Development of an Energy from Waste Combined Heat and Power Facility, Devonport, Plymouth

Assessment of Health Effects from Exposure to Particulate Matter, Nitrogen Dioxide and Sulphur Dioxide

March 2011

Prepared for

MVV Environment Devonport Ltd

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Assessment of Health Effects from Exposure to Particulate Matter, Nitrogen Dioxide and Sulphur Dioxide
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Glossary

The following terms and definitions relate to the meaning of these terms as used within this report.

Acute effect	An effect that occurs within a short time after exposure.
Air pollutant	A substance present in the atmosphere at concentrations that are elevated, usually by human activities. Most air pollutants occur naturally in the atmosphere at low concentrations.
Ambient concentrations	Concentrations of airborne substances in outdoor air.
Chronic effect	An effect that occurs over a long time period or following a long period of exposure.
Chronic bronchitis	A daily cough with production of sputum for 3 months, two years in a row.
Cohort study	A study in which a particular health effect, is compared using groups of people who are alike in most ways but differ by a defined characteristic, such as exposure to a source of pollution for example.
Concentration – response function	An equation that represents for example, the relationship between the predicted concentration of a pollutant in the air and the exposed populations response.
Deaths brought forward	This does not constitute new/additional deaths but represents a reduction in life expectancy for those whose health is already seriously compromised, where one death brought forward represents a cumulative two to six month loss of life expectancy for the population exposed.
Emissions	The substances or mass of a substance emitted into the atmosphere.
Epidemiology	The study of populations in order to determine the frequency and distribution of disease and to measure risks.
Exposed population	The population exposed to a meaningful change in air pollutant concentrations.
Exposure	Inhalation of air containing substances at predicted concentrations.
Fine particulate matter	Size fractions of particulate matter smaller than PM_{10}. In this report represented by $PM_{2.5}$.

Hazard	Something (e.g. an object, a property of a substance, a phenomenon or an activity) that can cause adverse effects.
Life table	A way of summarising mortality rates for the age classes within a population.
Lower respiratory system	The human respiratory system below the larynx.
Morbidity	The incidence or prevalence of disease/ill health in a population.
Mortality	The incidence of death or the number of deaths in a population.
Nitrogen dioxide	A molecule composed of one nitrogen atom and two oxygen atoms, present in outdoor air as a gas.
Oxides of nitrogen	A collective term for all gases composed of nitrogen and oxygen, including nitrogen dioxide.
Particulate Matter	A solid or liquid particle (a droplet) that in the context of this report is small enough to be suspended in air.
PM_{10}	Mass per cubic particles passing through the inlet of a size selective sampler with a transmission efficiency of 50% at an aerodynamic diameter of 10 micrometres.
$PM_{2.5}$	Mass per cubic particles passing through the inlet of a size selective sampler with a transmission efficiency of 50% at an aerodynamic diameter of 2.5 micrometres.
PM_1	Mass per cubic particles passing through the inlet of a size selective sampler with a transmission efficiency of 50% at an aerodynamic diameter of 1 micrometre.
Population	All people living in a defined area.
Predicted concentrations	Mass of pollutant per volume of air. Normally expressed as mean values over a defined time period, as calculated using dispersion models.
Relative risk	The likelihood of the event in an exposed group relative to those who have not been exposed.
Risk	The likelihood that a hazard will actually cause its adverse effects, together with a measure of the effect.
Sensitivity analysis	A procedure by which numerical estimates are tested to aid the interpretation of predicted values.
Years of life lost	A statistical measure of mortality effects at the population level.

Abbreviations

ACS	American Cancer Society
CAFE	Clean Air For Europe programme
COMEAP	Committee on the Medical Effects of Air Pollution
EC	European Commission
EU	European Union
GP	General Practitioner
IOM	Institute of Occupational Medicine
LRS	Lower Respiratory Symptoms
ONS	Office of National Statistics
WHO	World Health Organisation

1 Introduction

1.1.1 The proposed Energy from Waste facility, incorporating Combined Heat and Power technology (referred to in this report as EfW CHP facility), is to be located on land to the north of Her Majesty's Naval Base (HMNB) Devonport, Plymouth. A facility of this type will emit a mixture of substances, including particulate matter, oxides of nitrogen and sulphur dioxide into the atmosphere throughout its operational lifetime. The impact of the emissions from the proposed EfW CHP facility, on the atmospheric concentrations of particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide and sulphur dioxide, that the local population would be exposed to, have been sourced from the Air Quality Dispersion Modelling Report [1].

1.1.2 This report quantifies the human health effects associated with the exposure of the local community to the predicted change in the atmospheric concentrations of particulate matter, nitrogen dioxide and sulphur dioxide within 10 km of proposed EfW CHP facility

1.1.3 The Clean Air for Europe (CAFE) programme[2] revisited the management of air quality within the EU and resulted in The Ambient Air Quality and Cleaner Air for Europe Directive[3]. This directive defines Limit Values for ambient concentrations of specified air pollutants, including sulphur dioxide, nitrogen dioxide and particulate matter (as PM_{10} and as $PM_{2.5}$). These limit values represent a minimum standard of ambient air quality that all member states of the EU are obliged to achieve, everywhere except for a small number of prescribed locations. At the present time, the limit values have been transposed into national legislation through the Air Quality Standards Regulations 2010[4].

1.1.4 The National Air Quality Strategy[5] brought forward Air Quality Objectives to assist National and Local Government in achieving the Limit Values to prescribed timetables. The setting of national air quality Objective Values and EU Limit Values, for the protection of human health, was based on a substantial body of scientific evidence. The need for the EC and for National Governments to consider the costs and benefits of proposed Limit Values, resulted in the development of robust methodologies for the quantification of health effects associated with exposure to air pollution outside of the workplace.

1.1.5 This report applies approaches to the quantification of health effects from predicted pollutant concentrations published by the Department of Health's Committee on the Medical Effect of Air Pollutants (COMEAP) and the Clean Air for Europe (CAFE) programme. These methods are as set out in COMEAP's reports on the quantification of the effects of air pollution on health[6], the effect of long term exposure to air pollution[7], the mortality effects of long term exposure to particulate air pollution[8] and a cost benefit analysis methodology for CAFE[9]. COMEAP and CAFE both reviewed the scientific literature and took full account of this knowledge in the

[1] Scott Wilson (2011) Air Quality Technical Appendix 13.1,Energy from Waste Combined Heat and Power Facility, North Yard, Devonport: Environmental Statement Volume 3: Appendices
[2] CAFE Programme, Accessed via URL http://ec.europa.eu/environment/archives/cafe/index.htm , date accessed 15/10/2010.
[3] European Commission (2008) Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe, Journal of the European Union.
[4] H.M. Government (2010) The Air Quality Standards Regulations. SI 1001, the Stationary Office.
[5] Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland.
[6] Committee on the Medical Effects of Air Pollutants (COMEAP) (1998) Quantification of the Effects of Air Pollution on Health in the United Kingdom, Department of Health, The Stationery Office, London.
[7] COMEAP (2009) Long term Exposure to Air Pollution: Effect on Mortality, June 2009.
[8] COMEAP (2010) The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom, 2010
[9] AEA Technology (2005) Methodology for the Cost Benefit Analysis for CAFE. Volume 2: Health Impact Assessment, Accessed via URL http://www.cafe-cba.org/reports/ , date accessed 15/10/2010.

development of their methods for quantifying the health effects of air pollution. No further consideration of the scientific literature, on the epidemiology of exposure to air pollution that underpins these methods, has been undertaken in support of this report.

1.1.6 The relationship between exposure to air pollutants, either singly or in combination, and the resulting effects on health remains a topic of active research. Exposure to increased concentrations of pollutants such as particulate matter and sulphur dioxide are associated with effects on the respiratory and cardiovascular system, leading to increased morbidity and such exposure may contribute to individual deaths through mechanisms that are not yet fully understood. The methods used are based on current understanding of the effect of exposure on health as reported in the cited publications.

1.1.7 It is likely that exposure to airborne pollutants can cause acute effects on human health in the short term and chronic effects over the longer term. The vulnerability of individuals to short term effects of air pollution can vary depending on their general health at the time of exposure, their lifestyle and on presence of specific medical conditions. Exposure to air pollutants over the longer term may have a marginal effect that contributes to the progression of chronic diseases that have other causes.

1.1.8 The methodologies employed to quantify the health effect associated with the exposure of populations to predicted concentrations of air pollutants consider the effect on the affected population and not the effect on each individual living within that population. The health effects are reported as population statistics that should be considered appropriately[10] and in the context of the methods used to calculate them.

1.1.9 In this report the terminology used is of necessity technical and the meaning of the terms may differ from their use in conversational English. A glossary of the terms used is provided within this report.

[10] COMEAP specifically highlight the need for appropriate consideration of predicted effects on health in COMEAP (2000) Statement on the Applicability of time-series coefficients to areas affected by emissions of air pollutants from industrial sources, September 2000.

2 Methodology

2.1 Overview of Approach

2.1.1 The approach to quantifying acute health effects is based on the use of a concentration-response function. The functions used by COMEAP and CAFE and the exposure-response coefficients used within them, are derived from reviews of the empirical evidence generated by epidemiological studies. This body of evidence is such that the World Health Organisation and National bodies, with responsibility for public health, are convinced that the associations between exposure to polluted air and specific health outcomes (events) should be considered as causal.

2.1.2 The concentration-response function (Equation 2.1) combines the use of an exposure-response coefficient with, details of the specific population affected and the predicted change in ambient pollutant concentrations that the population would be exposed to.

Equation 2.1 $$\Delta E = \beta \times \Delta C \times P \times E$$

Where:

ΔE = (change in) background rate of events;

β = exposure-response coefficient;

ΔC = change in concentration of pollutant;

P = population exposed.

2.1.3 The effect of exposure on health is described as a change in the rate of occurrence of specified events. For example an event might be a hospital admission. For each pollutant considered in this study, the specific events used to represent health effects are considered in turn in the following sections of this report.

2.1.4 The total population considered is the same for assessment of acute effects associated with exposure to particulate matter, nitrogen dioxide and sulphur dioxide. The same total population is also used in the assessment of mortality effects associated with chronic exposure to fine particulate matter.

2.1.5 The CAFE methodology adopts the relationship between mortality and long-term exposure to fine particulate matter ($PM_{2.5}$) based on a cohort study by the American Cancer Society[11] and expresses the results of the calculations in terms of life years lost by the population, rather than the numbers of deaths within the population. This approach has been adopted in this assessment as it is consistent with the current consensus view of the subject. It requires an alternative spreadsheet method to be employed based on life tables, instead of using Equation 2.1. This approach was employed by COMEAP in its most recent reports on the quantification of the long term effects on mortality[7,8,12].

[11] Pope CA, Burnett RT, Thun MJ, Calle EE, Kreswki D, Ito K, Thurston GD (2002) Lung cancer, cardiopulmonary mortality and long-term exposure to fine particulate pollution. Journal of the American Medical Association **287** 1132-1141
[12] COMEAP (2001) Statement and Report on the Long Term Effects of Particles on Mortality, Accessed via URL: http://www.dh.gov.uk/ab/COMEAP/DH_108596, Date accessed 15/10/2010.

Approach to Quantifying the Health Effects of Particulate Matter

Assessment of Mortality Effects

2.1.6 The IOM[13,14] have developed a series of spreadsheets to predict the change in mortality based on the life table approach. This approach has the advantage of addressing the complicating issue of considering the link between death rates and surviving populations[15] when calculating impacts on chronic mortality.

2.1.7 In 2009, COMEAP recommended[7] coefficients which, when used in conjunction with methods developed for the Department of Health and the European Commission by the Institute of Occupational Medicine, allowed for the calculation of the potential impact on mortality and life expectancy of specified changes in concentrations of air pollutants, as presented in the 2010 COMEAP report[8]. This quantification used the coefficients in the 2009 report to calculate that decreasing $PM_{2.5}$ by 1 μgm^{-3} would save 4 million life years and increase life expectancy at birth by 20 days. The coefficients recommended by COMEAP in 2009 remain unchanged from those identified in the previous 2001 report[12], however COMEAP reported that the evidence base relating to the effects of long-term exposure to air pollutants had strengthened since the publication of the 2001 report.

2.1.8 The dispersion model predictions of particulate matter concentrations can be treated as being either PM_{10} or $PM_{2.5}$. In practice, almost all of the particulate matter emitted from the proposed plant will be in the size fraction 2.5 µm and less, because the fabric filter used will remove almost all of the particles with a larger diameter, whilst being least efficient at around 1 µm. For the assessment of mortality associated with long term exposure to particulate matter the predicted particulate matter concentrations are considered to relate to particles within the size fraction $PM_{2.5}$

2.1.9 The population located with 10 km of the proposed EfW CHP facility is determined from census data using GIS methods. A study area boundary of 10 km from the pollution source could be argued as being excessive for a study of this type, but as the data is already available from other elements of air quality impact assessment and is used here for consistency. Baseline life expectancies for the whole population are calculated based on data for male and female life expectancies. For a given change in the ambient concentration of $PM_{2.5}$ that the population are exposed to there is an associated change in the risk that the exposure will result in a decrease in life expectancy, or loss of life. The risk is expressed as an estimate of life years lost by using the life tables method for the total population exposed.

Assessment of Acute Health Effects

2.1.10 Acute health effects associated with exposure to airborne particulate matter are quantified using the concentration-response function presented as Equation 2.1. The health effects associated with exposure to particulate matter that considered in this assessment as specific events are:

- Chronic bronchitis (adults);

[13] Miller B. and Hurley J., 2006, Comparing estimated risks for air pollutants with risks for other health effects, Research Report TM/06/01, Institute of Occupational Medicine.
[14] Miller B., 2008, IOMLIFET version 2008, Spreadsheets for life-table calculations, Institute of Occupational Medicine.
[15] Miller B, and Hurley J: Life table methods for quantitative impact assessments in chronic mortality *Journal of Epidemiology and Community Health.2003; 57: 200-206*

- Respiratory hospital admissions;
- Cardiac hospital admissions;
- Lower respiratory system symptom days (children); and
- Lower respiratory system symptom days (adults).

2.1.11 The respective concentration-response coefficients applied for each of the event classes are summarised in Section 2.1.4.

Approach to Quantifying the Health Effects of Nitrogen Dioxide

2.1.12 The health effects associated with exposure to nitrogen dioxide that are considered in this assessment as specific events are:

- Respiratory hospital admissions;
- Cardiac hospital admissions; and
- Mortality.

2.1.13 The impact of exposure to nitrogen dioxide for respiratory hospital admissions are considered through the use of the relationship cited by COMEAP[16], of a 0.038% increase in the rate of the health event for every 1 µg m^{-3} rise in NO_2 concentrations.

2.1.14 Acute mortality and respiratory hospital admissions from NO_2 should be considered as an alternative to that used for particulate matter and not in addition. This is because NO_2 may be acting as a marker for the effect of locally emitted particulate matter[17] and there is therefore a risk of double counting the impact of local emissions on health. Likewise mortality and respiratory hospital admissions associated with SO_2 should not be added, as there may be some synergistic effects, i.e. the observed associations are not independent of each other.

2.1.15 The respective concentration-response coefficients applied for each of the event classes are summarised in Section 2.1.4.

2.1.16 In this assessment it has been assumed that 70 % of the predicted oxides of nitrogen concentrations contributed to total annual mean concentrations are in the chemical form of nitrogen dioxide. This is in accordance with the Environment Agency's screening method H1[18], which specifies the use of a conversion rate that equates to 70 % of oxides of nitrogen in the form of nitrogen dioxide.

Approach to Quantifying the Health Effects of Sulphur Dioxide

2.1.17 Health effects associated with exposure to sulphur dioxide that are considered in this assessment as specific events are:

- Respiratory hospital admissions; and

[16] Cardiovascular Disease and Air Pollution (2006) Department of Health. A Report by the Committee on Medical Effects of Air Pollutants' cardiovascular sub-group
[17] COMEAP, 2009, Statement on the Quantification of The Effects of Long-Term Exposure to Nitrogen Dioxide on Respiratory Morbidity in Children.
[18] Environment Agency, Conversion Ratios for NO_X and NO_2, Air Quality Modelling and Assessment Unit (AQMAU). Obtained from the Environment Agency website available at:
http://www.environment-agency.co.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf

- Mortality.

2.1.18 The respective concentration-response coefficients applied for each of the event classes are summarised in Section 2.1.4.

2.1.19 The impact of exposure to sulphur dioxide for respiratory hospital admissions are considered through the use of the relationship cited by COMEAP[6], of a 0.05% increase in the rate of the health event for every 1 µg m^{-3} rise in sulphur dioxide concentrations. The corresponding value of 0.06 % has been used for the change in the rate of mortality per 1 µg/m^3.

Summary of Concentration-Response Coefficients

2.1.20 Concentration-response coefficients for health events used in this study and applied to the increased exposure to air pollution are shown in Table 2.1 and 2.2.

Table 2.1 Increases in Health Effect from exposure to an additional 1 µgm^{-3} of $PM_{2.5}$

Health Event	Increase (based on relative risk)(1)	95 % Confidence Limits
Change in mortality hazards	0.6%	0.2 – 1.1%

Table 2.2 Increases in Health Effects from exposure to an additional 1 µgm^{-3} of air pollutant

Health Event	Increase (based on relative risk)(1)	Pollutant
Particulate Matter – CAFÉ[2]		
Chronic bronchitis (attack rates)	0.7%	PM_{10}
Cardiovascular hospital admissions	0.06%	PM_{10}
Respiratory hospital admissions	0.114%	PM_{10}
Consultation with GPs (asthma, April – Sept, 15 – 64 years age)	0.25%	PM_{10}
Lower respiratory symptoms (wheeze, shortness of breath, phlegm production) (in children)	0.0004%	PM_{10}
Lower respiratory symptoms (in adults)	0.0017%	PM_{10}
Nitrogen Dioxide – COMEAP		
Cardiovascular hospital admissions[16]	0.13%	NO_2
Respiratory hospital admissions[7]	0.038%	NO_2
Deaths brought forward[7]	0.035%	NO_2
Sulphur Dioxide – COMEAP [7]		
Deaths brought forward	0.06%	SO_2
Respiratory hospital admissions	0.05%	SO_2

1) Relative Risk is defined as the ratio of the incidence of disease in the exposed group divided by the corresponding incidence of disease in the non-exposed group.

2.2 Summary of Input Information

2.2.1 The calculation of health effects is based on the following project specific information:

- Predicted changes in annual mean pollutant concentrations for sulphur dioxide, oxides of nitrogen and particulate matter, expressed as µg/m^3. The values are made available to this assessment as a variable Cartesian grid of receptor points, covering a model domain of 20 km by 20 km. The grid is centred on the location of the source of emissions under consideration[1];
- Population data, at the 'super output area level', based on the 2001 census[19];
- Background data on the rates of all relevant health outcomes (national and local). This input is considered in Section 3 of this report.

2.2.2 The exposed population has been defined as the area within 10 km of the source of emissions. This circular boundary for the exposed population sits within the boundary of the dispersion model domain. The exposed population boundary encompasses an area that is large enough to capture the incremental reduction in meaningful effects. In setting this boundary there is a need to balance the requirement to provide adequate spatial coverage to capture the events under consideration, whilst avoiding the generation of values that are no more than artefact of the method, caused by the inclusion of an unnecessarily large population.

2.2.3 The pollutant concentrations are plotted as isopleths that form a pattern of decreasing magnitude and this is overlaid onto the population data using GIS software. The total population is then subdivided into 'bands' on the basis of the magnitude of the change in concentrations of pollution that they are predicted to experience. The process is repeated for each pollutant. The pollutant concentration used to represent each band is taken as the highest isopleth bounding the band, or in the case of the worse case bands the highest value at any receptor is used.

2.2.4 The population of each band is then calculated, from the population density of the wards that make up the area within the band. This technique assumes that there is an equal distribution of people within each super output area and the number of people in each area is determined on a pro rata basis.

2.2.5 This input information is illustrated in Annex A of this report as Figures 2.1 to 2.3.

2.3 Summary of Output Information

2.3.1 This assessment reports numerical information for each of the health events at the total population level per annum. The numerical estimates for morbidity events for the total population are the sum of the values for each band as summarised in Annex B of this report.

2.3.2 Results are expressed as numerical estimates for the morbidity outcomes described above over a 30 year period and this same information is also expressed as an estimate of the number of years operation that would give rise to a single new event.

[19] Obtained from the Office for National Statistics available at http://www.statistics.gov.uk/about/methodology_by_theme/sape/default.asp - accessed on 27th October 2010

2.3.3 Numerical estimates of life years lost are reported for the whole population for the effect on mortality.

2.4 Approach to Consideration of Additive Effects

2.4.1 The results for each pollutant are presented independently. In practice it is highly likely that the health effects estimated for each pollutant are not independent of each other. The approach taken to the calculation of the numerical estimates for the effect of exposure to each pollutant have taken a robust approach that already incorporates conservative values at several points in the calculation process. Adding the health effect estimates for separate pollutants together will result in an unreasonable over estimate of any health effects.

3 Baseline Conditions

3.1 The Context

3.1.1 The predicted health effects are considered in the context of observed rates of disease and observed life expectancies in the UK. The method used could make use of either national statistics or local level statistics if such data exists. In this assessment national level statistics have been used, as there are benefits to determining baseline population disease rates on statistics that represent larger numbers of people. There may be differences in the values for the statistical parameters used between the local and national level datasets, but the associated difference in the calculated health effects under consideration, would be so small as to be insignificant.

3.1.2 National statistics for disease rates and life expectancy have been used for this assessment, as presented in **Table 3.1**.

3.1.3 Use has been made of episode statistics sourced from surveys published by the Office of Population Censuses and Surveys (predecessor to the Office for National Statistics)[20]. Life expectancy at birth figures for England has been sourced from the Office of National Statistics (ONS)[21].

Table 3.1 Background Rates of Disease

Disease	Baseline Rate per 1,000 Population
Chronic Bronchitis	8
Cardiovascular Hospital admissions	14
Respiratory hospital admissions	7.8
GP Consultation Asthma	64.13
LRS Children	325
LRS adults	204.44
Mortality – Deaths (non traumatic) brought forward	7.69
Life Expectancy for 2005 to 2007 (Men)	77.3 years
Life Expectancy for 2005 to 2007 (Women)	81.5 years

[20] Office of Population Censuses and Surveys (1995) Morbidity Statistics from General Practice, Fourth National Study 1991-1992.
[21] Office for National Statistics (2010) Life Expectancy at Birth and at age 65, England and Wales, 1991-1993 to 2007-2009

4 Results

4.1 Particulate Matter

Years of Life lost through exposure to $PM_{2.5}$

4.1.1 The method described in section 2.1.1 has resulted in an estimated 0.70 years of life lost due to the effects of exposure to a maximum concentration of 0.13 µg/m^3 of $PM_{2.5}$, distributed across the entire exposed population. This represents a reduction of approximately 1.38 minutes per person (or 83 seconds) when averaged over the entire exposed population. However these results would not be distributed evenly over the entire exposed population with the population group with the largest exposure being most susceptible to experiencing the above reduction in life years. The latest Air Quality Strategy[5] produced by Defra estimates that the average loss of life expectancy at 2005 levels of exposure to all anthropogenic $PM_{2.5}$ is 8 months for each person in the UK. The most recent report published by COMEAP in 2010[8] calculates the mortality effects of long term exposure to particulate air pollution to be equivalent to 29,000 deaths in the UK associated with a loss of total population life of 340,000 years and a loss of life expectancy from birth of approximately 6 months. The predicted additional life years lost due to the proposed EfW CHP facility of 1.38 minutes per person can be considered as low when taken in context with the background figure for $PM_{2.5}$.

4.1.2 A sensitivity analysis for the number of potential life years lost was performed based on the upper and lower 95% confidence levels for the concentrations-response coefficient for mortality due to $PM_{2.5}$ exposure (Table 2.1). This gave a range from 0.24 to 1.26 life years lost across the whole of the exposed population. (These figures are based on average life expectancy for England and Wales (Table 3.1) and the 95% confidence values for the concentration response coefficient of 0.20% and 1.11% factored to the maximum $PM_{2.5}$ predicted concentration).

Morbidity Effects Associated with Exposure to Particulate Matter

4.1.3 Figure 2.1 shows the exposed population affected by the change in concentrations of particulate matter due to the EfW CHP facility. Table 4.1 shows the predicted change in the number of health events due to the change in concentration attributed to the EfW CHP facility, with the full set of results shown in Annex B.

Table 4.1 Predicted change in the number of health events due to the additional PM_{10} from the EfW CHP Facility

Disease	Baseline rate of disease for total exposed population per annum	Extra Cases per annum	Extra cases in 30 year period	Years of operation needed for one case	Extra cases per annum as % of baseline
Chronic Bronchitis	2,125	0.12	3.70	8.11	0.006
Cardiovascular Hospital admissions	3,719	0.02	0.56	54.0	0.001
Respiratory hospital admissions	2,072	0.02	0.59	51.0	0.001
GP Consultation Asthma	17,037	0.44	13.1	2.28	0.003
LRS Children	86,342	0.03	0.86	34.9	0.00003
LRS adults	54,313	0.01	0.23	131	0.00001

4.1.4 The change in concentration of PM_{10} due to the proposed EfW CHP facility is predicted to produce a slight increase in the number of cases of all the acute health events per annum.

4.1.5 The baseline rate for each of the health events has been calculated for the entire exposed population (approximately 265,000 people) in this study. The extra number of health events generated due to the change in concentration of particulate matter from the EfW CHP facility can be considered as less than 0.007% when compared to the baseline rate for the entire exposed population.

4.1.6 The largest impact on the number of health events is predicted to occur in GP consultation rates for Asthma. Approximately 13 new cases would be expected in the estimated 30 year operating period of the proposed EfW CHP facility with the first extra case anticipated to occur after 2 years. This represents an estimated increase in the rates of GP consultation for asthma of 0.003% of the baseline rate for total exposed population. The lowest change is predicted to occur in lower respiratory symptoms for adults where the proposed EfW CHP facility would need to be operated for 131 years for a single extra case to be observed.

4.1.7 This can be considered as a relatively small effect on the health of the exposed population as a whole.

4.2 Nitrogen Dioxide

4.2.1 Figure 2.2 shows the exposed population affected by the change in concentration of nitrogen dioxide due to the EfW CHP facility. Table 4.2 shows the predicted change in the number of health events due to the change in concentration of nitrogen dioxide attributed to the EfW CHP facility with the full set of results shown in Annex B.

Table 4.2 Predicted change in the number of health events due to the additional nitrogen dioxide from the EfW CHP facility

Disease	Baseline rate of disease for total exposed population per annum	Extra Cases per annum	Extra cases in 30 year period	Years of operation needed for one case	Extra cases per annum as % of baseline
Cardiovascular Hospital admissions	3,719	0.56	16.9	1.78	0.015
Respiratory hospital admissions	2,072	0.09	2.75	10.9	0.004
Deaths (non-traumatic) brought forward	2,043	0.08	2.50	12.0	0.004

4.2.2 The number of cardiovascular hospital admissions for the population as a whole is predicted to increase from a baseline rate of 3,719 admissions per year by 0.015%. An alternative way of expressing this population statistic is as an additional admission within a time period of 1.7 years. This means that this very small impact is likely to occur.

4.2.3 Additional hospital admissions for respiratory symptoms are predicted to increase by 0.004% on a baseline rate of 2,072 admissions per year. The population statistic of deaths brought forward is an abstract concept where one death brought forward represents a cumulative two to six month loss of life expectancy for the population exposed. The predicted impact for the measure death brought forward is an increase of 0.004% on a baseline rate of 2,043 deaths brought forward per annum.

4.2.4 These figures can be compared to the total number of Ischaemic Heart Disease (Coronary Heart Disease) primary diagnoses obtained from Hospital Episode Statistics. In the year 2009-2010, 407,675 diagnoses, attributed to diet/lifestyle etc, were made in England[22]. The extra cases of cardiovascular hospital admissions estimated from the operation of the EfW CHP facility are 0.56 per annum, which represents 0.0001% of the total cases in England. In comparison with the baseline rate for the entire exposed population, the EfW CHP facility will cause a 0.015% change in the number of cardiovascular hospital admissions.

4.2.5 When taken in context with the baseline rate for the health events of the entire exposed population and that of England, the impact on the number of health events, associated with the change in nitrogen dioxide concentrations in the study area, can be considered small.

4.3 Sulphur Dioxide

4.3.1 Figure 2.3 shows the exposed population affected by the change in concentration of sulphur dioxide due to the EfW CHP facility. Table 4.3 shows the predicted change in the number of health events due to the change in concentration of sulphur dioxide attributed to the EfW CHP facility with the full set of results shown in Annex B.

Table 4.3 Predicted change in the number of health events due to the additional sulphur dioxide from the EfW CHP facility

Disease	Baseline rate of disease for total exposed population per annum	Extra Cases per annum	Extra cases in 30 year period	Years of operation needed for one case	Extra cases per annum as % of baseline
Respiratory hospital admissions	2,072	0.04	1.29	23.3	0.002
Deaths (non-traumatic)	2,043	0.05	1.53	19.7	0.003

4.3.2 The number of respiratory hospital admissions for the population as a whole is predicted to increase from a baseline rate of 2,072 admissions per year by 0.002%. An alternative way of expressing this population statistic is as an additional admission within a time period of 23.3 years. The predicted impact for the measure death brought forward is an increase of 0.003% on a baseline rate of 2,043 deaths brought forward per annum.

4.3.3 Throughout the estimated operating time period of the proposed EfW CHP facility less than two additional cases of the above health events are predicted to occur.

4.3.4 The change in the number of additional health events, associated with the predicted change in sulphur dioxide concentrations in the study area, can be considered as an insignificant effect on the health of the exposed population.

[22] NHS Information Centre for Health and Social Care (2010) Hospital Episode Statistics Headline Figures, 2009-2010. Available at http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=193

5 Conclusions

5.1.1 An assessment of the potential effects on human health due to the operation of the proposed EfW CHP facility has been carried out with respect to the predicted change in population exposure to particulate matter, sulphur dioxide and nitrogen dioxide. This report applies approaches to the quantification of health effects from predicted pollutant concentrations published by the Department of Health's Committee on the Medical Effect of Air Pollutants (COMEAP) and the Clean Air for Europe (CAFE) programme.

5.1.2 The total population of an area extending 10 km from the location of the proposed EfW CHP facility were considered in the assessment of acute effects associated with exposure to particulate matter, nitrogen dioxide and sulphur dioxide.

5.1.3 The assessment concluded that, for each pollutant under consideration, the effect of the proposed EfW CHP facility emissions of particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide and sulphur dioxide on human health would be relatively small.

5.1.4 The main outcomes of the study are as follows:

- 0.70 years of life would be lost through exposure to the maximum concentration of $PM_{2.5}$, which averaged out across the whole exposed population is 1.38 minutes per person. By comparison, the most recent report published by COMEAP in 2010[8] calculated that the mortality effects of long term exposure to particulate air pollution to be equivalent to 29,000 deaths in the UK associated with a loss of total population life of 340,000 years and a loss of life expectancy from birth of approximately 6 months.

- The estimated number of extra chronic bronchitis events, associated with the predicted change in concentration of particulate matter in the study area, is 0.12 per annum, which represents 0.006% of the corresponding baseline rates for the entire exposed population. Additional cases of hospital admissions for cardiovascular and respiratory symptoms are predicted to rise by 0.02 per annum. The estimated increase in the occurrence of lower respiratory symptoms in children is 0.03 per annum, which represents a 0.00003% increase of baseline rates. This can be considered as a relatively small effect on the health of the exposed population as a whole.

- Rates of hospital admissions for cardiovascular symptoms, associated with the predicted change in concentration of nitrogen dioxide in the study area, are estimated to increase by 0.56 per annum which represents 0.015% of the corresponding baseline rates for the entire exposed population. This is considered insignificant when compared to the total incidence of heart disease in the entire population of England, attributable to factors such as, diet and lifestyle. The estimated increase in hospital admissions for respiratory symptoms are predicted to increase by 0.004% on a baseline rate of 2,072 admissions per year. The predicted impact for the measure death brought forward is an increase of 0.004% on a baseline rate of 2,043.

- The predicted impact for the measure death brought forward, associated with the predicted change in concentrations of sulphur dioxide in the study area, is an increase of 0.003% on a baseline rate of 2,043 deaths brought forward per annum. Rates of hospital admissions for respiratory symptoms are estimated to increase by 0.04 per annum, which represents a 0.002% increase of baseline rates. The change in sulphur dioxide concentrations due to

the proposed EfW CHP facility can be considered as a relatively small effect on the health of the exposed population.

Annex A

Figure 2.1 Predicted Particulate Matter Impacts and Population Density

Figure 2.2 Predicted Nitrogen Dioxide Impacts and Population Density

Figure 2.3 Predicted Sulphur Dioxide Impacts and Population Density

N

THIS DRAWING MAY BE USED FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

NOTES

Population Density (People per Hectare)

- < 10
- 10 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Stack Location
- Model Domain

Zone	Median Conc µg/m^3	Total Pop. People
1	0.0005	578
2	0.0015	4,106
3	0.0005	0
4	0.0015	4,430
5	0.0025	39,885
6	0.0035	33,902
7	0.0045	44,301
8	0.0055	31,560
9	0.0065	16,179
10	0.0075	12,535
11	0.0085	9,527
12	0.0095	8,392
13	0.0011	14,541
14	0.0130	9,650
15	0.0150	7,198
16	0.0170	5,644
17	0.0190	4,204
18	0.0225	5,609
19	0.0275	2,537
20	0.0350	2,676
21	0.0450	1,410
22	0.0550	1,061
23	0.0650	863
24	0.0750	623
25	0.0850	489
26	0.0950	385
27	0.1050	253
28	0.1150	147
29	0.0130	411
30	0.0150	299
31	0.0170	179
32	0.0190	142
33	0.0225	294
34	0.0275	144
35	0.0350	20
36	0.0075	745
37	0.0030	434
38	0.0050	314

0 500 1,000 2,000 Meters

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: EFW CHP FACILITY, NORTH YARD, DEVONPORT

Drawing Title: PREDICTED PARTICULATE MATTER IMPACTS AND POPULATION DENSITY

Scale at A3	1:80,000		
Drawn	EW	Approved	GG
Stage 1 Check	Stage 2 Check	Originated	Date
DD	DD	9511NM	14/04/11

Rev

Drawing Number: FIGURE 2.1

N

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NOTES

Population Density (People per Hectare)

- < 10
- 10 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Stack Location
- Model Domain

Zone	Median Conc µg/m^3	Total Pop. People
1	0.025	17
2	0.005	94
3	0.015	3,570
4	0.025	1,259
5	0.015	1,540
6	0.025	10,227
7	0.035	27,811
8	0.045	19,762
9	0.055	33,833
10	0.065	29,091
11	0.075	24,539
12	0.085	14,800
13	0.095	10,439
14	0.110	15,992
15	0.130	12,423
16	0.150	10,887
17	0.170	8,010
18	0.190	6,227
19	0.225	11,412
20	0.275	6,479
21	0.350	5,658
22	0.450	2,267
23	0.625	2,746
24	0.875	1,649
25	1.125	978
26	1.375	610
27	1.590	206
28	0.170	361
29	0.190	258
30	0.225	420
31	0.275	248
32	0.350	317
33	0.452	47
34	0.180	508
35	0.075	378
36	0.020	607

0 500 1,000 2,000 Meters

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

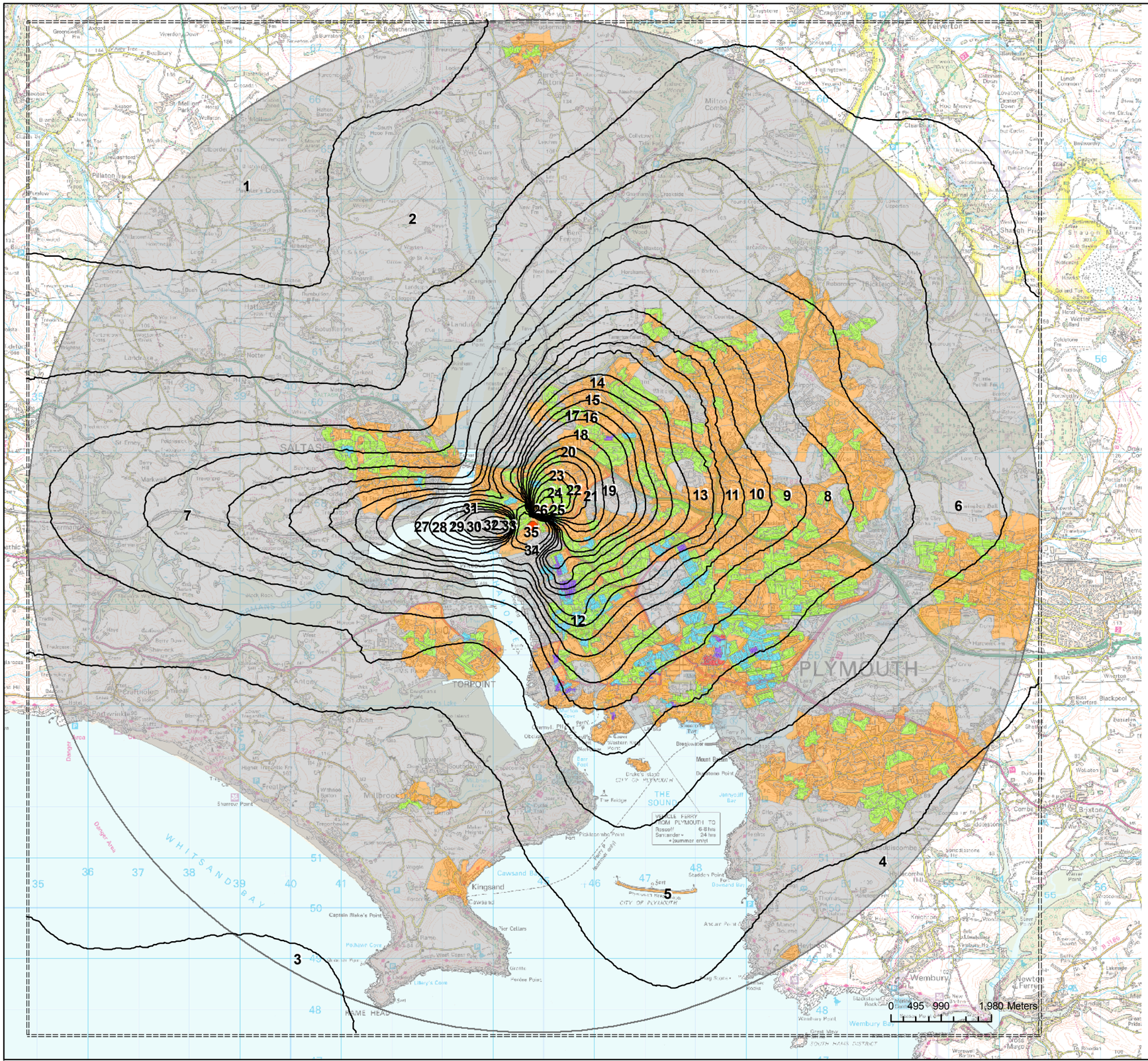
Job Title: EFW CHP FACILITY, NORTH YARD, DEVONPORT

Drawing Title: PREDICTED NITROGEN DIOXIDE IMPACTS AND POPULATION DENSITY

Scale at A3	1:80,000		
Drawn	EW	Approved	GG
Stage 1 Check	Stage 2 Check	Originated	Date
DD	DD	9511NM	14/04/11

Rev

Drawing Number: FIGURE 2.2



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NOTES

Population Density (People per Hectare)

- < 10
- 10 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Stack Location
- Model Domain

Zone	Median Conc µg/m^3	Total Pop. People
1	0.025	578
2	0.005	4,106
3	0.015	0
4	0.025	4,431
5	0.015	39,884
6	0.025	33,905
7	0.035	44,299
8	0.045	31,560
9	0.055	16,179
10	0.065	12,535
11	0.075	9,527
12	0.085	8,392
13	0.095	14,767
14	0.110	9,650
15	0.130	7,198
16	0.150	5,644
17	0.170	4,204
18	0.190	5,609
19	0.225	2,537
20	0.275	1,535
21	0.350	1,140
22	0.450	1,410
23	0.625	1,061
24	0.875	1,486
25	1.125	874
26	1.375	400
27	1.590	411
28	0.170	299
29	0.190	179
30	0.225	142
31	0.275	294
32	0.350	144
33	0.452	20
34	0.180	519
35	0.075	748

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: EFW CHP FACILITY, NORTH YARD, DEVONPORT

Drawing Title: PREDICTED SULPHUR DIOXIDE IMPACTS AND POPULATION DENSITY

Scale at A3	1:80,000		
Drawn: EW		Approved: GG	
Stage 1 Check: DD	Stage 2 Check: DD	Originated: 9511NM	Date: 14/04/11

Drawing Number: FIGURE 2.3 Rev

MVV Environment Devonport Ltd	Contractor to SWDWP
Scott Wilson	Environmental & Planning Consultant
MVV O&M	EPC Contractor
Envi Con Envi Con & Plant Engineering GmbH	General Designer
KIER	Civil Works
SC	Architect
Lab	Air Pollution Control
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SAR www.sar.biz	Electrical & Control
Imtech	Water Steam System

Annex B

Table B1 Predicted number of additional cases of selected diseases per annum in the exposed population based on additional NO_2

Disease	Extra cases per annum in each exposed population zone																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Cardiovascular Hospital admissions	7.74×10^{-7}	8.55×10^{-6}	9.75×10^{-4}	5.73×10^{-4}	4.20×10^{-4}	4.65×10^{-3}	1.77×10^{-2}	1.62×10^{-2}	3.39×10^{-2}	3.44×10^{-2}	3.35×10^{-2}	2.29×10^{-2}	1.80×10^{-2}	3.20×10^{-2}	2.94×10^{-2}	2.97×10^{-2}	2.48×10^{-2}	2.15×10^{-2}	4.67×10^{-2}
Respiratory hospital admissions	1.26×10^{-7}	1.39×10^{-6}	1.59×10^{-4}	9.33×10^{-5}	6.85×10^{-5}	7.58×10^{-4}	2.89×10^{-3}	2.64×10^{-3}	5.52×10^{-3}	5.60×10^{-3}	5.46×10^{-3}	3.73×10^{-3}	2.94×10^{-3}	5.21×10^{-3}	4.79×10^{-3}	4.84×10^{-3}	4.04×10^{-3}	3.51×10^{-3}	7.61×10^{-3}
Deaths (non-traumatic) brought forward	1.14×10^{-7}	1.27×10^{-6}	1.44×10^{-4}	8.47×10^{-5}	6.22×10^{-5}	6.88×10^{-4}	2.62×10^{-3}	2.39×10^{-3}	5.01×10^{-3}	5.09×10^{-3}	4.95×10^{-3}	3.39×10^{-3}	2.67×10^{-3}	4.73×10^{-3}	4.35×10^{-3}	4.40×10^{-3}	3.67×10^{-3}	3.18×10^{-3}	6.91×10^{-3}

Table B1 - Continued

Disease	Extra cases per annum in each exposed population zone																Total extra cases per annum
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
Cardiovascular Hospital admissions	3.24×10^{-2}	3.60×10^{-2}	1.86×10^{-2}	3.12×10^{-2}	2.63×10^{-2}	2.00×10^{-2}	1.53×10^{-2}	5.96×10^{-3}	1.12×10^{-3}	8.92×10^{-4}	1.72×10^{-3}	1.24×10^{-3}	2.02×10^{-3}	3.64×10^{-4}	1.66×10^{-3}	5.16×10^{-4}	2.21×10^{-4}	0.563
Respiratory hospital admissions	5.28×10^{-3}	5.87×10^{-3}	3.02×10^{-3}	5.09×10^{-3}	4.28×10^{-3}	3.26×10^{-3}	2.49×10^{-3}	9.71×10^{-4}	1.82×10^{-4}	1.45×10^{-4}	2.80×10^{-4}	2.02×10^{-4}	3.29×10^{-4}	5.92×10^{-5}	2.71×10^{-4}	8.40×10^{-5}	3.60×10^{-5}	0.092
Deaths (non-traumatic) brought forward	4.80×10^{-3}	5.33×10^{-3}	2.75×10^{-3}	4.62×10^{-3}	3.88×10^{-3}	2.96×10^{-3}	2.26×10^{-3}	8.82×10^{-4}	1.65×10^{-4}	1.32×10^{-4}	2.54×10^{-4}	1.84×10^{-4}	2.99×10^{-4}	5.38×10^{-5}	2.46×10^{-4}	7.63×10^{-5}	3.27×10^{-5}	0.083

Table B2 Predicted number of additional cases of selected diseases per annum in the exposed population based on additional SO_2

Disease	Extra cases per annum in each exposed population zone																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Deaths (non-traumatic)	6.67×10^{-6}	1.42×10^{-4}	0	1.53×10^{-4}	2.30×10^{-3}	2.74×10^{-3}	4.60×10^{-3}	4.00×10^{-3}	2.43×10^{-3}	2.17×10^{-3}	1.87×10^{-3}	1.84×10^{-3}	3.75×10^{-3}	2.89×10^{-3}	2.49×10^{-3}	2.21×10^{-3}	1.84×10^{-3}	2.91×10^{-3}
Respiratory hospital admissions	5.64×10^{-6}	1.20×10^{-4}	0	1.30×10^{-4}	1.94×10^{-3}	2.31×10^{-3}	3.89×10^{-3}	3.38×10^{-3}	2.05×10^{-3}	1.83×10^{-3}	1.58×10^{-3}	1.55×10^{-3}	3.17×10^{-3}	2.45×10^{-3}	2.11×10^{-3}	1.87×10^{-3}	1.56×10^{-3}	2.46×10^{-3}

Table B2 - Continued

Disease	Extra cases per annum in each exposed population zone																	Total extra cases per annum
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
Deaths (non-traumatic)	1.61×10^{-3}	1.15×10^{-3}	9.86×10^{-4}	1.46×10^{-3}	1.35×10^{-3}	2.40×10^{-3}	1.81×10^{-3}	1.02×10^{-3}	1.23×10^{-4}	1.03×10^{-4}	7.02×10^{-5}	6.22×10^{-5}	1.53×10^{-4}	9.14×10^{-5}	1.50×10^{-5}	8.38×10^{-5}	4.31×10^{-5}	0.051
Respiratory hospital admissions	1.36×10^{-3}	9.73×10^{-4}	8.34×10^{-4}	1.24×10^{-3}	1.14×10^{-3}	2.03×10^{-3}	1.53×10^{-3}	8.58×10^{-4}	1.04×10^{-4}	8.75×10^{-5}	5.93×10^{-5}	5.26×10^{-5}	1.29×10^{-4}	7.72×10^{-5}	1.27×10^{-5}	7.08×10^{-5}	3.65×10^{-5}	0.043

Table B3 Predicted number of additional cases of selected diseases per annum in the exposed population based on additional PM_{10}

Disease	Extra cases per annum in each exposed population zone																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Chronic Bronchitis	1.62×10^{-5}	3.45×10^{-4}	0	3.72×10^{-4}	5.58×10^{-3}	6.64×10^{-3}	1.12×10^{-2}	9.72×10^{-3}	5.89×10^{-3}	5.26×10^{-3}	4.53×10^{-3}	4.46×10^{-3}	8.96×10^{-3}	7.03×10^{-3}	6.05×10^{-3}	5.37×10^{-3}	4.47×10^{-3}	7.07×10^{-3}
Cardiovascular Hospital admissions	2.43×10^{-6}	5.17×10^{-5}	0	5.58×10^{-5}	8.38×10^{-4}	9.97×10^{-4}	1.67×10^{-3}	1.46×10^{-3}	8.83×10^{-4}	7.90×10^{-4}	6.80×10^{-4}	6.70×10^{-4}	1.34×10^{-3}	1.05×10^{-3}	9.07×10^{-4}	8.06×10^{-4}	6.71×10^{-4}	1.06×10^{-3}
Respiratory hospital admissions	2.57×10^{-6}	5.48×10^{-5}	0	5.91×10^{-5}	8.87×10^{-4}	1.06×10^{-3}	1.77×10^{-3}	1.54×10^{-3}	9.35×10^{-4}	8.36×10^{-4}	7.20×10^{-4}	7.09×10^{-4}	1.42×10^{-3}	1.12×10^{-3}	9.60×10^{-4}	8.53×10^{-4}	7.10×10^{-4}	1.12×10^{-3}
GP Consultation Asthma	5.75×10^{-5}	1.22×10^{-3}	0	1.32×10^{-3}	1.98×10^{-2}	2.36×10^{-2}	3.96×10^{-2}	3.45×10^{-2}	2.09×10^{-2}	1.87×10^{-2}	1.61×10^{-2}	1.58×10^{-2}	3.18×10^{-2}	2.49×10^{-2}	2.15×10^{-2}	1.91×10^{-2}	1.59×10^{-2}	2.51×10^{-2}
LRS Children	3.76×10^{-6}	8.01×10^{-5}	0	8.64×10^{-5}	1.30×10^{-3}	1.54×10^{-3}	2.59×10^{-3}	2.26×10^{-3}	1.37×10^{-3}	1.22×10^{-3}	1.05×10^{-3}	1.04×10^{-3}	2.08×10^{-3}	1.63×10^{-3}	1.40×10^{-3}	1.25×10^{-3}	1.04×10^{-3}	1.64×10^{-3}
LRS adults	1.00×10^{-6}	2.14×10^{-5}	0	2.31×10^{-5}	3.47×10^{-4}	4.12×10^{-4}	6.93×10^{-4}	6.03×10^{-4}	3.65×10^{-4}	3.27×10^{-4}	2.81×10^{-4}	2.77×10^{-4}	5.56×10^{-4}	4.36×10^{-4}	3.75×10^{-4}	3.33×10^{-4}	2.78×10^{-4}	4.39×10^{-4}

Table B3 - Continued

Disease	Extra cases per annum in each exposed population zone																	
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Chronic Bronchitis	3.91×10^{-3}	5.24×10^{-3}	3.55×10^{-3}	3.27×10^{-3}	3.14×10^{-3}	2.62×10^{-3}	2.33×10^{-3}	2.05×10^{-3}	1.49×10^{-3}	9.47×10^{-4}	2.99×10^{-4}	2.51×10^{-4}	1.70×10^{-4}	1.51×10^{-4}	3.70×10^{-4}	2.22×10^{-4}	3.92×10^{-5}	3.13×10^{-4}
Cardiovascular Hospital admissions	5.86×10^{-4}	7.87×10^{-4}	5.33×10^{-4}	4.90×10^{-4}	4.71×10^{-4}	3.92×10^{-4}	3.49×10^{-4}	3.07×10^{-4}	2.23×10^{-4}	1.42×10^{-4}	4.49×10^{-5}	3.77×10^{-5}	2.56×10^{-5}	2.27×10^{-5}	5.56×10^{-5}	3.33×10^{-5}	5.88×10^{-6}	4.69×10^{-5}
Respiratory hospital admissions	6.20×10^{-4}	8.33×10^{-4}	5.64×10^{-4}	5.19×10^{-4}	4.99×10^{-4}	4.15×10^{-4}	3.70×10^{-4}	3.25×10^{-4}	2.36×10^{-4}	1.50×10^{-4}	4.75×10^{-5}	3.99×10^{-5}	2.71×10^{-5}	2.40×10^{-5}	5.88×10^{-5}	3.52×10^{-5}	6.22×10^{-6}	4.97×10^{-5}
GP Consultation Asthma	1.39×10^{-2}	1.86×10^{-2}	1.26×10^{-2}	1.16×10^{-2}	1.12×10^{-2}	9.29×10^{-3}	8.26×10^{-3}	7.27×10^{-3}	5.28×10^{-3}	3.36×10^{-3}	1.06×10^{-3}	8.92×10^{-4}	6.05×10^{-4}	5.36×10^{-4}	1.32×10^{-3}	7.87×10^{-4}	1.39×10^{-4}	1.11×10^{-3}
LRS Children	9.07×10^{-4}	1.22×10^{-3}	8.25×10^{-4}	7.59×10^{-4}	7.29×10^{-4}	6.07×10^{-4}	5.40×10^{-4}	4.75×10^{-4}	3.45×10^{-4}	2.20×10^{-4}	6.95×10^{-5}	5.83×10^{-5}	3.96×10^{-5}	3.51×10^{-5}	8.60×10^{-5}	5.15×10^{-5}	9.10×10^{-6}	7.26×10^{-5}
LRS adults	2.42×10^{-4}	3.26×10^{-4}	2.21×10^{-4}	2.03×10^{-4}	1.95×10^{-4}	1.62×10^{-4}	1.44×10^{-4}	1.27×10^{-4}	9.23×10^{-5}	5.88×10^{-5}	1.86×10^{-5}	1.56×10^{-5}	1.06×10^{-5}	9.38×10^{-6}	2.30×10^{-5}	1.38×10^{-5}	2.43×10^{-6}	1.94×10^{-5}

Table B3 - Continued

Disease	Extra cases per annum in each exposed population zone		Total extra cases per annum
	37	38	
Chronic Bronchitis	7.29×10^{-5}	8.79×10^{-6}	0.123
Cardiovascular Hospital admissions	1.09×10^{-5}	1.32×10^{-6}	0.019
Respiratory hospital admissions	1.16×10^{-5}	1.40×10^{-6}	0.020
GP Consultation Asthma	2.59×10^{-4}	3.12×10^{-5}	0.438
LRS Children	1.69×10^{-5}	2.04×10^{-6}	0.029
LRS adults	4.53×10^{-6}	5.46×10^{-7}	0.008