Report

Armagh City and District Council Stage 2 update and Stage 3 Review and Assessment

Report to Armagh City and District 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. The NI Environment Order came into operation in January 2003 and implements both the European Air Framework Directive 96/62EC and the UK Air Quality Strategy. The Air Quality Strategy and provides a framework for air quality control through air quality management and air quality standards. New air quality standards have been proposed by the Expert Panel on Air Quality Standards (EPAQS) for the UK.

All local authorities are thus required to undertake an air quality review. In areas where air quality objectives are not anticipated to be met by the specified date, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

Local Air Quality Management Policy Guidance (LAQM.PGNI (03)) is guidance designed to help relevant authorities with their local air quality management duties under Part III of the environment (NI) Order 2002. The guidance sets out the legislative framework for the system of local Air quality Management (LAQM). The Environment (NI) Order 2002 provides the framework for LAQM across Northern Ireland.

The air Quality Objectives set out in the Air Quality Regulations (NI) 2003 provide the statutory basis for the system of LAQM.

The first step in this process is to undertake a review of current and potential future air pollution. Armagh City and District Council have completed a Stage 1 review and assessment which concluded that a Stage 2 review and assessment was required for the pollutants nitrogen dioxide, sulphur dioxide and particulate matter.

Armagh have also completed the stage 2 review and assessment. It identified the need to further assess domestic combustion. Since the stage 2, new data regarding traffic has also become available and so the stage 2 road traffic assessment for NO_2 will also be revisited.

This report forms the Stage 3 Air Quality Review for Armagh City and District Council. PM_{10}, NO_2 and SO_2 are considered within this report. This report investigates current and potential future PM_{10}, SO_2 and NO_2 levels through an examination of the location and size of traffic, industrial and domestic combustion sources, emissions modelling exercises and by reference to monitored air quality data. As part of this report, detailed modelling of domestic fuel combustion using ADMS version 3.1 has been undertaken at the 3, $1km^2$, grids in Armagh, identified in the Stage 2 as needing further assessment.

The conclusions of the report are:

PM_{10}
Emissions arising from road transport and domestic fuel combustion in Armagh City and District Council are not predicted to cause an exceedence of the air quality objective within Armagh.

Nitrogen Dioxide
Emissions arising from road transport in Armagh City and District Council are not predicted to cause an exceedence of the air quality objective within Armagh.

Sulphur dioxide
It is not yet possible to conclude whether emissions arising from domestic fuel combustion in Armagh City and District Council are likely to cause an exceedence of the air quality objective within Armagh as the modelling results have yet to be corrected using local monitoring data. Monitoring is currently in place and data are anticipated to be available in March 2004; therefore the model results will be revisited in April 2004.

Maps reproduced within this document

Acronyms and definitions

ADMS	an atmospheric dispersion model
AQDD	Common Position on Air Quality Daughter Directives
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network
d.f.	degrees of freedom
Defra	Department for the Environment, Food and Rural Affairs (Defra)
DETR	Department of the Environment, Transport and the Regions (now Defra)
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
GIS	Geographical Information System
LADS	Urban background model specifically developed for Stage 3 Review and Assessment work. This model allowed contributions of the urban background and domestic emissions to be calculated
n	number of pairs of data
NAEI	National Atmospheric Emission Inventory
AQS	Air Quality Strategy
ppb	parts per billion
r	the correlation coefficient
roadside	1 to 5 m from the kerb

Contents

1 Introduction

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1.1 PURPOSE OF THE STUDY

netcen was commissioned to complete the second stage review and assessment and undertake a third stage for domestic fuel combustion for Armagh City and District Council.
The review:

- Investigates present and potential future air quality in Armagh City and District Council area
- Identifies any actions that are likely to be required by Armagh City and District Council under the Environment (NI) Order 2002.
- Recommends actions, if necessary, to control the subsequent air quality within Armagh City and District Council area.

1.2 GENERAL APPROACH TAKEN

The approach taken in this study was to:

- Collect and interpret additional data to support the third stage assessment, including the detailed fuel use survey data for the location where exceedences were predicted;
- Use the monitoring data to assess the ambient concentrations produced by domestic fuel combustion and to validate the output of their own modelling studies.
- Model the concentrations of PM_{10} and SO_2 in the selected grid squares, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives;
- Present the concentrations as contour plots of concentrations and comment on the uncertainty in the predicted concentrations
- Reassess traffic source emissions using the latest version of DMRB and new traffic data to finalise the stage 2 review and assessment for traffic sources

- Assess a number of quarries in the council area to finalise the stage 2 review and assessment for industrial sources.

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 throughout this report are presented in $\mu g\ m^{-3}$ (which is consistent with the presentation of the AQS objectives), unless otherwise noted.

1.6 STRUCTURE OF THE REPORT

This document is the completion of the outstanding stage 2 sources and the stage 3 review and assessment for domestic fuel combustion for Armagh City and District 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). In addition, it discusses when implementation of an AQMA is required.

Chapter 3 contains details of the information used to conduct the stage 3 review and assessment for Armagh City and District Council.

Chapters 4, 5 and 6 describe the results of the assessment and discuss whether both the PM_{10} and sulphur dioxide objectives will be exceeded in Armagh City and District Council in 2004/5. The results of the analysis are displayed as contour plots.

2 The updated Air Quality Strategy

2.1 THE NEED FOR AN AIR QUALITY STRATEGY

After agreement, in June 1998 at the European Union Environment Council, of a Common Position on the Air Quality Daughter Directives (AQDD), the government published its proposals for review of the National Air Quality Strategy (in 1999). Subsequently the Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in January 2000.

The NI Environment Order came into operation in January 2003 and implements both the European Air Framework Directive 96/62EC and the UK Air Quality Strategy. The Expert Panel on Air Quality Standards (EPAQS) has proposed new air quality standards for the UK.

The NI Environment Order 2002 provides the framework for LAs to review air quality and for implementation of an AQMA. It is issued by the Department of the Environment in Northern Ireland under Article 16 of the Environment (NI) Order 2002. Under section 16 of the Order, District Councils and other relevant authorities are required to have regard to this guidance when carrying out any of their duties under, or by virtue of Part III of the order. The guidance is outlined in Table 2.1 below.

NI Environment Order 2002 key Guidance:

- The statutory background and the legislative framework within which relevant authorities have to work
- The new principles behind reviews and assessments of air quality up to 2010 and the recommended steps that relevant authorities should take
- The timetable for reviews and assessments up to 2010
- How district councils should handle the designation of AQMAs
- How relevant authorities should handle the drawing up and implementation of action plans
- Recommendations and suggestions on taking forward the development of local and regional air quality strategies
- Suggestions of how relevant authorities should consult and liase with others
- Local transport measures which Roads Service might wish to consider
- The general principles behind air quality and land use planning; and
- How enforcing authorities should use powers of entry under Article 19 of the Order

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

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

- The use of a health effects based approach using air quality standards and objectives.
- The use of policies by which the objectives can be achieved and which include the input of important actors such as industry, transportation bodies and local authorities.
- The predetermination of timescales with a 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 Air Quality Standards

At the centre of the AQS is the use of 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 exceedences that are permitted (where applicable).

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 exceedences 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. Proposed Objectives included in the Air Quality Regulations (NI) 2003 for the purpose of Local Air Quality Management.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 μgm^{-3}	Running annual mean	31.12.2003
	3.25 μgm^{-3}	Running annual mean	31.12.2010
1,3 Butadiene	2.25 μgm^{-3}	Running annual mean	31.12.2003
Carbon Monoxide	10.0 mgm^{-3}	Maximum daily running 8-hour mean	31.12.2003
Lead	0.5 μgm^{-3}	Annual mean	31.12.2003
	0.25 μgm^{-3}	Annual mean	31.12.2008
Nitrogen Dioxide[1]	200 μgm^{-3} no to be exceeded more than 18 times a year	1 hour mean	31.12.2005
	40 μgm^{-3}	annual mean	31.12.2005
Particles (PM_{10})[2] **Gravimetric**[3]	50 μgm^{-3} not to be exceeded more than 35 times a year	24 hour mean	31.12.2004
	40 μgm^{-3}	annual mean	31.12.2004
Sulphur Dioxide	350 μgm^{-3} not to be exceeded more than 24 times per year	1 hour mean	31.12.2004
	125 μgm^{-3} not to be exceeded more than 3 times per year	24 hour mean	31.12.2004
	266 μgm^{-3} not to be exceeded more than 35 times per year	15 minute mean	31.12.2005

Notes
1. The objectives for nitrogen dioxide are provisional.
2. Likely to be new particles objective for 2010, not in regulation at present, expected after the review of the EU's first Air Quality Daughter Directive (2004).
3. Measured using the European gravimetric transfer standard or equivalent.

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

As a member state of the EU, the UK must comply with European Union 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 framework directive. 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 objectives for some pollutants, for example, sulphur dioxide.

The Government is ultimately responsibility 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 Policies in place to allow these objectives to be achieved

The policy framework to allow these objectives to be achieved is one that 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 which already exist provide a good basis for progress towards the air quality objectives set for 2003 to 2010. 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 will meet the air quality standards set out in the AQS. Northern Ireland now has in place the Air Quality Limit Value regulation (NI) 2002, the Air Quality (Amended) Limit Value Regulations (NI) 2002 and the Air Quality (Ozone) Regulations (NI) 2003. The Government has recognised the problems associated with achieving the standard for ozone, 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. Northern Ireland now has in place the Air Quality (Ozone) regulations (NI) 2003.

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 Borough. 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.

2.2.4 Timescales to achieve the objectives

In most local authorities, 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.

2.3 AIR QUALITY REVIEWS

2.3.1 Technical guidance

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 the Technical Guidance LAQM.TG(03), and the previous version LAQM.TG4(00) May 2000, on 'Review and Assessment: Pollutant Specific Guidance'. This review and assessment has considered the procedures set out in the guidance.

2.3.2 Phased Approach

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet 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.

At present District Councils are engaged in the 3 staged approach of review and assessment. The Stages are briefly described in Table 2.3. In this process a Stage 1 equates to an 'updating and Screening assessment, and a stage 2 and 3 equates to a 'detailed assessment'. The latest technical guidance LAQM.TG(03) is based on the revised '2 step' approach. The Steps are briefly described in Table 2.4.

The department recommends that district councils where feasible should use the latest technical guidance LAQM.TG(03) to complete their first rounds of review and assessment. Where District councils have commenced using the old technical guidance (LAQM. TG (00)) they may continue using the old guidance. However the methodology should be cross-referenced with the new guidance.

2.3.3 Technical guidance for Armagh

As Armagh had already embarked on the stage 3 review and assessment the domestic fuel grids assessed are 1x1km grids, as defined in (LAQM. TG (00)). Other than this however, the latest technical guidance LAQM.TG (03) has been used as the guidance document for the domestic fuel combustion modelling methodology and the road traffic assessment. In practice, the high resolution modelling and the method of source definition used in this report means that defining a 1x1km area makes no difference to the output when compared with a smaller total area. This is because the source within that is modelled the same as it would be if the area were over a smaller total area, for example; 500m x 500m.

Table 2.3 Brief details of Stages in the Air Quality Review and Assessment process

Stage	Objective	Approach	Outcome
First Stage Review and Assessment	• Identify all significant pollutant sources within or outside of the authority's area.	• Compile and collate a list of potentially significant pollution sources using the assessment criteria described in the Pollutant Specific Guidance	
	• Identify those pollutants where there is a **risk** of exceeding the air quality objectives, and for which further investigation is needed.	• Identify sources requiring further investigation.	• Decision about whether a Stage 2 Review and Assessment is needed for one or more pollutants. If not, no further review and assessment is necessary.
Second Stage Review and Assessment	• Further screening of significant sources to determine whether there is a significant risk of the air quality objectives being exceeded.	• Use of screening models or monitoring methods to assess whether there is a risk of exceeding the air quality objectives.	
	• Identify those pollutants where there is a **risk** of exceeding the objectives, and for which further investigation is needed.	• The assessment need only consider those locations where the highest likely concentrations are expected, and where public exposure is relevant.	• Decision about whether a Stage 3 Review and Assessment is needed for one or more pollutants. If, as a result of estimations of ground level concentrations at suitable receptors, a local authority judges that there is no significant risk of not achieving an air quality objective, it can be confident that an Air Quality Management Area (AQMA) will not be required. • However, if there is doubt that an air quality objective will be achieved a third stage review should be conducted.

Table 2.3 (contd.) Brief details of Stages in the first Review and Assessment process

Stage	Objective	Approach	Outcome
Third Stage Review and Assessment	• Accurate and detailed assessment of both current and future air quality. Assess the **likelihood** of the air quality objectives being exceeded.	• Use of validated modelling and quality-assured monitoring methods to determine current and future pollutant concentrations.	
	• Identify the geographical boundary of any exceedences, and description of those areas, if any, proposed to be designated as an AQMA.	• The assessment will need to consider all locations where public exposure is relevant. For each pollutant of concern, it may be necessary to construct a detailed emissions inventory and model the extent, location and frequency of potential air quality exceedences.	• Determine the location of any necessary Air Quality Management Areas (AQMAs). Once an AQMA has been identified, there are further sets of requirements to be considered. • A further assessment of air quality in the AQMA is required within 12 months which will enable the degree to which air quality objectives will not be met and the sources of pollution that contribute to this to be determined. A local authority must also prepare a written action plan for achievement of the air quality objective. Both air quality reviews and action plans are to be made publicly available.

Table 2.4 Brief details of Steps in the revised Air Quality Review and Assessment process

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 an air quality objective being exceeded.	• Use a checklist to identify significant changes that require further consideration. • Where such changers are identified, then apply simple screening tools to decide whether there is sufficient risk of an exceedence 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 of 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 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 exceedences 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 (Northern Ireland) Order 2002 has implemented an 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 actors 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 Information used to support this assessment

This chapter presents the information used to support this review and assessment.

3.1 INFORMATION PROVIDED BY ARMAGH CITY AND DISTRICT COUNCIL TO SUPPORT THIS ASSESSMENT

The following information from Armagh City and District Council was used to complete this Review and Assessment:

- Local air quality monitoring data
- Domestic Fuel Combustion Survey
- Local Fuel Data
- Traffic flow and speed data
- Transport strategy
- Information on Quarries in the District.

3.1.1 Industrial and Transport Development in Armagh City and District Council

Some developments may have an important impact on air quality in the future. Therefore they need to be included in the Stage 2 Review and Assessment. There are no developments that need to be considered in Armagh City and District Council area.

3.2 LOCAL AIR QUALITY MONITORING DATA

3.2.1 Extent of data available

Armagh City and District Council has carried out monitoring of nitrogen dioxide using diffusion tubes and continuous monitor and Sulphur Dioxide and PM_{10} with a continuous monitor, see Appendix 1. Armagh City and District Council has also carried out Sulphur Dioxide monitoring using a bubbler for over 14 years. The pollutant specific chapters give more details about the local air quality monitoring.

3.2.2 Quality Assurance/Quality control of data

The analyst laboratory used by Armagh City and District Council for NO_2 diffusion tubes was Harwell Scientifics but is currently Lambeth Scientific Services Ltd, which participate in the laboratory intercomparison exercises for the UK National NO_2 Diffusion Tube Network. The change of laboratory has been taken into account when analysing diffusion tube data.

3.3 TRAFFIC DATA

Appendix 2 summarises the traffic information used in the assessment Armagh City and District Council supplied traffic counts based on the Roads Service Annual Traffic Census Report and projections to the relevant years.

3.3.1 Flow and speed

Armagh City and District Council provided traffic flow measurements at a range of locations within Armagh (Appendix 2). Average traffic speeds were also supplied.

3.3.2 Traffic growth

The air quality objectives are targets for 2004 or 2005. The predicted increase in traffic flows for the years 2004 and 2005 relative to the date of traffic counts have been supplied by Armagh City and District Council.

3.3.3 Fraction of HGVs

The model requires estimates of the fraction of HGVs on the roads to predict the pollutant concentrations. This data was available from Armagh City and District Council for some of the links and where it wasn't default figures from the NAEI were used.

3.3.4 Distance of the receptor from the centre of the road and the kerbside.

The model used to predict the roadside concentrations requires estimates of the distance of the receptor from the centrepoint of the road. As a precautionary approach the minimum value permitted (2m) was entered into DMRB.

3.4 MAPS

Armagh City and District Council provided maps of the grids to be modelled.

3.5 METEOROLOGICAL DATA USED IN THE DISPERSION MODELLING

Hourly sequential data was obtained for 1999 from the Meteorological Office for the Aldergrove site for input into the ADMS dispersion model. This is the same year as the monitoring data available for PM_{10}.

4 Review and Assessment of Nitrogen Dioxide

4.1 INTRODUCTION

Nitrogen oxides are formed during high temperature combustion processes from the oxidation of nitrogen in the air or fuel. The principal source of nitrogen oxides, (nitric oxide (NO) and nitrogen dioxide (NO_2)), collectively known as NO_x, is road traffic, which is responsible for approximately half the emissions in Europe. NO and NO_2 concentrations are therefore greatest in urban areas where traffic is heaviest. Other important sources are power stations, heating plant and industrial processes.

Nitrogen oxides are released into the atmosphere mainly in the form of NO, which is then readily oxidised to NO_2 by reaction with ozone. Elevated levels of NO_x occur in urban environments under stable meteorological conditions, when the air mass is unable to disperse.

Nitrogen dioxide has a variety of environmental and health impacts. It is a respiratory irritant, may exacerbate asthma and possibly increase susceptibility to infections. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone. In addition, nitrogen oxides have a lifetime of approximately 1 day with respect to conversion to nitric acid. This nitric acid is in turn removed from the atmosphere by direct deposition to the ground, or transfer to aqueous droplets (e.g. cloud or rainwater), thereby contributing to acid deposition.

4.1.1 Standards and objectives for nitrogen dioxide

The air quality objectives for NO_2 are:

- An annual average concentration of 40 $\mu g\ m^{-3}$ (21 ppb); to be achieved 31st December 2005
- 200 $\mu g\ m^{-3}$ (105 ppb) as an hourly average with a maximum of 18 exceedences in a year to be achieved 31st December 2005

Modelling studies suggest that in general achieving the annual mean of 40 $\mu g\ m^{-3}$ is more demanding than achieving the hourly objective. If the annual mean is achieved, the modelling suggests the hourly objectives will also be achieved.

4.1.2 The National Perspective

All combustion processes produce some NO_x, but only NO_2 is associated with adverse effects on human health. The main sources of NO_x in the United Kingdom are road transport, which, in 2000 accounted for 42% of the emissions. In urban areas, the proportion of local emissions due to road transport sources is larger.

The results of the analysis set out in the Air Quality Strategy suggest that for NO_2 a reduction in NO_x emissions over and above that achievable by national measures will be required to ensure that air quality objectives are achieved everywhere by the end of 2005. Local authorities with major roads, or highly congested roads, which have the

potential to result in elevated levels of NO_2 in relevant locations, are expected to identify a need to progress to the second or third stage review and assessment for this pollutant.

4.1.3 Background concentrations of Nitrogen dioxide

The background concentrations for Armagh City and District Council have been taken from the netcen website
http://www.airquality.co.uk/archive/laqm/tools.php?tool=background

An estimated NOx background concentration has been taken from the highest NOx value in the NAEI mapped dataset to provide a conservative estimate. Therefore a background NO_x estimate of 14$\mu g/m^3$ has been estimated for 2005 in the Armagh City and District Council region.

4.1.4 Monitoring of nitrogen dioxide in Armagh City and District Council

Monthly average concentrations of NO_2 have been measured with diffusion tubes at eight sites in Armagh City and District Council. The results for 2001 are summarised in Table 4.1. The monitoring period of 11 months is considered to be representative of a full year and can be compared with the annual mean objective. Analysis of the tubes was carried out by Harwell Scientifics Ltd. Harwell Scientifics was found to have a positive bias of 50.2% in 2001 relative to an automatic analyser (Intercomparison report still to be approved by DEFRA).

Table 4.1. Annual average concentrations measured at locations in the Armagh City and District Council area (2001).

Location			2001 Annual Average $\mu g/m^3$	Corrected for Lab Bias	Projected to 2005
25 Railway St	Site 1	k	33.6	16.7	15.2
Bridge House	Site 2	k	39.4	19.6	17.8
Desert Lane	Site 3	b	16.0	8.0	7.0
Folly Lane	Site 4	b	19.5	9.7	8.6
Scotch St	Site 5	k	17.6	8.8	8.0
Victoria St	Site 6	k	34.5	17.2	15.6
LWR Irish St	Site 7	k	32.6	16.2	14.7
Portadown Rd	Site 8	k	32.3	16.1	14.6

K=kerbside 1-5m from a busy road
B = background in a residential area more than 50 metres from a busy road.
NB Table A1 analyses 2002 data

The diffusion tubes placed at the kerbside locations do not exceed the annual mean standard for nitrogen dioxide of 40 $\mu g/m^3$. The diffusion tube measurements suggest that it is likely that the NO_2 annual mean objective will be met at this location by 2005.

4.1.5 Impact of Road traffic on concentrations of oxides of nitrogen in Armagh City and District Council

The Stage one Review and Assessment for Armagh City and District Council identified some road links as needing further study in a Stage two assessment. The concentrations at these kerbside locations were originally estimated using the original 'Design Manual for Roads and Bridges' (DMRB) using the traffic flow data provided by Armagh City and District Council.

However this model was considered to overread in some cases and so when the new version of DMRB (Version 1.01) was made available in January 2003 the roads links were modelled again in the newer version which is considered to be more representative of actual concentrations.

The effect of junctions has been taken into account in DMRB where traffic data have been provided. Traffic flow details are given in Appendix 2. The model has been used to predict nitrogen dioxide concentrations for 2005.

Table 4.2. Nitrogen dioxide concentrations at roadside locations in the Armagh City and District council using supplied HGV data

Road name	Distance from link centre to receptor (m)	AADT (combined, veh/day) 2005	Annual average speed (km/h)	Total % HDV	Predicted 2005 NO_2 ($\mu g/m^3$)
A3	2.0	10520	50	12.1	20.0
A29	2.0	11000	50	5.8	17.3
A28	2.0	11000	50	5.8	17.3
A3	2.0	11000	50	5.8	17.3
A29	2.0	11000	50	5.8	17.3
A28	2.0	11000	50	5.8	17.3
A3	2.0	11000	50	5.8	17.3
Urban A road	2.0	11000	50	5.8	17.3
Portadown Rd	8.8	20952	48	10.0	22.1
Drumadd Rd	10.0	19992	48	12.0	22.8
Victoria St	7.5	19992	48	12.0	23.3
Barrack St	7.5	19992	48	12.0	23.3
Railway St	10.0	19992	48	12.0	22.8
Lonsdale Rd	12.6	19992	48	12.0	22.1
Mall West	8.8	19992	48	12.0	23.1
Irish St	8.8	20952	48	16.0	25.5

In the previous version of DMRB annual average concentrations of nitrogen dioxide in 2005 were predicted to be exceeded (40 µg m^{-3} or more) at three locations within the town. However, when run in the new DMRB version 1.01, there are no longer any predicted exceedences. This is in agreement with the diffusion tubes in Armagh and indicates the objective will be met.

4.1.6 Conclusions for nitrogen dioxide concentrations in Armagh City and District Council

Emissions arising from road transport in Armagh City and District Council are not predicted to cause an exceedence of the air quality objective within the Armagh City and District Council region.

5 Review and assessment of PM_{10}

5.1 INTRODUCTION

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 particules in air size <10 μm aerodynamic 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, $PM_{2.5}$, which is capable of penetrating deepest into the lungs, or to even smaller size fractions or total particle numbers.

5.1.1 Standards and objectives for particulate matter

The Air Quality Strategy 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.

5.1.2 The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 172,000 tonnes in 2000. Of this total, around 18% was derived from road transport sources. 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) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999)[5]. APEG 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 $\mu g\ m^{-3}$ 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.

5.2 ARMAGH CITY AND DISTRICT COUNCIL

5.2.1 Background concentrations of PM_{10}

The background concentrations for Armagh City and District Council have been taken from the netcen website and estimated annual average background concentration for 2004 in Armagh City and District Council was 20 $\mu g/m^3$ or lower.
http://www.airquality.co.uk/archive/laqm/tools.php?tool=background

5.2.2 Armagh City and District Council - impact of Road traffic on PM_{10}

The Stage one Review and Assessment for Armagh City and District Council identified some road links as needing further study in a Stage two assessment. The concentrations at these kerbside locations were originally estimated using the original 'Design Manual for Roads and Bridges' (DMRB) using the traffic flow data provided by Armagh City and District Council.
However this model was considered to overread in some cases and so when the new version of DMRB (Version 1.01) was made available in January 2003 the roads links were modelled again in the newer version which is considered to be more representative of actual concentrations.

The effect of junctions has been taken into account in DMRB where traffic data have been provided. Traffic flow details are given in Appendix 2. The model has been used to predict PM_{10} concentrations for 2004. Estimated traffic flows for 2005 have been used as this was the data supplied by the LA. In the context of exceedence of the objectives for 2004 then, as traffic counts are likely to be higher in 2005 than in 2004, it can be assumed that if the objective is met with 2005 traffic data it would certainly have been met with 2004 traffic data.

Guidance LAQM.TG4(00) states that the 24-hour PM_{10} objective is highly unlikely to be exceeded if the annual mean concentration is below 28 $\mu g\ m^{-3}$, gravimetric.

Table 5.1 shows the 2004 predictions for comparison to the objectives. For 2004, the method predicts annual average concentrations of PM_{10} less than 28 $\mu g\ m^{-3}$ at all of the locations modelled. Therefore it is predicted that there will be no exceedence of the objective.

Table 5.1. Predicted PM_{10} concentrations at roadside locations in the Armagh City and District Council region.

Road name	Distance from link centre to receptor (m)	AADT (combined, veh/day) 2004	Annual average speed (km/h)	Total % HDV	Predicted 2004 PM10 (μg/m3)	Number of PM10 exceedences 2004
A3	2.0	10520	50	12.1	19.0	2
A29	2.0	11000	50	5.8	18.0	1
A28	2.0	11000	50	5.8	18.0	1
A3	2.0	11000	50	5.8	18.0	1
A29	2.0	11000	50	5.8	18.0	1
A28	2.0	11000	50	5.8	18.0	1
A3	2.0	11000	50	5.8	18.0	1
Urban A o	2.0	11000	50	5.8	18.0	1
Portadown Rd	8.8	20952	48	10.0	20.3	4
Drumadd Rd	10.0	19992	48	12.0	20.6	4
Victoria St	7.5	19992	48	12.0	20.9	5
Barrack St	7.5	19992	48	12.0	20.9	5
Railway St	10.0	19992	48	12.0	20.6	4
Lonsdale Rd	12.6	19992	48	12.0	20.2	4
Mall West	8.8	19992	48	12.0	20.8	4
Irish St	8.8	20952	48	16.0	22.0	6

*Using supplied 2005 traffic flow data

5.2.3 Armagh City and District Council - PM_{10} Monitoring

PM_{10} concentrations have been measured using sophisticated automated analysers during 1999 at Shambles market, Armagh. The Annual mean value for 1999 was 19 μgm^{-3}. This annual mean concentration can be used to predict a concentration for 2004. Following the guide in the Pollutant Specific Guidance (Box 8.5), the results are summarised in Table 5.3

Table 5.3. Determination of 2004 Background PM_{10} concentration

Calculated:	PSG Box 8.5 Ref	$\mu g/m^3$
Monitored annual mean	A	19.00
96 secondry PM_{10} concentration	B	8.00
Secondry PM_{10} adjusted to year	C	7.49
Local primary PM_{10}	E	1.01
Adjusted for 2004	F	0.83
Secondry PM_{10} for 2004	G	6.63
Total PM_{10} for 2004	H	17.96

A 2004 annual mean prediction of 17.96 $\mu g\ m^{-3}$ has been calculated, TG (03) guidance (Chapter 8.11) recommends that to predict for the 90th percentile of the 24-hour mean the 2004 mean can be multiplied by 1.79. Therefore the 90th percentile for 2004 is 32 $\mu g\ m^{-3}$. This is well within the 50 $\mu g\ m^{-3}$ limit and therefore an exceedence at this location is unlikely.

5.2.4 Fugitive emission from quarries.

There are a number of quarries within the Armagh City and District Council area:

- Navan Quarries (Achesons), Navanfort Rd, Armagh;
- Croziers Quarry, Outlack, Lisnadill;
- Cootes Quarry, Redrock;
- Collen Bros Quarry, Glebehill, Tandragee;
- Emersons Quarry and Concrete Dispatch, Lisbane, Tandragee;
- Navan Quarries(Achesons)at Tynan;
- Armagh City Quarries, Loughgall Rd, Armagh;
- Mill's Lime Quarry, Carganamuck,Armagh;
- McCones Quarry and Coating Plant, Cashel, Coolmillish Rd., Armagh;
- Vallelys Quarry, Clady, Armagh;
- Loughrans Quarry at Cladybeg, Armagh;
- Whitemountain Coating Plant at Cladybeg, Armagh. (modelled and ruled out in previous stages of review and assessment for CO and Pb).
- Quinn Group Landfill Site, Lisbane, Tandragee.

Those that were considered most likely to pose a risk to the air quality objectives have been assessed according to the new technical guidance, paragraphs 8.67 and Box 8.4 of TG (03).
The following sites have been considered in the assessment:

- Navan Quarries (Achesons), Navanfort Rd, Armagh;
- Croziers Quarry, Outlack, Lisnadill;
- Cootes Quarry, Redrock;
- Collen Bros Quarry, Glebehill, Tandragee;
- Emersons Quarry and Concrete Dispatch, Lisbane, Tandragee;
- Quinn Group Landfill Site, Lisbane, Tandragee.

The assessment is in two steps:

1. **Establish whether there is relevant exposure 'near' to the source of dust emission.**

The term 'near ' is determined by considering the background annual mean concentration.
The highest value of 2004 background PM_{10} in the Armagh region is 16.1$\mu g/m^3$ (http://www.airquality.co.uk/archive/laqm/tools.php?tool=background). Visual inspection identified that there were properties at some of the quarry locations that appeared to be within 200m of the site boundaries. According to the 'near' criteria specified in the technical guidance some of the sites did have receptors that could be defined as 'near'.

2. **Determine whether there are dust concerns associated with the facility.**

A site visit to the listed sites was undertaken and the recent complaints record was checked by Armagh City and District Council. The guidance asks these questions…

Are there recent complaints about dust?
No. Armagh City and District Council have informed that there are no recent complaints about dust from any of the listed facilities.

Does the visual inspection indicate significant dust?
No. Visual inspection of the site found there to be some dust deposits from some of the sites on roads and perimeter hedging but this disappeared rapidly as distance from the site increased and the level of dust deposition was not deemed to be significant. There was no evidence of significant dust deposition within close proximity to any of the receptors for the listed sites.

The answer to both of the questions was no, the technical guidance advises that there is no further action required for this source of PM_{10}.

5.2.5 Conclusions for PM_{10} concentrations Armagh City and District Council

Emissions from traffic are not predicted by DMRB to lead to an exceedence of the PM_{10} objectives in 2004 and monitoring data supports this. Therefore it is recommended that it is not necessary for Armagh City and District Council to proceed to a further stage of Assessment for this source.

5.2.6 Domestic Fuel Combustion.

The domestic fuel combustion source is assessed separately in chapter 6 in conjunction with SO_2 from this source.

6 Review and assessment of PM_{10} and SO_2 from Domestic Fuel combustion

6.1 DOMESTIC FUEL COMBUSTION: STAGE 1 CONCLUSIONS

Solid fuel burning for domestic heating is still relatively common in parts of Northern Ireland. Where solid fuel burning is predominant it may have the potential to cause exceedences of the objectives. According to PSG (LAQM TG (00)), ' the risk of exceedence within an area can be considered significant where the density of coal burning (or solid smokeless fuel burning) houses exceeds 300 properties per $1km^2$. In such cases PSG recommends an authority proceed to a 2^{nd} or third stage review and assessment.

In the first stage of Review and Assessment, Armagh City and District Council found areas exceeding the threshold of permitted coal burning properties per $1km^2$. It was therefore necessary to proceed to a second stage review and assessment.

6.2 ARMAGH CITY AND DISTRICT COUNCIL FUEL USE SURVEY

Armagh City and District Council looked at the Northern Ireland Housing Executive properties and identified areas with 300+ houses burning coal. Armagh City and District Council conducted a fuel use survey of properties in March 2002 which identified the fuel usage profile in the grids.
The grids identified for stage 3 assessment are:

- Southwest Armagh
- Northwest Armagh
- Central Armagh

10% of properties in the grids answered fuel use questionnaires across the areas and the findings are summarised in table 6.1a – 6.1c.

6.2.1 Southwest Armagh

There were a total of approximately 580 houses within the $1km^2$ grid in Southwest Armagh.

Table 6.1a Fuels for heating purposes

	Number Properties	*% of Properties*
Oil	346	59.6
Coal/Solid Fuel	196	33.9
Electricity	38	6.5
Total	580	100

6.2.2 Northwest Armagh

There were a total of approximately 555 houses within the 1km^2 grid in Northwest Armagh

Table 6.1b Fuels for heating purposes

	Number Properties	*% of Properties*
Oil	312	56.3
Coal/Solid Fuel	208	37.5
Electricity	35	6.2
Total	555	100

6.2.3 Central Armagh

There were a total of approximately 775 houses within the 1km^2 grid in Central Armagh

Table 6.1c Fuels for heating purposes

	Number Properties	*% of Properties*
Oil	460	59.3
Coal/Solid Fuel	265	34.2
Electricity	50	6.5
Total	775	100

6.3 DOMESTIC SOURCES STAGE TWO REVIEW AND ASSESSMENT

As Stated in PSG, Second Stage Review and Assessment should focus upon a review of monitoring data within the local area. Based upon that, if local concentrations exceed the air quality objectives (or in the absence of monitoring data) then a third stage review and assessment should be carried out.
The monitoring data is not a complete data set and not directly comparable to the objectives. As there is not enough monitoring information to determine any likely exceedence of the SO_2 objectives it has been decided by Armagh City and District Council to proceed to a Stage 3 Review and assessment for domestic combustion sources of SO_2 based on more detailed modelling.

6.4 DOMESTIC SOURCES STAGE THREE REVIEW AND ASSESSMENT

The Fuel use survey undertaken by Armagh City and District Council has been used in combination with the Air Dispersion Model ADMS 3.1 to determine whether domestic fuel combustion is likely to cause exceedences of the objectives. The 15 minute mean SO_2 objective of 266μg/m^3 is the most stringent of the three SO_2 objectives. The daily PM_{10} objective is the most stringent of the PM_{10} objectives. Therefore the ADMS modelling was carried out relevant to these objectives because if these objectives can be met the other objectives will also be met.

The emission rate for up to 5 area sources within the 3 1km^2 grids were calculated based on the number of properties within each area and the fuel use. The emission rate was calculated in grams/metre^3/second. This enabled them to be entered directly into the ADMS model as a volume source.

6.4.1 Southwest Armagh

Table 6.2a Emission rates resulting from coal combustion Southwest Armagh:

	Number of Houses	No houses burning coal	Coal per week (kg)	Coal per year (kg)	g SO2 per year	g PM10 per year
Volume 1	123	42	5,244	272,672	2,726,722	2,726,722
Volume 2	267	90	11,410	593,335	5,933,347	5,933,347
Volume 3	69	23	2,936	152,696	1,526,964	1,526,964
Volume 4	122	41	5,202	270,491	2,704,908	2,704,908
Total	390	196	24,792	1,289,194	12,891,941	12,891,941

Table 6.2b Emissions rates resulting from oil combustion Southwest Armagh

	Number of Houses	No houses burning oil	Oil per year (l)	Oil per year (kg)	g SO2 per year	g PM10 per year
Volume 1	123	73	114,471	116,417	48,895	1,164
Volume 2	267	159	249,089	253,324	106,396	2,533
Volume 3	69	41	64,104	65,194	27,381	652
Volume 4	122	73	113,555	115,486	48,504	1,155
Total	390	346	541,220	369,741	231,177	5,504

6.4.2 Northwest Armagh

Table 6.2c Emission rates resulting from coal combustion Northwest Armagh:

	Number of Houses	No houses burning coal	Coal per week (kg)	Coal per year (kg)	g SO2 per year	g PM10 per year
Volume 1	96	36	3,609	187,660	1,876,599	1,876,599
Volume 2	256	96	9,648	501,703	5,017,029	5,017,029
Volume 3	150	56	5,671	294,894	2,948,941	2,948,941
Volume 4	53	20	1,989	103,404	1,034,044	1,034,044
	555	208	20,917	1,087,661	10,876,613	10,876,613

Table 6.2d Emission rates resulting from oil combustion Northwest Armagh

	Number of Houses	No houses burning oil	Oil per year (l)	Oil per year (kg)	g SO2 per year	g PM10 per year
Volume 1	96	54	84,281	85,714	36,000	857
Volume 2	256	144	225,324	229,154	96,245	2,292
Volume 3	150	85	132,442	134,694	56,571	1,347
Volume 4	53	30	46,441	47,230	19,837	472
	555	312	488,488	314,868	208,653	4,968

6.4.3 Central Armagh

Table 6.2e emission rates resulting from coal combustion Central Armagh

	Number of Houses	No houses burning coal	Coal per week (kg)	Coal per year (kg)	g SO2 per year	g PM10 per year
Volume 1	171	58	5,425	282,115	2,821,147	2,821,147
Volume 2	168	57	5,330	277,136	2,771,362	2,771,362
Volume 3	141	48	4,468	232,330	2,323,297	2,323,297
Volume 4	252	86	8,010	416,534	4,165,340	4,165,340
Volume 5	43	15	1,372	71,358	713,584	713,584
	775	265	24,605	1,208,115	12,081,146	12,794,730

Table 6.3f emission rates resulting from oil combustion Central Armagh

	Number of Houses	No houses burning oil	Oil per year (l)	Oil per year (kg)	g SO2 per year	g PM10 per year
Volume 1	171	101	158,654	161,351	67,767	1,614
Volume 2	168	100	155,854	158,503	66,571	1,585
Volume 3	141	83	130,656	132,877	55,808	1,329
Volume 4	252	150	234,248	238,230	100,056	2,382
Volume 5	43	26	40,130	40,812	17,141	408
	775	460	719,541	731,773	307,345	7,318

The assumptions in the modelling exercise are:

- Chimney height 10m.
- Temperature 15 °C.
- Varying emission rates for discrete areas based on the number of properties.
- Surface Roughness 1m
- Time varying Emission factors adjusted to reflect normal fuel use scenarios (burning of fuels for 3 hours in the morning and 6 hours in the evening, assuming burning in winter months not summer months) providing a conservative* estimate.
- Properties with the ability to burn the fuel, will do so.
- Meteorological data from Aldergrove 1999.
- Concentrations calculated to a resolution of 20m

* The use of the term 'conservative' refers to: the result is likely to be a higher emission (i.e. increased SO_2) and therefore erring on the side of caution in our estimates of impacts on concentrations.

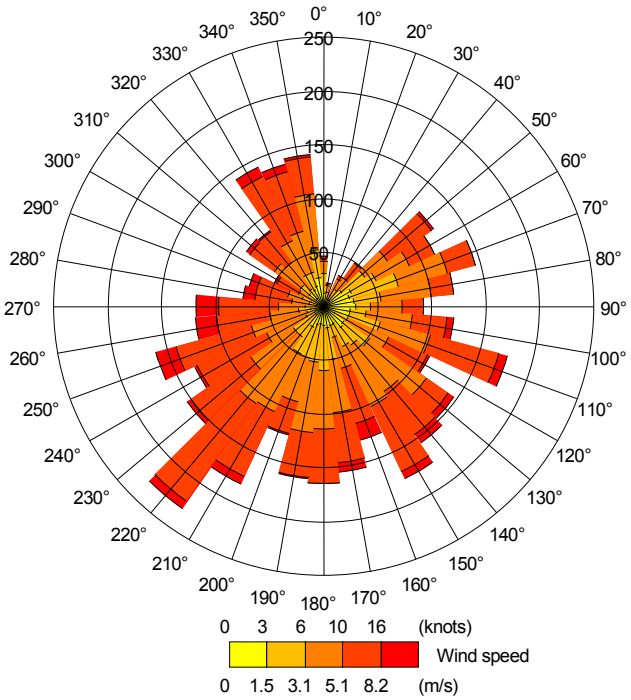
The background concentrations were then added to the modelled concentrations. The background concentrations were estimated for the Armagh City and District Council region from the netcen background concentration maps:

PM_{10} 2004	$16.1 \mu g m^{-3}$
SO_2 2001	$5.5 \mu g m^{-3}$

To make the SO_2 background relevant to the 15 minute mean PSG (LAQM TG (00) recommends that the background for 2005 is doubled. Therefore the background contribution that has been added on to the 15 minute mean SO_2 concentrations is 11 $\mu g/m^3$.

Figure 6 shows the wind rose produced by ADMS from the met data supplied to the model.

Fig 6.1 Wind rose for the Aldergrove 1999 met data



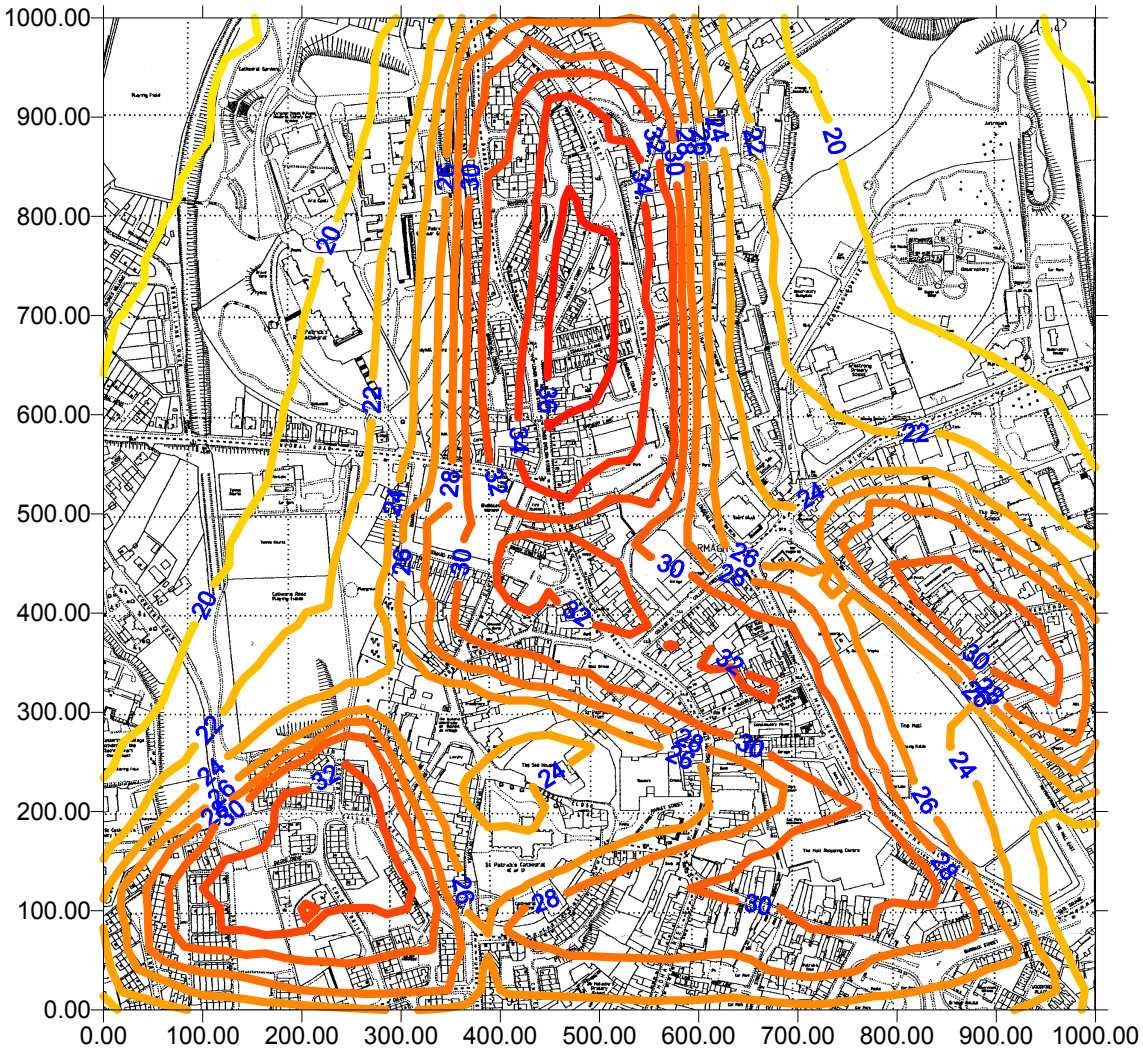
6.4.4 Bias Correction

Bias correction should ideally be made using SO_2 and PM_{10} monitoring data within the modelled coal burning areas. There is PM_{10} monitoring data available for 1999 at Shambles Market, Armagh. There is currently monitoring of SO_2 at Dobbin Street. However, there is not yet a complete dataset available that is suitable for model adjustment; it is anticipated that as soon as a suitable monitoring period of data is available this will be revisited (6 months winter period) and applied for correction/calibration of the model output. This is anticipated to be completed in April 2004.

6.5 MODEL RESULTS

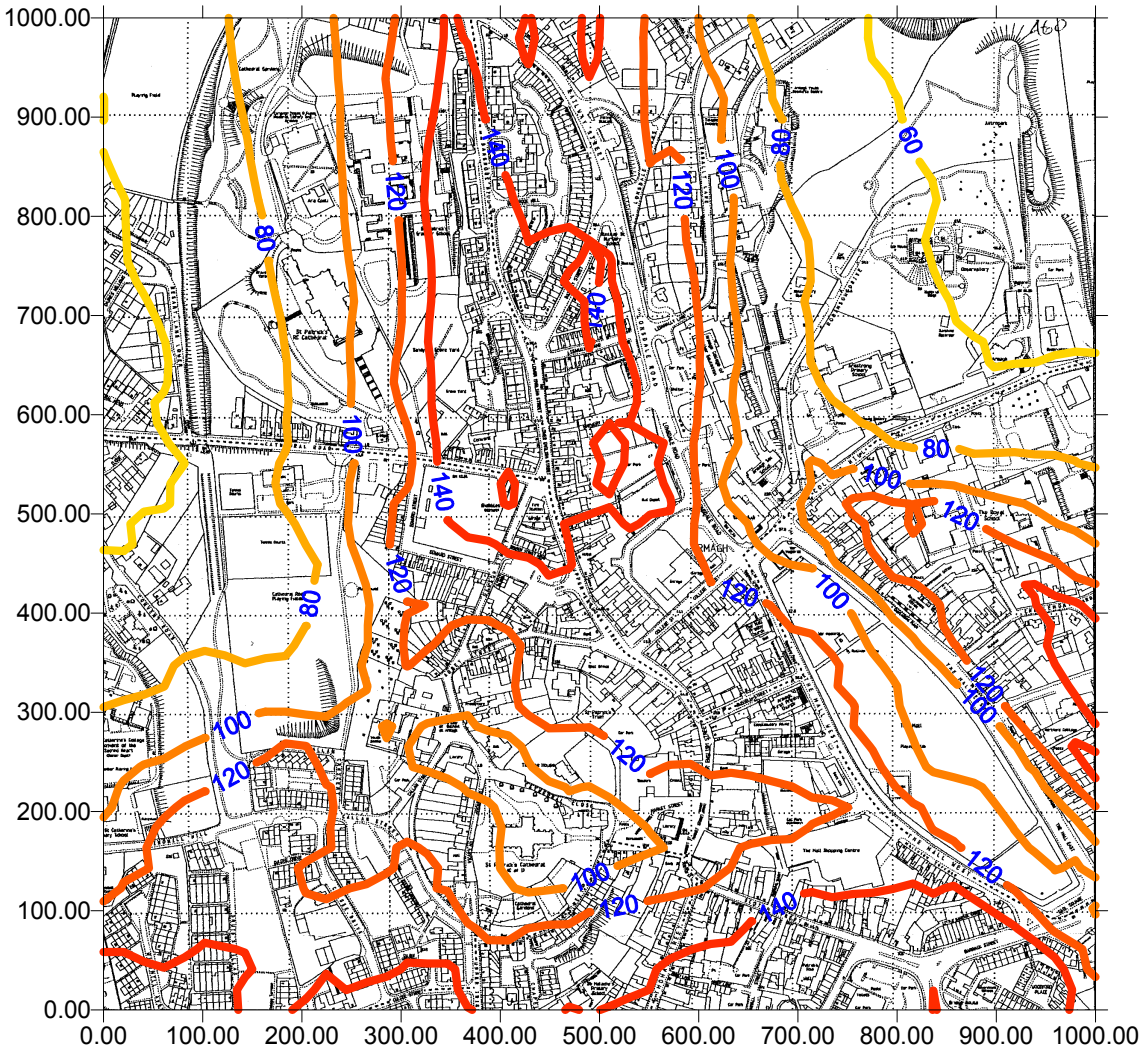
The model results are presented here, although it must be noted that for SO_2 these are in raw form, uncorrected for model bias. There could be a considerable change in the implications of these SO_2 model results once the model bias has been corrected and therefore no judgement should yet be made on the implications of these results. However it can been seen that the spatial distribution is well matched to the areas of higher density fuel combustion. The PM_{10} plots are in their final form.

Figure 6.2a. **Central grid** - PM_{10} Corrected for model bias with monitoring data from Shambles Market in 1999.



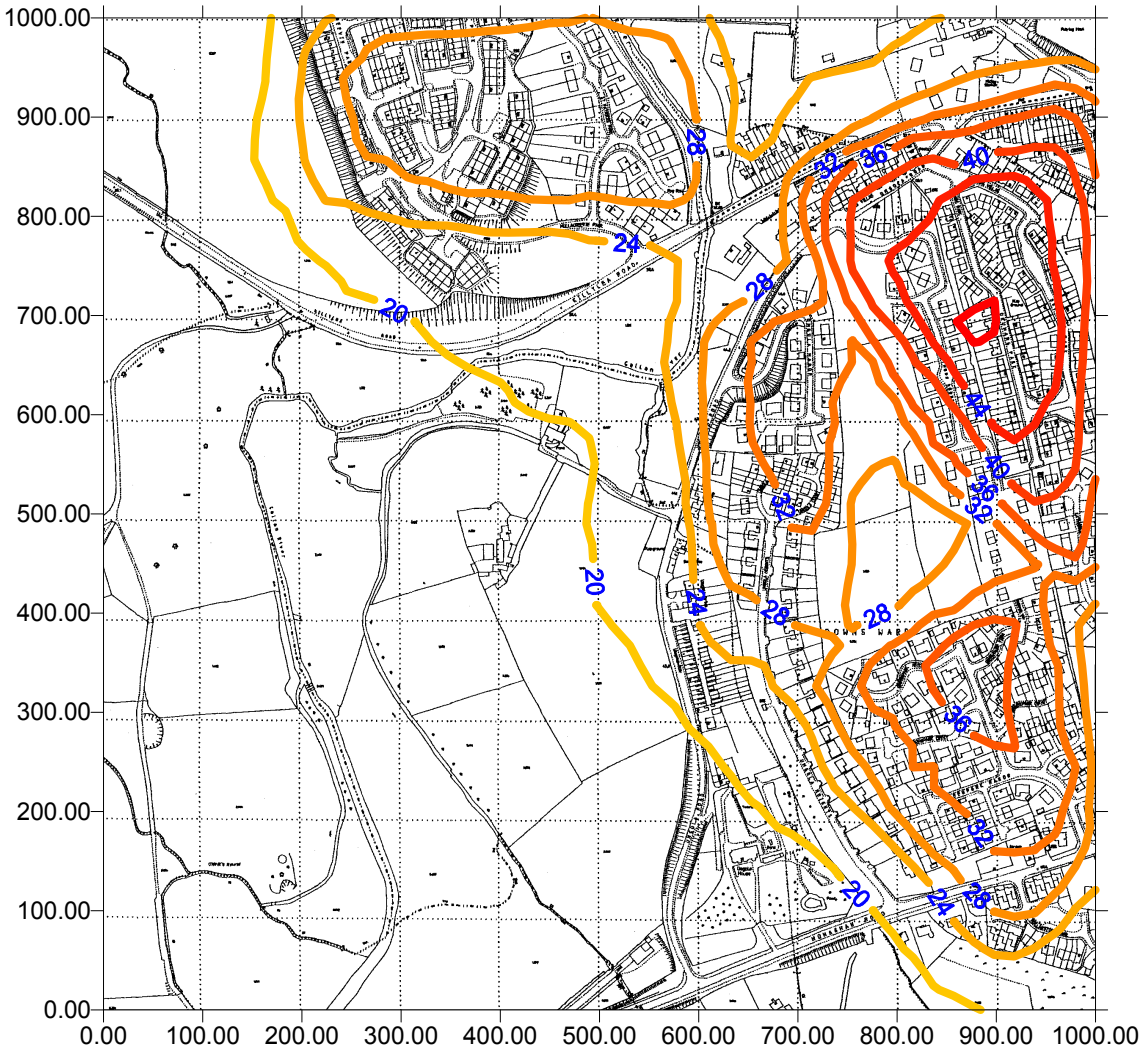
Contour units are in μg m^{-3}

Figure 6.2b. **Central grid** – SO_2 (not corrected for model bias, as a relevant monitoring period dataset is not yet available).



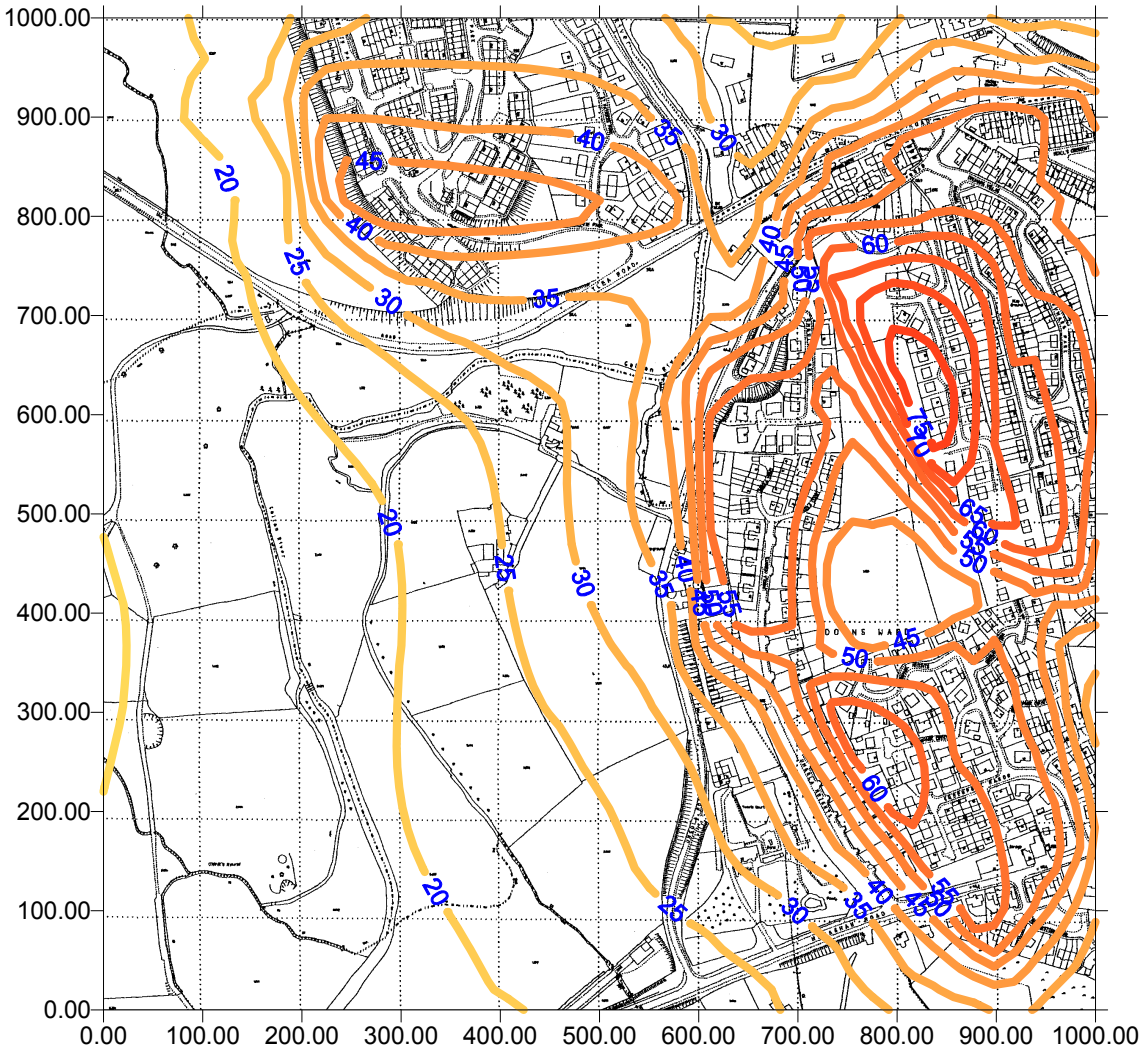
Contour units are in μg m^{-3}

Figure 6.3a. **Southwest grid** - PM_{10} corrected for model bias using the model bias factor from the central grid (the bias factor was determined using monitoring data from Shambles Market in 1999).



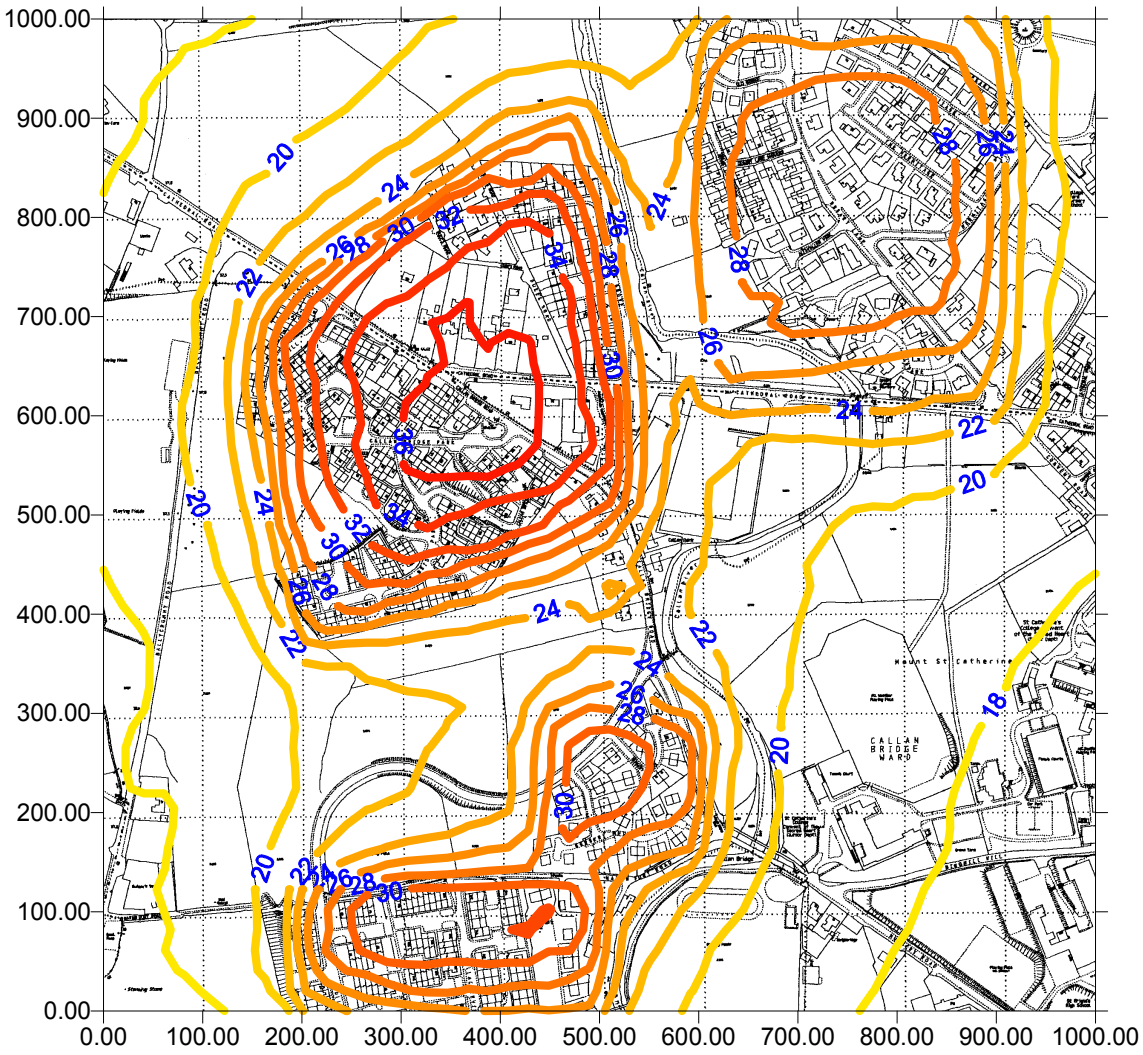
Contour units are in μg m^{-3}

Figure 6.3b. **Southwest grid** - SO_2 (not corrected for model bias, as a relevant monitoring period dataset is not yet available).



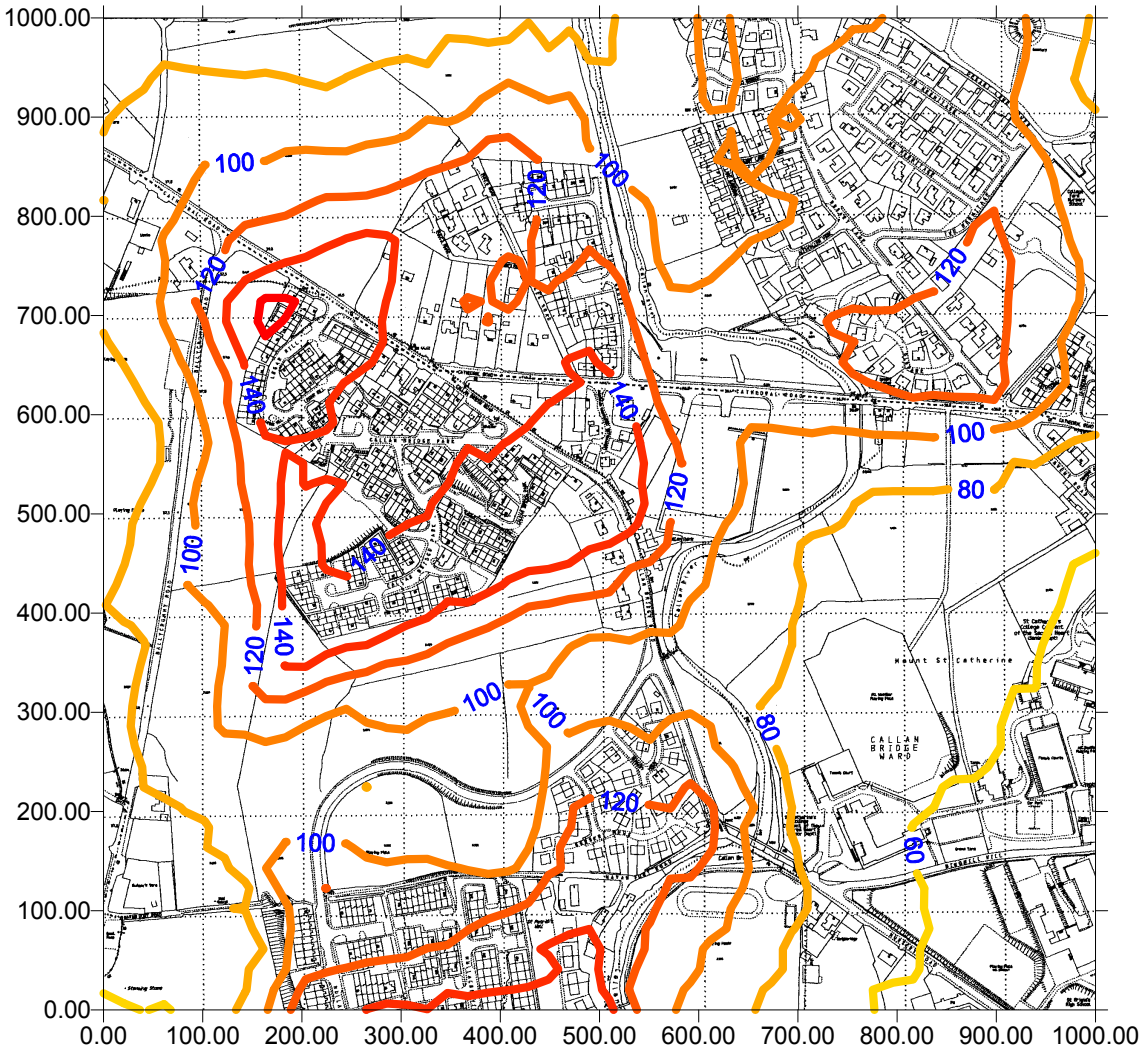
Contour units are in μg m^{-3}

Figure 6.4a. **Northwest grid** - PM_{10} corrected for model bias using the model bias factor from the central grid (the bias factor was determined using monitoring data from Shambles Market in 1999).



Contour units are in μg m^{-3}

Figure 6.4b. **Northwest grid** - SO_2 (not corrected for model bias, as a relevant monitoring period dataset is not yet available).



Contour units are in μg m^{-3}

6.6 DISCUSSION

6.6.1 PM_{10}

It can be seen from figures 6.2a, 6.3a and 6.4a that the concentration contours show clearly the areas of higher and lower PM_{10} concentrations which are well correlated to the areas of higher density housing; in some cases a slight offsetis evident which is most likely due to prevailiong meteorological conditions.
The areas have been modelled so that the contours can be directly compared with the PM_{10} 24 hour mean objective; 50μgm^{-3} with 35 exceedences. Simply this means that when looking at the plots, if there are any contours shows a location with concentration over 50μgm^{-3}, then there is predicted to be an exceedence of the objective.
There are no locations in the modelled areas showing concentrations higher than 50μgm^{-3} indicating that there are no locations predicted to exceed the PM_{10} daily average objective. It can be assumed that as the daily objective will be met the annual mean will also be met.

6.6.2 SO_2

It can be seen from figures 6.2b, 6.3b and 6.4b that the concentration contours show clearly the areas of higher and lower SO_2 concentrations which are well correlated to the areas of higher density housing; in some cases a slight offset is evident which is most likely due to prevailiong meteorological conditions. The contours differ from those in the PM_{10} plots due to the differing averaging period of the objective.
The areas have been modelled so that the contours can be directly compared with the SO_2 15 minute objective; 266μgm^{-3}. Simply this means that when looking at the plots, if there are any contours shows a location with concentration over 266μgm^{-3} there is predicted to be an exceedence of the objective.
The SO_2 model has not yet been corrected for model bias as no monitoring data is available at this time although it is anticipated that when monitoring data from Dobbin Street in Armagh becomes available this will be revisited, this is likely to be in April of 2004. When the model has then been corrected for model bias the conclusion can then be drawn on the likelihood of any exceedence.

6.7 DOMESTIC FUEL COMBUSTION CONCLUSIONS

6.7.1 PM_{10}

Domestic fuel combustion is not predicted to cause an exceedence of the PM_{10} air quality objectives.

6.7.2 SO_2

It cannot yet be determined whether there will be an exceedence of the SO_2 air quality objectives. However this will be quickly determined in April 2004 when the monitoring already underway has provided a complete dataset.

7 Conclusions

7.1 NITROGEN DIOXIDE

Emissions arising from road transport in Armagh City and District Council are not predicted to cause an exceedence of the air quality objective within Armagh.

7.2 SULPHUR DIOXIDE

It is not yet possible to conclude whether emissions arising from domestic fuel combustion in Armagh City and District Council are likely to cause an exceedence of the air quality objective within Armagh as the modelling results have yet to be corrected using local monitoring data. This data is anticipated to be available in March and therefore the model results will be revisited in April.

7.3 PM_{10}

Emissions arising from road transport and domestic fuel combustion in Armagh City and District Council are not predicted to cause an exceedence of the air quality objective within Armagh.

Appendices

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Appendix 1

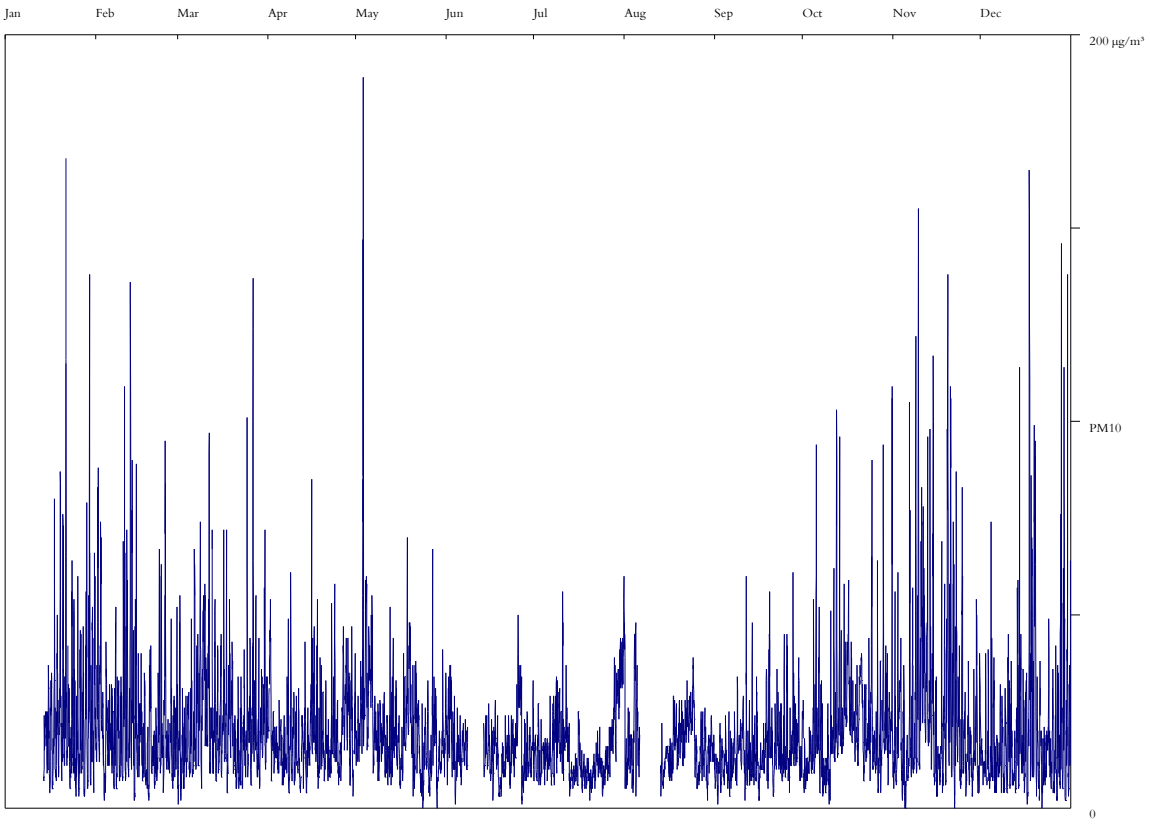
CONTENTS

ARMAGH PM_{10} January to December 1999
These data have been fully ratified by netcen

POLLUTANT	PM_{10} (TEOM data)
Number Very High	0
Number High	0
Number Moderate	37
Number Low	8054
Maximum 15-minute mean	189 µg m^{-3}
Maximum hourly mean	189 µg m^{-3}
Maximum running 8-hour mean	105 µg m^{-3}
Maximum running 24-hour mean	61 µg m^{-3}
90%ile of daily means	30 µg m^{-3}
Maximum daily mean	49 µg m^{-3}
Average	19 µg m^{-3}
Data capture	92.4 %

All mass units are at 20'C and 1013mb. Exceedence data below has been corrected to gravimetric using a default factor of 1.3.

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
PM_{10} Particulate Matter (Gravimetric)	Daily mean > 50 µg m^{-3}	10	10
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 40 µg m^{-3}	0	-
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 20 µg m^{-3}	1	-



Armagh PM10 Air Monitoring Hourly Mean Data for January to December 1999

NO_2 Diffusion Tube Data

Lab	Harwell[1]	Harwell[1]	Harwell[1]	Harwell[1]	Harwell[1]	Harwell[1]	Lambeth[2]	Lambeth[2]	Lambeth[2]	Lambeth[2]	Lambeth[2]	Lambeth[2]
	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02
1	46.3	45.4	35.1	30.7	25.6	31.4	28	18	29	48	20	47
2	40.8	36.6	40	43.7	36.7	39.5	20	11	36	46	44	50
3		14.4	15.4	14.8	12	12.4	16	15	13	33	7	23
4	16.6	18.7	17.9	17.2	13.7	14.6	28	18		21	13	29
5	38.4	20	21.6	19.4	15.6	18.3	11	14	23	24	17	32
6	26.1	38.1	37.2	41.6	37.1	39.9	19	34	8	36	23	45
7	37.5	34.3	34.4	30.7	24.2	34.4	27	28	32	44	33	31
8	26.5	31.5	30.5	31.8	30.9	33	27	27	38		11	6

[1] Harwell Scientifics Ltd
[2] Lambeth Scientific Services

Appendix 2

CONTENTS

Link	Distance (m) from Link to Receptor	AADT	Average Speed (km/h)	Road Type	Total HDV %	Background Concentration						Total Concentrations						
						CO mg/m3	Benzene $\mu g/m^3$	1,3-butadiene $\mu g/m^3$	NOx $\mu g/m^3$	NO2 $\mu g/m^3$	PM10 $\mu g/m^3$	CO mg/m^3	Benzene $\mu g/m^3$	1,3-butadiene $\mu g/m^3$	NOx $\mu g/m^3$	2005 NO2 $\mu g/m^3$	2004 PM10 $\mu g/m^3$	No. Of PM10 Exceedences 2004
Portadown Rd	8.75	20952	24	A	10	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.4	73.1	**25.0**	**23.3**	9
Drumadd Rd	10.00	19992	24	A	12	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.4	78.5	**25.9**	**23.8**	10
Victoria St	7.50	19992	24	A	12	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.5	82.6	**26.6**	**24.4**	11
Barrack St	7.50	19992	24	A	12	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.5	82.6	**26.6**	**24.4**	11
Railway St	10.00	19992	24	A	12	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.4	78.5	**25.9**	**23.8**	10
Lonsdale Rd	12.55	19992	24	A	11	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.4	70.2	**24.4**	**22.8**	8
Mall West	8.75	19992	24	A	8.5	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.4	65.5	**23.6**	**22.4**	7
Irish St	8.75	20952	24	A	10.6	0.2	0.3	0.1	14.0	11.0	15.4	0.4	0.5	0.5	75.7	**25.4**	**23.6**	9