Report

Air Quality Review and Assessment

Stage 2 Road Traffic & Stage 3 Domestic Fuel Combustion

A report for Lisburn City 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 Environment (NI) 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 provides a framework for air quality control through air quality management and air quality objectives.

Under the Air Quality Strategy all Local Authorities are 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 designed to help relevant authorities with their Local Air Quality Management (LAQM) duties under Part III of the Environment (NI) Order 2002. 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.

This report forms the completion of the Stage 2/3 Air Quality Review for traffic and domestic emissions sources within Lisburn City Council. This report investigates current and potential future PM_{10} and NO_2 from road traffic, and PM_{10} and SO_2 levels due to domestic fuel combustion emissions in two grids (North grid: 7.5km^2 and South grid: 15 km^2 at 35m resolution). This assessment has been undertaken by means of modelling and monitoring.

Concentrations arising from domestic fuel combustion have been assessed using **netcen**'s DISP model. Ambient air quality data was obtained from three automatic monitoring stations located in Lisburn: Dunmurry High School (Suburban – PM_{10}), Island Civic Centre (Suburban – SO_2 and PM_{10}), and Lagan Valley Hospital (Roadside – PM_{10} and NO_2).

The conclusions of the report are:

Particulate Matter (PM_{10} gravimetric)

Road traffic modelling using DMRB has not predicted any exceedance of the objectives at relevant locations. Detailed domestic fuel combustion modelling has shown that PM_{10} emissions arising from domestic fuel combustion in Lisburn City Council are not predicted to cause an exceedence of the PM_{10} objectives at relevant receptors within the assessed areas.

Therefore further assessment or designation of an Air Quality Management Area is not necessary for PM_{10}.

Sulphur dioxide (SO_2)

Detailed domestic fuel combustion modelling has shown that SO_2 emissions arising from domestic fuel combustion in Lisburn City Council are not predicted to cause an exceedence of the air quality objectives at relevant receptors within the assessed areas.

Therefore further assessment or designation of an Air Quality Management Area is not necessary for SO_2.

Nitrogen dioxide (NO_2)

Modelling using DMRB has not predicted any exceedance of the objectives at relevant locations.

Therefore further assessment or designation of an Air Quality Management Area is not necessary for NO_2.

Maps reproduced within this document

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

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Under the Air Quality Strategy all Local Authorities are 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.

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1.1 PURPOSE OF THE STUDY

netcen was commissioned to complete a Stage 2/3 review and assessment of for Lisburn City Council, covering road traffic and domestic fuel combustion.

The assessment investigates whether emissions from these sources are likely to contribute to exceedences of the UK Air Quality Objectives for PM_{10}, NO_2 and SO_2. This study:

- Assesses the air quality in 2004 and 2005 (NO_2 and PM_{10}) in Lisburn CC due to Road traffic
- Assesses the air quality in 2004 and 2005 (PM_{10} and SO_2) in Lisburn CC due to domestic fuel combustion
- Identifies any actions that are likely to be required by Lisburn CC under the Environment (NI) Order 2002.

1.2 GENERAL APPROACH TAKEN

The general approach taken in this Stage 2/3 Assessment has been to:

- Collate Road traffic and fuel use survey data for Lisburn CC;
- Assess traffic source using the 'DMRB' model;
- Analyse domestic emission inventory information for surveyed properties;
- Compile an emission inventory for the whole area;
- Use monitoring data to assess the ambient concentrations in the area and, where appropriate, verify the output of the modelling studies;
- Model the concentrations of PM_{10} and SO_2 in the selected domestic fuel combustion areas 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 throughout this report are presented in $\mu g\ m^{-3}$ 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 is the completion of the Stage 3 review and assessment for domestic fuel combustion for Lisburn City 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 contains details of the information used to conduct this review and assessment for Lisburn City Council.

Chapter 4 gives a description of the three pollutants assessed in this report (NO_2, PM_{10} and SO_2).

Chapter 5 describes the Stage 2 Assessment on Road Traffic including the results of the modelling.

Chapter 6 describes the Stage 3 Assessment on domestic fuel combustion including the results of the modelling

Chapter 7 summarises the finding of this report.

Chapter 8 concludes the finding of this report and makes recommendations.

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 First Air Quality Daughter Directive (AQDD), the UK government published its proposals for review of the National Air Quality Strategy. Subsequent to this review, the Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in January 2000.

The Environment (NI) Order 2002 came into operation in January 2003 and implements both the European Air Framework Directive 96/62/EC, Daughter Directives and the UK Air Quality Strategy.

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

Table 2.1 Environment (NI) Order 2002 Key Guidance:

- The statutory background and the legislative framework within which relevant authorities have to work
- The 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 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 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.

The UK Government intention is that the AQS provides 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 encouraged within the context of existing and potential future international policy commitments.

2.2.1 Air Quality Strategy

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).

Table 2.2. 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	31.12.2004
	0.25 μgm^{-3}	Annual mean	31.12.2008
Nitrogen Dioxide[1]	200 μgm^{-3} not 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 (2005)
3. Measured using the European Gravimetric reference 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 four EU ambient air quality directives that the UK has transposed into 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).

- **2002/03/EC** Directive of the European Parliament and the Council of 12 Feb 2002 relating to ozone in ambient air (the third Daughter Directive).

The first, second and third daughter directives contain air quality Limit Values for the pollutants that are listed in the framework directive. The United Kingdom must comply as a minimum with these Limit Values. The UK Air Quality Strategy must comply with the limit values set out in the EU Air Quality Daughter Directives but the UK Air Quality Strategy also includes stricter objectives for some pollutants, for example, sulphur dioxide.

The UK 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 the relevant 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 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 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 station emissions will result in ambient concentrations that meet the air quality standards set out in the AQS.

Northern Ireland now has in place the Air Quality Regulation (NI) 2002. The Government has recognised the problems associated with achieving the AQS 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. For this reason Ozone is specifically excluded from the LAQM regime.

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.

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 area. 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

Objectives are to be met within the timescales shown in Table 2.2. Note: the objectives for NO_2 remain provisional.

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 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 these guidance.

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 Councils in Northern Ireland are engaged in the 3 staged approach to review and assessment as set out in the original technical guidance. The Stages are briefly described in Table 2.3. The latest technical guidance LAQM.TG(03) is based on a revised '2 step' approach. The revised steps are briefly described in Table 2.4. 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 department recommends that councils should use the latest technical guidance LAQM.TG(03) to complete their first rounds of review and assessment. Where 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.

The latest technical guidance LAQM.TG (03) has been used as the guidance document for both the road emissions and domestic fuel combustion modelling methodology.

Table 2.3 Brief details of Stages in the Air Quality Review and Assessment process (LAQM.TG4(00))

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 (LAQM.TG(03))

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 changes 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 on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 2.5 summarises the locations where the objectives should and should not apply.

Table 2.5 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 2.5 (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, locations should represent non-occupational exposure.

AQS Key Points

- The Environment (NI) 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 detail necessary depends on the likelihood of achieving the objectives

3 Information and tools used to support this assessment

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

3.1 DATA SOURCES

Lisburn CC provided the information necessary for domestic fuel combustion modelling. The following data was provided:

- Fuel Use Survey 2002 (including type of fuel, consumption, XY variables etc.),
- Average cost of different fuel types from local suppliers,
- GIS shape files with and
- COMPASS data file for Lisburn CC which contains information for all the houses across the City.

For traffic assessment the following was provided:

- Traffic counts
- HGV counts

3.2 EMISSION FACTORS

Emissions factors for household emissions where obtained from the NAEI website (www.naei.org.uk). Vehicle emissions factors have recently been revised by defra[1]. The most recent emission factors have been used in this report.

3.3 BACKGROUND AIR QUALITY DATA

Background concentration of oxides of nitrogen (NO_x), nitrogen dioxide (NO_2), particulates (PM_{10}) and sulphur dioxide (SO_2) have been taken from the Local Air Quality Management section in the UK Air Quality Archive (http://www.airquality.co.uk/archive/laqm/laqm.php) and scaled to the year of interest where necessary following the recommended procedure in LAQM. TG(03).

3.4 LOCAL AIR QUALITY MONITORING DATA

3.4.1 Extent of data available

Lisburn City Council has carried out automatic air quality monitoring at 3 locations:

- Island Civic Centre – Since march 2003, suburban background 327202, 364336
  - PM_{10}, SO_2
- Lagan valley Hospital – Since March 2003, roadside
  - PM_{10}, NO_2
- Dunmurry High School – Since October 2003, suburban background 328595, 367325
  - PM_{10}

The instrumentation employed uses UV fluorescence for the measurement of SO_2, the TEOM technique for PM_{10}, and chemiluminescence for the measurement of NO_2 these methods are appropriate for Stage 3 Assessment under LAQM (LAQM TG(03)). All TEOM data are quoted as

[1] The new set of emission factors on the NAEI website (www.naei.org.uk/emissions/index.php) approved by DEFRA and DTLR for use in emissions and air quality modelling. This is based on review and assessment of new factors for Euro I and II vehicles given in TRL Database of Emission Factors, September 2001 (Barlow, Hickman and Boulter) and reconsideration of scaling factors for Euro III, IV vehicles by netcen

gravimetric equivalent in accordance with the guidance. Appendix 1 provides more details about the local air quality monitoring programme.

These data are managed by **netcen** and used in the verification and adjustment of the modelled output. **netcen** has undertaken a review of the data comparing the trends of the pollutants to other nearby National Network monitoring stations. The Lisburn datasets follows the same temporal variation as seen at the AURN station at Belfast Centre, Belfast East, Derry and Lough Navar providing confidence in the dataset.

3.5 MAPS

Lisburn City Council provided Ordnance Survey maps for the council in the form of GIS shape file tiles.

3.6 MET DATA USED IN THE DISPERSION MODELLING

Hourly sequential data was obtained for 2003 for the Aldergrove site for input into the dispersion model. This Met station is located approximately 19km from Lisburn (see figure 3.1). Further details are given in Appendix 2.

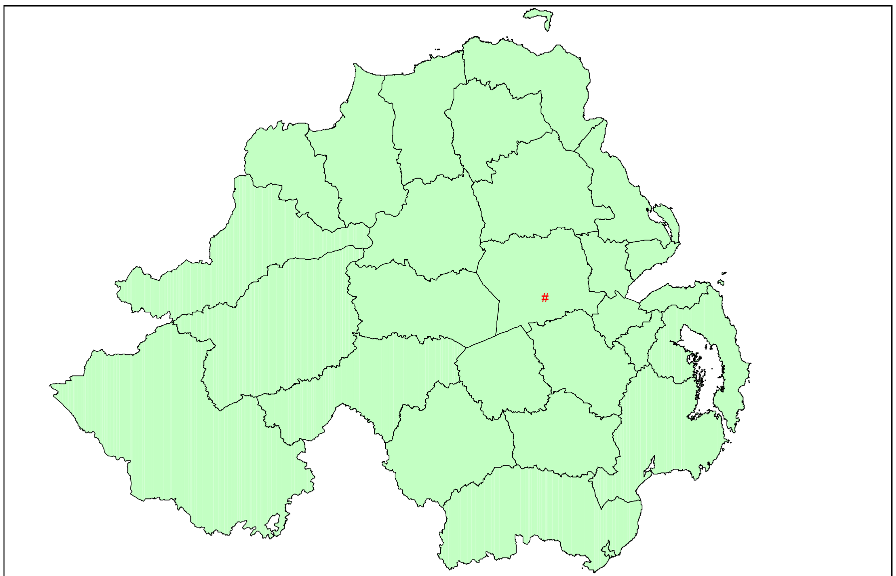

Figure 3.1 Location of Aldergrove Meteorological Station

3.7 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.

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 35 m intervals across the grids. This high spatial resolution is recommended in Technical Guidance LAQM.TG(03). The model has been run for the relevant objective years. Existing monitoring data has been used to verify and adjust the model result if necessary. 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. It has been specially developed for Review and Assessments by **netcen**. The model uses ADMS-3.1 to provide dispersion kernels over a grid.

3.7.1 Model verification and adjustment

The two monitoring sites in Lisburn, Island Civic Centre and Dunmurry High School, have been used as a reference to verify the model results. The monitoring data has been ratified by **netcen**. Lagan Valley Hospital roadside PM_{10} monitoring site has not been considered for model verification as it is a roadside location not relevant to the domestic fuel combustion area.

The purpose of model verification and subsequent adjustment is, as specified in technical guidance, to ensure that the modelled concentrations reflect the monitored concentrations. Further details of model verification and adjustments are given in Appendix 3.

3.7.2 Model uncertainties

The modelling approach has not taken account of:

- 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

The above 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 is a sample survey. It is assumed that the fuel use survey is representative and will remain representative of the fuel use at the time of the objectives. As we are assuming the fuel use profile will remain the same there is no need to correct the fuel use survey to the year of the objective. Predicted future background concentrations have been calculated and applied.

The dispersion modelling is based upon the meteorology and emissions for 2003, clearly meteorological conditions will vary from year to year but overall would be expected to be broadly representative of local conditions for the year of the objectives.

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

3.7.3 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 Pye and Vincent (2003).

3.7.3.1 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 3.2. The daily mean objective is likely to be exceeded more than 35 times when PM_{10} annual mean is above 30 μgm^{-3}.

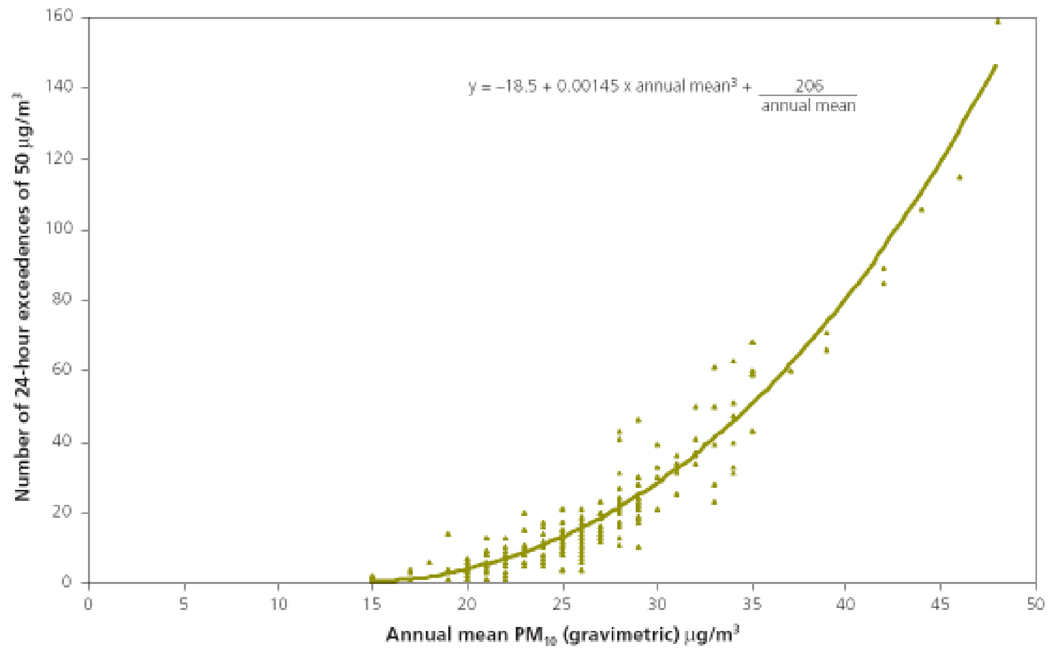

Figure 3.2 Relationship between the number of 24-hour exceedences of 50 μgm^{-3} and the annual mean concentration (derived from UK Automatic Network Sites 1997-2001) (*from LAQM.TG(03)*)

3.7.3.2 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 3.1 shows the regression equations that will be applied to a map of annual mean concentrations to produce the respective map of short-term mean sulphur dioxide concentrations.

Table 3.1: 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

4 Pollutants Assessed

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

4.1 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.

4.1.1 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.

4.1.2 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) 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 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.

4.2 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.

4.2.1 Objectives for sulphur dioxide

The Air Quality Strategy Objectives to be achieved are:

- 266 $\mu g\ m^{-3}$ 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 $\mu g\ m^{-3}$ 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 $\mu g\ m^{-3}$ 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.

4.2.2 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 accounted 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.

4.3 NO_2

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.

4.3.1 Objectives for nitrogen dioxide

The Air Quality Strategy objectives to be achieved by 31^{st} December 2005 are:

- An annual average concentration of 40 $\mu g\ m^{-3}$;
- 200 $\mu g\ m^{-3}$ as an hourly average with a maximum of 18 exceedences in a year.

4.3.2 The National Perspective

The National Air Quality Strategy was reviewed in 1999 (DETR, 1999). The Government proposed that the annual objective of 40 $\mu g\ m^{-3}$ be retained as a provisional objective and that the original hourly average be replaced with the AQDD objective. The revised Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DETR, 1999; 2000) included the proposed changes.

The new hourly objective is slightly more stringent than the original hourly objective. Modelling studies suggest that in general achieving the annual mean of 40 $\mu g\ m^{-3}$ is more demanding than achieving either the former or current hourly objective. If the annual mean is achieved, the modelling suggests the hourly objective will also be achieved.

The main source of NO_x in the United Kingdom is road transport, which, in 2000 accounted for approximately 42% of emissions. Power generation contributed approximately 29% and domestic sources 5%. In urban areas, the proportion of local emissions due to road transport sources is larger (NAEI, 2000).

National measures are expected to produce reductions in NO_x emissions and achieve the objectives for NO_2 in many parts of the country. However, the results of the analysis set out in the National 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 a detailed assessment for this pollutant.

5 Review and Assessment of NO_2 and PM_{10} from Road Traffic

5.1 ROAD TRAFFIC MODELLING ASSESSMENT

The concentrations of NO_2 and PM_{10} close to busy roads, junctions, narrow congested streets and busy streets where people may spend an hour or more in the district have been assessed using the DMRB model (The Design Manual for Roads and Bridges model). This model has been updated since the first round of review and assessment in the UK and therefore we have used the most up to date version. This includes a revised set of vehicle emission factors, improved roadside dispersion curves and a new relationship to estimate NO_2 from NO_X.

DMRB has been used to assess NO_2 and PM_{10} concentrations at 8 locations in the district:

A	Rural A road
B	A1, Location 1
C	M1/Slip road junction
D	Motorway slip road
E	Lagan V Hospital
F	A1, Location 2
G	A1/A3 Junction
H	A1/A49 Junction

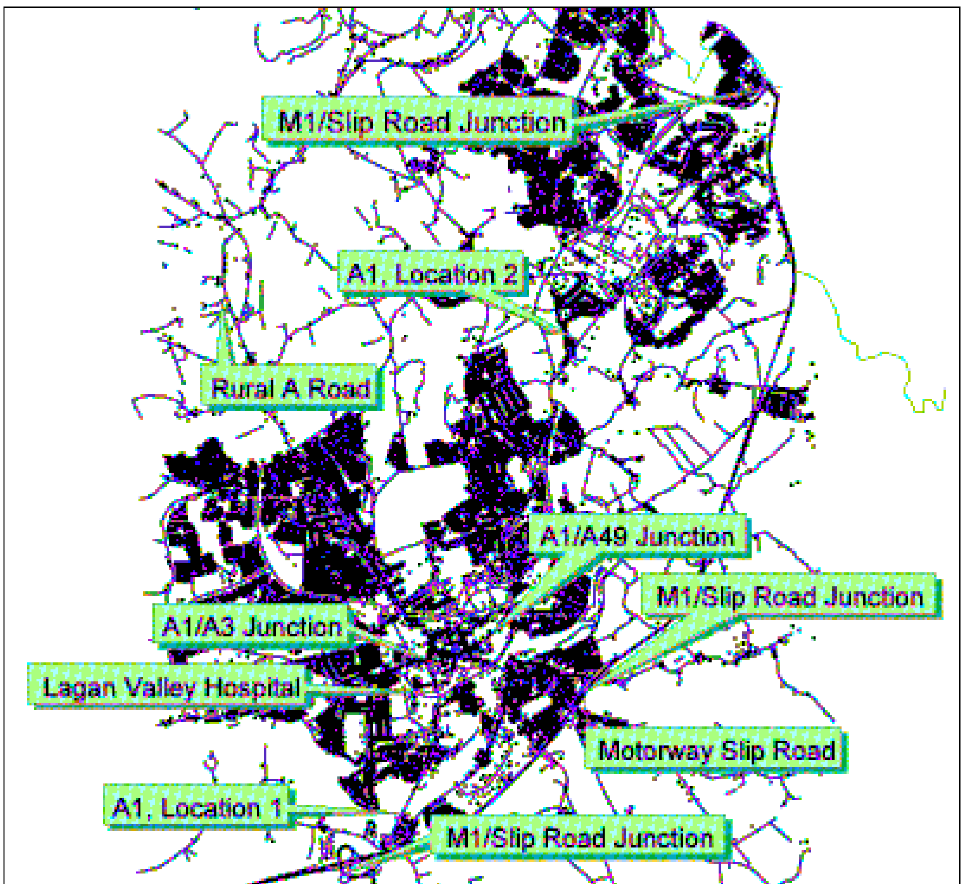

Figure 5.1 Locations assessed with DMRB

The Air Quality Objectives for nitrogen dioxide (NO_2) are an annual mean of 40 $\mu g/m^3$ to be achieved by the end of 2005 and an hourly mean of 200 $\mu g/m^3$ not to be exceeded more than 18 times a year. The annual objective is the more stringent of the two objectives. Therefore if the annual mean is predicted to be met, then it is likely that so too will the hourly objective.

The Air Quality Objectives for PM_{10} are an annual mean of 40 $\mu g/m^3$ to be achieved by the end of 2004 and a daily mean of 50 $\mu g/m^3$ not to be exceeded more than 35 times a year. The daily objective is the more stringent of the two objectives. Therefore if the daily mean is predicted to be met, then it is likely that so too will the annual objective.

Annual mean NO_2 and PM_{10} concentrations have been predicted using a minimal distance as a screening distance at each road junction. Two metres is the minimum distance that DMRB can predict to and will show the highest concentrations to be contributed by traffic. Therefore if no exceedance is produced by a traffic profile at 2 metres then an exceedance will not be seen at the nearby receptors. Figures for the proportion of heavy-duty vehicles on have been taken from the NAEI and provided by Lisburn City Council. Conservative traffic speeds have been used to represent a worst-case scenario. Estimated background concentrations have been taken from the NAEI website (www.naei.org.uk). This is as recommended in the Technical Guidance (TG (03)). Table 5.1 below shows the results of the updated DMRB model run.

Table 5.1: Estimated annual mean NO_2 and PM_{10} concentrations at the nearest relevant receptors in 2004 & 2005 ($\mu g/m^3$)

Receptor	*Road name*	*Distance from link centre to receptor (m)*	*AADT (veh/ day)*	*Annual average speed (km/h)*	*Total % HDV*	*NO2 2005*	*PM10 2004*	*Number of PM10 2004 exceedences*
A	Rural A road	2	9188	30	10	28.91	27.04	18
B	A1, Location 1	2	10300	30	8	28.37	26.84	17
C	Mway slip	5	12713	50	10	36.81	30.96	31
	M1	15	28910	70	10			
D	Mway slip	5	12713	50	10	29.41	26.79	17
E	Lagan V Hosp	10	9581	30	10	28.16	26.58	16
F	A1, Location 2	2	9581	30	8	28.18	26.70	17
G	A1	2	9581	30	8	33.45	30.20	28
	A3	2	8000	30	10			
H	A1	2	9581	30	8	33.45	30.20	28
	A49	2	8000	30	10			

Further Details are given in table Appendix 4

The DMRB modelling results show that there is no predicted exceedence of either the NO_2 or PM_{10} objectives.

5.2 NITROGEN DIOXIDE AUTOMATIC MONITORING

Nitrogen dioxide concentrations have been measured by chemiluminescence at Lagan Valley Hospital since March 2003 (see appendix 1). **netcen** has undertaken quality control of the station dataset since November 2003. The dataset between November 2003 to April 2004 exhibits consistency high and unstable NO_x zero baseline throughout the period. For this reason, a service engineer visited the station in April 2004 and eventually resolved the issue. The dataset prior to April 2004 is of uncertain quality and it is not representative of what might be expected of the location considering distance from Kerb, traffic count and % HGV. For these reasons, the data has not been used for assessing NO_2 levels. Since the service engineers visit, data quality has improved and as such will be available for future Review and Assessment.

5.3 NITROGEN DIOXIDE DIFFUSION TUBE RESULTS

Nitrogen dioxide concentrations have been measured by diffusion tubes at 8 receptor locations. The diffusion tubes have been analysed by Ruddock & Sherratt. The concentrations recorded between January and December 2003 are presented in Table 5.2 below. Unfortunately there is no local bias correction available as there is no co-location with a continuous monitor in Lisburn[2]. Co-location studies for the laboratory are limited. However a conservative bias adjustment factor of 1.035 has been applied as suggested by experts within netcen's ambient monitoring team, based on a quarterly triplicate exposure co-location study at Wigan Leigh. The bias corrected results have then been predicted forward to 2005 using factors provided in the Technical Guidance (TG (03)).

Table 5.2: Nitrogen dioxide concentrations as recorded by diffusion tubes between January and December 2003 ($\mu g/m^3$)

ID	Location	Uncorrected Tubes	Corrected results 2003	Corrected results 2005
1	Northern bank	25.8	26.7	25.3
2	Antrim rd	19.3	20.0	18.9
3	Ventnor pk	11.5	11.9	11.3
4	Edgewater	12.8	13.3	12.6
5	Moira	27.1	28.1	26.6
6	Kingsway	23.0	23.8	22.6
7	Lagan valley hospital	16.6	17.1	16.3
8	Beechlawn	19.7	20.4	19.4

5.4 ROAD TRAFFIC ASSESSMENT RESULTS

Both the results of the diffusion tube survey and the DMRB model runs show that it is unlikely that the either the PM_{10} or NO_2 objectives will be exceeded in Lisburn at relevant receptor locations. Comparatively the DMRB results are predicting higher concentrations than the diffusion tube monitoring data, for example at the Lagan Valley hospital site. Therefore it is recommended that the diffusion tubes now co-located in triplicate with the continuous monitor be used at the progress report stage (when sufficient data has been collected) to calculate a local diffusion tube bias adjustment factor. The data can then be reconsidered then.

There have been no predicted exceedances of the objectives for PM_{10} or NO_2 in the relevant years and therefore no further assessment is required at this time.

[2] Triplicate co-location has been ongoing at the Lagan Valley Hospital monitoring station site since beginning of april 2004. However, this has not been used due as it does not cover the same sampling period as the reported diffusion tube results.

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

6.1 DOMESTIC FUEL COMBUSTION

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 the guidance, "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 the guidance recommends an authority proceed to a second or third stage review and assessment.

6.2 LISBURN CITY COUNCIL FUEL USE SURVEY

Lisburn City Council undertook a fuel use survey in 2002. This consisted of 1272 interviews across residents in Lisburn. As can be seen in table 6.1, more than ½ of the households use oil as their main fuel. The remainder use gas, electricity and solid fuels as their primary source of energy. Solid fuel is predominantly Smokeless Solid Fuel (SSF).

Table 6.1 Main fuel type across Lisburn CC

	Number Households	% of Properties
Oil	738	58
Gas	102	8
Electricity	127	10
Solid Fuel (non SSF)	127	10
Solid Fuel (SSF)	178	14
Total	1272	100

6.2.1 Modelled area

There are two areas in Lisburn identified as locations that could potentially exceed the objectives. An overview of the two areas modelled is shown in Figure 6.1. The North grid is 7.5km^2 (Figure 6.2) and the South Grid is 127.5km^2 (Figure 6.3). These are large areas but a high resolution is maintained.

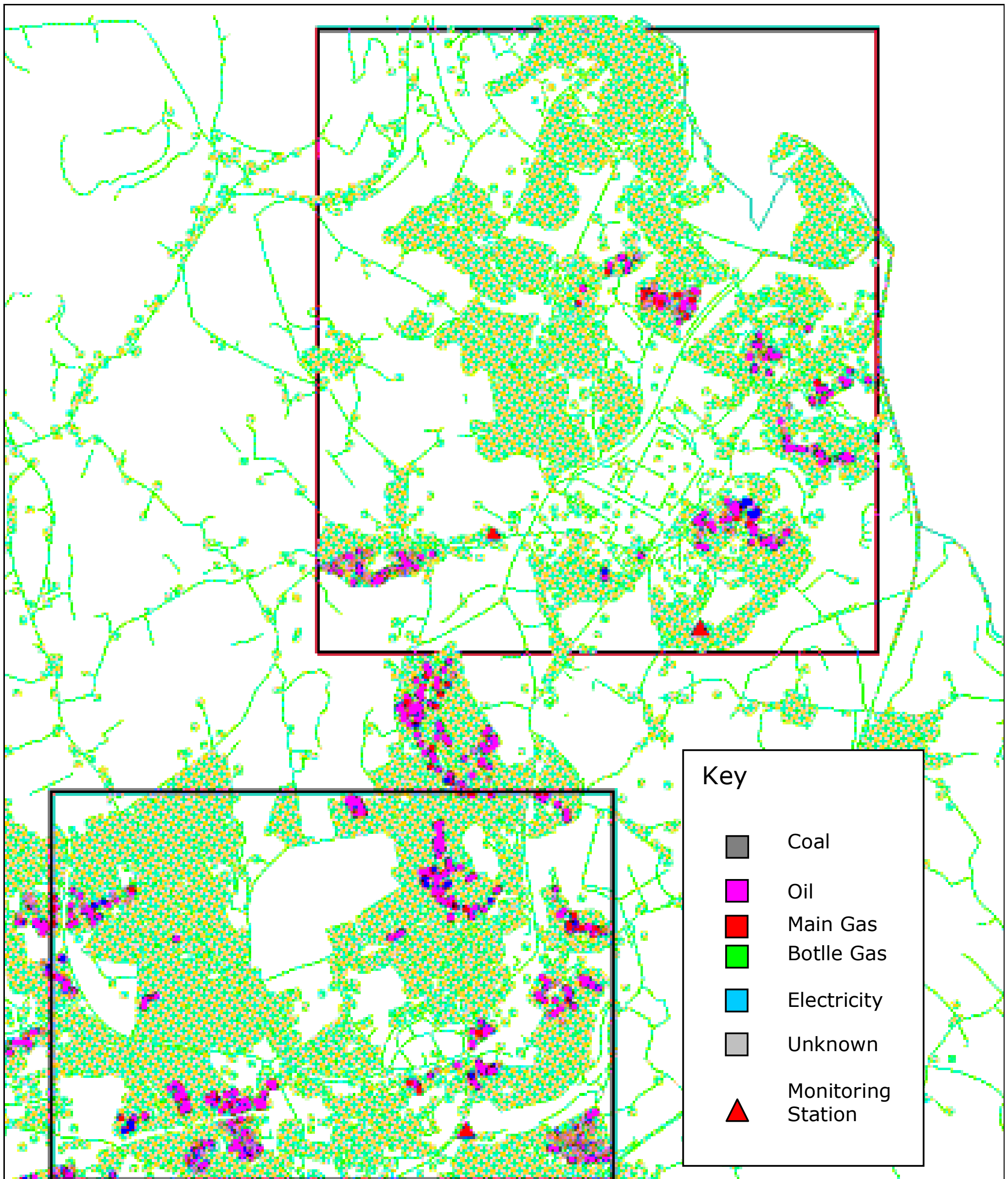

Figure 6.1 Overview of the modelled areas in Lisburn, and Fuel Use survey data

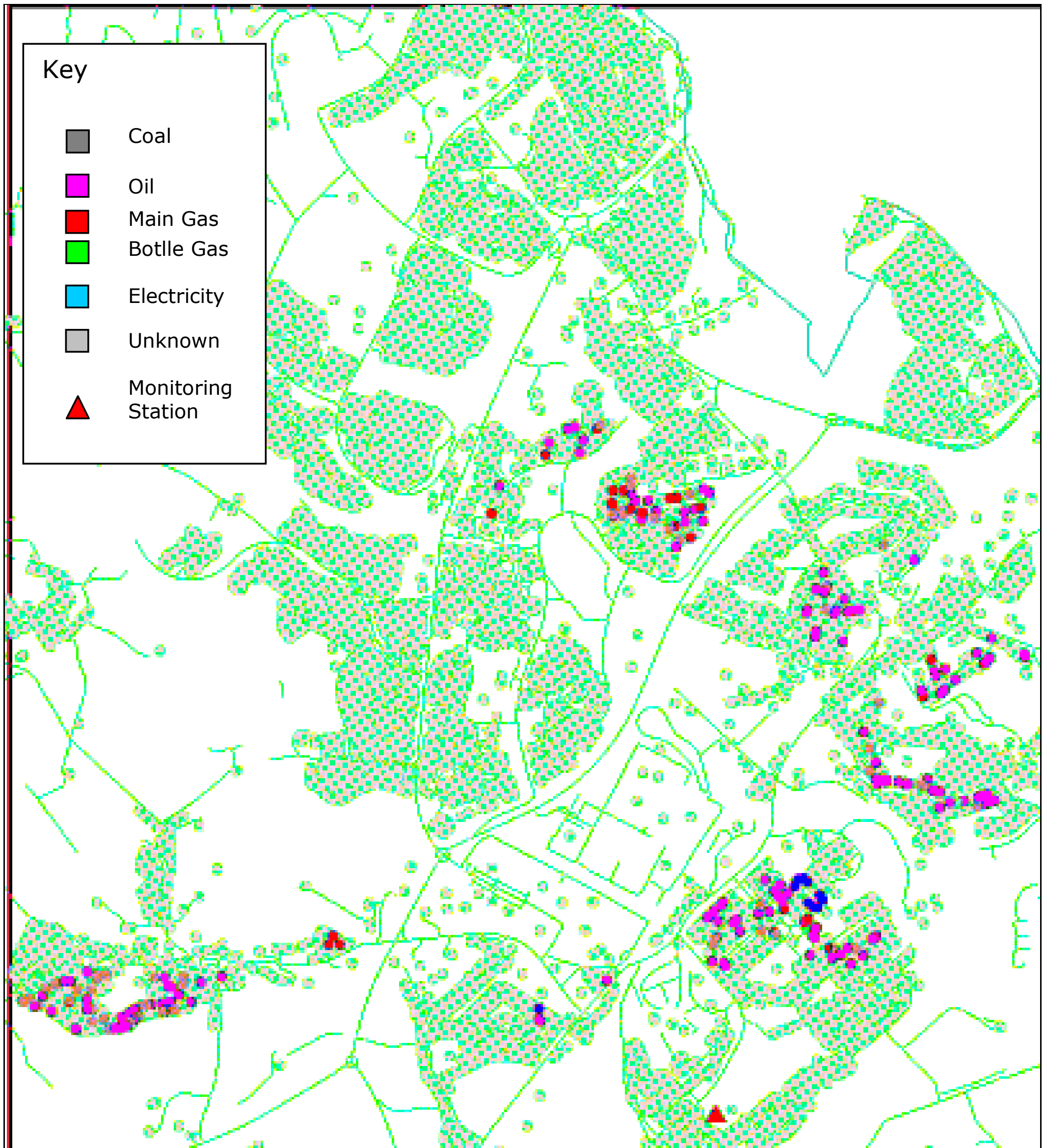

Figure 6.2 The North grid area

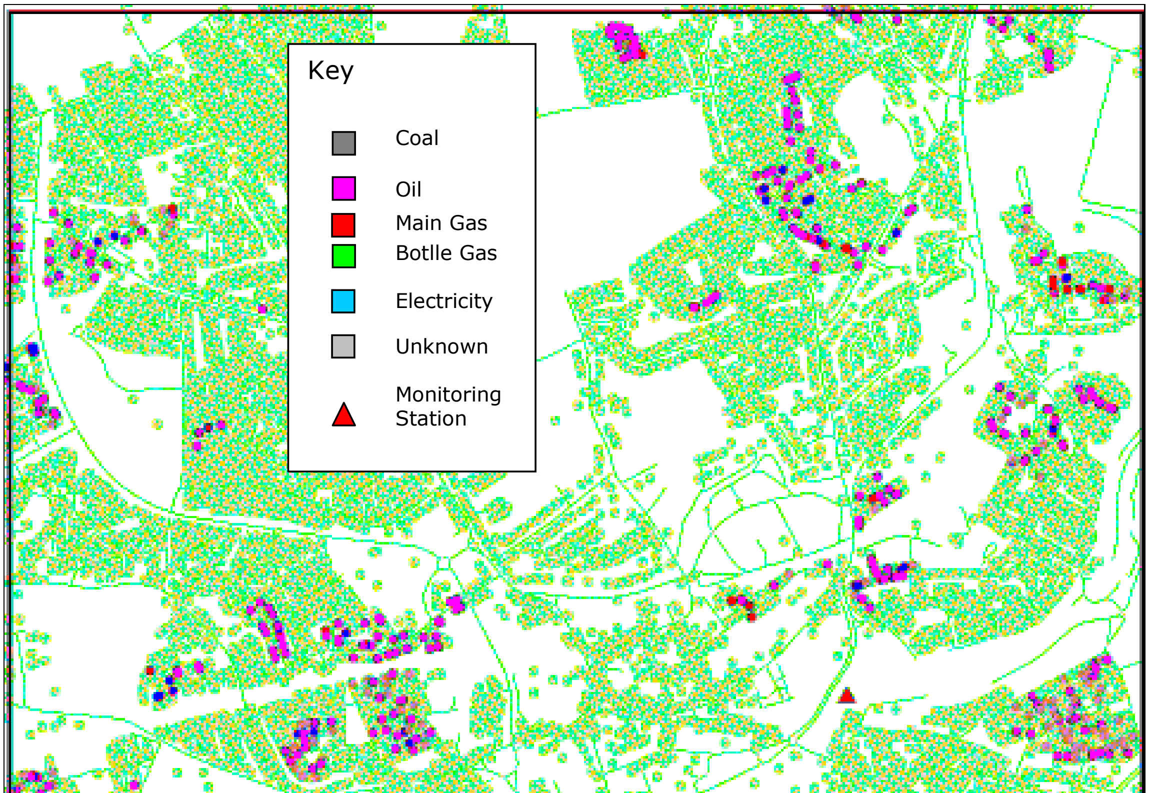

Figure 6.3 The South grid area

6.3 DOMESTIC SOURCES REVIEW AND ASSESSMENT

The fuel use survey data supplied by Lisburn City Council has been used within **netcen**'s DISP model to determine whether domestic fuel combustion is likely to cause exceedences of the 2004 SO_2 and PM_{10} objectives. The DISP model calculates the annual contribution to SO_2 and PM_{10}. Conversion factors from Pye and Vincent (2003) have been used to calculate 99.9 percentile of 15 minute means, the 99.73 percentile of hourly means and the 99.18 percentile of daily means for SO_2.

The relationship between the number of daily exceedences of 50μgm^{-3} and the annual mean concentration of PM_{10} in LAQM.TG (03) has been used calculate likely exceedences of the daily PM_{10} objective.

6.3.1 Emissions rates

The PM_{10} and SO_2 emission rate for each dwelling has been calculated using information from the fuel use survey (annual expenditure and fuel use type). Oil and Solid fuel annual expenditure was converted into litres and kilograms, respectively using an average cost from different providers in the Lisburn area (One litre of heating oil costs 22.2p and a 50kg bag of coal costs £9.50). Using the emissions rates in table 6.2, an annual emission rate for each dwelling was calculated (see table 6.3). This average annual emissions rate per dwelling was then applied to dwellings not included in the fuel use survey.

Table 6.2 Emissions rates for different fuel type

Fuel Type	SO_2	PM_{10}	Units
Oil	0.42	0.01	Kt/mt fuel
Coal	10	10	Kt/mt fuel
SSF	16	5.6	Kt/mt fuel

Table 6.3 Emission rates resulting from domestic fuel combustion

	SO_2 (g/s)	PM_{10} (g/s)
Total emission from all Surveyed houses	0.52193805	0.28967452
Average emission from Surveyed houses	0.00047753	0.00026503
Total emission from North grid*	4.7911561	2.6778158
Total emission from South grid*	4.7449179	2.6132816

*Assuming average fuel use profile from survey applies to all dwellings

6.3.2 Point source characteristics (Domestic Heating)

The assumptions in the modelling exercise are:

- Chimney height 10m.
- Chimney diameter of 0.2m
- Exit velocity of 4 m/s and temperature of 60 °C.
- Surface Roughness 1m
- The fuel use survey sample is representative of the grid area population.
- Monitoring data is representative of ambient concentrations

Additionally, Meteorological data from Aldergrove in 2003 has been used ad the concentrations have been calculated to a resolution of 25m.

6.3.3 Background concentrations

The modelled concentrations have been added to the background concentrations. The background concentrations have been estimated using the **netcen** background concentration maps. In order to avoid double counting, rural background levels south of the modelled grid have been used. The values estimated are:

Table 6.4 Background concentrations

	2001	2003	2004
PM_{10} south grid	19 μgm^{-3}	18 μgm^{-3}	17 μgm^{-3}
PM_{10} north grid	20 μgm^{-3}	19 μgm^{-3}	18 μgm^{-3}
SO_2	4 μgm^{-3}	4 μgm^{-3}	4 μgm^{-3}

6.4 MODEL RESULTS

The model results form **netcen**'s DISP model are presented below.

6.4.1 PM_{10} Predicted Concentration

Figures 6.4 and 6.5 show PM_{10} annual mean concentrations in the modelled areas. Exceedences of the Annual Mean PM_{10} have not been predicted. Based on the relationship between daily means and annual means the daily mean objective will not be exceeded within the grid.

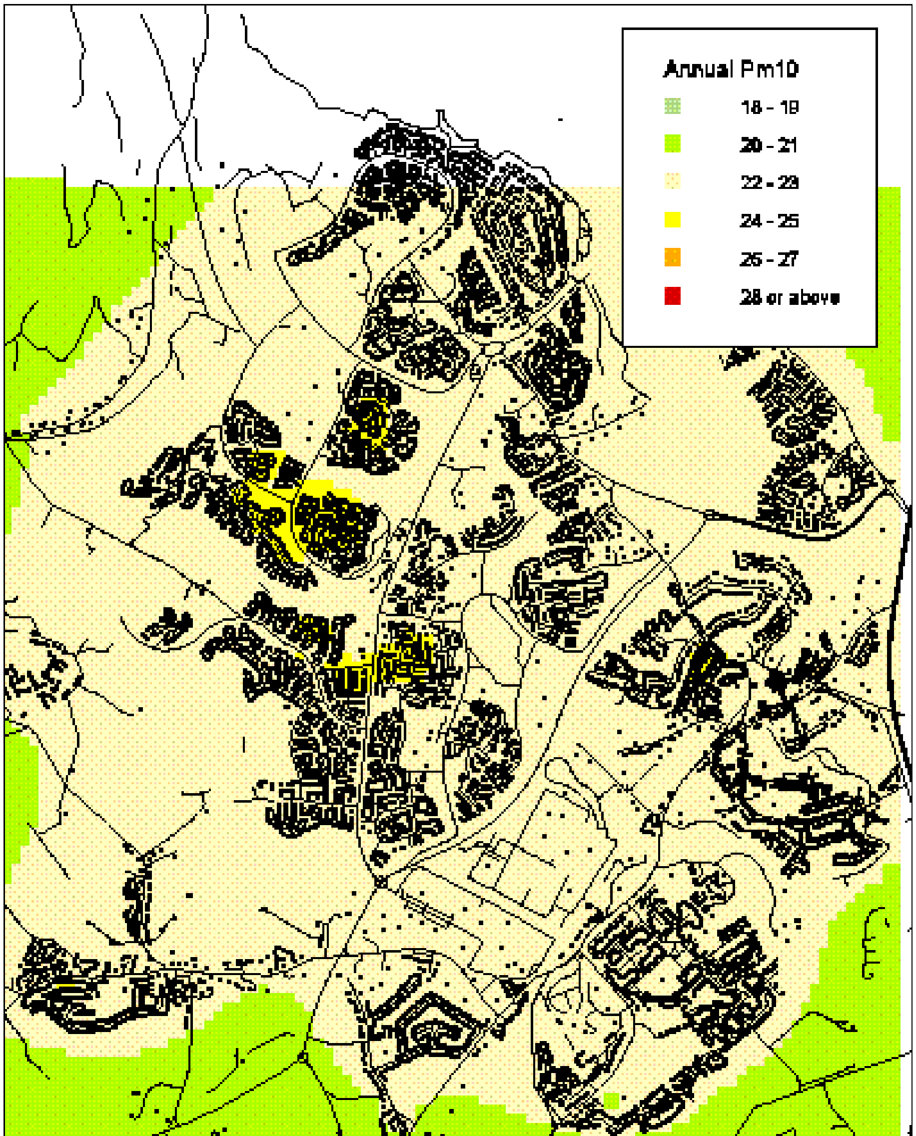

Figure 6.4 North Lisburn 2004 PM_{10} Annual mean, bias corrected, modelled results
Contour units are in µg m^{-3}

Figure 6.5 south Lisburn 2004 PM_{10} Annual mean, bias corrected, modelled results
Contour units are in $\mu g\ m^{-3}$

6.4.2 SO_2 Predicted Concentration

Figures 6.6 – 6.11 show the predicted concentrations for SO_2. for each of the objectives, for each of the modelled areas. None of the 3 SO_2 Objectives are predicted to be exceeded within the grid:

- 266 $\mu g\ m^{-3}$ 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 (see figure 6.3)
- 350 $\mu g\ m^{-3}$ 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 (see figure 6.4)
- 125 $\mu g\ m^{-3}$ 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 (see figure 6.5)

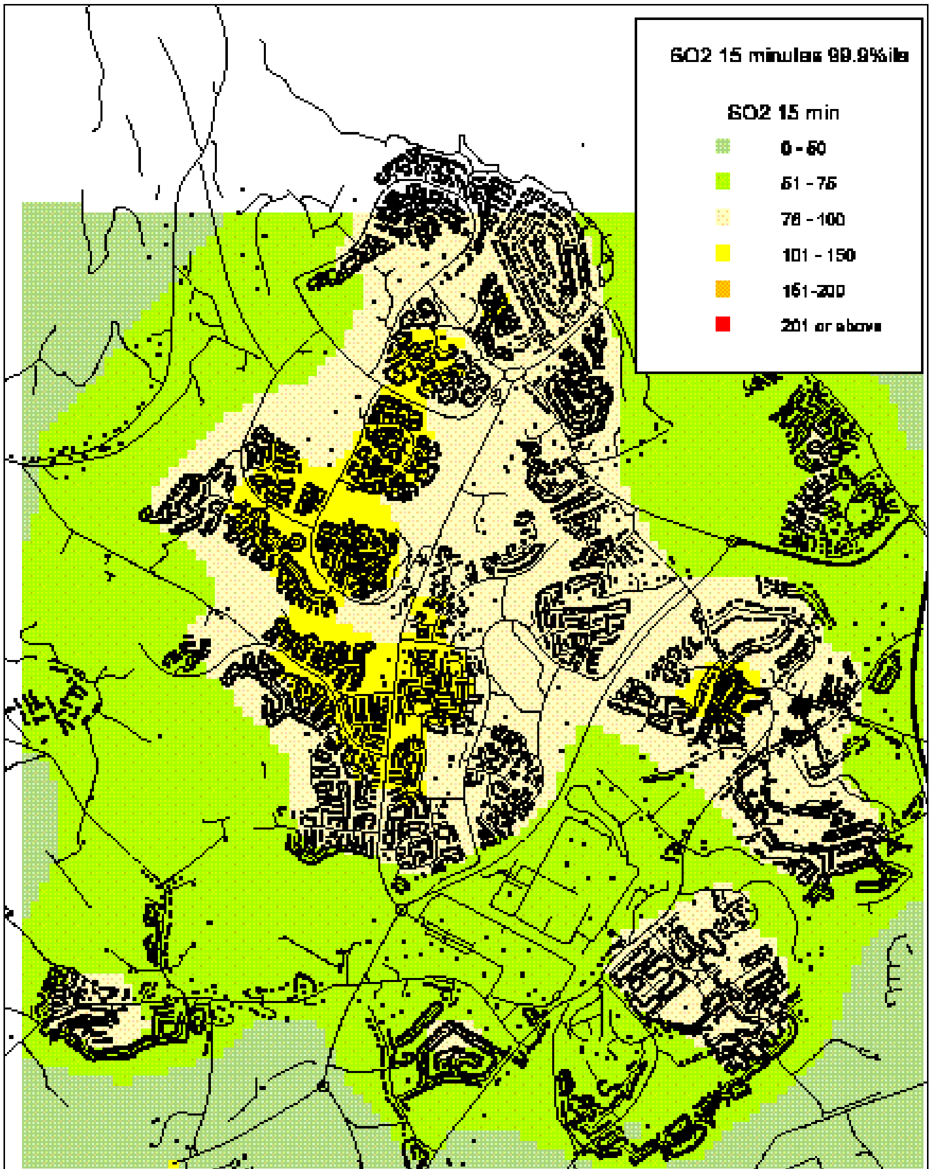

Figure 6.6 - 2005 SO_2 15 minute mean (99.9%ile)
Contour units are in $\mu g\ m^{-3}$

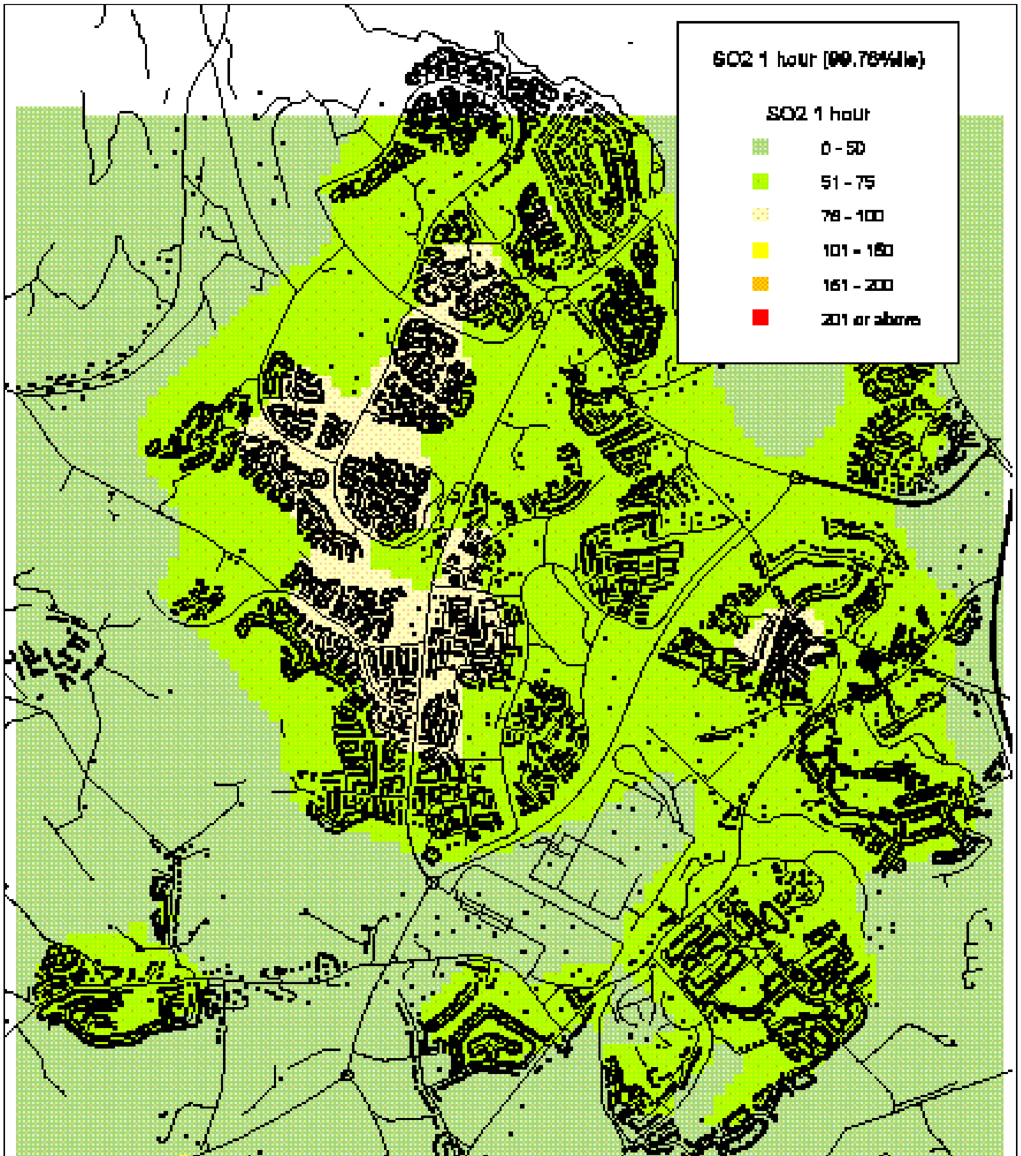

Figure 6.7 - 2004 SO_2 1 hour mean (99.73%ile)
Contour units are in $\mu g\ m^{-3}$

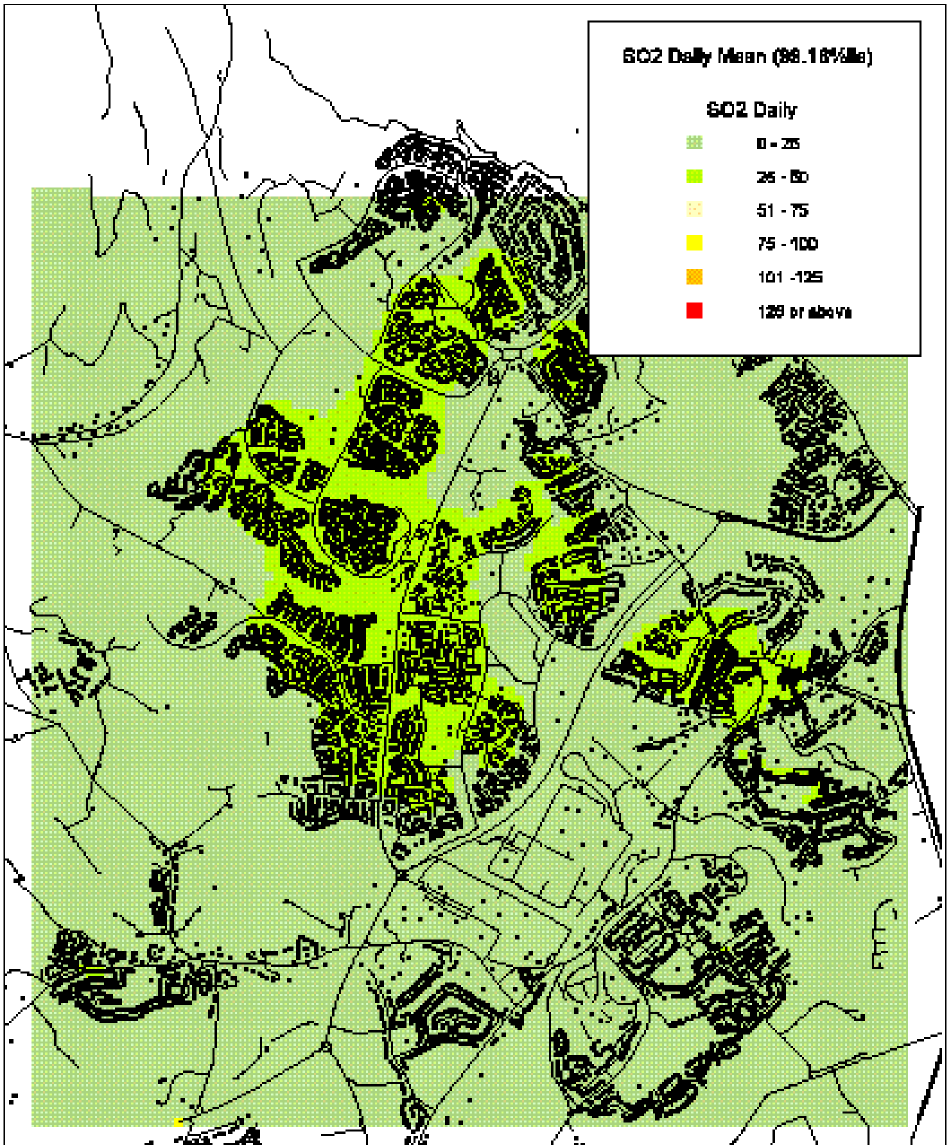

Figure 6.8 - 2004 SO_2 24 hours mean (99.18%ile)
Contour units are in $\mu g\ m^{-3}$

Figure 6.9 - 2005 SO_2 15 minute mean (99.9%ile)
Contour units are in $\mu g\ m^{-3}$

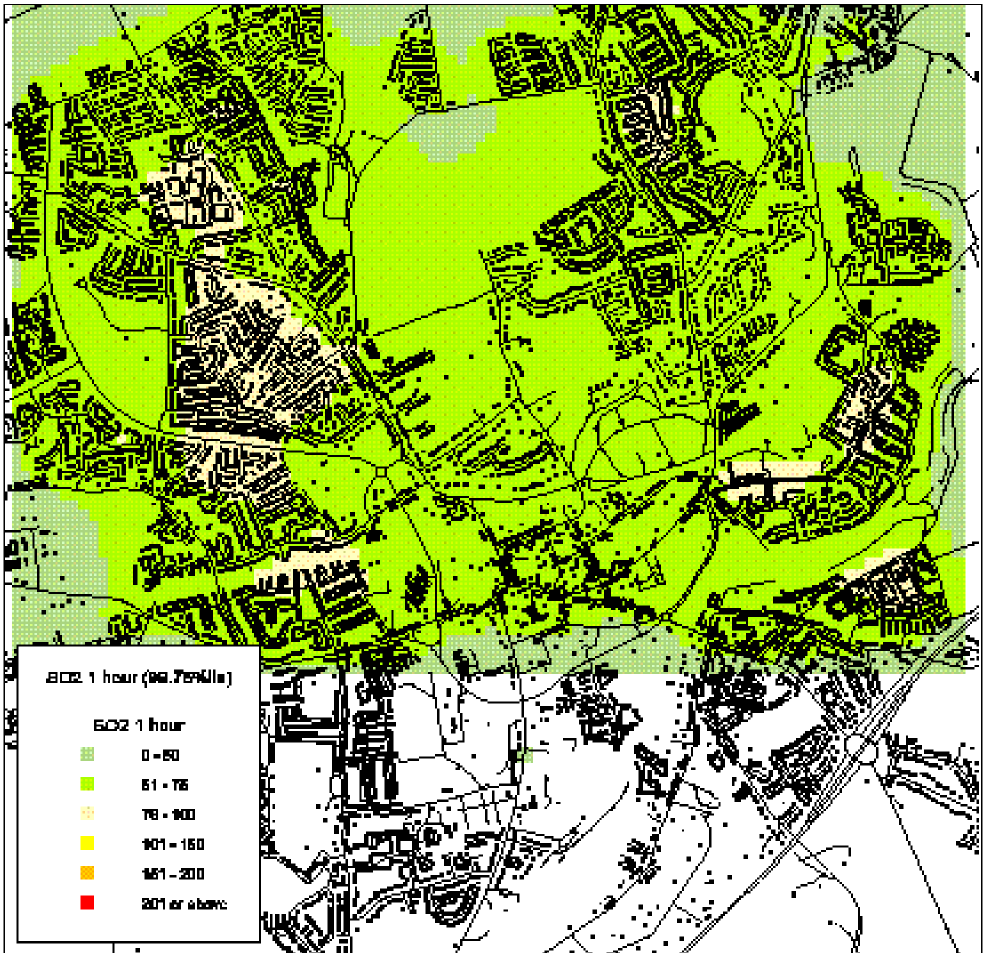

Figure 6.10 - 2004 SO_2 1 hour mean (99.73%ile)
Contour units are in $\mu g\ m^{-3}$

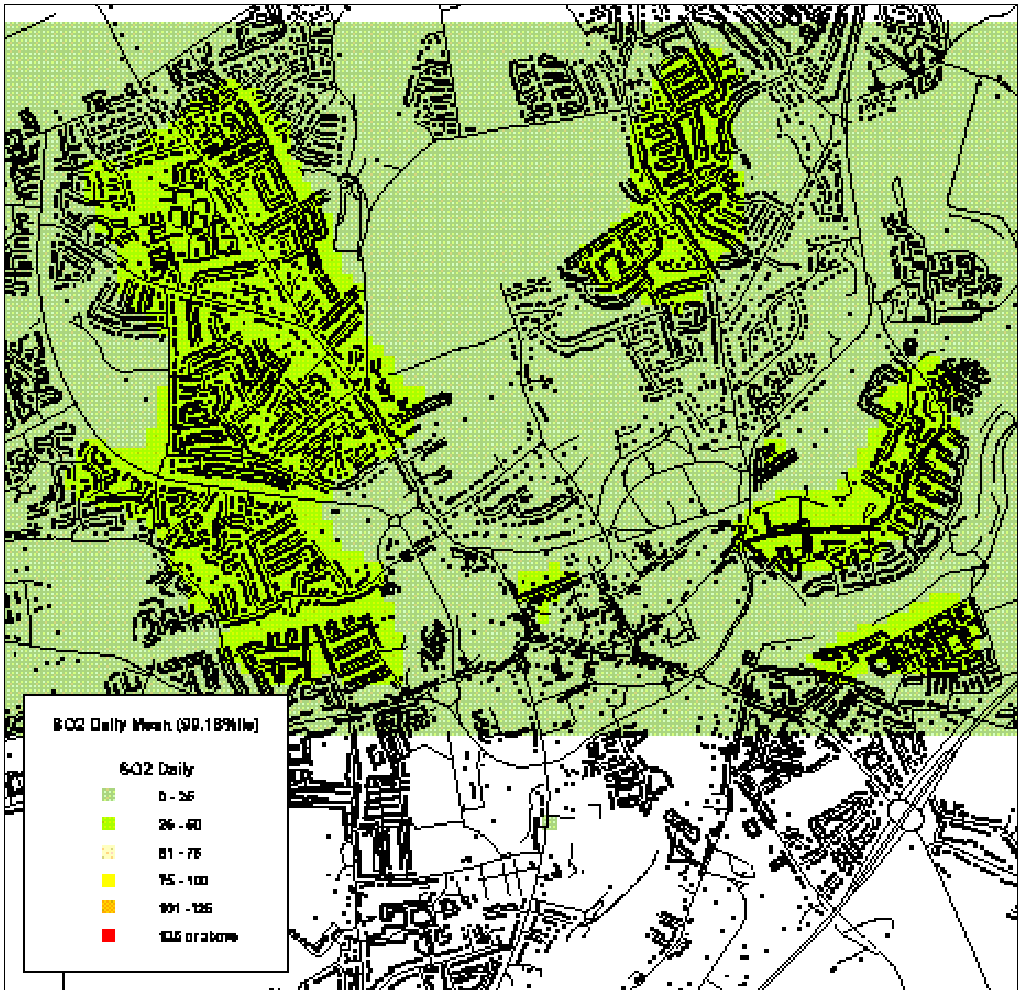

Figure 6.11 - 2004 SO_2 24 hours mean (99.18%ile)
Contour units are in $\mu g\ m^{-3}$

7 Discussion

7.1 ROAD TRAFFIC

7.1.1 NO_2

The results of the diffusion tube survey and the DMRB model runs show that it is unlikely that the NO_2 objectives will be exceeded in Lisburn at relevant receptor locations. Comparatively the DMRB results are predicting higher concentrations than the diffusion tube monitoring data, this should be reviewed again when the local collocation in triplicate study is complete for a full year at the progress report stage.

7.1.2 PM_{10}

The DMRB model runs show that it is unlikely that the PM_{10} objectives will be exceeded in Lisburn at relevant receptor locations.

7.2 DOMESTIC FUEL COMBUSTION

7.2.1 PM_{10}

PM_{10} levels are not predicted to exceed the 2004 objectives. The areas modelled are all predicted to be below 50μg m^{-3}.

7.2.2 SO_2

PM_{10} levels are not predicted to exceed the 2004/2005 objectives. The areas modelled are all predicted to be below 50μg m^{-3}.

8 Conclusions

The modelling shows that there will be no exceedences of NO_2, PM_{10} and SO_2 objectives in Lisburn in 2004/05 from road traffic or domestic emissions sources assessed in this report. Therefore no further assessment of these sources is required. This report should now be submitted to DoE NI for review.

It is recommended that the existing monitoring be continued in order to provide data to substantiate these conclusions in the progress report and any future rounds of review and assessment. The next formal R&A reporting requirement will be the production of a progress report in April 2005.

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Appendices

CONTENTS

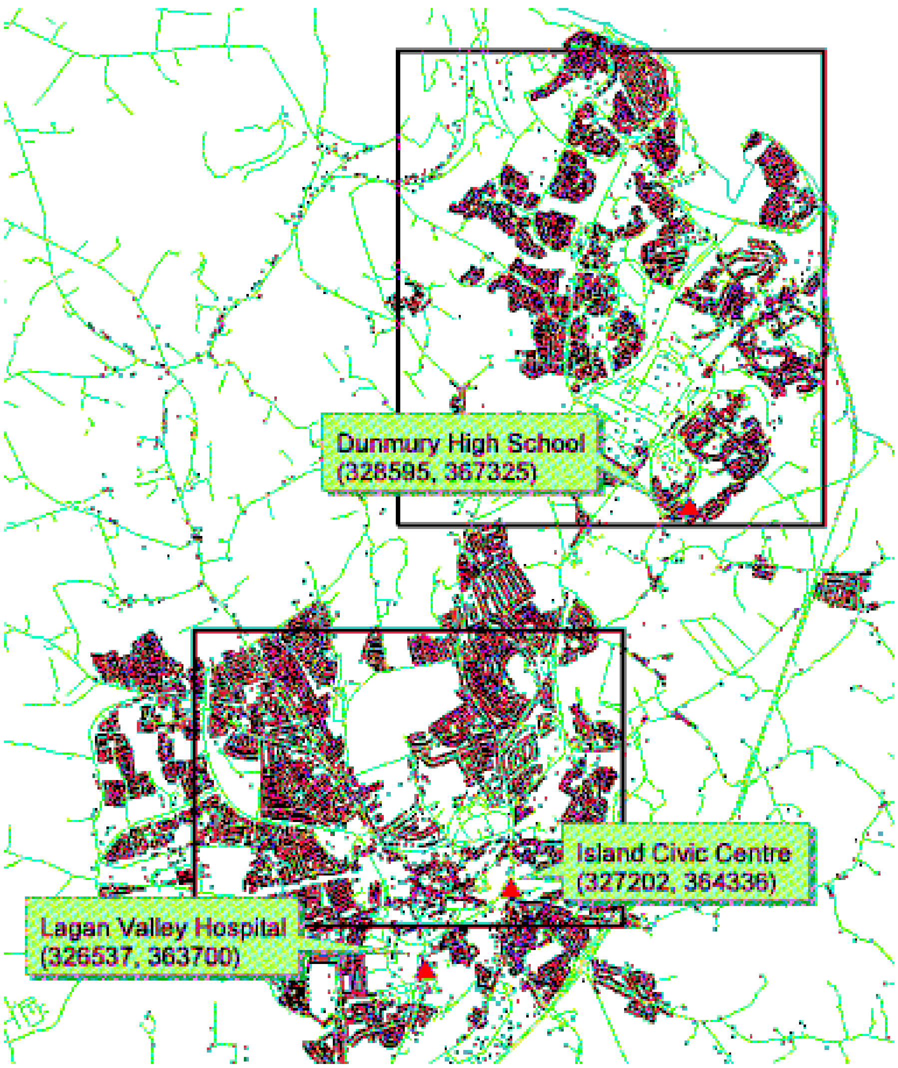
Appendix 1
Automatic Monitoring Station Data

LISBURN AMBIENT AIR MONITORING PROGRAMME

Lisburn City Council has carried out automatic air quality monitoring at 3 locations:

- Island Civic Centre – Since march 2003, suburban background 327202, 364336
  - PM_{10}, SO_2
- Lagan valley Hospital – Since March 2003, roadside
  - PM_{10}, NO_2
- Dunmurry High School – Since October 2003, suburban background 328595, 367325
  - PM_{10}

The data has been ratified up to February 2004. Data from Island Civic Centre and Dunmurry High School have been used in this assessment. The instrumentation employed uses UV fluorescence for the measurement of SO_2, the TEOM technique for PM_{10}, and chemiluminescence for the measurement of NO_2 these methods are appropriate for Stage 3 Assessment under LAQM (LAQM TG (03)). All TEOM data are quoted as gravimetric equivalent in accordance with the guidance.



Location of the Automatic Monitoring Stations in Lisburn

These data are managed by **netcen** and used in the verification and adjustment of the modelled output. **netcen** has undertaken a review of the data comparing the trends of the pollutants to other nearby National Network monitoring stations. The Lisburn datasets follows the same temporal variation as seen at the AURN station at Belfast Centre, Belfast East, Derry and Lough Navar providing confidence in the dataset.

The data has been compared with AURN stations located in Northern Ireland (Belfast Centre, Belfast East, Derry and Lough Navar) in order to obtain an annual average for 2003. This has been done following LAQM guidelines. See Appendix 3 for more information.

Dunmurry High School Air Monitoring

01 November 2003 to 29 February 2004

Table A1.2 Air Quality Summary Statistics, Dunmury

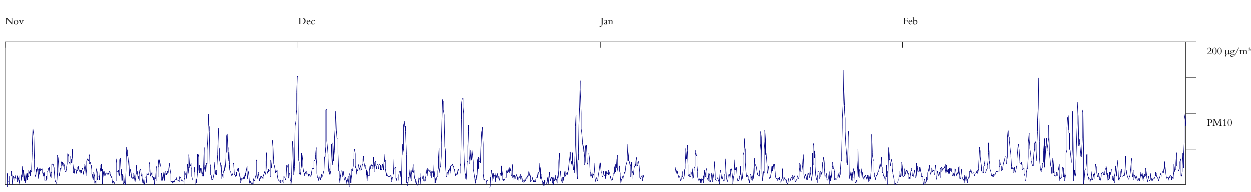
POLLUTANT	PM_{10}
Number Very High	0
Number High	0
Number Moderate	131
Number Low	2674
Maximum 15-minute mean	185 µg m^{-3}
Maximum hourly mean	161 µg m^{-3}
Maximum running 8-hour mean	116 µg m^{-3}
Maximum running 24-hour mean	66 µg m^{-3}
Maximum daily mean	57 µg m^{-3}
Average	27.3 µg m^{-3}
Data capture	95.7 %

Note: A factor of 1.3 has been used to correct TEOM PM_{10} to gravimetric equivalent PM_{10} All mass units are at 20'C and 1013mb

Table A1.3: Air Quality Exceedence Statistics, Dunmurry

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
PM_{10} Particulate Matter (Gravimetric)	Daily mean > 50 µg m^{-3}	11	11
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 40 µg m^{-3}	-	-

Note: A factor of 1.3 has been used to correct TEOM PM_{10} to gravimetric equivalent PM_{10} (GR_{10} in Table A1.2)



LISBURN ISLAND CIVIC CENTRE

01 March 2003 to 29 February 2004

Table A1.2 Air Quality Summary Statistics, Island Civic Centre

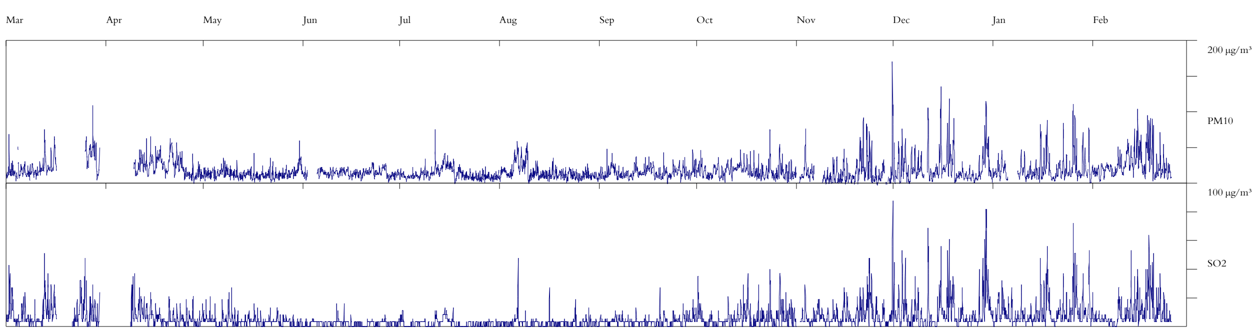
POLLUTANT	PM_{10}	SO_2
Number Very High	0	0
Number High	0	0
Number Moderate	107	0
Number Low	7716	32422
Maximum 15-minute mean	222 μg m^{-3}	120 μg m^{-3}
Maximum hourly mean	171 μg m^{-3}	88 μg m^{-3}
Maximum running 8-hour mean	107 μg m^{-3}	63 μg m^{-3}
Maximum running 24-hour mean	66 μg m^{-3}	42 μg m^{-3}
Maximum daily mean	59 μg m^{-3}	38 μg m^{-3}
Average	23.4 μg m^{-3}	6 μg m^{-3}
Data capture	89.8 %	94.2 %

Note: A factor of 1.3 has been used to correct TEOM PM_{10} to gravimetric equivalent PM_{10} All mass units are at 20'C and 1013mb

Table A1.3: Air Quality Exceedence Statistics, Island Civic Centre

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
PM_{10} Particulate Matter (Gravimetric)	Daily mean > 50 μg m^{-3}	15	15
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 40 μg m^{-3}	0	-
Sulphur Dioxide	15-minute mean > 266 μg m^{-3}	0	0
Sulphur Dioxide	Hourly mean > 350 μg m^{-3}	0	0
Sulphur Dioxide	Daily mean > 125 μg m^{-3}	0	0
Sulphur Dioxide	Annual mean > 20 μg m^{-3}	0	-

Note: A factor of 1.3 has been used to correct TEOM PM_{10} to gravimetric equivalent PM_{10} (GR_{10} in Table A1.2)



Appendix 2
Aldergrove Met Station Data

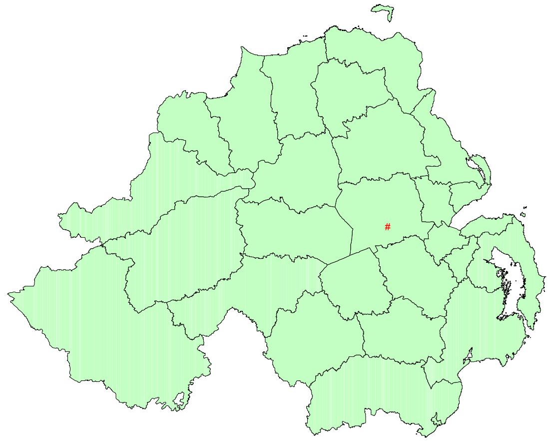
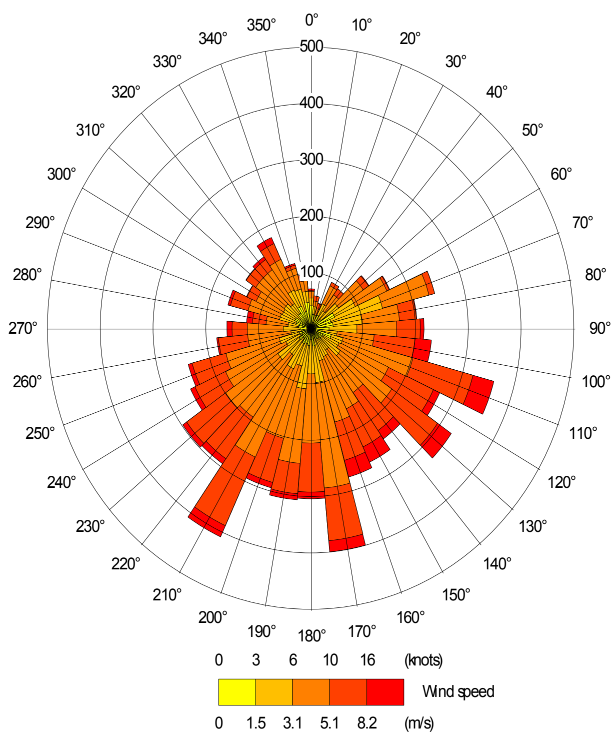


Figure A2- Location of Aldergrove Station

Table A2 - Characteristics of Aldergrove Station

Description – Aldergrove International airport.	
DCNN	9142
Eastings	314700
Northings	379800
Latitude Deg Min	54 39 N
Longtitude Deg Min	06 13 W
Station height AMSL (m)	68
Effective height of anemograph (m)	10



Wind rose for the Aldergrove 2003 met data

Appendix 3
Model Verification and Adjustment

Data from two monitoring stations in Lisburn CC has been used to verify and adjust the output results from DISP model. The data used is from Lisburn Island Civic Centre (PM_{10} and SO_2) and Dunmurry High School (PM_{10}).

SO_2 verification and adjustment

SO_2 data from Island Civic Centre has been use to verify and adjust the model results. As covered in Appendix 1, the SO_2 data runs from March 2003 to February 2004. In order to verify whether this result could be applied as representative of the full dataset for 2003, the data was compared to Belfast Centre, Derry and Lough Navar. As specified in LAQM.TG (03), SO_2 period averages from the three AURN stations have been compared to SO_2 annual averages. Table A3.1 shows the corrected SO_2 annual average (SO_2 annual average does not change).

Table A3.1 Corrected SO_2 Annual Averages

Station	Pollutant	01/01/2003	31/12/2003	01/03/2003	29/02/2004	Am/Pm	Ra
Derry	Sulphur Dioxide	11		11		1	1
Belfast East	Sulphur Dioxide	8		8		1	
Belfast Centre	Sulphur Dioxide	8		8		1	
Island Civic Centre		**6***		6			

(*Applying RA obtained - see LAQM.TG (03))

Annual average rural SO_2 background was obtained from 1kmx1km maps ($3\mu g\ m^{-3}$). The modelled contribution at the Island Civic Centre monitoring station was of $3.4\ \mu g\ m^{-3}$. Therefore, the modelled results at the Island Civic Centre was of $6.4\mu g\ m^{-3}$.

Table A3.2 SO_2 Model Verification ($\mu g\ m^{-3}$)

Background	Modelled contribution	Final modelled
3 +	3.4 ≃	6*

*model output overestimate slightly

$SO_{2\ monitoring\ data}$ = $background_{SO2}$ + Modelled result
[Annual mean]

Pye and Vincent (2003) relationships from short-term concentration and annual mean were obtained. As can be seen in table A3.3 the modelled results and monitored short term concentrations match very well.

Table A3.3 SO_2 Model Verification for short term concentrations

Short term concentration	**Modelled** (using Pye and Vincent, 2003)	**Measured at Island Civic Centre**
15 minute mean - 99.9^{th} percentile	**70**	**69**
1 hour mean - 99.7^{th} percentile	**52.7**	**51**
24 hour mean – 99.18^{th} percentile	**18**	**25**

PM_{10}

PM_{10} data from both monitoring stations have been used to verify and adjust model results. The data obtained from a period of monitoring has been converted to full 2003 following recommendations in the LAQM.TG(03). Table A3.4 and A3.5 show the results obtained at both monitoring stations. The PM_{10} results from DISP have to be adjusted as shown in table A3.6

Table A3.4 Corrected PM_{10} Island Civic Centre

Station	01/01/2003 31/12/2003	01/03/2003 29/02/2004	Am/Pm	Ra
Lough Navar	11	11	1	**1**
Belfast Centre	18	18	1	
Derry	18	18	1	
Island Civic Centre	**18**	18		

(*applying RA obtained - see LAQM.TG(03))
**Teom data (need to multiply it by a factor of 1.3 to obtain gravimetric)

Table A3.5 Corrected PM_{10} Dunmurry High School

Station	01/01/2003 31/12/2003	01/11/2003 29/02/2004	Am/Pm	Ra
Lough Navar	18	19	0.947	**0.935**
Belfast Centre	18	18	1.000	
Derry	18	21	0.857	
Dunmury High School	**19.63**	21		

(*applying RA obtained - see LAQM.TG(03))
**Teom data (need to multiply it by a factor of 1.3 to obtain gravimetric)

Table A3.6 Summary of model bias correction

	Monitoring data 2003	**Background** (from NAEI)	**DISP** (Domestic Fuel)	**Adjustment background factor**
Island Civic Centre	23.4 μg m^{-3}	18 μg m^{-3}	1.9 μg m^{-3}	***3.5*μg m^{-3}**
	23.4 = 18 + 1.9 + **3.5**			
Dunmury High School	25.4 μg m^{-3}	19 μg m^{-3}	1.9 μg m^{-3}	***4.5*μg m^{-3}**
	25.4 = 19 + 1.9 + **4.5**			

(All data in gravimetric equivalent)

The number of monitored exceedences at Island Civic Centre for a full year has been verified against modelled outputs. Table A3.7 shows that 15 exceedences where measured at Island Civic Centre. When applying the relationship in page 18 to the annual average concentration of 23.4μg m^{-3}, 9 exceedences are predicted.

Both the monitored number of exceedences, and the modelled (using the relationship on page18) indicate that the number of exceedences are well below the permitted 35 in a calendar year. The differences between the monitored and predicted may, to some degree, be the result of long range transboundary episodes experienced in 2003 (not related to domestic contribution).

Further, the maximum modelled concentration (*circa* 26.5μg m^{-3}) in the grid areas modelled indicated 16 exceedences. This suggests that even in exceptional pollution years, exceedences of the daily objective are unlikely.

Table A3.7 Verification of 24hr mean concentrations

	Monitoring data Mar03 to Feb04	**Number of monitored exceedences**	**Number of modelled exceedences** (using relationship in page 18)
Island Civic Centre	23.4 μg m^{-3}	15	9

Appendix 4
Detailed DMRB data and results

Table A.4.1. Detailed DMRB data and Results

2005		Background concentrations (linked to year)												
X	Y	CO (mg/m3)	Benzene (mg/m3)	1,3-butadiene (mg/m3)	NOx (mg/m3)	NO2 (mg/m3)	PM10 (mg/m3)							
141500	525500	0.32	0.94	0.15	32.90	21.40	22.92							
Receptor	**Link no**	**Road name**	**Distance from link centre to receptor (m)**	**AADT (veh/day)**	**Annual average speed (km/h)**	**Road type**	**Total % HDV**	**CO (mg/m3)**	**Benzene (µg/m3)**	**1,3-butadiene (µg/m3)**	**NOx (µg/m3)**	**NO2 (µg/m3)**	**PM10 (µg/m3)**	**Number of PM10 exceedences**
A	1	Rural A n	2	9188	30	A	10	0.41	1.04	0.28	63.40	28.91	26.71	17
B	2	A1	2	10300	30	A	8	0.42	1.05	0.28	60.91	28.37	26.52	16
C	3	Mway slip	5	12713	50	A	10	0.49	1.15	0.46	105.90	36.81	30.39	29
	4	M1	15	28910	70	A	10							
D	5	Mway slip	5	12713	50	A	10	0.40	1.03	0.27	65.79	29.41	26.47	16
E	6	Lagan V Hosp	10	9581	30	A	10	0.40	1.03	0.27	59.94	28.16	26.28	16
F	7	A1 data Council	2	9581	30	A	8	0.42	1.04	0.27	60.05	28.18	26.38	16
G	8	A1 data Council	2	9581	30	A	8	0.50	1.12	0.39	86.50	33.45	29.67	26
	9	A3	2	8000	30	A	10							
H	10	A1 data Council	2	9581	30	A	8	0.50	1.12	0.39	86.50	33.45	29.67	26
	11	A49	2	8000	30	A	10							

2004		Background concentrations (linked to year)												
X	Y	CO (mg/m3)	Benzene (mg/m3)	1,3-butadiene (mg/m3)	NOx (mg/m3)	NO2 (mg/m3)	PM10 (mg/m3)							
141500	525500	0.32	1.00	0.15	34.94	22.34	23.00							
Receptor	**Link no**	**Road name**	**Distance from link centre to receptor (m)**	**AADT (combined, veh/day)**	**Annual average speed (km/h)**	**Road type (A,B)**	**Total % HDV**	**CO (mg/m3)**	**Benzene (µg/m3)**	**1,3-butadiene (µg/m3)**	**NOx (µg/m3)**	**NO2 (µg/m3)**	**PM10 (µg/m3)**	**Number of PM10 exceedences**
A	1	Rural A n	2	9188	30	A	10	0.43	1.11	0.30	67.27	30.17	27.04	18
B	2	A1	2	10300	30	A	8	0.44	1.12	0.30	64.70	29.62	26.84	17
C	3	Mway slip	5	12713	50	A	10	0.51	1.23	0.49	113.01	38.47	30.96	31
	4	M1	15	28910	70	A	10							
D	5	Mway slip	5	12713	50	A	10	0.42	1.09	0.28	70.02	30.73	26.79	17
E	6	Lagan V Hosp	10	9581	30	A	10	0.42	1.09	0.28	63.61	29.39	26.58	16
F	7	A1 data Council	2	9581	30	A	8	0.43	1.11	0.29	63.78	29.42	26.70	17
G	8	A1 data Council	2	9581	30	A	8	0.53	1.21	0.43	91.81	34.90	30.20	28
	9	A3	2	8000	30	A	10							
H	10	A1 data Council	2	9581	30	A	8	0.53	1.21	0.43	91.81	34.90	30.20	28
	11	A49	2	8000	30	A	10							