Report

Air Quality Review and Assessment - Detailed

Domestic Fuel Combustion

A report for Scottish Borders Council

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Executive Summary

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality which culminated in the Environment Act, 1995. The Air Quality Strategy provides a framework for air quality control through air quality management and air quality standards. These and other air quality standards[1] and their objectives[2] have been enacted through the Air Quality Regulations in 1997 and 2000 and the Air Quality (Amendment) Regulations 2002. The Environment Act 1995 requires Local Authorities to undertake an air quality review. In areas where the air quality objective is not anticipated to be met, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

The intention is that local authorities should only undertake a level of assessment that is proportionate to the risk of air quality objectives being exceeded. The first step in the second round of review and assessment is an Updating and Screening Assessment (USA), which is to be undertaken by all authorities. Where the USA has identified a risk that an air quality objective will be exceeded, the authority is required to undertake a detailed assessment.

Following the outcome of their updating and screening report of November 2003, Scottish Borders Council have commissioned **netcen** to undertake a Detailed Assessment for sulphur dioxide and particulate matter (PM_{10}) at Newcastleton:

This report constitutes an Air Quality Review and Assessment for domestic emissions sources within the Scottish Borders Council area. The report assesses current and potential future PM_{10} and SO_2 concentrations as a result of domestic fuel combustion emissions in Newcastleton. This assessment has been undertaken by means of modelling. Monitoring was carried out during a period of 7 winter months from December 2004 to June 2005. Concentrations arising from domestic fuel combustion have been assessed using **netcen**'s DISP model.

The conclusions of the report are:

Particulate Matter (PM_{10} gravimetric)
Detailed modelling has shown that PM_{10} emissions arising from domestic fuel combustion in Newcastleton are **not predicted** to cause an exceedence of the annual and daily PM_{10} objectives at relevant receptors within the assessed area.

Sulphur dioxide (SO_2)
Detailed modelling has shown that SO_2 emissions arising from domestic fuel combustion in Scottish Borders Council are **not predicted** to cause an exceedence of the air quality objectives at relevant receptors within the assessed area.

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[1] Refers to standards recommended by the Expert Panel on Air Quality Standards. Recommended standards are set purely with regard to scientific and medical evidence on the effects of the particular pollutants on health, at levels at which risks to public health, including vulnerable groups, are very small or regarded as negligible.
[2] Refers to objectives in the Strategy for each of the eight pollutants. The objectives provide policy targets by outlining what should be achieved in the light of the air quality standards and other relevant factors and are expressed as a given ambient concentration to be achieved within a given timescale.

Acronyms and definitions

AADTF	Annual Average Daily Traffic Flow
ADMS	Atmospheric Dispersion Modelling System
AQDD	Air Quality Daughter Directive
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network
defra	Department for the Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions (now defra)
DoE NI	Department of Environment Northern Ireland
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
GIS	Geographical Information System
LADS	model specifically developed for Review and Assessment by **netcen**.
NAEI	National Atmospheric Emissions Inventory
NAQS	National Air Quality Strategy (now the Air Quality Strategy)
ppb	parts per billion
roadside	1 to 5 m from the kerb
SD	standard deviation (of a range of data)
TEMPRO	software for forecasting traffic flow increases
$\mu g\ m^{-3}$	micrograms per cubic meter

Contents

1 Introduction

1.1 PURPOSE OF THE STUDY

netcen has been commissioned to complete a detailed review and assessment for Scottish Borders Council, covering domestic fuel combustion in the village of Newcastleton.

This study further assesses the ambient concentrations of PM_{10} and SO_2 within Newcastleton. The modelling:

- Assesses air quality in 2004, 2005 and 2010 (PM_{10} and SO_2) in Newcastleton as a result of local domestic fuel combustion
- Considers any actions that are likely to be required by Scottish Borders Council, as a result of the findings of this report.

1.2 GENERAL APPROACH TAKEN

The general approach taken in this Detailed Assessment has been to:

- Analyse available domestic emission inventory information for surveyed properties;
- Compile an emission inventory for the whole of Newcastleton;
- Use monitoring data to assess the ambient concentrations in the area and verify the output of the modelling studies;
- Model the concentrations of PM_{10} and SO_2 in the domestic fuel combustion area including local background concentration using netcen's DISP model;

Present the concentrations as contour plots, directly comparable to the relevant objectives, overlaid onto a map of local housing;

1.3 VERSION OF THE LAQM TECHNICAL GUIDANCE USED IN THIS ASSESSMENT

In preparing this report the latest version of the Government Guidance has been used LAQM.TG (03) in conjunction with the previous 'Pollutant Specific Guidance' (2000).

1.4 NUMBERING OF FIGURES AND TABLES

The numbering scheme is not sequential, the figures and tables are numbered according to the chapter and section that they relate to.

1.5 UNITS OF CONCENTRATION

The units of concentration throughout this report are presented in µg m^{-3} and the PM_{10} levels are gravimetric equivalent (which is consistent with the presentation of the AQS objectives), unless otherwise noted.

1.6 STRUCTURE OF THE REPORT

This document completes the review and assessment process for domestic fuel combustion for Scottish Borders Council.

This chapter, Chapter 1, has summarised the need for the work and the approach to completing the study.

Chapter 2 of the report describes the most recent developments in the UK's Air Quality Strategy (AQS).

Chapter 3 gives a description of the two pollutants assessed in this report (PM_{10} and SO_2).

Chapter 4 describes the information and tools used to support this assessment

Chapter 5 describes the impact of domestic fuel combustion including the results of the modelling

Chapter 6 discusses the finding of this report.

Chapter 7 concludes the findings of this report and makes recommendations.

2 The Updated Air Quality Strategy

2.1 THE NEED FOR AN AIR QUALITY STRATEGY

The Government published its proposals for review of the National Air Quality Strategy in early 1999 (DETR, 1999). These proposals included revised objectives for many of the regulated pollutants. A key factor in the proposals to revise the objectives was the agreement in June 1998 at the European Union Environment Council of a Common Position on Air Quality Daughter Directives (AQDD).

Following consultation on the Review of the National Air Quality Strategy, the Government prepared the Air Quality Strategy for England, Scotland, Wales and Northern Ireland for consultation in August 1999. It was published in January 2000 (DETR, 2000).

The Environment Act (1995) provides the legal framework for requiring LA's to review air quality and for implementation of an AQMA. The main constituents of this Act are summarised in Table 2.1 below.

Table 2.1 Major elements of the Environment Act 1995

Part IV Air Quality	Commentary
Section 80	Obliges the Secretary of State (SoS) to publish a National Air Quality Strategy as soon as possible.
Section 81	Obliges the Environment Agency to take account of the strategy.
Section 82	Requires local authorities, any unitary or Borough, to review air quality and to assess whether the air quality standards and objectives are being achieved. Areas where standards fall short must be identified.
Section 83	Requires a local authority, for any area where air quality standards are not being met, to issue an order designating it an air quality management area (AQMA).
Section 84	Imposes duties on a local authority with respect to AQMAs. The local authority must carry out further assessments and draw up an action plan specifying the measures to be carried out and the timescale to bring air quality in the area back within limits.
Section 85	Gives reserve powers to cause assessments to be made in any area and to give instructions to a local authority to take specified actions. Authorities have a duty to comply with these instructions.
Section 86	Provides for the role of County Councils to make recommendations to a district on the carrying out of an air quality assessment and the preparation of an action plan.
Section 87	Provides the SoS with wide ranging powers to make regulations concerning air quality. These include standards and objectives, the conferring of powers and duties, the prohibition and restriction of certain activities or vehicles, the obtaining of information, the levying of fines and penalties, the hearing of appeals and other criteria. The regulations must be approved by affirmative resolution of both Houses of Parliament.
Section 88	Provides powers to make guidance which local authorities must have regard to.

2.2 OVERVIEW OF THE PRINCIPLES AND MAIN ELEMENTS OF THE NATIONAL AIR QUALITY STRATEGY

The main elements of the AQS can be summarised as follows:

- The use of a health effects based approach using national air quality standards and objectives.
- The use of policies by which the objectives can be achieved and which include the input of important factors such as industry, transportation bodies and local authorities.
- The predetermination of timescales with target dates of 2003, 2004, 2005, 2008 and 2010 for the achievement of objectives and a commitment to review the Strategy every three years.

It is intended that the AQS will provide a framework for the improvement of air quality that is both clear and workable. In order to achieve this, the Strategy is based on several principles which include:

- the provision of a statement of the Government's general aims regarding air quality;
- clear and measurable targets;
- a balance between local and national action and
- a transparent and flexible framework.

Co-operation and participation by different economic and governmental sectors is also encouraged within the context of existing and potential future international policy commitments.

2.2.1 National Air Quality Standards

At the centre of the AQS is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2003 and 2010 are shown in Table 2.2. The table shows the standards in $\mu g\ m^{-3}$ with the number of exceedances that are permitted (where applicable) and the equivalent percentile.

Specific objectives relate either to achieving the full standard or, where use has been made of a short averaging period, objectives are sometimes expressed in terms of percentile compliance. The use of percentiles means that a limited number of exceedances of the air quality standard over a particular timescale, usually a year, are permitted. This is to account for unusual meteorological conditions or particular events such as November 5th. For example, if an objective is to be complied with at the 99.9th percentile, then 99.9% of measurements at each location must be at or below the level specified.

Table 2.2 Air Quality Objectives in the Air Quality Regulations (2000) and (Amendment) Regulations 2002 for the purpose of Local Air Quality Management.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene All authorities	16.25 µg/m^3	running annual mean	31.12.2003
Authorities in England and Wales only	5.00 µg/m^3	annual mean	31.12.2010
Authorities in Scotland and Northern Ireland only[a]	3.25 µg/m^3	running annual mean	31.12.2010
1,3 Butadiene	2.25 µg/m^3	running annual mean	31.12.2003
Carbon monoxide Authorities in England, Wales and Northern Ireland only[a]	10.0 mg/m^3	maximum daily running 8-hour mean	31.12.2003
Authorities in Scotland only	10.0 mg/m^3	running 8-hour mean	31.12.2003
Lead	0.5 µg/m^3 0.25 µg/m^3	annual mean annual mean	31.12.2004 31.12.2008
Nitrogen dioxide[b]	200 µg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31.12.2005
	40 µg/m^3	annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)[c] All authorities	50 µg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31.12.2004
	40 µg/m^3	annual mean	31.12.2004
Authorities in Scotland only[d]	50 µg/m^3 not to be exceeded more than 7 times a year	24 hour mean	31.12.2010
	18 µg/m^3	annual mean	31.12.2010
Sulphur dioxide	350 µg/m^3 not to be exceeded more than 24 times a year	1 hour mean	31.12.2004
	125 µg/m^3 not to be exceeded more than 3 times a year	24 hour mean	31.12.2004
	266 µg/m^3 not to be exceeded more than 35 times a year	15 minute mean	31.12.2005

a. In Northern Ireland none of the objectives are currently in regulation. Air Quality (Northern Ireland) Regulations are scheduled for consultation early in 2003.
b. The objectives for nitrogen dioxide are provisional.
c. Measured using the European gravimetric transfer sampler or equivalent.
d. These 2010 Air Quality Objectives for PM_{10} apply in Scotland only, as set out in the Air Quality (Scotland) Amendment Regulations 2002.

2.2.2 Relationship between the UK National Air Quality Standards and EU air quality Limit Values

As a member state of the EU, the UK must comply with EU Directives.

There are three EU ambient air quality directives that the UK has transposed in to UK law. These are:

- **96/62/EC** Council Directive of 27 September 1996 on ambient air quality assessment and management (the Ambient Air Framework Directive).

- **1999/30/EC** Council Directive of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide, oxides of nitrogen, particulate matter and lead in ambient air (the First Daughter Directive).

- **2000/69/EC** Directive of the European Parliament and the Council of 16 Nov 2000 relating to limit values for benzene and carbon monoxide in ambient air (the Second Daughter Directive).

The first and second daughter directives contain air quality Limit Values for the pollutants that are listed in the directives. The United Kingdom (i.e. Great Britain and Northern Ireland) must comply with these Limit Values. The UK air quality strategy should allow the UK to comply with the EU Air Quality Daughter Directives, but the UK air quality strategy also includes some stricter national objectives for some pollutants, for example, the 15-minute sulphur dioxide objective.

The Government is ultimately responsible for achieving the EU limit values. However, it is important that Local Air Quality Management is used as a tool to ensure that the necessary action is taken at local level to work towards achieving the EU limit values by the dates specified in those EU Directives.

2.2.3 New particle objectives (not included in Regulations[3])

For particulates (as PM_{10}) further new objectives have been introduced which are not in Regulations with regard to local authority air quality management.

- For all parts of the UK, except London and Scotland, a 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 10 times a year and an annual mean of 20 $\mu g/m^3$, both to be achieved by the end of 2010;
- For London, a 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 10 times a year and an annual mean of 23 $\mu g/m^3$, both to be achieved by the end of 2010;
- For London, an annual mean of 20 $\mu g/m^3$, to be achieved by the end of 2015;

specified in those EU Directives.

2.2.4 New particle objectives (included in Regulations)

New Objectives for particulates (as PM_{10}) have been introduced in Scottish Regulations. These are:

- A 24-hour mean of 50 $\mu g/m^3$ not to be exceeded more than 7 times a year, and an annual mean of 18 $\mu g/m^3$ both to be achieved by the end of 2010.

[3] The exception is the Scottish Executive which has incorporated the new PM_{10} objectives in their Regulations.

2.2.5 Policies in place to allow the objectives for the pollutants in AQS to be achieved

The policy framework to allow these objectives to be achieved is one that takes a local air quality management approach. This is superimposed upon existing national and international regulations in order to effectively tackle local air quality issues as well as issues relating to wider spatial scales. National and EC policies that already exist provide a good basis for progress towards the air quality objectives set for 2003 to 2008. For example, the Environmental Protection Act 1990 allows for the monitoring and control of emissions from industrial processes and various EC Directives have ensured that road transport emission and fuel standards are in place. These policies are being developed to include more stringent controls. Developments in the UK include the announcement by the Environment Agency in January 2000 on controls on emissions of SO_2 from coal and oil fired power stations. This system of controls means that by the end of 2005 coal and oil fired power stations should have met the air quality standards set out in the AQS.

Local air quality management provides a strategic role for local authorities in response to particular air quality problems experienced at a local level. This builds upon current air quality control responsibilities and places an emphasis on bringing together issues relating to transport, waste, energy and planning in an integrated way. This integrated approach involves a number of different aspects. It includes the development of an appropriate local framework that allows air quality issues to be considered alongside other issues relating to polluting activity. It should also enable co-operation with and participation by the general public in addition to other transport, industrial and governmental authorities.

An important part of the Strategy is the requirement for local authorities to carry out air quality reviews and assessments of their area against which current and future compliance with air quality standards can be measured. Over the longer term, these will also enable the effects of policies to be studied and therefore help in the development of future policy. The Government has prepared guidance to help local authorities to use the most appropriate tools and methods for conducting a review and assessment of air quality in their District. This is part of a package of guidance being prepared to assist with the practicalities of implementing the AQS. Other guidance covers air quality and land use planning, air quality and traffic management and the development of local air quality action plans and strategies.

2.2.6 Timescales to achieve the objectives

In most local authorities in the UK, objectives will be met for most of the pollutants within the timescale of the objectives shown in Table 2.2. It is important to note that the objectives for NO_2 remain provisional. The Government has recognised the problems associated with achieving the standard for ozone and this will not therefore be a statutory requirement. Ozone is a secondary pollutant and transboundary in nature and it is recognised that local authorities themselves can exert little influence on concentrations when they are the result of regional primary emission patterns.

2.3 AIR QUALITY REVIEWS

A range of Technical Guidance has been issued to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This includes LAQM.TG(03), on 'Local Air Quality Management: Technical Guidance, February 2003. This review and assessment has considered the procedures set out in the guidance.

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet national air quality objectives and ensure that air quality is considered in local authority decision making processes. The complexity and detail required in a review depends on the risk of failing to achieve air quality objectives and it has been proposed in the second round that reviews should be carried out in two stages. Every authority is expected to undertake at least a first stage Updating and screening Assessment (USA) of air quality in their authority area. Where the USA has identified a risk that an air quality objective will be exceeded at a location with relevant public exposure, the authority will be required to undertake a detailed assessment. The Stages are briefly described in the following table, Table 2.3.

Table 2.3: The phased approach to review and assessment.

Level of assessment	Objective	Approach
Updating and screening assessment (USA)	To identify those matters that have changed since the last review and assessment, which might lead to a risk of the air quality objective being exceeded.	Use a check list to identify significant changes that require further consideration. Where such changes are identified, apply simple screening tools to decide whether there is sufficient risk of an exceedance of an objective to justify a detailed assessment
Detailed assessment	To provide an accurate assessment of the likelihood of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation or amendment or any necessary AQMAs.	Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.

2.4 LOCATIONS THAT THE REVIEW AND ASSESSMENT MUST CONCENTRATE ON

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 2.4 summarises the locations where the objectives should and should not apply.

Table 2.4 Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	• 1,3 Butadiene • Benzene • Lead • Nitrogen dioxide • Particulate Matter (PM_{10})	• All background locations where members of the public might be regularly exposed.	• Building facades of offices or other places of work where members of the public do not have regular access.
		• Building facades of residential properties, schools, hospitals, libraries etc.	• Gardens of residential properties.
			• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term
24 hour mean and 8-hour mean	• Carbon monoxide • Particulate Matter (PM_{10}) • Sulphur dioxide	• All locations where the annual mean objective would apply.	• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
		• Gardens of residential properties.	

Table 2.4 (contd.) Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives should apply at …	Objectives should generally not apply at …
1 hour mean	• Nitrogen dioxide • Sulphur dioxide	• All locations where the annual mean and 24 and 8-hour mean objectives apply.	• Kerbside sites where the public would not be expected to have regular access.
		• Kerbside sites (e.g. pavements of busy shopping streets).	
		• Those parts of car parks and railway stations etc. which are not fully enclosed.	
		• Any outdoor locations to which the public might reasonably be expected to have access.	
15 minute mean	• Sulphur dioxide	• All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

It is unnecessary to consider exceedances of the objectives at any location where public exposure over the relevant averaging period would be unrealistic, and the locations should represent non-occupational exposure.

Key Points

- The Environment Act 1995 has required the development of a National Air Quality Strategy for the control of air quality.
- A central element in the Strategy is the use of air quality standards and associated objectives based on human health effects that have been included in the Air Quality Regulations.
- The Strategy uses a local air quality management approach in addition to existing national and international legislation. It promotes an integrated approach to air quality control by the various factors and agencies involved.
- Air quality objectives, with the exception of ozone, are to be achieved by specified dates up to the end of 2010.
- A number of air quality reviews are required in order to assess compliance with air quality objectives. The number of reviews necessary depends on the likelihood of achieving the objectives.

3 Pollutants Assessed

This chapter gives information about the two pollutants assessed in this report.

3.1 PM_{10}

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. Particles are often classed as either primary (those emitted directly into the atmosphere) or secondary (those formed or modified in the atmosphere from condensation and growth). PM_{10} particles (the fraction of particles in air size <10 µm aerodynamic equivalent diameter) can potentially pose significant health risks as they are small enough to penetrate deep into the lungs. Larger particles are not readily inhaled.

A major source of fine primary particles is combustion processes, in particular diesel combustion, where transport of hot exhaust vapour into a cooler tailpipe or stack can lead to spontaneous nucleation of "carbon" particles before emission. Secondary particles are typically formed when low volatility products are generated in the atmosphere, for example the oxidation of sulphur dioxide to sulphuric acid. The atmospheric lifetime of particulate matter is strongly related to particle size, but may be as long as 10 days for particles of about 1 µm in diameter.

Concern about the potential health impacts of PM_{10} has increased very rapidly over recent years. Increasingly, attention has been turning towards monitoring the smaller particle fraction, $PM_{2.5}$, and even smaller size fractions or total particle numbers.

3.1.1 Objectives for particulate matter

The AQS objectives to be achieved by 31st December 2004 are:

- An annual average concentration of 40 µg m^{-3} (gravimetric);
- A maximum 24-hourly mean concentration of 50 µg m^{-3} (gravimetric) not to be exceeded more than 35 times a year.

The AQS objectives (in Scotland) to be achieved by 31st December 2010 are:

- An annual average concentration of 18 µg m^{-3} (gravimetric);
- A maximum 24-hourly mean concentration of 50 µg m^{-3} (gravimetric) not to be exceeded more than 7 times a year.

3.1.2 The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 182,000 tonnes in 2001. Of this total, around 18% was derived from road transport sources, 11% from power stations and 21% from combustion in commercial and residential. It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

The Government established the Airborne Particles Expert Group (APEG), and more recently, the Air Quality Expert Group (AQEG), to advise on sources of PM_{10} in the UK and current and future ambient concentrations. APEGs' conclusions were published in January 1999 (APEG, 1999) and those of AQEG in 2005 (AQEG, 2005). These studies concluded that a significant proportion of the current annual average PM_{10} is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. These are regional scale pollutants and the annual concentrations do not vary greatly over a scale of tens of kilometres. There are also natural or semi-natural sources such as wind-blown dust and sea salt particles. The impact of local urban sources is superimposed on this regional background. Such local sources are generally responsible for winter episodes of hourly mean concentrations of PM_{10} above 100 µg m^{-3} associated with poor dispersion. However, it is clear that many of the sources of PM_{10} are outside the control of individual local authorities and the estimation of future concentrations of PM_{10} are in part dependent on predictions of the secondary particle component.

3.2 SO_2

Sulphur dioxide is a corrosive acid gas which combines with water vapour in the atmosphere to produce acid rain. Both wet and dry deposition have been implicated in the damage and destruction of vegetation and in the degradation of soils, building materials and watercourses. SO_2 in ambient air is also associated with asthma and chronic bronchitis.

The principal source of this gas is power stations burning fossil fuels which contain sulphur. Episodes of high concentrations of SO_2 now only tend to occur in cities in which coal is still widely used for domestic heating, in areas affected by heavy industry and in footprints of power stations. As power stations are now generally located away from urban areas, SO_2 emissions may affect air quality in both rural and urban areas. Since the decline in domestic coal burning in cities and in power stations overall, SO_2 emissions have diminished steadily and, in most European countries, they are no longer considered to pose a significant threat to health.

3.2.1 Objectives for sulphur dioxide

The Air Quality Strategy Objectives to be achieved are:

- 266 µg m^{-3} as a 15 minute mean (maximum of 35 exceedences a year or equivalent to the 99.9th percentile) to be achieved by the 31st December 2005
- 350 µg m^{-3} as a 1 hour mean (maximum of 24 exceedences a year or equivalent to the 99.7th percentile) to be achieved by the 31st December 2004
- 125 µg m^{-3} as a 24 hour mean (maximum of 3 exceedences a year or equivalent to the 99th percentile) to be achieved by the 31st December 2004

The 15-minute mean objective is the most stringent; the other two objectives are unlikely to be exceeded if this objective is not exceeded.

3.2.2 The National Perspective

Sulphur dioxide is emitted in the combustion of coal and oil. Emissions today are dominated by fossil fuelled power stations. Combustion in energy production account for 73% of the national total emission. Emissions from road transport are a very small fraction of the national total: less than 1% and combustion in Commercial, institutional and residential combustion accounted for 18% of the national total.

Exceedences of the 15-minute air quality standard currently occur near industrial processes for which the stack heights were designed to meet previous air quality standards and downwind of large combustion plant such as power stations. Exceedences are also possible in areas where significant quantities of coal are used for space heating. These large combustion plants are currently regulated under BATNEEC and the EPA 1990, and will come under the provisions of the IPPC. The government considers that bearing in mind the envisaged change in fuel use, it does not expect exceedences of the 15-minute objective by 2005 from these sources.

4 Information and tools used to support this assessment

This chapter presents the information and tools used to support the review and assessment of domestic fuel combustion sources.

4.1 DATA SOURCES

Scottish Borders Council provided the information necessary for domestic fuel combustion modelling. The following data was provided:

- Fuel Use Survey 2004/5 (including type of fuel, consumption, address etc.),
- GIS shape files
- COMPASS data file for Scottish Borders Council that contains geographical location information for all the properties.

4.2 EMISSION FACTORS

Emissions factors for household emissions were obtained from latest estimates within the National Atmospheric Emissions Inventory (NAEI). Domestic emissions factors have recently been revised within the NAEI and the emissions factors used are as detailed in table 4.1.

Table 4.1 Domestic Emissions Factors taken from the NAEI

	SO_2 kt/mt fuel burnt	PM_{10} kt/mt fuel burnt
Oil	0.58	2.31
Non smokeless coal	20.83	9.70
Smokeless coal	16.00	3.11
Turf/peat	20.83	9.70
Logs/sticks	0.11	7.90

4.3 BACKGROUND AIR QUALITY DATA

Background concentrations of particulates (PM_{10}) and sulphur dioxide (SO_2) have been taken from the UK Air Quality Mapping work undertaken by netcen on behalf of defra and the Devolved Administrations, some of which is available through the air quality Archive (http://www.airquality.co.uk/archive/laqm/laqm.php). Data have been scaled to the year of interest where necessary following the recommended procedure in LAQM. TG (03). For PM_{10} data were scaled to match the year of assessment (2004/2010). For SO_2 data were available for 2003, 2005 and 2010.

4.4 LOCAL AIR QUALITY MONITORING DATA

4.4.1 Extent of data available

Scottish Borders carried out continuous monitoring for PM_{10} and SO_2 in Newcastleton for a period of seven months between December 2004 and June 2005. The monitoring station was location at the car park of Newcastleton Health Centre, in a residential area where solid fuel is commonly used for domestic heating (OS grid coordinates were 348347, 587774).

Figures 4.1 and 4.2 show its map location and photograph, respectively. The instrumentation employed used UV fluorescence for the measurement of SO_2 and the TEOM technique for PM_{10}. These methods are appropriate for Detailed Assessment under LAQM (LAQM TG (03)). All TEOM data are quoted as gravimetric equivalent in accordance with the guidance using a 1.3 conversion factor. Appendix 1 provides more details about the local air quality monitoring programme and QA/QC of procedures.

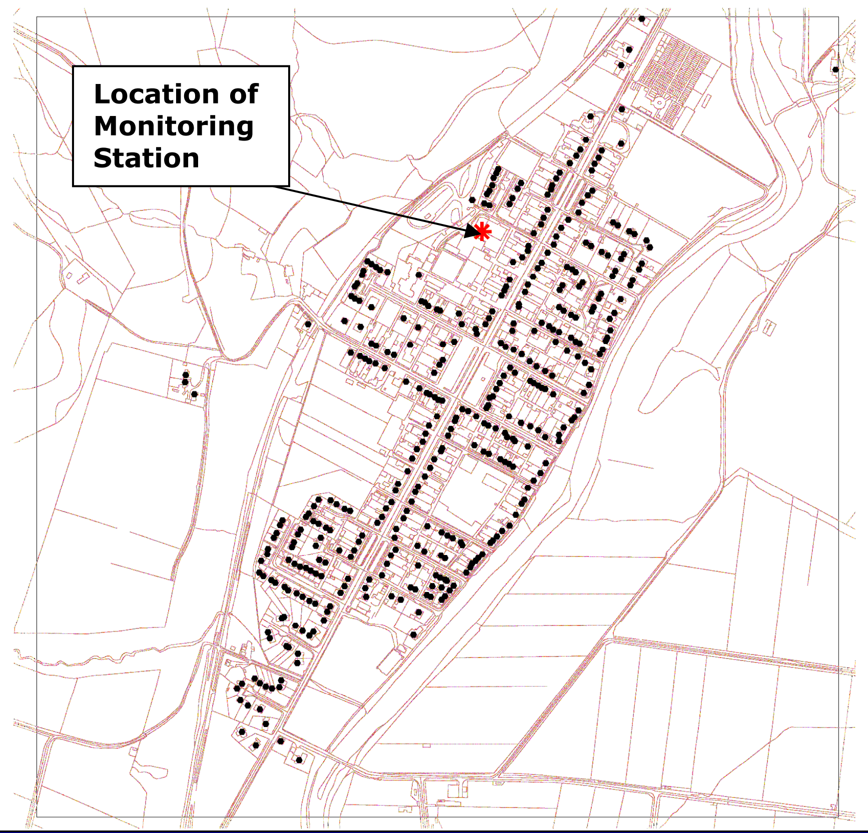

Figure 4.1 Location of PM_{10} and SO_2 monitoring station

Figure 4.2 Location of PM_{10} and SO_2 monitoring station

The dataset has been used for verification and adjustment of the modelled output. Netcen has undertaken calibration and ratification and the data are suitable for use in review and assessment.

The monitoring period covered 7 months between December 2004 and June 2005. Table 4.2 summarises the monitoring data for this period.

Table 4.2 Summary statistics of monitoring data

POLLUTANT	SO_2	PM_{10}*
Number Very High	0	0
Number High	0	0
Number Moderate	0	0
Number Low	19921	4369
Maximum 15-minute mean	112 $\mu g\ m^{-3}$	235 $\mu g\ m^{-3}$
Maximum hourly mean	93 $\mu g\ m^{-3}$	145 $\mu g\ m^{-3}$
Maximum running 8-hour mean	45 $\mu g\ m^{-3}$	53 $\mu g\ m^{-3}$
Maximum running 24-hour mean	29 $\mu g\ m^{-3}$	46 $\mu g\ m^{-3}$
Maximum daily mean	25 $\mu g\ m^{-3}$	44 $\mu g\ m^{-3}$
Average	6 $\mu g\ m^{-3}$	17 $\mu g\ m^{-3}$
Data capture	97.2 %	83.9 %

***PM_{10} gravimetric**

The data capture for PM10 over the 7 months was of 84%. As can be seen in plots in Appendix 1, there is a gap between mid December and mid January. However, data capture over the six month period (January to June) is of 90%. This small gap is accounted for in the period to annual adjustment (see appendix 2).

4.5 MAPS

Scottish Borders Council provided Ordnance Survey maps for the council in the form of DXF file tiles.

4.6 MET DATA USED IN THE DISPERSION MODELLING

Hourly sequential meteorological data for the nearest suitable meteorological station, Eskdalemuir was obtained for 2004. This was the latest year for which good data capture was available for this site. The meteorological data provided information on wind speed and direction and the extend of cloud cover for each hour of 2004.

4.7 OVERVIEW OF THE MODELLING APPROACH

In order to assess domestic fuel combustion emissions of SO_2 and PM_{10}, **netcen**'s DISP model has been used.

Domestic fuel combustion has been carried out using DISP to predict PM_{10} and SO_2 concentrations arising from domestic fuel burning in the area. This model has been specially developed for Review and Assessments by **netcen**. The model uses ADMS-3.2 to provide dispersion kernels over a grid. The model has been run for the relevant objective years. Concentrations of SO_2 and PM_{10} from domestic fuel combustion emissions have been assessed using a high-resolution approach, with concentrations being modelled at 25 m intervals across the grids. This high spatial resolution is recommended in Technical Guidance LAQM.TG (03).

4.7.1 Model verification and adjustment

Existing monitoring data from Newcastleton and local modelling has been used to calculate a model bias factor. The monitoring data has been ratified by **netcen**. The purpose of model verification and subsequent adjustment is, as specified in the technical guidance TG(03), to ensure that the modelled concentrations reflect the monitored concentrations. Further details of model verification and adjustments are given in Appendix 2.

4.7.2 Model uncertainties

Uncertainty in the modelling predictions will include:

- Uncertainties in domestic fuel use survey data;
- Uncertainties in how the burning of domestic fuel might change in future years;
- Uncertainty resulting from year to year variations in atmospheric conditions;
- Uncertainty in emission factors
- Uncertainty in monitoring data
- Uncertainty in conversion between TEOM PM_{10} data and PM_{10} gravimetric data

These uncertainties are dealt with as fully as possible but it is important to remember that the modelling depends highly on the accuracy of the fuel use survey, which represents 50% of all households in Newcastleton. It is assumed that the fuel use survey and predictions are representative of the amount used and also typical of fuel use in future years. Predicted future background concentrations have been calculated and applied where possible and appropriate.

The dispersion modelling is based upon the meteorology and emissions for the period 1st January to 31st December 2004. Clearly meteorological conditions will vary from year to year but overall the data would be expected to be broadly representative of local conditions for the year of the objectives. A single year's met data has been in used in the modelling in accordance with Guidance LAQM.TG(03).

Emissions Factors are average emission factors and do not take into account, for example, natural variation in coal and its sulphur content variability.

4.7.3 Relationship between annual means and short term concentrations

The DISP model calculates the annual mean contribution of domestic fuel combustion emissions. In order to predict short term AQ objectives, we have followed recommendations in LAQM.TG (03) and used information available from the report by Pye and Vincent (2003): "*Determining the impact of domestic solid fuel burning on concentrations of PAHs and sulphur dioxide in Northern Ireland*".

4.7.3.1 Relationship between annual mean PM_{10} and number of 24-hour exceedences of 50 μgm^{-3}

The relationship between PM_{10} annual mean and number of daily exceedences of 50 μgm^{-3} (LAQM.TG (03), Figure 8.1) has been used, shown here in figure 4.3. The daily mean objective is likely to be exceeded more than 35 times when the PM_{10} annual mean is above 30 μgm^{-3}.

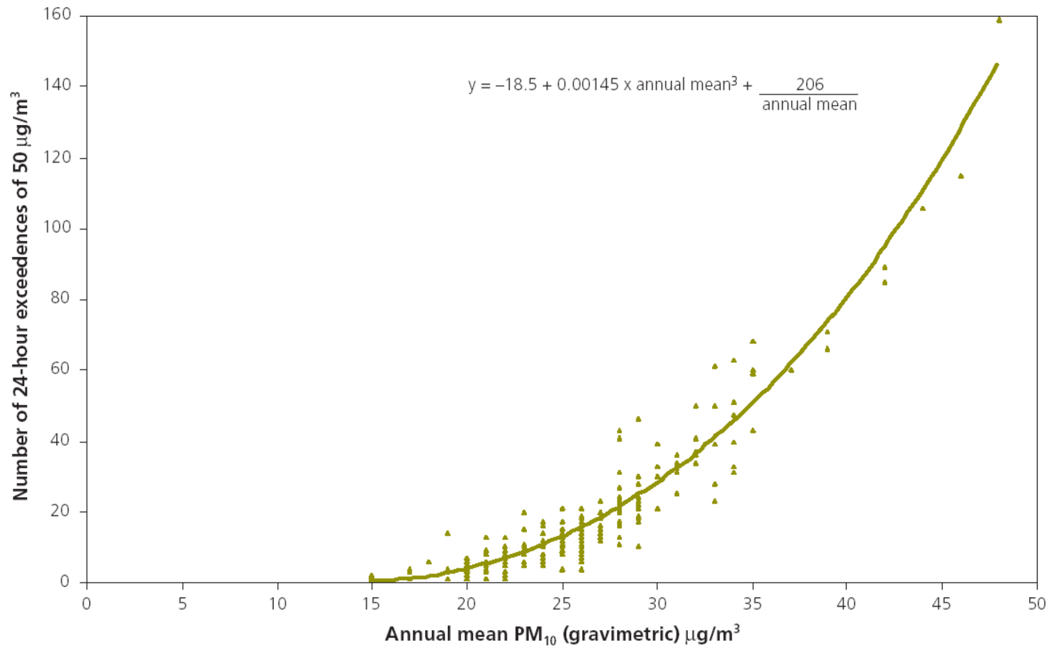

Figure 4.3 Relationship between the number of 24-hour exceedences of 50 μgm^{-3} and the annual mean concentration (derived from UK Automatic Network Sites 1997-2001) (*from LAQM.TG (03)*)

4.7.3.2 Relationship between annual mean and short term sulphur dioxide concentrations

Pye and Vincent (2003) published a report "*Determining the impact of domestic solid fuel burning on concentrations of PAHs and sulphur dioxide in Northern Ireland*". This report includes a relationship between annual mean and short-term sulphur dioxide concentrations in Northern Ireland. When the annual mean concentrations for all years (between 1990 to 2002) and for each site (Belfast Centre, Belfast East and Derry) are plotted against each of the short-term average concentrations, strong associations are observed. Table 4.3 shows the regression equations that can be applied to annual mean concentrations to produce the respective short-term mean sulphur dioxide concentrations.

Table 4.3: Regression equations used to predict SO_2 concentrations over short term averaging times (from Pye and Vincent, 2003)

Short term mean (Y) Averaging period	Regression equation	R^2
15 minute (99.9 %ile)	Y = 15.6 × Annual mean concentration – 23.6	0.91
Hourly (99.73 %ile)	Y = 11.9 × Annual mean concentration – 18.7	0.87
Daily (99.18 %ile)	Y = 5.87 × Annual mean concentration – 17.8	0.95

5 Review and Assessment of PM_{10} and SO_2 from Domestic Fuel Combustion

5.1 DOMESTIC FUEL COMBUSTION

Solid fuel burning for domestic heating is still relatively common in parts of Scotland. Where solid fuel burning is predominant it may have the potential to cause exceedences of the objectives. According to the guidance, "the risk of exceedence within an area can be considered significant when a single 500m x 500m grid has more than 50 houses burning solid fuel as their primary source of heating".

5.1.1 Modelled area

There is one area within Scottish Borders Council considered to be at risk of exceeding the objectives: **Newcastleton**.

5.2 SCOTTISH BORDERS COUNCIL FUEL USE SURVEY

Scottish Borders Council undertook a fuel use survey in winter 2004/2005 which covered 50% of the households in Newcastleton (218 out of 439). The summary of this survey information is given in Table 5.1 and Figure 5.1. As can be seen, oil is the predominant primary fuel but solid fuel and electricity are also a significant portion of the fuel use profile. Electricity is the predominant secondary fuel use type.

Table 5.1 Primary and Secondary Fuel Types used by residents in Newcastleton (results of winter 04/05 fuel survey)

Fuel Type	Primary	Secondary
Oil	86	4
Smokeless coal	18	4
Non smokeless coal	49	43
Electricity	45	81
Bottled gas	18	33
Logs/sticks	1	10
Turf/peat	1	0
No data	*221*	*227*

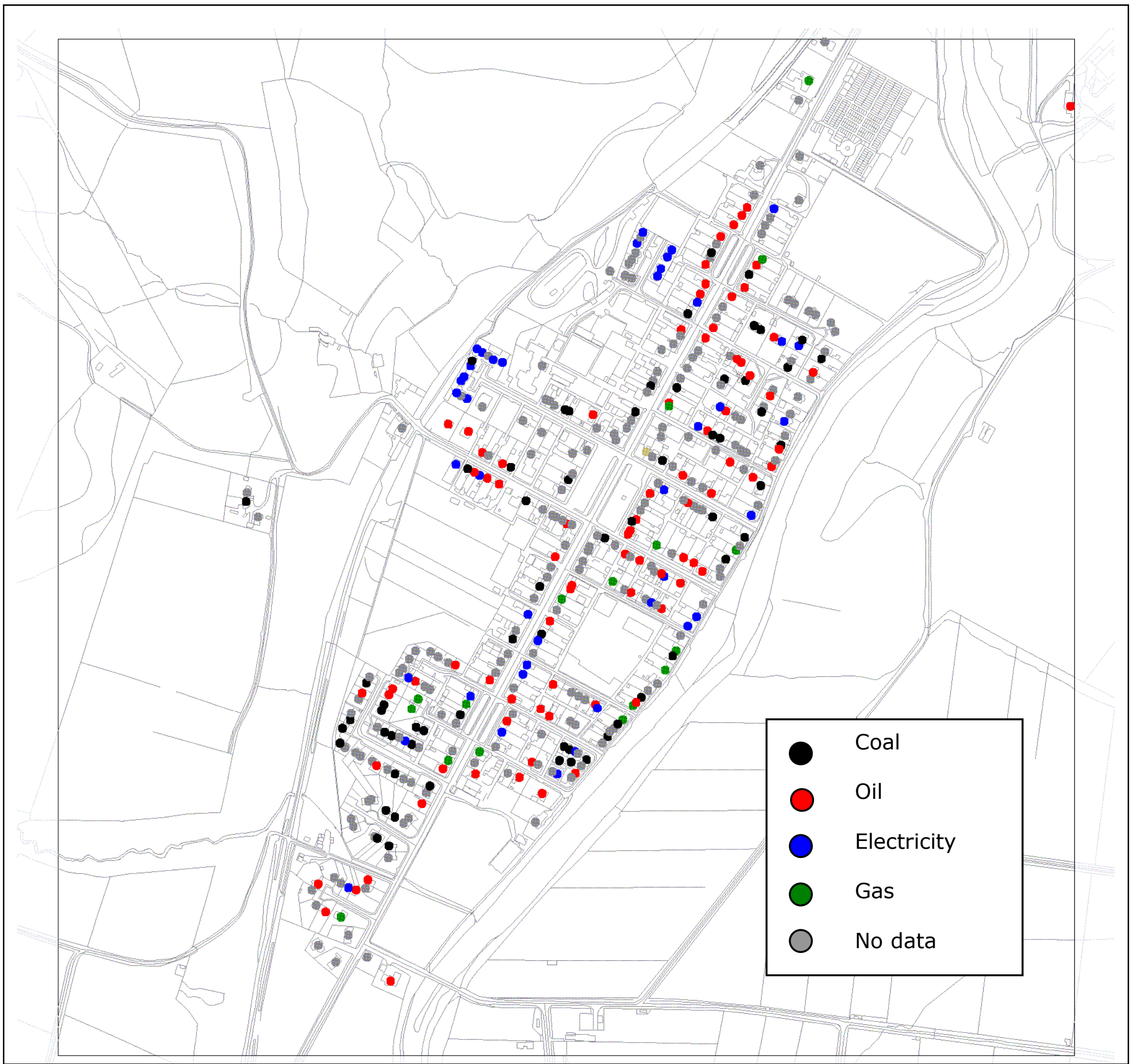

Figure 5.1 Map of Fuel Use Type in Newcastleton

5.3 DOMESTIC MODELLING

Fuel use survey data supplied by Scottish Borders Council has been used within **netcen**'s DISP model to determine whether domestic fuel combustion is likely to cause exceedences of the SO_2 and PM_{10} objectives. The DISP model calculates the annual contribution to SO_2.

Conversion factors from LAQM.TG (03) have been used to calculate 24-hour means. The Technical guidance includes a relationship between annual mean and 24-hour concentrations (see section 4.7.3.1)

Conversion factors from Pye and Vincent (2003) have been used to estimate the 99.9 percentile of 15 minute means for SO_2. This report includes a relationship between annual mean and short-term sulphur dioxide concentrations in the UK (see 4.7.3.2). Table 5.2 shows the regression equation from annual mean concentrations to estimate the 15 minute mean sulphur dioxide concentrations.

Table 5.2 Regression equations used to predict SO_2 concentrations over short term averaging times (from Pye and Vincent, 2003)

Short term mean (Y) Averaging period	Regression equation	R^2
15 minute (99.9 %ile)	Y = 15.6 × Annual mean concentration – 23.6	0.91

5.3.1 Emissions rates

The PM_{10} and SO_2 emission rate for each dwelling surveyed has been calculated using information from the fuel use survey (fuel use type and quantity). Using the emissions factors in table 4.1, an annual emission rate for each surveyed dwelling was calculated. The emission for the surveyed properties in each area was then averaged and this average was applied to the properties without emissions data.

5.3.2 Point source characteristics

The assumptions in the modelling exercise are that each property has the following point source characteristics:

- Chimney height 10m.
- Chimney diameter of 0.2m
- Exit velocity of 4 m/s and temperature of 60 °C.
- Surface Roughness 0.5m
- Meteorological data from Eskdalemuir in 2004
- Concentrations calculated to a resolution of 20m
- Building Wake effects for representative building 10m high * 20m * 20m

5.3.3 2004 Background concentrations PM_{10}

Background PM_{10} and SO_2 concentrations for 2004 in Newcastleton have been extracted from the UK national background maps.

Newcastleton (348500, 587500)	*PM_{10}*	*SO_2*
Total Annual Mean Background 2004	10.42	1.32
Total Annual Mean Background 2010	9.13	1.32

5.4 MODEL RESULTS

The model results from ADMS and **netcen**'s DISP model are presented below in the following figures:

- Figure 5.2 – Modelled 2004 Annual Mean PM10 concentrations
- Figure 5.3 – Modelled 2010 Annual Mean PM10 concentrations
- Figure 5.4 – Modelled number of 24-hour exceedence of PM10 50μgm-3 in 2004 and 2010
- Figure 5.5 – Modelled SO_2 Annual Mean for 2005 and 2010
- Figure 5.6 – Modelled SO_2 15-minute mean for 2005 and 2010.

Figures 5.2 to 5.4 show that the annual mean objective of 40 μgm^{-3} will not exceeded in the modelled area. For 2010, the annual mean objective of 18 μgm^{-3} is not likely to be exceeded across the modelled area. The daily mean objective is not likely to be exceeded

Figures 5.5 to 5.6 show that the maximum annual mean of SO_2 is 17 μgm^{-3} and the SO_2 15 minute mean do not exceed the objective of 266 $\mu g\ m^3$

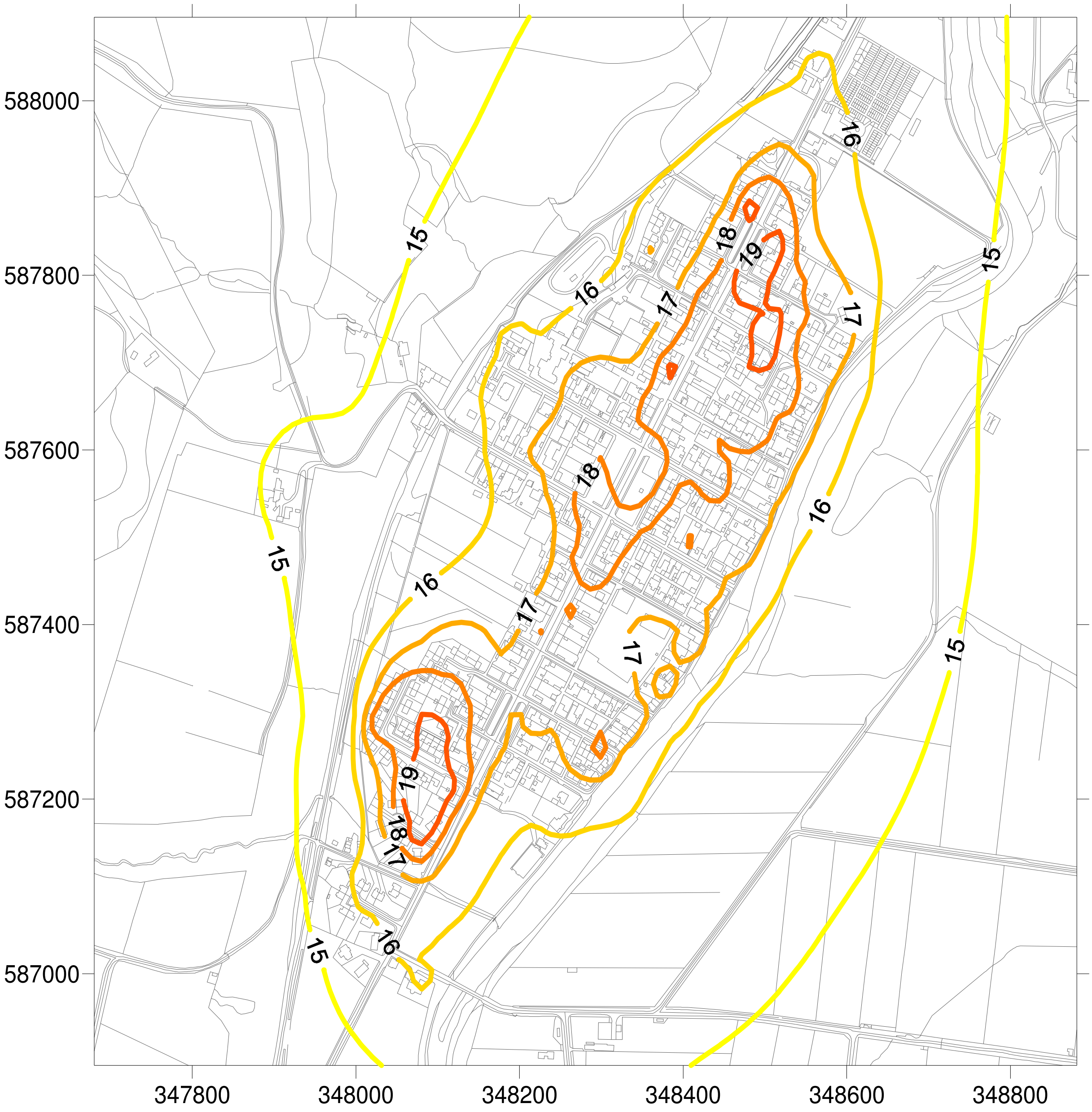

Figure 5.2 Modelled 2004 annual mean PM_{10} concentrations (µg m³)

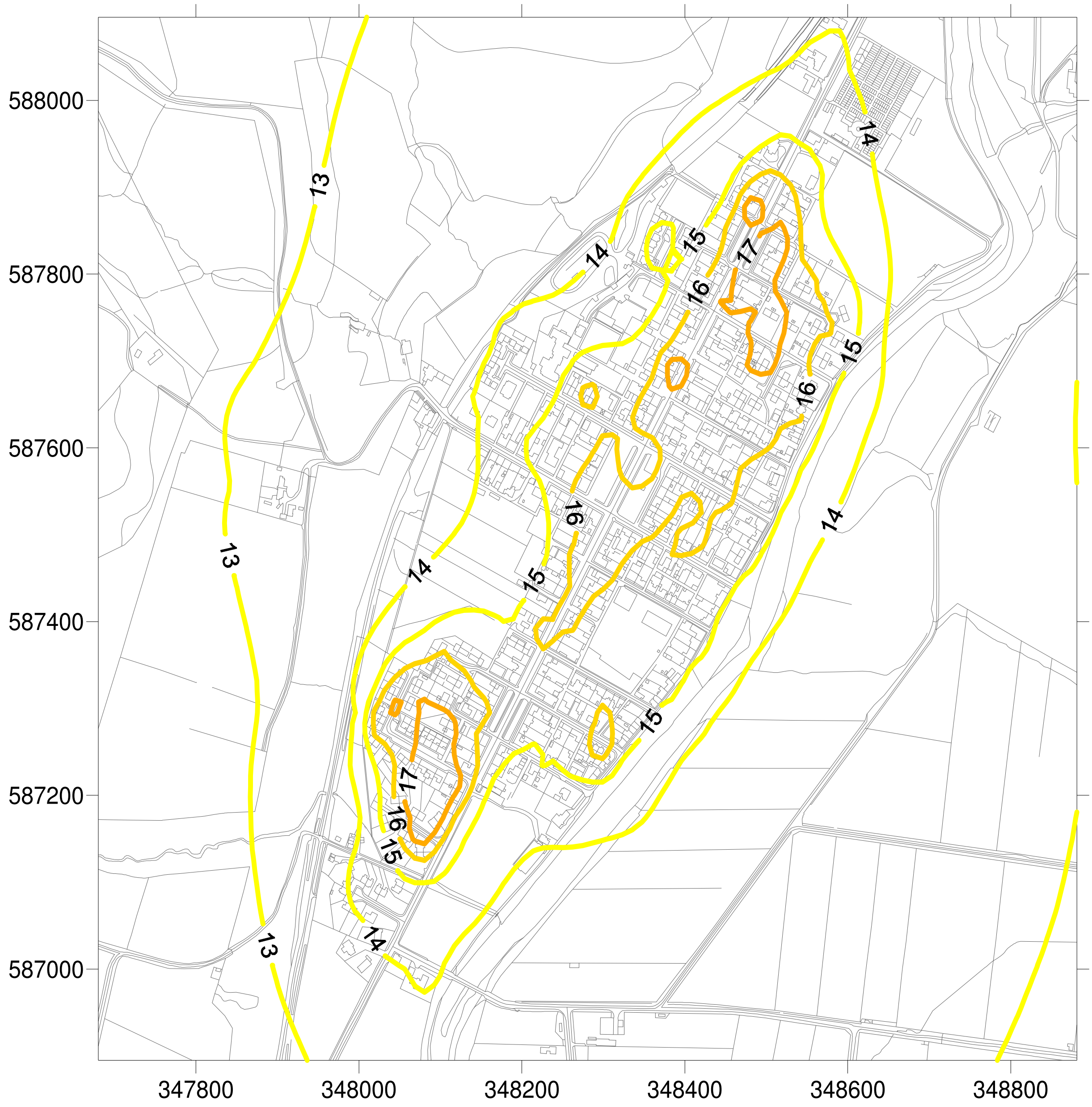

Figure 5.3 Modelled 2010 annual mean PM_{10} concentrations($\mu g\ m^{3}$)

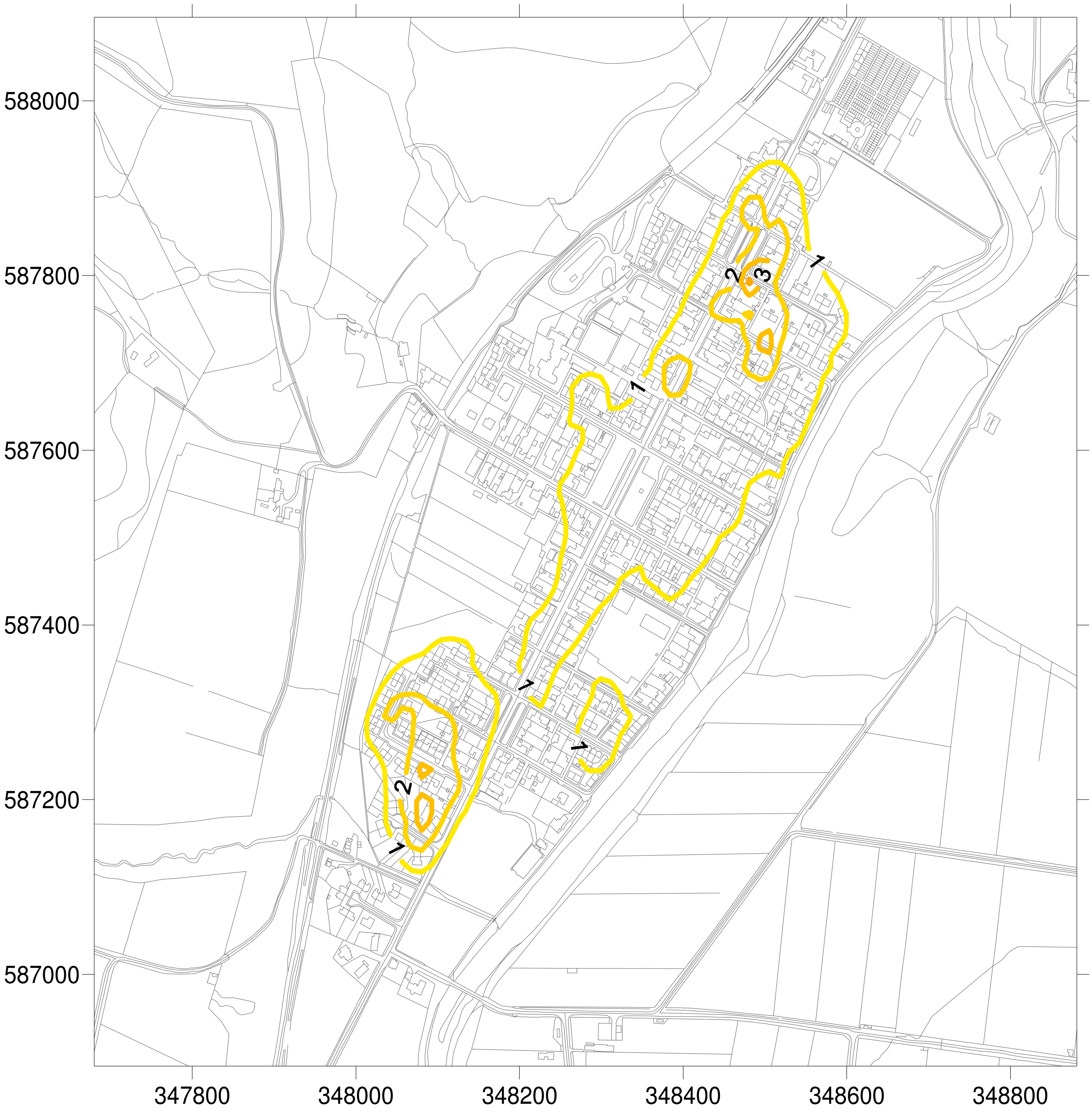

Figure 5.4 Modelled number of 24-hour exceedence of 50 μg m³ in 2004 and 2010 (2004 background data used).

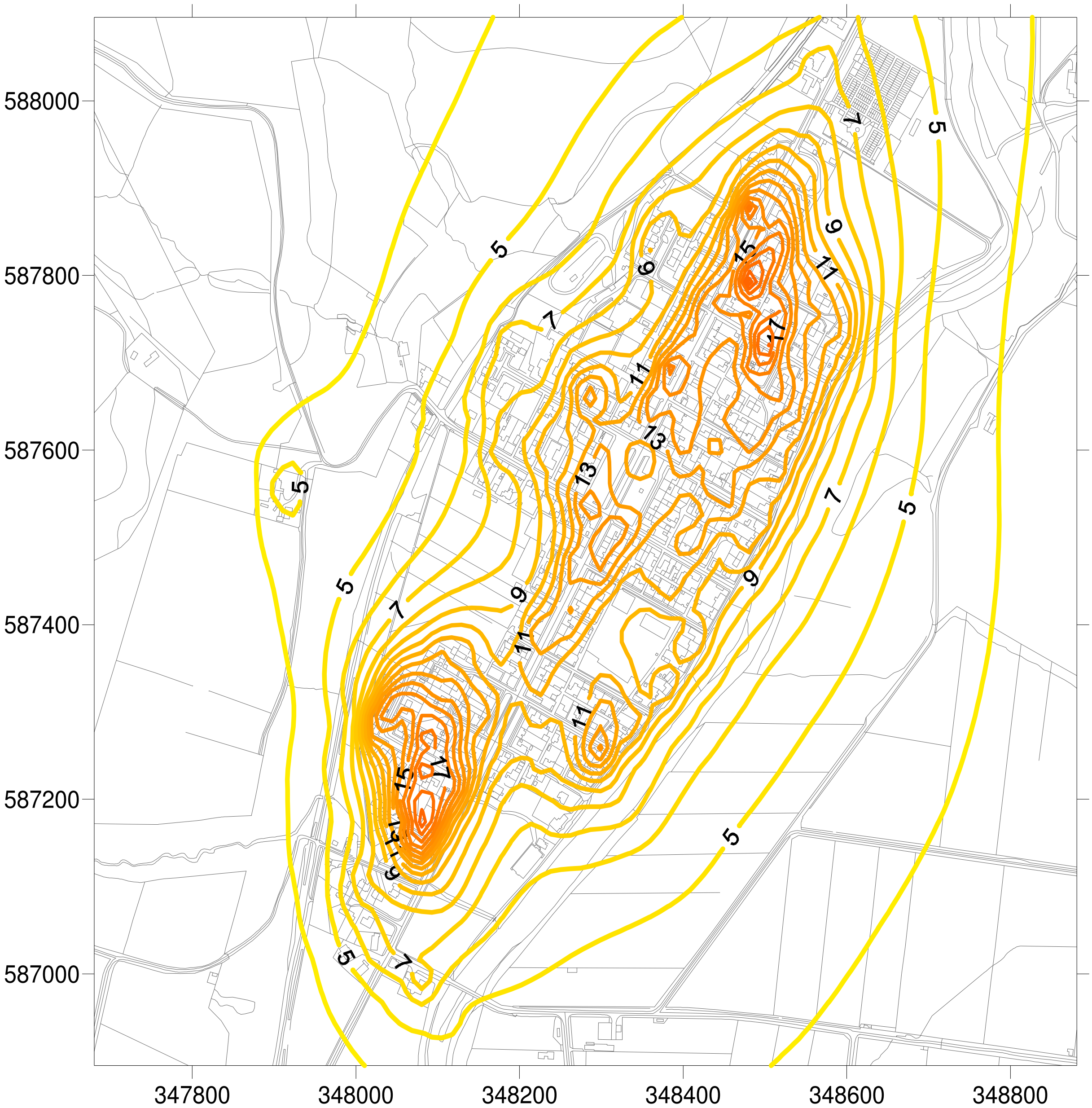

Figure 5.5 Modelled SO_2 Annual Mean for 2005 and 2010 (µg m^3)

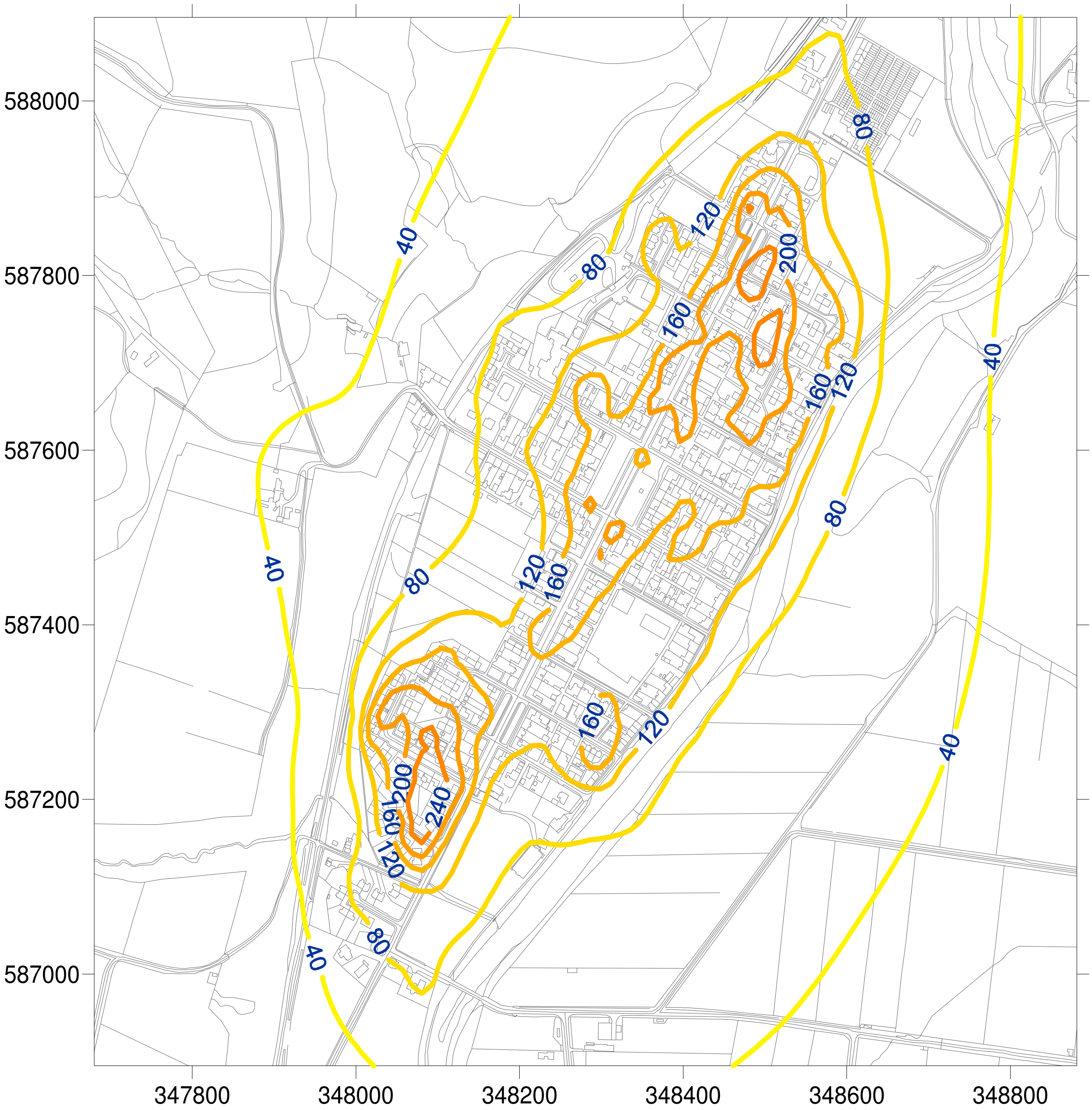

Figure 5.6 Modelled SO_2 15-minute mean for 2004 and 2005 ($\mu g\ m^3$)

The SO_2 2010 99.9 percentile 15 minute mean plots are not presented as they are the same of the plots shown for 2005.

6 Discussion

The modelled plots presented in section 5 have been bias adjusted using a bias correction factor calculated from the results of monitoring carried out in Newcastleton.

PM_{10} Annual Objective

Figures 5.2 and 5.3 show the 2004 and 2010 annual mean PM_{10} concentrations. These plots are directly comparable with the 2004 annual PM_{10} objective of 40 μg m^3 and with the 2010 annual PM_{10} objective of 18 μg m^3. The annual PM_{10} objectives are not predicted to be exceeded in Newcastleton.

PM_{10} Daily Objective

Figure 5.4 show the predicted number of 24-hour exceedences of 50 μg m^3 in 2004 and 2010. Daily exceedences in 2004 and 2010 are well below 35 times a year in 2004 and below 7 times a year in 2010.

SO_2 15 Minute Mean Objective

The 15 minute mean is the most stringent of the SO_2 short term objectives. Figure 5.6 shows the 99.9 percentile of 15 minute means for SO_2 in 2005. These plots are directly comparable with the 2005 15 minute mean objective of 266 μg m^3. The SO_2 15 minute mean objective of 266 μg m^3 is not predicted to be exceeded in Newcastleton.

7 Conclusions

The modelling has predicted no exceedances of the regulated objectives for SO_2 and PM_{10} in Newcastleton in 2004, 2005 and 2010. This report concludes:

Particulate Matter (PM_{10} gravimetric)
Detailed modelling has shown that PM_{10} emissions arising from domestic fuel combustion in Newcastleton are **not predicted** to cause exceedences of the annual and daily PM_{10} objectives in 2004 and 2010 at relevant receptors within the assessed area.

Sulphur dioxide (SO_2)
Detailed modelling has shown that SO_2 emissions arising from domestic fuel combustion in Scottish Borders Council are **not predicted** to cause an exceedence of the air quality objectives in 2005 and 2010 at relevant receptors within the assessed area.

References

Airborne Particles Expert Group (APEG), 1999. Source apportionment of particulate matter in the United Kingdom. HMSO.

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Defra (2003). Part IV of the Environment Act 1995. Local Air Quality Management. Technical Guidance LAQM. TG(03).

NAEI (2003). UK Emissions of Air Pollutants 1970 – 2001. Report produced by Netcen for Defra, National Assembly of Wales, the Scottish Executive and the Department of the Environment, Northern Ireland.

Pye, S and Vincent, K (2003) Determining the impact of domestic solid fuel burning on concentrations of PAHs and sulphur dioxide in Northern Ireland. AEAT/ED47047 http://www.airquality.co.uk/archive/reports/cat05/0401151142_NI_PAH_draftv4.pdf

Stedman et al (2004). UK air quality modelling for annual reporting 2003 on ambient air quality assessment under Council Directives 96/62/EC, 1999/30/EC and 2000/69/EC (http://www.airquality.co.uk/archive/reports/cat05/0501121424_dd12003mapsrep4.pdf)

Appendices

CONTENTS

Appendix 1

Automatic Monitoring Station Data

NEWCASTLETON
25 November 2004 to 30 June 2005

These data have been fully ratified by netcen

Netcen on behalf of Scottish Borders Council installed continuous monitoring equipment for PM_{10} and SO_2 between November 2004 and June 2005 (see figure below for exact location). The instrumentation employed uses UV fluorescence for the measurement of SO_2 and the TEOM technique for PM_{10}. These methods are appropriate for Detailed Assessment under LAQM (LAQM TG(03)). All TEOM data are quoted as gravimetric equivalent in accordance with the guidance. Netcen has undertaken all calibration and ratifications and the data is suitable for use in review and assessment.

The quality control programme comprised two principal components:

- Six-monthly quality control audits
- Management of the data set

The quality control audits provided valuable information on equipment performance that has been used for the data management of the station's results.

The data management process covered:

- The retrieval of raw data from the analyser
- Appending this data to the netcen site data base
- Screening and scaling of the data
- Final Ratification

Measurement technique and QA/QC

Ultraviolet Fluorescence is the reference method specified by the EC SO_2 Directives. The analyser was calibrated using compressed gas mixtures certified to ISO17025 by netcen's Gas Standards Calibration Laboratory. This provides traceability of measurement to recognised national standards held at NPL or equivalent organisations. The expected accuracy of the method for sulphur dioxide is ±11% with a precision of ±3.5 ppb. netcen undertook installation of the equipment, site calibrations, checking of calibration data and validation of the real-time results using documented procedures.

The TEOM analyser is the most widely used instrument in the UK for monitoring PM_{10} particulate material. However, due to evaporation of volatile species in the heated inlet of the analyser, this monitoring method generally under-reads particle concentrations by between 15 and 30 % compared to measurements by the EU gravimetric reference method . There is a study by defra underway at the time of writing to investigate this effect in more detail. The UK Air Quality Objectives for PM_{10} are based on the European reference method and it is therefore necessary to apply a "correction factor" when comparing TEOM measurements with these objectives. In line with the defra Technical Guidance, a constant factor of 1.3 has therefore been applied to the measurements from this survey when comparing with the objectives. Measurements thus corrected in this report will therefore be referred to as µg/m3 (gravimetric). In this study, the TEOM analyser was operated in line with procedures used in the AURN and hence the data will be of comparable quality. The estimated precision of the TEOM measurements is +/- $4ug/m^{-3}$, but, due to the loss of volatile material and the use of a correction factor, the accuracy cannot be fully assessed at present.

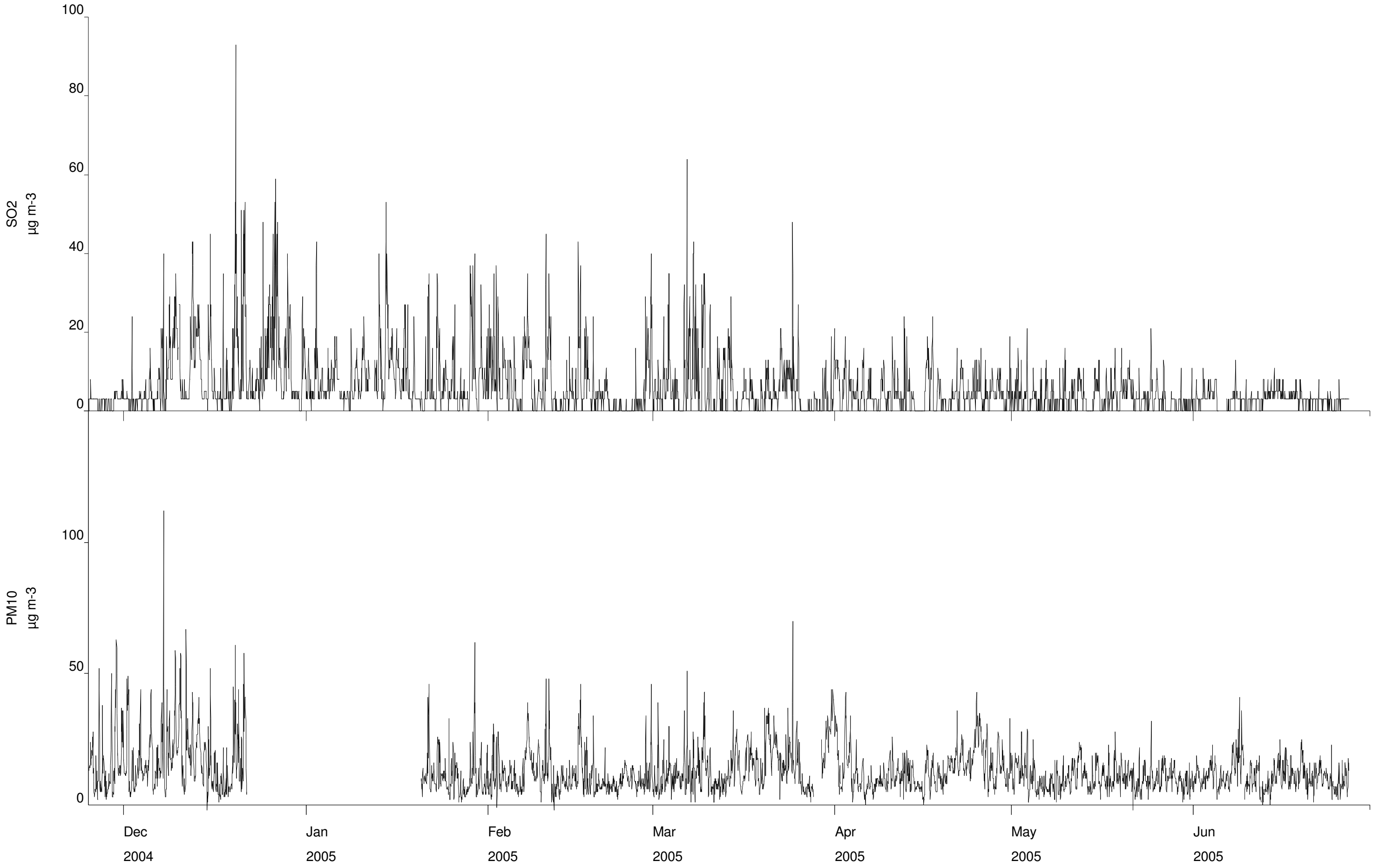
Location of PM_{10} and SO_2 monitoring station

POLLUTANT	SO_2	PM_{10}*
Number Very High	0	0
Number High	0	0
Number Moderate	0	0
Number Low	19921	4369
Maximum 15-minute mean	112 $\mu g\ m^{-3}$	235 $\mu g\ m^{-3}$
Maximum hourly mean	93 $\mu g\ m^{-3}$	145 $\mu g\ m^{-3}$
Maximum running 8-hour mean	45 $\mu g\ m^{-3}$	53 $\mu g\ m^{-3}$
Maximum running 24-hour mean	29 $\mu g\ m^{-3}$	46 $\mu g\ m^{-3}$
Maximum daily mean	25 $\mu g\ m^{-3}$	44 $\mu g\ m^{-3}$
Average	6 $\mu g\ m^{-3}$	17 $\mu g\ m^{-3}$
Data capture	97.2 %	83.9 %

***PM_{10} gravimetric**
PM_{10} instrument is a TEOM
All mass units are at 20'C and 1013mb

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
Sulphur Dioxide	15-minute mean > 266 $\mu g\ m^{-3}$	0	0
Sulphur Dioxide	Hourly mean > 350 $\mu g\ m^{-3}$	0	0
Sulphur Dioxide	Daily mean > 125 $\mu g\ m^{-3}$	0	0
Sulphur Dioxide	Annual mean > 20 $\mu g\ m^{-3}$	-	-
PM_{10} Particulate Matter (Gravimetric)	Daily mean > 50 $\mu g\ m^{-3}$	0	0
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 40 $\mu g\ m^{-3}$	-	-
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 18 $\mu g\ m^{-3}$	-	-

Newcastleton Air Monitoring
Hourly Mean Data for 25 November 2004 to 30 June 2005



Appendix 2
Model Verification and Adjustment

Year adjustment
The modelled results were adjusted using monitoring data available from Newcastleton between November 2004 and June 2005. Following LAQM.TG(03), the 7 months datasets from Newcastleton were adjusted to a yearly figure using data from Edinburgh St Leonards, Newcastle Centre, Glasgow Centre, Aberdeen and Perth. Table A2.2 and A2.3 show the adjustment carried out on the PM_{10} and SO_2 data.

Despite the 84% data capture of PM_{10} over 7 months, a total of 6 months were successful monitored giving a good winter representation. Adjusting the period to annual will take into account any gap of data. However, the possible effect of the data capture has been double-checked by calculating the period average for three AURN stations with and without the mid December to mid January data gap. This does not make any difference to the period measured with 84% data capture (see table A2.1).

Table A2.1 PM_{10} Year Adjustment

Site name	Dec-June (Longer)	Dec-June without gap mid Dec to mi Jan (shorter)	Longer over shorter
Aberdeen	18	17	1.06
Edinburgh St Leonards	18	19	0.95
Glasgow Centre	20	20	1.00
		Average (**Longer over shorter**)	1.00

Table A2.2 PM_{10} Year Adjustment

Site name	Start date	End date		Average TEOM	*Gravimetric* =*1.3	DC (%)	Units
Newcastleton	01/01/04	31/12/04		-	-	-	µg m-3 (20'C 1013mb)
Edinburgh St Leonards	01/01/04	31/12/04	*Am*	14	18.2	98.7	µg m-3 (20'C 1013mb)
Newcastle Centre	01/01/04	31/12/04	*Am*	13	16.9	92.6	µg m-3 (20'C 1013mb)
Glasgow Centre	01/01/04	31/12/04	*Am*	15	19.5	66.6	µg m-3 (20'C 1013mb)
Aberdeen	01/01/04	31/12/04	*Am*	14	18.2	93.3	µg m-3 (20'C 1013mb)
Perth	01/01/04	31/12/04	*Am*	13	16.9	98.6	µg m-3 (20'C 1013mb)
Newcastleton	25/11/04	30/06/05	*Pm*	13	16.9	83.9	µg m-3 (20'C 1013mb)
Edinburgh St Leonards	25/11/04	30/06/05	*Pm*	14	18.2	97.9	µg m-3 (20'C 1013mb)
Newcastle Centre	25/11/04	30/06/05	*Pm*	13	16.9	97.1	µg m-3 (20'C 1013mb)
Glasgow Centre	25/11/04	30/06/05	*Pm*	15	19.5	98.5	µg m-3 (20'C 1013mb)
Aberdeen	25/11/04	30/06/05	*Pm*	14	18.2	90.1	µg m-3 (20'C 1013mb)
Perth	25/11/04	30/06/05	*Pm*	14	18.2	99.5	µg m-3 (20'C 1013mb)
Edinburgh St Leonards				Ratio (Am/Pm)	1.00		
Newcastle Centre					1.00		
Glasgow Centre					1.00		
Aberdeen					1.00		
Perth					0.93		
				Average (Ra)	**0.99**		
Newcastleton	01/01/04	31/12/04			**16.66**	monitored gravimetric equivalent	

Table A2.3 SO_2 Year Adjustment

Site name	Start date	End date		Average	DC %	Units
Newcastleton	01/01/2004	31/12/2004		-	-	µg m-3 (20'C 1013mb)
Edinburgh St Leonards	01/01/2004	31/12/2004	Am	3	99	µg m-3 (20'C 1013mb)
Newcastle Centre	01/01/2004	31/12/2004	Am	4	84	µg m-3 (20'C 1013mb)
Glasgow Centre	01/01/2004	31/12/2004	Am	2	87	µg m-3 (20'C 1013mb)
Aberdeen	01/01/2004	31/12/2004	Am	4	93	µg m-3 (20'C 1013mb)
Newcastleton	25/11/2004	30/06/2005	Pm	6	97	µg m-3 (20'C 1013mb)
Edinburgh St Leonards	25/11/2004	30/06/2005	Pm	2	99	µg m-3 (20'C 1013mb)
Newcastle Centre	25/11/2004	30/06/2005	Pm	3	94	µg m-3 (20'C 1013mb)
Glasgow Centre	25/11/2004	30/06/2005	Pm	1	97	µg m-3 (20'C 1013mb)
Aberdeen	25/11/2004	30/06/2005	Pm	3	89	µg m-3 (20'C 1013mb)
Edinburgh St Leonards		**Ratio (Am/Pm)**		1.50		
Newcastle Centre				1.33		
Glasgow Centre				2.00		
Aberdeen				1.33		
		Average (Ra)		1.54		
Newcastleton	01/01/2004	31/12/2004		**9.25**		

Model Adjusment

The model adjustment factor used is based on Monitoring/(Modelled+Background). This approach takes into account the uncertainty of the two modelling approaches (1x1km UK Background maps using empirical model and 25m resolution using DISP). By adding up modelled and background, we are adjusting both uncertainties rather than only adjusting the domestic modelling and leaving background unadjusted. This way, we are also taking into account other sources that may arise in the local area that might not be included in the background data such as traffic.

Experience with point source ADMS and DISP modelling has placed a good level of confidence is this approach. Netcen is confident that this approach is the most reliable and the approach is consistent with the uncertainties reported by Stedman et al. in UK air quality modelling for annual reporting 2003 on ambient air quality assessment under Council Directives 96/62/EC, 1999/30/EC and 2000/69/EC: (http://www.airquality.co.uk/archive/reports/cat05/0501121424_dd12003mapsrep4.pdf). Figure 2.9 of this report, shows the verification plots for SO_2. As can be seen, specially at the lower end, the underestimation of the plots can be of 100 to 150%. In the Newcastleton example, 1.32 background figure is adjusted (in the overall calculations) to 2.76. This adjusment is reasonable if compared to values in figure 2.9. Figure 4.8 shows the PM_{10} verification plots. This show that all the sites are within +/-50%, the adjustment used falls within this range.

SO_2

Background	1.32
Modelled (using ADMS & DISP)	3.1
Background + Modelled	**4.42**

Adjusted Monitoring in 2004	9.25
Adjusting factor	***2.09***

Adjusted value = (modelled DISP + 1.32) * 2.09

PM_{10} *gravimetric equivalent*

Background	10.42
Modelled (using ADMS & DISP)	1.52
Background + Modelled	**11.94**
Adjusted Monitoring in 2004	16.65
Adjusting factor	***1.39***

Adjusted value = (modelled DISP + 10.42) * 1.39