, results for 2002 are presented for long and short-term means respectively.

5.2.1 NO_2 Impacts

Figure 5.1 and **5.2** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (80m, 100 and 120m).

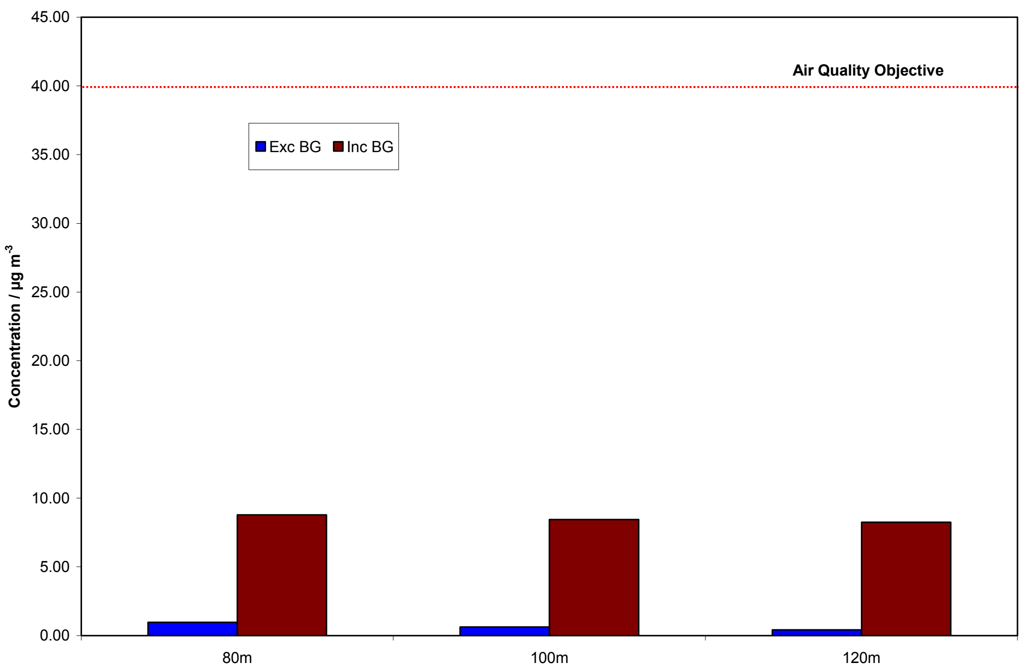
Long-term Annual Concentrations

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.11). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~22%, in the case of emissions from an 80m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the plant dropping to 2.4% of the AQO.

At this level, the process contributions infringe the Environment Agency's insignificance test for the annual metric. However, this is a common occurrence across the spectrum of combustion processes in the UK. The critical test is that of complying with the AQO, and retaining a reasonable margin, and all stack height scenarios achieve this target.

Figure 5.11 Long Term NO_2 Concentrations

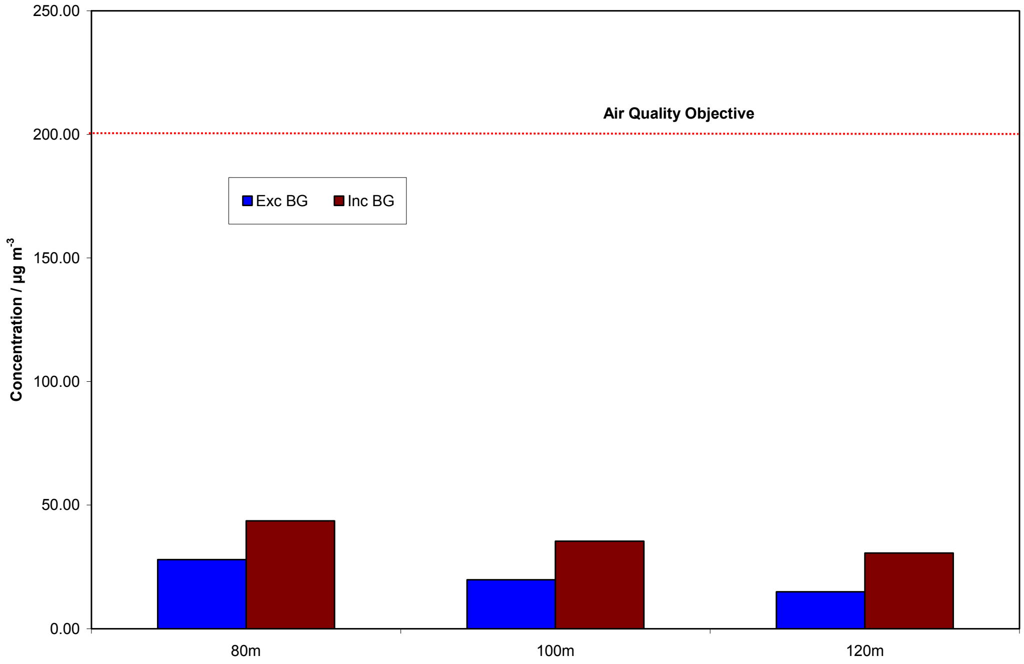


Short-term 1-hour Concentrations

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.12). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~22%, in the case of emissions from an 80m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the EfW plant dropping to 14% of the AQO. This does not infringe the short-term test for insignificance and, therefore, short-term process contributions can be considered insignificant for all stack heights.

Figure 5.12 NO_2 Short-term Concentrations



5.2.2 Impacts on Ecological Receptors

NOx

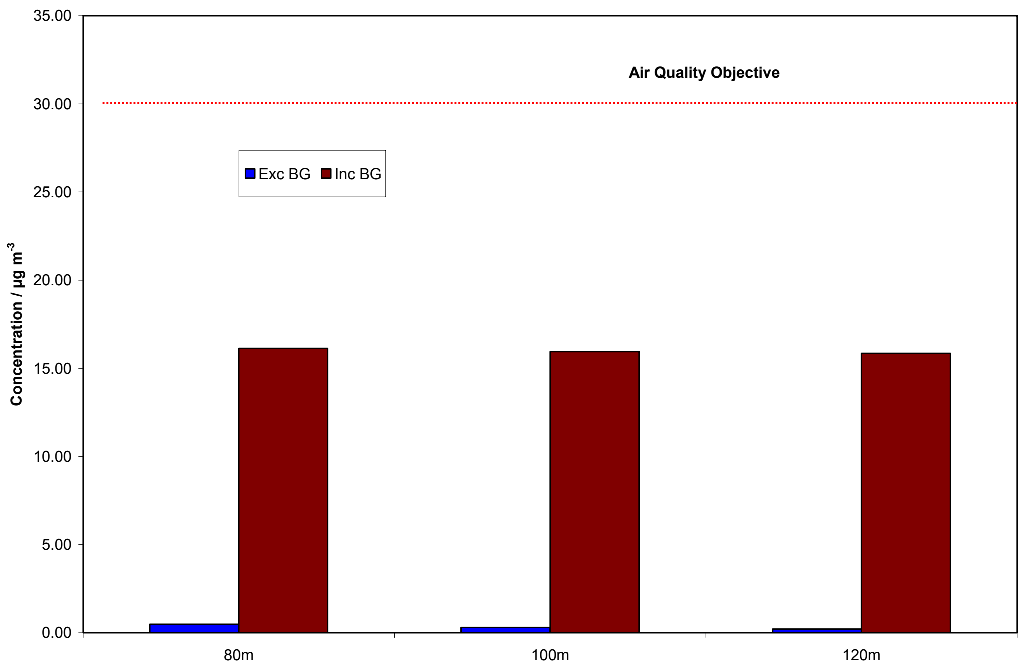
Figure 5.13 contains the summarised results of the dispersion modelling for the Ernesettle site, where annual mean ground-level concentrations at the ecological receptor experiencing the greatest levels are included for each of the three stack heights (80m, 100 and 120m).

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.13). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~54%, in the case of emissions from an 80m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the plant dropping to 1.6% of the AQO.

At this level, the process contributions infringe the Environment Agency's insignificance test for the annual metric. However, this is a common occurrence across the spectrum of combustion process in the UK. The critical test is that of complying with the AQO, and retaining a reasonable margin, and all stack height scenarios achieve this target. It should also be noted that this objective remains non-statutory.

Figure 5.13 NOx Long-term Concentrations (Ecological Receptors)



Nitrogen Deposition

Modelled nitrogen deposition rates for the sensitive ecological sites are included in Table 5.4.

The modelled nitrogen deposition rate from a 180,000 tpa facility at Ernesettle, affecting the South Dartmoor Woods SPA is 0.16 kg N ha^{-1} $year^{-1}$, slightly less than 1% of the current background deposition rate of 16.9 kg N ha^{-1} $year^{-1}$. On this basis, the level of effect is considered to be insignificant. For the other sites, the predicted deposition rates in relation to the existing background and Critical Load ranges (30-40 kg N ha^{-1} $year^{-1}$) are also insignificant. In relation to other sites more distant from the proposed facility, deposition rates would be smaller than those reported in Table 5.4, as a result of increased dispersion and decreased availability of material fro deposition and washout.

Table 5.4 Modelled Deposition Rates at Ecological Sites

Site	Modelled Deposition Rate (kg N ha^{-1} $year^{-1}$)
Tamar-Tavy Estuary	0.1
South Dartmoor Woods	0.16
Plymouth Sound and Estuaries	0.09
Tamar Estuaries Complex	0.12

5.2.3 PM_{10} Impacts

Figure 5.14 and **5.15** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (80m, 100m and 120m). Currently, there is no objective for ecological receptors from particulates.

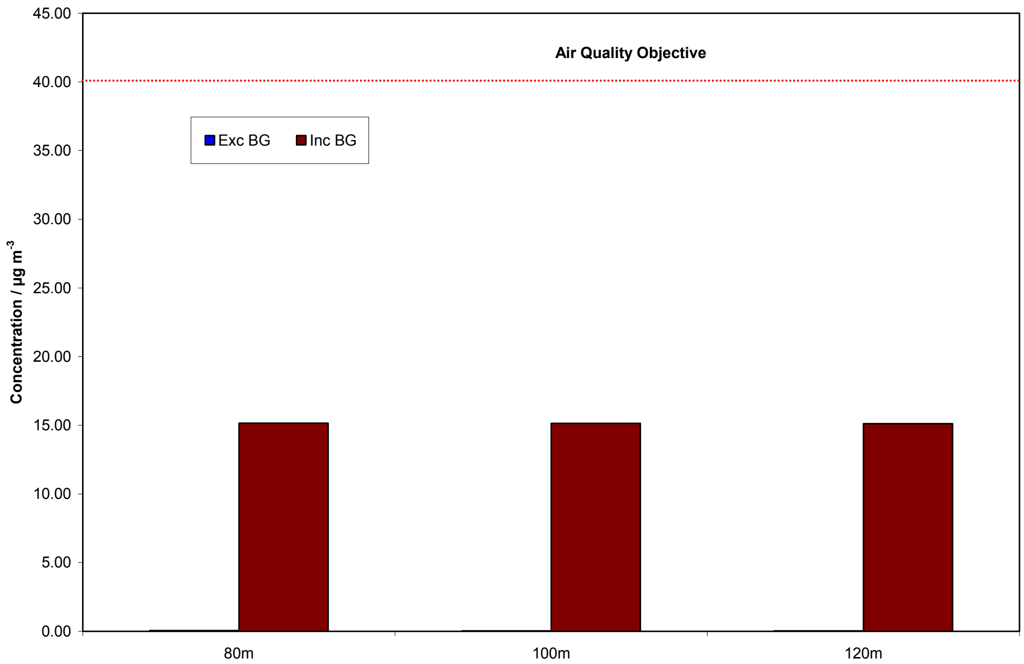
Long-term Annual Concentrations

It is evident that none of the stack height scenarios results in an exceedence of the AQO when combined with ambient background levels (Figure 5.14). Indeed, the maximum percentage of the AQO that is achieved by any scenario is ~38%, in the case of emissions from an 80m stack height.

The figure clearly shows that the background concentration is the significant factor in this analysis, with maximum individual predicted concentrations from the plant accounting for less than 0.1% of the AQO.

This does not infringe the short-term test for insignificance and, therefore, long-term process contributions can be considered insignificant for all stack heights.

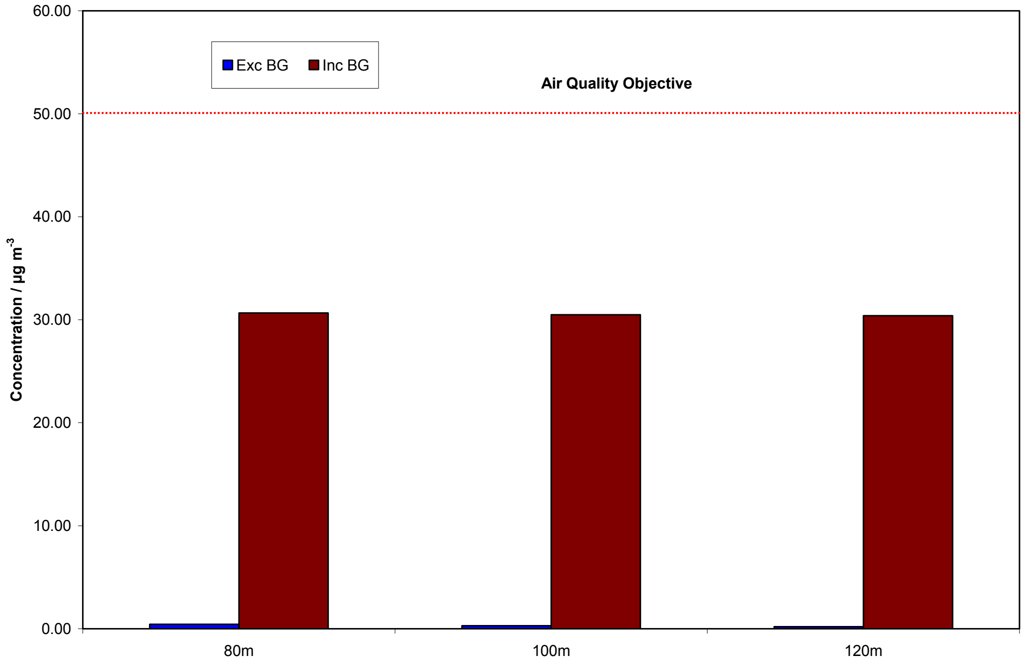
Figure 5.14 PM_{10} Long-term Concentrations



Short-term 24-hour Concentrations

The short-term impacts are similar when compared to the annual affects, with the background concentrations being the dominating factor in the comparison against the AQO (Figure 5.15). The maximum process contribution to the AQO from any stack height is 1% and, therefore, short-term emissions can therefore be considered insignificant. Furthermore, there are no exceedances of the AQO for any stack height scenario.

Figure 5.15 PM_{10} Short-term Concentrations



5.2.4 SO_2 Impacts

Long-term Annual Average

Maximum concentrations of SO_2 at human receptors are predicted to be significantly less than the relevant EAL in each stack height scenario. Maximum long term predicted environmental concentrations at human receptors account for 8% of the AQO, with site specific contributions representing 0.4% of this value

Maximum concentrations of SO_2 at ecological receptors are also expected to comply with the non-statutory 20 µg m^{-3} objective for the protection of vegetation and ecosystems, accounting for less than 27% of the AQO, with site specific emissions contributing 0.6% of this value.

Owing to the small site contributions predicted by the modelling, it has not been possible to produce graphical results as the scale of the predicted concentrations is significantly less than the EAL/AQO.

Short-term Averages

Figure 5.16, 5.17 and **5.18** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (80m, 100m and 120m).

SO_2 impacts against all of the AQOs (15-minute, 1-hour and 24-hour) and stack heights considered are predicted to be insignificant, with maximum percentage site contributions to the AQOs (4.6%) occurring from a 80m stack and for an averaging period of 24-hours.

The site contributions combined with background concentrations for all stack heights considered easily satisfy each of the AQOs, with the maximum value being 7.5% of the AQO. This was achieved for a stack height of 50m and averaging period of 24-hours.

Figure 5.16 SO_2 15-minute Mean Concentrations

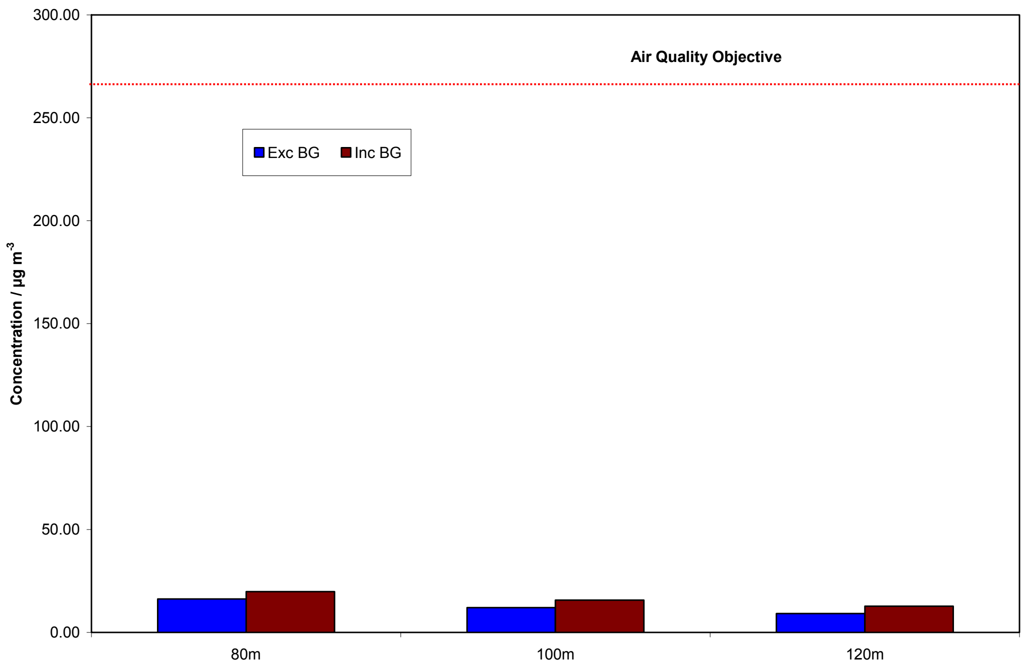


Figure 5.17 SO_2 1-hour Mean Concentration

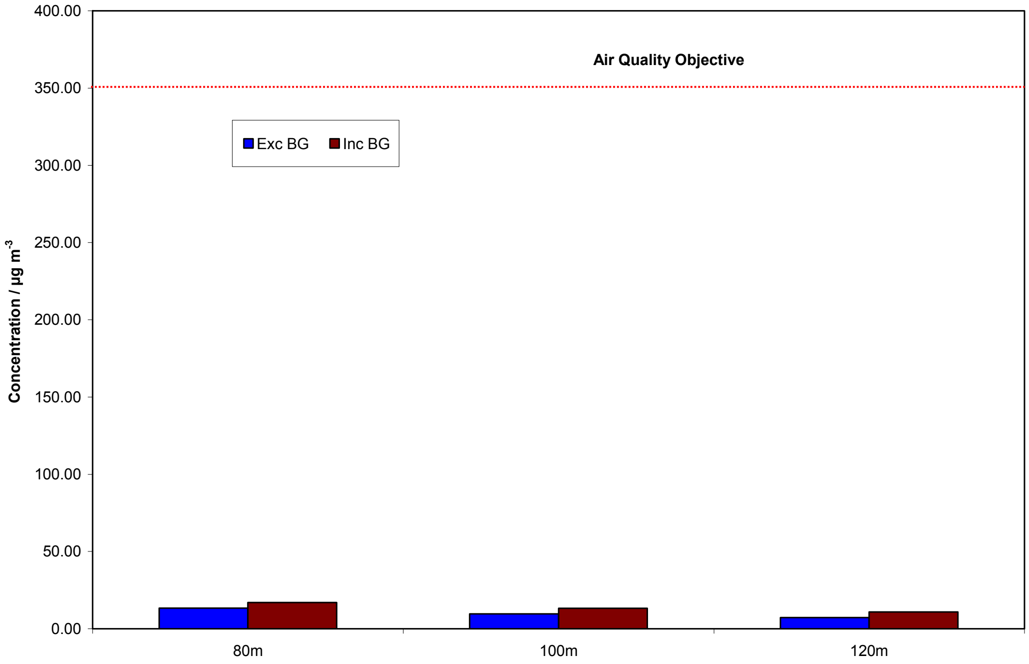
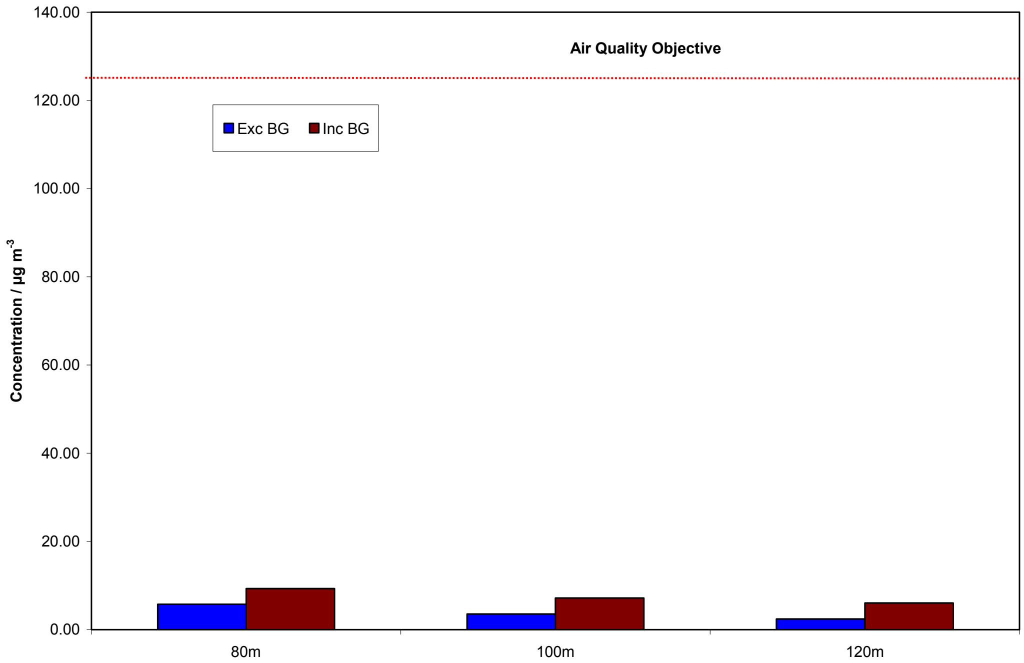


Figure 5.18 SO_2 24-hour Mean Concentrations



5.2.5 CO Impacts

Figure 5.19 and **5.20** contain the summarised results of the dispersion modelling for the Ernesettle site, where ground-level concentrations at the human receptor experiencing the greatest levels are included for each of the three stack heights (80m, 100m and 120m). Currently, there is no objective for ecological receptors from CO.

It is evident from both figures that CO percentage contributions towards the AQO/EAL, arising from site processes during each stack height scenario are minimal, with the existing background concentration being the major factor in addressing any exceedence of the AQO.

Maximum long-term predicted environmental concentrations represent 78% of the EAL, with site processes accounting for less than 0.1% of this value. Maximum short-term predicted environmental concentrations represent 24% of the AQO with site processes contributing less than 0.1% of this value.

Figure 5.19 CO Long-term Concentrations

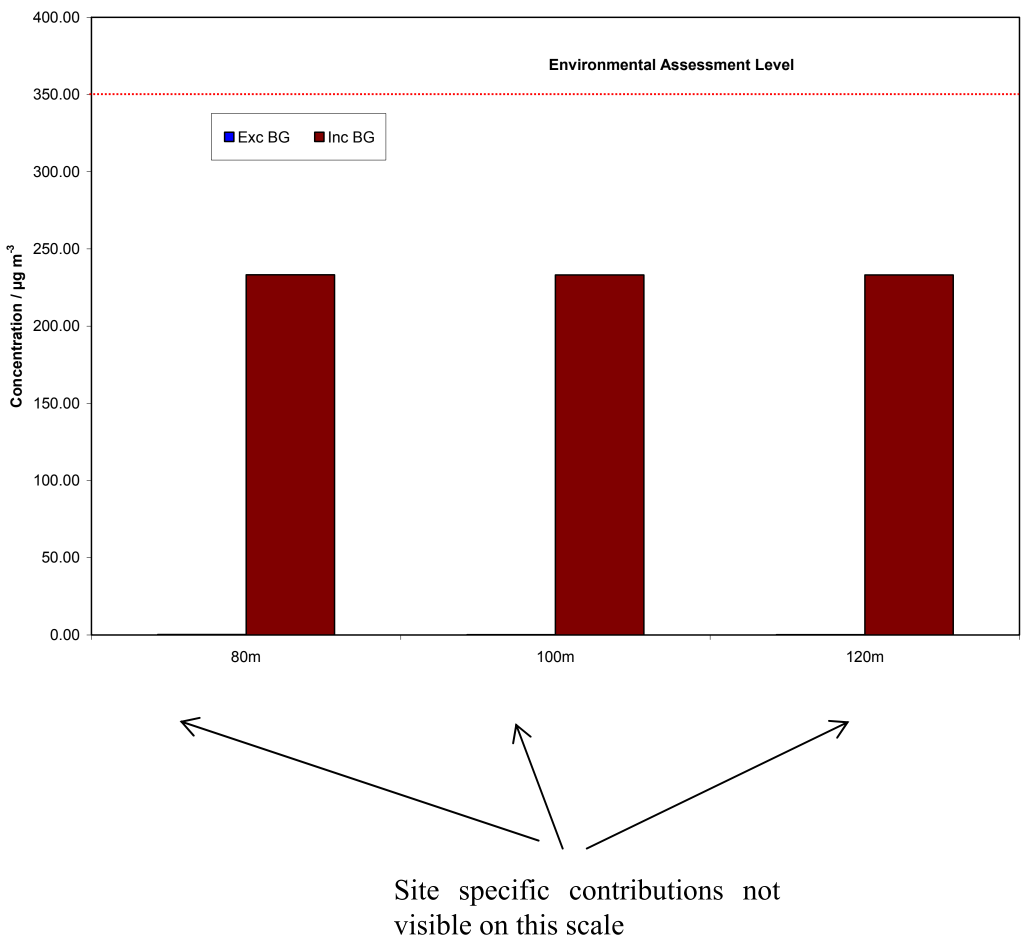
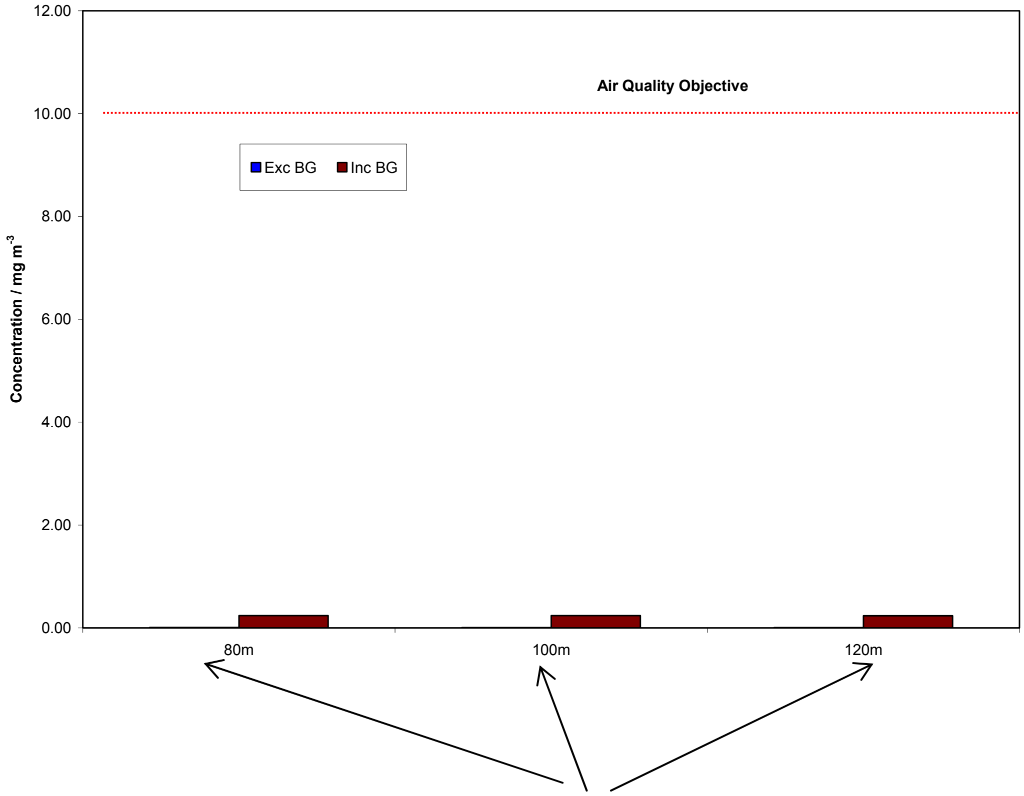


Figure 5.20 CO Short-term Concentrations



Site specific contributions not visible on this scale

5.2.6 Acid Gas Impacts

This section summarises the maximum impacts at any of the human receptors considered. Currently, there is no AQO/EAL for ecological receptors from HCl and HF.

Maximum concentrations of HCl and HF are predicted to be significantly less than the relevant EAL in each stack height scenario. Maximum long and short-term predicted environmental concentrations of HCl represent 0.25% and 0.87% of the EAL, respectively. Maximum short-term HF predicted environmental concentrations are less than 0.2% of the EAL. There is no long-term standard for HF.

Owing to the small concentrations predicted by the modelling, it has not been possible to produce graphical results as the scale of the predicted concentrations is significantly less than the EAL.

5.2.7 Metals Impacts

This section summarises the maximum impacts at any of the human receptors considered. Currently, there is no AQO/EAL for ecological receptors from any of the group metals considered.

The emission limit values implemented in the WID are for total metals in each Group. In order to quantify the impacts of the emissions, each metal group concentration has been compared against the standard for a specific metal in each group. For Group 1 metals this was the cadmium standard, for Group 2 metals the mercury standard and for Group 3 metals the lead standard, being the standards of lowest concentration for any of the metals within the relevant Group.

It should therefore be noted that this results in a highly conservative estimate of the impacts. If the Group metals were speciated and, compared against the relevant standard, the predicted impacts will be less significant.

Group 1 Metals

Maximum long-term predicted environmental concentrations from any stack height scenario account for less than 5% of the cadmium EAL, whilst maximum short-term concentrations account for less than 0.4% of the short-term standard. At these levels, the risk to human health is minimal. Furthermore, speciation of the Group will reduce impacts further.

Group 2 Metals

Maximum long-term and short-term predicted environmental concentrations from any stack height scenario account for less than 0.1% of the relevant mercury EAL. At these levels, the risk to human health is minimal. Furthermore, speciation of the Group will reduce impacts further.

Group 3 Metals

Maximum long-term predicted environmental concentrations from any stack height scenario account for less than 1% of the statutory lead AQO. Currently, there is no short-term objective for lead. Site emissions can therefore be considered insignificant under Environment Agency definitions of significant releases.

5.2.8 Dioxin and TOC Impacts

There are no standards for dioxins or TOCs. Therefore, results cannot be presented with quantification of impact. However, it should be noted that predicted concentrations are low during each stack height scenario (Table 5.5).

Table 5.5 Maximum Dioxin and TOC Concentrations at Human Receptors (µg m^{-3})

Dioxin Annual Mean	Dioxin 1-hour Mean	TOC Annual Mean	TOC 1-hour Mean
4.82×10^{-10}	1.16×10^{-8}	0.05	1.16

These values were obtained from a 80m stack height

5.3 Surface Inversion and Fumigation Events

The predominant structure of the atmosphere is for temperature to decrease with height due to the adiabatic[3] expansion of air at the lower pressures found at altitude. This results in cooler and, therefore, dense air residing above layers of warmer, less dense air. This is a statically unstable situation and results in the overturning of the atmosphere. This process is responsible for the vast majority of turbulent mixing of pollutants in the atmosphere.

However, certain meteorogical conditions may result in temperature increasing with height in certain atmospheric layers. Such a situation is known as an inversion. Strong negative buoyancy forces within an inversion layer suppress vertical mixing and, coupled with low wind conditions, can result in stagnant air with poor dispersion characteristics.

There are several causes of atmospheric inversions, for example, large scale subsidence of upper level air, which warms adiabatically during its descent, and upper level warm air thermal advection. However, the most common occurring within the UK is the radiation induced nocturnal inversion layer, which affects the lower atmosphere. This frequently occurs during the winter months with clear night skies and low wind speeds, when the layer of air next to the surface is cooled by the low surface temperatures.

If this occurs within a valley, or in an area where gradients in terrain are evident, the cooler, dense air next to the surface can begin to move down the valley side under the influence of gravity. This can cause localised wind conditions known as katabatic[4] winds. The limited turbulent mixing within an inversion layer and katabatic winds may combine to produce elevated surface concentrations. However, for buoyant plumes from tall stacks, the plume may be emitted above the inversion layer, in which case, ground level concentrations can approach zero.

[3] An adiabatic process is where there is no net heat flow between two systems.

[4] A localised movement of down sloping air which can develop when a pool of cold, high elevation air begins to descend from the highlands, due to the high density of the cold air.

In order to assess the impacts of inversion layers within the complex terrain surrounding the site, a quantitative assessment was undertaken. Two scenarios were developed. For the first, the model was run for hours in the meteorological data file with winter months, clear night skies and low wind speeds, which would be conducive to inversion formation. The second was run with meteorological variables representative of a Pasquill-Gifford stability class F [5] (extremely stable). Wind directions were considered that were perpendicular and parallel to the valley floor in order to assess the impacts of katabatic winds.

The dispersion modelling results in the previous section indicated that NO_2 was the pollutant of primary concern. From the two inversion scenarios considered, the maximum increase in short-term 1-hour concentrations was by a factor of 1.8 (process contribution of 1.63 μgm^{-3} in the inversion event, compared with 0.91 μgm^{-3} from the original modelling). This still results in predicted environmental concentrations of less than 50% of the AQO, when the background concentration is added.

In the immediate hours after sunrise, the developing convective turbulence associated with an increasingly positive surface heat flux can force pollutants trapped under the inversion to the surface, culminating in high ground level concentrations. Such a process is known as a fumigation event. However, it should be noted that fumigation events only occur over a period of less than 10 minutes and the greatest effects are limited to the immediate vicinity of the pollutant source. Therefore, it is not expected that fumigation events will result in concentrations that will exceed any of the AQOs at the receptors considered.

5.4 Plymouth City Airport Operational Issues

5.4.1 Obstacle Obstruction Analysis

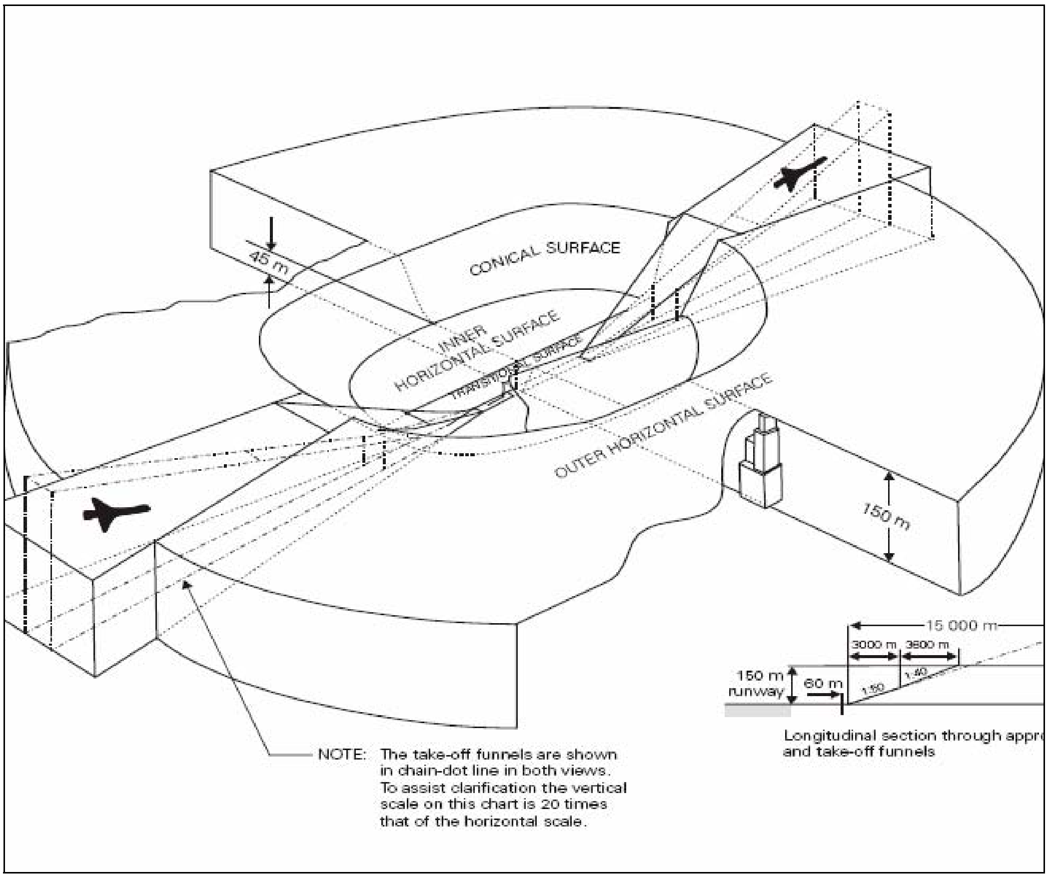
Due to the close location of the site to Plymouth City Airport, approximately 6km, any object of considerable height installed at the site may pose a hazard for landing and departing aircraft. Using guidance in the Civil Aviation Authority's CAP 168 document[6], an assessment of the obstruction impacts of the stacks on aircraft movements was undertaken.

CAP 168 defines approach and take-off climb surfaces which an object must not infringe. The dimensions and gradients of these surfaces are dependent upon the runway code and type of approach and direction of departure. A conical surface surrounding the entire aerodrome is also defined where consideration and precautionary measures, such as high visibility lighting of structure, may have to be installed (figure 5.11)

[5] Pasquill, F. and Smith, F.B., (1983) 'Atmospheric Diffusion', Ellis Horwood Ltd.

[6] Civil Aviation Authority (2004), CAP 168 – Licensing of Aerodromes, CAA Safety Regulation Group

Figure 5.21 Obstacle Limitation Surfaces



The runway of primary concern is runway (RWY) 06/24 as the extended centreline of this runway passes closest to the site. The Take-Off Distance Available (TODA) of this runway is 1169m and contains an Instrument Landing System (ILS). This classifies RWY 13/31 as a Code 2 runway with a precision approach. Aerodrome charts also instruct aircraft to climb straight ahead.

Based upon these factors, it has been determined that a stack from a facility on the Ernesettle site would not infringe upon the lateral extents of either of the take-off climb surface and precision approach surfaces. These surfaces are the most critical and the most stringent in terms of obstructions. None of the stack heights would infringe the vertical extents of the conical surface.

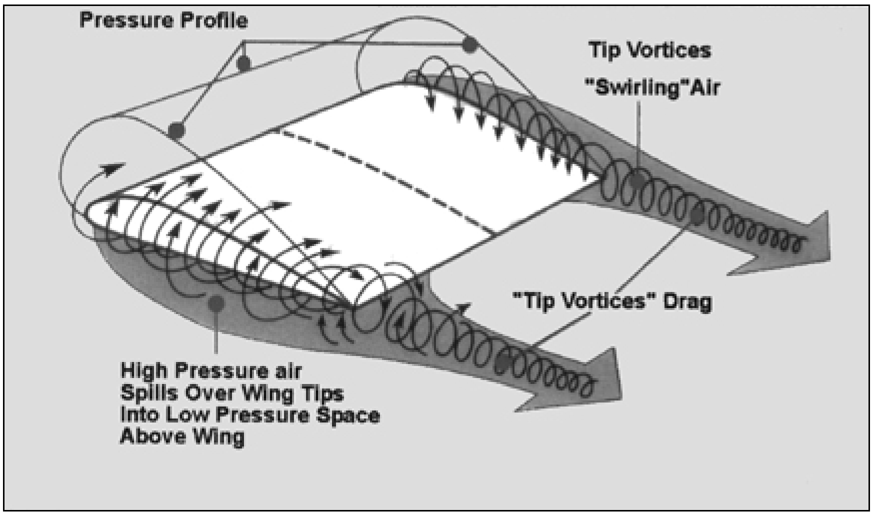
However, consideration still may have to be given to the potential obstacle hazard of the stacks and precautionary measures, such as high-visibility lighting, may require installation on the stacks. From an air quality perspective, given that predicted concentrations from all stack heights are considerably less than the objectives, there are no concerns as to which stack height is chosen.

5.4.2 Aircraft Vortices

Aircraft moving through the air cause an atmospheric disturbance. This wake vortex turbulence is usually described as wing-tip vortices, which are produced as a result of the lifting force generated by the wings (Figure 5.12). As the vortices leave each wing, they descend at a rate of between 1.25-2.5 ms^{-1}. Vortices can be drifted by wind but generally stay parallel to each other.

The strength of the wake vortex is directly proportional to an aircraft's size and weight and inversely proportional to its speed, i.e. the largest vortices are produced by large aircraft flying at low speeds.

Figure 5.22 Representation of Aircraft Wing-tip Vortices



Due to the close proximity of the Ernesettle site to Plymouth City Airport, it may be possible for the emitted plume to become entrained within the wing-tip vortices generated by landing and departing traffic. The impact of this interaction will be two-fold; the increased turbulence within each vortex will enhance dispersion and result in lower concentrations within the plume, however, part of the plume may be forced to the ground by the descending vortex. The dominating effect by wake vortices on ground-level pollution concentrations will, therefore, be spatially dependent.

A detailed study of the impact of wake vortices[7], on plumes emitted from an EfW Plant underneath the flight path of London Gatwick Airport, indicated that the expected effect on ground level concentration would be minimal.

The majority of aircraft movements at Plymouth City Airport are from turboprop and small (<100 seat) jet aircraft (e.g. BAe 146), whereas, a significant proportion of aircraft movements at London Gatwick are from heavy variants (e.g. B747, A330, B767). Based upon the knowledge that the intensity of aircraft generated wake turbulence decreases with aircraft size and weight, it is not expected that wake vortices will be an issue at the Ernesettle site.

[7] Entec (2001), Capel Energy from Waste Plant Air Quality and Health Risk Assessment

6. Conclusions

This assessment has used atmospheric dispersion modelling to determine the potential air quality constraints associated with a thermal processing plant at the former University of Plymouth playing fields, Ernesettle. For the purposes of the assessment, two scenarios have been considered for, based upon the assumption of calculated process parameters and emissions resulting from:

- 80,00 tpa thermal processing; and
- 180,000 tpa thermal processing.

The assessment considered the contribution of site emissions of the following pollutants at Waste Incineration Directive limits on nearby human and ecological assessments;

- Carbon Monoxide (CO)
- Oxides of Nitrogen (NO_X as NO_2);
- Particulate matter of diameter less than 10 µm (PM_{10}); and
- Sulphur Dioxide (SO_2).
- Total Organic Compounds (TOC)
- Hydrogen Chloride (HCl)
- Hydrogen Fluoride (HF)
- Group 1 Metals (e.g. Cadmium)
- Group 2 Metals (e.g. Mercury)
- Group 3 Metals (e.g. Lead)
- Dioxins and furans

Emissions from three stack heights were considered for both capacity scenarios: 50, 70 and 90m for the 80,000 TPA capacity plant and 80, 100, 120m TPA capacity scenario, respectively. It was determined that, as to be expected, the maximum impacts at the sensitive receptors were from emissions from a 50m and 80m stack, resulting from the 80,000 and 180,000 TPA capacity plants, respectively.

The dispersion modelling predicts that maximum environmental concentrations of all pollutants comfortably satisfy the appropriate Air Quality Objective, with the vast majority of pollutant concentrations less than 50% of the objectives when combined with background levels.

It was determined that maximum long-term NO_2 site specific emissions had the potential to infringe upon the Environment Agency test for insignificance. However, this is a common occurrence across the spectrum of combustion processes in the UK. The critical test is that of complying with the AQO, and retaining a reasonable margin, and all stack height scenarios achieve this target. Furthermore, the assumptions made in this report regarding the proportion of

NO_x present as NO_2 are pessimistic. Actual concentrations are expected be less than those predicted in this assessment.

An assessment of the potential for dry and wet deposition of nitrogen onto sensitive ecological sites in the area has indicated that the potential addition to existing background levels would be so small as to be insignificant.

An assessment of the impacts of atmospheric inversions and aircraft generated vortices on plume behaviour, revealed ground level concentrations that still easily satisfied the appropriate objectives.

Based upon guidance in the Civil Aviation Authority's CAP168 document, it has been determined that the proposed stack would not infringe upon the lateral extents of the critical precision approach and take-off climb obstacle avoidance surfaces of the runway of greatest concern. None of the stack heights would infringe upon the vertical extents of a conical surface surrounding the entire airport. However, consideration still may have to be given to the potential obstacle hazard of the stacks and precautionary measures, such as high-visibility lighting, may require installation on the stacks. From an air quality perspective, given that predicted concentrations from all stack heights are considerably less than the objectives, there are no concerns as to which stack height is chosen.

In conclusion, maximum environmental concentrations of all pollutants comfortably satisfy the appropriate Air Quality Objectives, with the vast majority of pollutant concentrations being <50% of the objectives when combined with background levels.

It is recommended that, should development of a facility on the site be pursued, the following additional work should be considered;

- undertaking an ambient air quality monitoring survey in the vicinity of the site to better characterise background air quality; and
- consultation with Plymouth City Airport and CAA on the obstacle limitation surface issues.

Appendix A
Air Quality Standards

3 Pages

Air Quality Standards

The regulatory and non-statutory instruments setting air quality standards, guidelines and objectives are discussed below and the standards, guidelines and objectives appropriate to this assessment are detailed below;

EU Directives

In 1996 an EU-wide common position on air quality standards was adopted under the framework of the Ambient Air Quality Assessment and Management Directive (96/62/EC). A main aim of the Directive is to protect human health and the environment by avoiding, reducing or preventing harmful concentrations of air pollutants. Within the framework of this Directive fall a number of Daughter Directives. The First Daughter Directive (99/30) set limit values for Sulphur dioxide (SO_2), oxides of Nitrogen (NO_X), particulate matter (PM) and Lead (Pb), and was transposed into UK legislation through the Air Quality Limit Values Regulations 2001. The Second Daughter Directive (2000/69/EC) establishes limits for Carbon monoxide (CO) and Benzene (C_6H_6), and was ratified into UK law through the 2002 amendment to the Air Quality Limit Values Regulations 2001.

The Third Daughter Directive (2002/3/EC) sets target values and long-term objectives, for the protection of human health and vegetation by limiting Ozone (O_3) in ambient air.

UK Regulations

There are currently three key UK regulations covering ambient air quality standards:

Air Quality Standards Regulations 1989, as amended 1995

The Regulations implement EU Directives 80/779/EEC, 82/884/EEC and 85/203/EEC setting various air quality limit values, guide values and air quality standards for SO_2, PM, Pb and NO_2.

The Air Quality Limit Values Regulations 2001 revoke the articles of this Regulation relating to the measurement of SO_2, PM, Pb and NO_2, and the articles relating to limit values, will be repealed on January 1, 2005 (or January 1, 2010 for NO_2).

Air Quality (England) Regulations 2000, as amended 2002

These Regulations incorporate the objectives contained in the AQS, against which local authorities must review and assess air quality.

In addition to the Regulations, the EU set Limit Values for nitrogen dioxide (NO_2) and benzene and indicative values for PM_{10}, to be achieved by 1 January 2010. There is no statutory obligation for air quality to be assessed against the EU Limit Values. However, consideration of these criteria is likely to assist with assessment of development proposals considering the requirement for England to achieve tighter objective concentrations by 2010 in relation to benzene and PM_{10}.

Air Quality Limit Values Regulations 2003, as amended 2004

This Regulation implements the EU Directive (96/62/EC) on ambient air quality assessment and management and Directive 99/30/EC setting limit values for SO_2, NO_X, PM and Pb and transposes the Second Air Quality Daughter Directive (2000/69/EC) setting limit values for CO and C_6H_6 and (2002/3/EC) for O_3 in ambient air. This regulation revokes for England and at different dates parts of the Air Quality Standards Regulations 1989 giving effect to limit values, the Ozone Monitoring and Information Regulations 2001 and the Air Quality Limit Values Regulations 2001 (as amended 2002).

Air Quality Limit Values Regulations 2007

The 2007 Air Quality Strategy for England, Scotland, Wales and Northern Ireland, provides a framework for improving air quality at a national and local level. Central to the Air Quality Strategy are health-based standards for key air pollutants; these standards are based on medical and scientific reports on how and at what concentration each pollutant affects human health. The air quality objectives (AQOs) based on these standards were made statutory through the *Air Quality Regulations 2000*, as amended in 2002 and the *Air Quality Standards Regulations 2007*.

The *Air Quality Standards Regulations 2007* seek to simplify air quality regulation and provide a new transposition of the Air Quality Framework Directive, First, Second and Third Daughter Directives and also transpose the Fourth Daughter Directive, relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air. The Air Quality Limit Values are transposed into the updated Regulations as 'Air Quality Standards' (AQS) with attainment dates in line with the European Directives.

The AQOs are based on the Air Quality Limit Values, with interim target dates to help the UK move toward the achievement of the Air Quality Limit Values. The air quality objectives in the Air Quality Strategy are a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except as far as these mirror any equivalent legally binding limit values in EU legislation.

The Air Quality Strategy (AQS)

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS) (DETR, 2000, as amended 2002) was published in January 2000 and supersedes the National Air Quality Strategy (NAQS) published in March 1997.

The AQS provides a revised framework designed to improve and protect ambient air quality in the UK, at national and local levels, in the medium-term. Central to the AQS are health-based standards for eight air pollutants. These standards are based on recommendations made by the Government's Expert Panel on Air Quality Standards (EPAQS), EU objectives, and WHO guidelines. The Air Quality Strategy (AQS) contains a number of air quality objectives (AQOs). These objectives are based on standards in the EU Air Quality Daughter Directives, the Expert Panel on Air Quality Standards (EPAQS) and the World Health Organisation (WHO) recommendations. The AQS sets objectives for nine main air pollutants to protect health, and two objectives to protect vegetation and ecosystems. The AQOs take into account the costs and benefits, as well as the feasibility and practicality of moving towards the standards. The relevant dates for achieving each of the objectives range from 2003 to 2010.

With the exception of Ozone, which is considered to be a trans-boundary pollutant, Local Government is responsible for implementing and enforcing action plans to ensure that the objectives for the remaining pollutants are achieved,

> *"in areas where people are likely to be exposed over the relevant averaging period".*

These objectives were made statutory through the Air Quality (England) Regulations 2000, as amended 2002.

Other Guideline Values

In the absence of statutory standards for the other prescribed substances that may be found in the emissions, there are several sources of applicable air quality guidelines.

Air Quality Guidelines for Europe, the World Health Organisation (WHO)

The aim of the WHO Air Quality Guidelines for Europe (WHO, 2000) is to provide a basis for protecting public health from adverse effects of air pollutants and to eliminate or reduce exposure to those pollutants that are known or likely to be hazardous to human health or well-being. These guidelines are intended to provide guidance and information to international, national and local authorities making risk management decisions, particularly in setting air quality standards.

Environmental Assessment Levels (EALs)

The Environment Agency's Technical Guidance Note IPPC H1 (Environment Agency, 2003) provides methods for quantifying the environmental impacts of emissions to all media. IPPC H1 contains long and short-term Environmental Assessment Levels (EALs) for releases to air derived from a number of published UK and international sources.

IPPC H1 gives the following criteria for identifying significant releases:

- Long-term Process Contribution > 1% of the long-term environmental benchmark; and
- Short-term Process Contribution > 10% of the short-term environmental benchmark; and
- Short-term Process Contributions not exceeding 20% of the short-term EAL "may be considered to be tolerable".

Appendix B
Waste Incineration Directive Emission Limit Values

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Table B.1 Waste Incineration Directive Emission Limit Values (ELVs)

Pollutant	ELV* (mg m^{-3})	Averaging Period
Total Dust	10	Daily
Total Dust	30	100% 30-min
Total Dust	10	97% 30-min
TOC	10	Daily
TOC	20	100% 30-min
TOC	10	97% 30-min
HCl	10	Daily
HCl	60	100% 30-min
HCl	10	97% 30-min
HF	1	Daily
HF	4	100% 30-min
HF	2	97% 30-min
SO_2	50	Daily
SO_2	200	100% 30-min
SO_2	50	97% 30-min
NO_X	200	Daily
NO_X	400	100% 30-min
NO_X	200	97% 30-min
CO	50	Daily
CO	150	100% 30-min
CO	100	97% 30-min
Group 1 Metals	Total 0.05	30min-8hrs
Group 2 Metals	Total 0.05	30min-8hrs
Group 3 Metals	Total 0.5	30min-8hrs
Dioxins and furans	0.1 ng m^{-3} TEQ	6-8hrs

* referenced to 273K, 101.3 kPa, 11% oxygen, dry gas