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Air Quality Monitoring in Northern Ireland 2004

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Air Quality Monitoring in Northern Ireland, 2004

A report produced for the Department of the Environment in Northern Ireland in partnership with the Chief Environmental Health Officers Group.

December 2005

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"Our aim is to protect and conserve the natural and built environment and to promote its appreciation for the benefit of present and future generations."

Foreword

Many significant improvements in Northern Ireland's air quality have been made since the introduction of the Clean Air Act in 1964 and more so in the last ten years. Gone are the days of smogs that were once so prevalent in many urban areas. Monitoring trends have clearly shown a significant reduction across the province of pollutants associated with the burning of solid fuels. However as knowledge and understanding of air pollution increases, there remains much to be done as demonstrated by the number of district councils in the past year who have identified areas at risk of exceeding air quality objectives. Many of these councils have now declared air quality management areas and are currently drawing up action plans with other relevant bodies and agencies aimed to improve local air quality.

At the European level the Commission has published its draft thematic strategy CAFÉ, which will put in place a policy framework up to 2020 aimed at improving air quality further in all member states. The strategy proposes a new objective for fine particles and introduces a new approach based on population exposure. At the national level Defra and the Devolved administrations are currently reviewing the Air Quality Strategy and plan to publish a draft for consultation early in 2006. The draft will focus more on additional measures to further improve air quality.

Monitoring of air quality is an important element in the management of air quality. It provides us with information with which we can assess progress towards meeting air quality objectives and better inform those tasked with air quality policy development. The 2004 report draws on all the results of air quality monitoring in Northern Ireland and provides a comprehensive view of air quality in 2004 and discusses long term trends, where data is available.

This report has been drawn up in partnership with the Chief Environmental Health Officers Group.

We commend this Report to you and would welcome any comments you may have.

Richard Rogers
Chief Executive Environment and Heritage Service

Sam Knox
Chairman of the Chief Environmental Health Officers Group

Executive Summary

This report presents a summary of air quality monitoring in Northern Ireland over the calendar year 2004. It is intended to bring together in one report, results from all the District Councils and Government air quality monitoring sites in Northern Ireland over this period, both as part of larger monitoring networks and for other purposes. The report aims to provide information on the main pollutants of concern, details of the air quality monitoring undertaken in 2004, a summary of results for each pollutant, and an update on local air quality management.

Six new automatic monitoring sites were set up during 2004, bringing the total number to 36. These sites are located in areas where high pollutant concentrations were expected.

AQS objectives for the following pollutants were to be met by the end of 2004:

- Sulphur Dioxide
- Lead
- Particulate matter as PM_{10}.

All sites in Northern Ireland achieved the AQS objectives for 1-hour mean and 24-hour mean sulphur dioxide concentration by the due date of 31st December 2004, and also achieved the AQS objective for the 15-minute mean sulphur dioxide concentration, which is to be met by the end of 2005.

Monitoring carried out in Northern Ireland in 2000-01 (see previous reports in this series) established that annual mean lead concentrations were well within the AQS Objective and EC Limit Value, which was to be met by the end of 2004.

However, not every site met the AQS Objectives for PM_{10}, which were to be achieved by the same date. Monitoring results also indicate that the following pollutants may present a problem in meeting air quality objectives, in some parts of Northern Ireland: nitrogen dioxide, ozone, and polycyclic aromatic hydrocarbons.

Carbon monoxide was monitored using automatic techniques at two sites (Belfast and Londonderry). Both continued to meet the EC 2nd Daughter Directive limit value and UK AQS Objective for this pollutant, having previously achieved this AQS Objective and Limit Value by the due date.

Benzene was monitored at two sites, Belfast Centre and Belfast Upper Newtownards Road, using pumped tube samplers. Both sites remain well within the EC 2nd Daughter Directive limit value and UK AQS Objective for this pollutant, achieved by its due date the previous year.

Nitrogen dioxide was monitored using the automatic chemiluminescent technique at 19 sites. Results from some sites showed potential exceedences of AQS Objectives. Belfast Westlink exceeded the 1st Daughter Directive limit and AQS Objective of 200 μg m^{-3} for the hourly mean more than the permitted 18 times during 2004. In addition, three sites exceeded the EC 1st Daughter Directive limit value and AQS Objective for the annual mean nitrogen dioxide (40 μg m^{-3}). These were all roadside sites, near busy major roads: Belfast Westlink, Belfast Upper Newtownards Road, and Londonderry Dale's Corner. It is predicted that these three sites (and possibly other similar locations) may not meet the AQS Objective for the annual mean by the end of 2005. One (Belfast Westlink) may not meet the EC Daughter Directive limit value in 2010.

Nitrogen dioxide was also monitored on a monthly basis using passive diffusion tube samplers at 276 sites in 2004. The EC 1st Daughter Directive limit value and AQS Objective for the annual mean (40 μg m^{-3}) was exceeded at 22 diffusion tube sites in 2004, of which 20 were roadside. These sites were situated beside busy roads in both major urban centres and smaller towns. Four sites are predicted not to meet the EC Daughter Directive limit value in 2010.

Sulphur dioxide (SO_2) was monitored using automatic techniques at 19 sites, of which two were new in 2004. All automatic sites met the AQS Objectives for the 1-hour and 24-hour mean SO_2 concentrations by the due date of 31st December 2004. All sites also met the AQS Objective for the 15-minute mean, and the EC Limit Values for the 1-hour and 24-hour mean, for which the compliance date is not until 31st December 2005. In particular, Belfast East (which had recorded high concentrations of this pollutant in the past) met all the AQS Objectives for SO_2.

PM_{10} was monitored at 27 automatic sites during 2004. Four sites exceeded the AQS Objective of 50 μg m^{-3} (gravimetric equivalent) for the 24-hour mean, on more than the permitted 35 occasions: these were Ballymoney (a new site), Belfast Westlink, Newry Trevor Hill, and Strabane Springhill Park. These four sites have therefore failed to achieve the AQS Objective for 24-hour mean PM_{10} by the due date. (The identical EC Limit Value for this parameter has not yet been exceeded, as the due date is 31st December 2005.) Belfast Westlink and Newry Trevor Hill are close to busy or congested roads, Ballymoney and Strabane are situated in housing estates where solid fuel use is prevalent, and dispersion can be poor. Strabane also exceeded the AQS Objective for the annual mean PM_{10} concentration – the only Northern Ireland site to do so.

Ozone was monitored at four sites: three using automatic techniques (Belfast, Londonderry and the rural Lough Navar) and one using diffusion tubes (in Fermanagh). No sites exceeded the target value of the AQS Objective on more than the permitted ten days during 2004, though Londonderry came close, with exactly ten days exceedence. Londonderry has had difficulty meeting this objective in recent years. However, ozone is a transboundary pollutant and not easy to control by local action.

Polycyclic aromatic hydrocarbons (PAH) were monitored at two sites: Lisburn Dunmurry and Belfast Clara Street. The Belfast site met the AQS Objective of 0.25 ngm^{-3}. However, benzo (a) pyrene B(a)P concentrations at Lisburn Dunmurry remained considerably higher than those measured at most urban sites in the network, and above the AQS Objective. Although the site has until 2010 to meet this objective, there is so far no evidence of a significant downward trend in annual mean B(a)P concentrations at Lisburn Dunmurry. The major source of PAH around Lisburn is the widespread use of domestic solid fuels.

All twenty-six District Councils in Northern Ireland have now completed the first round of review and assessments of local air quality. Eleven have identified areas that are likely to exceed Air Quality Objectives, and nine of these have declared Air Quality Management Areas. The remaining two, Limavady and Newry, are still considering the outcome of their stage 3 assessments, and (at the time of writing) have not yet made the decision on whether to declare an AQMA.

Contents

1 Introduction

1.1 BACKGROUND

This report on air quality monitoring in Northern Ireland has been produced for the Department of the Environment, by **netcen** (an operating division of AEA Technology Environment). It contains information on monitoring carried out in Northern Ireland on behalf of Government and by District Councils during 2004. There are now a considerable number of air quality monitoring sites established across Northern Ireland, a significant number of which are incorporated into large-scale national networks such as the Automatic Urban and Rural Network, and Non-Automatic Networks. Data from these sites are reported together with data from the many other monitoring sites operated by Northern Ireland's District Councils.

Much of Northern Ireland is rural, and in such areas air quality is usually good. However, urban localities experience generally higher levels of pollution. Historically, there has been limited availability of natural gas in Northern Ireland; as a result, domestic use of coal, solid fuels and oil has remained relatively widespread. Therefore, levels of pollutants associated with domestic solid fuel burning, such as particulate matter (smoke and PM_{10}) and sulphur dioxide (SO_2), can be particularly high in parts of Northern Ireland. Oxides of nitrogen (NO and NO_2) are also pollutants of concern in some urban areas; the dominant source of these pollutants is likely to be motor vehicles. In rural areas, ozone episodes can be a problem (particularly during hot weather). Now that the majority of District Councils have completed their first round of Review and Assessment reports, the pollutants of concern in each District have been highlighted, and Air Quality Management Areas declared where necessary.

1.2 OBJECTIVES

Air quality monitoring in Northern Ireland is carried out by various District Councils and other bodies. Techniques used range from simple passive samplers to sophisticated automatic analysers. Some monitoring sites are part of larger networks; others are not. This report aims to bring together all air quality monitoring data obtained for Northern Ireland in 2004. It is intended to assist District Councils in their ongoing Review and Assessments of local air quality by:

- providing information on the main pollutants of concern,
- setting out details of the air quality monitoring undertaken in 2004, including details of new monitoring sites which began operation during this year,
- comparing the monitoring data obtained by the District Councils with applicable limit values and objectives, and
- presenting a brief summary of trends, based on historical data from the long-running monitoring sites.

It is not intended that this report will make specific comment or recommendations on air quality monitoring in Northern Ireland. The need for additional monitoring within individual District Council areas should be identified as part of the ongoing Review and Assessment process (referred to later). This report is intended to be primarily an update on developments in the field of air quality and a summary of air quality data across Northern Ireland for 2004.

2 Air Quality Developments

2.1 THE EUROPEAN UNION

The European Council Directive 96/62/EC on Ambient Air Quality Assessment and Management, (The Framework Directive), establishes a framework under which the EU will agree air quality limit values for specified pollutants in a series of 'Daughter Directives'. The structures established under the UK Air Quality Strategy and supporting legislation provide the principal means of implementing the UK's commitments under this Directive. So far, four Daughter Directives have been agreed:

- The First Daughter Directive (1999/30/EEC) sets limit values for sulphur dioxide (SO_2), oxides of nitrogen, particulate matter as PM_{10}, and lead. It came into force on 19th July 1999 and was transposed into legislation by The Air Quality Limit Values Regulations (Northern Ireland) 2002.

- The Second Daughter Directive (2000/69/EC) sets limit values for carbon monoxide (CO) and benzene. It came into force on 13th December 2000 and was transposed by The Air Quality Limit Values (Amendment) Regulations (Northern Ireland) 2002.

- The Third Daughter Directive (or EC Ozone Directive, 2002/3/EC) sets target values for protection of human health and vegetation. It came into force on 12th February 2002. This Directive was transposed into legislation by The Air Quality (Ozone) Regulations (Northern Ireland) 2003.

- The fourth Daughter Directive (2004/107/EC) covers the remaining pollutants listed in the Framework Directive. These pollutants are polycyclic aromatic hydrocarbons and the metallic elements cadmium, arsenic, nickel and mercury. Member States have until the 11th August 2006 to transpose into national law. It is expected that the Department will commence work on regulations during 2005/06.

2.1.1 Clean Air for Europe (CAFÉ)

The European Commission launched its Thematic Strategy on air pollution in September 2005 which establishes a framework for European policy on air quality up to 2020.

This Strategy aims to cut by 2020 the annual number of premature deaths from air pollution-related diseases by almost 40% from the 2000 level. Under the Strategy the Commission is proposing to start regulating fine airborne particulates: the size fraction known as $PM_{2.5}$. For the first time it would require reductions in average $PM_{2.5}$ concentrations throughout each Member State and proposes to set a cap on concentrations in the most polluted areas.

The Commission also proposes to streamline air quality legislation by merging existing legal instruments into a single Ambient Air Quality Directive. In addition, a range of other possible measures will be examined, such as the introduction of a new "Euro V" set of car emission standards. Other initiatives relating to energy, transport and agriculture sectors, the Structural Funds and international co-operation will also be explored.

2.2 THE AIR QUALITY STRATEGY

The first Air Quality Strategy (AQS) was published in 1997 and subsequently revised in 2000 and 2003. The strategy sets out policies for the management of ambient air quality and thus fulfils the requirement of the Environment (NI) Order 2002 for an air quality strategy. Pollutants covered by the strategy are: benzene, 1,3-butadiene, carbon monoxide, lead, oxides of nitrogen, particulate matter (as PM_{10}), ozone, polycyclic aromatic hydrocarbons and sulphur dioxide. The strategy sets

out a strategic framework within which air quality policies will be taken forward in the short to medium term, and sets objectives to be met by specified dates.

Defra and the Devolved Administrations are currently reviewing the Air Quality Strategy and plan to publish a draft for consultation during the winter. The revised strategy will focus on additional measures that work towards delivering air quality objectives. The review will also consider links to climate change, the concept of "exposure reduction" and an objective on $PM_{2.5}$.

2.3 LOCAL AIR QUALITY MANAGEMENT REVIEW AND ASSESSMENT

Under the Environment (Northern Ireland) Order 2002, District Councils in Northern Ireland are required to carry out a Review and Assessment of their local air quality. The process is set out in the Department of the Environment's Local Air Quality Management Policy Guidance LAQM PGNI(03).

All District Councils in Northern Ireland have now completed the first round of review and assessments of local air quality. Table 2.1 below provides a summary of the first round of review and assessment and the pollutants identified at each assessment stage.

Where as a result of a review it appears that air quality objectives are not being or are unlikely to be achieved there is a statutory requirement to declare an Air Quality Management Area (AQMA). AQMAs are designated officially by means of an "order".

Details of those Councils who have declared AQMAs are provided in Table 2.2. Eleven Councils have identified areas that are likely to exceed Air Quality Objectives, of which nine have now declared those areas as AQMAs. Limavady and Newry are still considering the outcome of their stage 3 assessments, and the need to declare an AQMA.

Table 2.2 provides further details of the AQMAs declared in Northern Ireland, including information on the source of the pollutants giving rise to the exceedences and the number of AQMAs specified. Further information on the exact location of the AQMAs is available from the respective Councils.

Table 2.1 Summary of 1st Round of Review and Assessment

Council	Stage 1 Pollutants	Stage 2 Pollutants	Stage 3 Pollutants	AQMA Declared ?
Antrim	PM_{10}, SO_2, NO_2	NO_2, SO_2	SO_2	Yes
Ards	CO, PM_{10}, NO_2, SO_2	PM_{10}, SO_2, NO_2	PM_{10}	Yes
Armagh	CO, Benzene PM_{10}, SO_2, NO_2	PM_{10}, SO_2	PM_{10}	
Ballymena	PM_{10}, SO_2, NO_2	PM_{10}, SO_2, NO_2	PM_{10}	Yes
Ballymoney	PM_{10}, SO_2, NO_2	PM_{10}, SO_2	PM_{10}	Yes
Banbridge	PM_{10}, NO_2, SO_2	PM_{10}	None	
Belfast	CO, PM_{10}, NO_2, SO_2, Lead	PM_{10}, SO_2	PM_{10}, NO_2	Yes
Carrickfergus	PM_{10}, SO_2, NO_2	PM_{10}, SO_2	PM_{10}	Yes
Castlereagh	CO, PM_{10}, NO_2, SO_2	PM_{10}, SO_2, NO_2	None	
Coleraine	PM_{10}, SO_2, NO_2	PM_{10}, SO_2	None	
Cookstown	PM_{10}, SO_2, NO_2	PM_{10}, SO_2	None	
Craigavon	PM_{10}, SO_2, NO_2	NO_2	None	
Derry City	PM_{10}, SO_2, NO_2	PM_{10}, SO_2, NO_2	NO_2	Yes
Down	PM_{10}, SO_2, NO_2		None	
Dungannon and South Tyrone	PM_{10}, SO_2, NO_2	NO_2	None	
Fermanagh	PM_{10}, SO_2, NO_2	PM_{10}	None	
Larne	PM_{10}, SO_2, NO_2	PM_{10}, SO_2, NO_2	None	
Limavady	PM_{10}, SO_2, NO_2	PM_{10}	PM_{10}	Under consider-ation
Lisburn	PM_{10}, SO_2, NO_2	PM_{10}, SO_2, NO_2	None	
Magherafelt	PM_{10}, SO_2, NO_2	PM_{10}, SO_2, NO_2	None	
Moyle	PM_{10}, SO_2	PM_{10}, SO_2	None	
Newry	PM_{10}, SO_2, NO_2	PM_{10}, SO_2, NO_2	PM_{10} and NO_2	Under Consider-ation
Newtownabbey	CO, PM_{10}, SO_2, NO_2, Lead	PM_{10}, SO_2, NO_2	PM_{10}	Yes
North Down	PM_{10}, SO_2, NO_2	PM_{10}, SO_2, NO_2	None	
Omagh	PM_{10}, SO_2, NO_2	PM_{10} , SO_2	None	
Strabane	PM_{10}, SO_2	PM_{10}	PM_{10}	Yes

Table 2.2 Details of Local Authority AQMA's

Council	Pollutant	Source	Date Declared	Number of AQMA's
Antrim	SO_2	Domestic	31/10/04	1
Ards	PM_{10}	Domestic	1/04/05	1
Ballymena	PM_{10}	Domestic	1/11/04	2
Ballymoney	PM_{10}	Domestic	1/08/05	1
Belfast	NO_2 & PM_{10}	Roads & Domestic	31/08/04	4
Carrickfergus	PM_{10}	Domestic	7/09/04	2
Derry	NO_2	Roads	21/02/05	1
Newtownabbey	PM_{10}	Domestic	26/10/04	1
Strabane	PM_{10}	Domestic	30/06/04	3

2.3.1 Air Quality Management Action Plans

District Councils, in conjunction with relevant authorities, are required under the Environment (NI) Order 2002 to prepare written action plans in pursuit of the achievement of air quality objectives in AQMAs. Relevant authorities are required to identify actions in pursuit of the achievement of air quality objectives so far as is compatible with their powers and functions. Relevant authorities include; DRD, DOE, DHSSPS, DETI, NIHE, the Northern Ireland Authority for Energy Regulation and District Councils.

Strabane District Council has submitted its final action plan to the Department for appraisal. Belfast City Council is currently finalising its action plan following a consultation exercise.

2.3.2 Local Air Quality Management Progress Reports

Statutory local air quality management progress reports were due to be submitted to the Department by April 2005. Progress reports are intended to check if there have been any changes in respect to all seven pollutants since the last round of the review and assessment process and to report on the development and implementation of Air Quality Action Plans. Progress reports have now been received by the Department from all District Councils.

2.3.3 Local Air Quality Grants

In 2004/05 £564,000 grant aid was provided by the Department to District Councils under the EU Building Sustainable Prosperity programme. The grant is specifically aimed at providing support to councils to carry out their statutory LAQM duties under the Environment (NI) Order 2002. For the 2004/05 financial year an element of the grant was introduced for the first time to provide support for staff costs.

2.3.4 The Second Round of Review and Assessment

The Department's policy guidance LAQMPG NI (03) sets out a revised two stage process that follows the first round of review and assessment.

Updating and Screening Assessment to identify those aspects that have changed since the first round of reviews and assessments. Lessons learnt from the first round that may require further assessment should be examined and stated. The updating and screening assessment should include an explanation of the conclusion reached as to whether the District Council should proceed to a detailed assessment or not.

Detailed Assessment of those pollutants and specific locations that have been identified as requiring further work – i.e. where an exceedence of an air quality objective is likely, and members of the public are likely to be exposed over the averaging period of the relevant air quality objective.

The timetable for the second round of review and assessment is set out in the Departments policy guidance LAQMPG NI(03). Update and screening reports are required to be submitted to the Department by April 2006.

2.4 MONITORING

For many years District Councils in Northern Ireland have continued to make a valuable contribution to national networks including the Automatic Urban and Rural Network (AURN), the Nitrogen Dioxide Network and Smoke and Sulphur Dioxide Network.

Defra and the Devolved Administrations have recently reviewed the non-automatic networks and have written to Councils to advise them of the changes. These include scaling down the Smoke and Sulphur Dioxide network to a much smaller smoke-only network of around 30 sites. The NO_2 Network in its current format will no longer exist, but there will be a web-based central data repository for diffusion tube data, and a centralised QA/QC programme for diffusion tube monitoring. District Councils will be encouraged to continue monitoring and reporting nitrogen dioxide results within this infrastructure.

No monitoring of metallic air pollutants was undertaken in Northern Ireland during 2004. The most recent study in the region (reported in the 2000-2001 report in this series) involved the monitoring of five metals; lead (Pb), cadmium (Cd), arsenic (As), nickel (Ni), and mercury (Hg), at three sites over a 12-month period, December 1999 to November 2000. This monitoring was carried out by Casella Stanger on behalf of the Department of Environment, Transport and the Regions (now Defra), as part of a study investigating ambient concentrations of these metals around industrial emission sources. The three sites were all located near to power stations or large industrial plant. The study concluded that, even in industrial locations, ambient concentrations of these metallic pollutants were unlikely to constitute a problem. Annual mean ambient lead concentrations at the three industrial sites ranged from 3 to 12 ng m^{-3}; well within the EC Limit Value, and AQS Objective (500 ng m^{-3} for the calendar year mean) which was to be met by the end of 2004.

2.5 QUALITY ASSURANCE AND QUALITY CONTROL

In the tables of site details in the subsequent sections of the report, sites belonging to the AURN and the Calibration Club will be indicated. (QA/QC procedures for Calibration Club sites are the same as for AURN sites, apart from supply of calibration gases. Data ratification is carried out on a 6-monthly basis).

Not all sites whose data are reported here belong to a larger network or to the Calibration Club, but it is assumed that in all cases the QA/QC specifications of the Technical Guidance[1] will have been followed.

3 Carbon Monoxide

Carbon monoxide (CO) is a pollutant gas generated by combustion sources. The dominant source is road transport, although domestic and other combustion processes contribute. At very high concentrations (such as may occur inside a building with a faulty heating appliance), it can be a dangerous asphyxiant. Whilst outdoor concentrations do not generally reach dangerous levels, they may still have adverse health effects for vulnerable people. As CO is a component of vehicle emissions, the highest outdoor concentrations occur near busy roads.

In this report, concentrations of carbon monoxide are expressed as milligrammes (i.e. 10^{-3} grammes) per cubic metre (mgm^{-3}). To convert to parts per million, if necessary, the following relationship should be used:

1 ppm = 1.16 mgm^{-3} for carbon monoxide at 293K (20°C) and 1013mb.

3.1 MONITORING OF CARBON MONOXIDE

CO is monitored at two sites in Northern Ireland. They are part of the Automatic Urban and Rural Network (AURN) and use the Non-Dispersive Infra Red (NDIR) continuous monitoring technique. The sites are listed in Table 3.1, and their locations are shown in Figure 3.1.

Table 3.1 CO Monitoring Sites

Site	Grid Reference	Classification	Network
Belfast Centre	J 339 744	Urban Centre	AURN
Londonderry (Brooke Park)	C 429 172	Urban Background	AURN

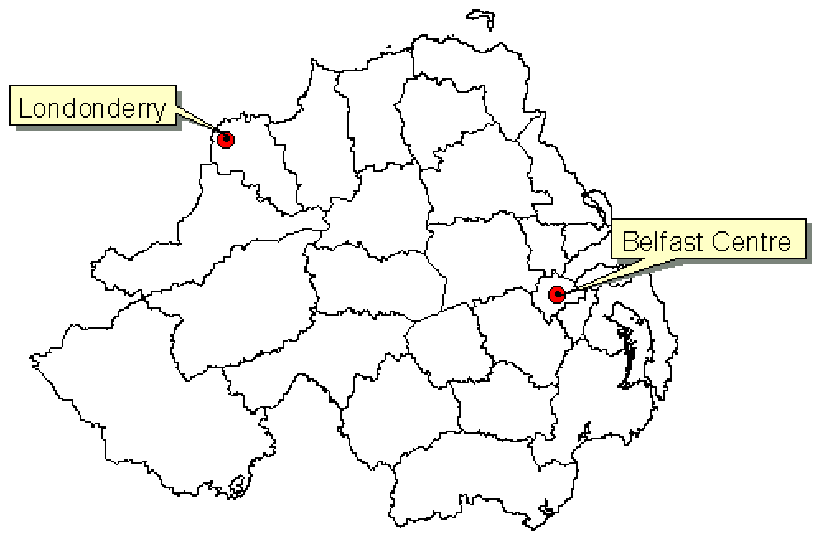

Figure 3.1 CO Monitoring Sites in Northern Ireland, 2004

Figure 3.2 shows the Belfast Centre automatic monitoring site at Lombard Street, a typical example of an automatic AURN site used to monitor CO and other pollutants.

Figure 3.2 Belfast Centre AURN Monitoring Site

3.2 LIMIT VALUES AND OBJECTIVES FOR CARBON MONOXIDE

The World Health Organisation has established non-mandatory air quality guidelines for carbon monoxide. Within the European Community, CO is covered by EC Directive 2000/69/EC (the 2nd Daughter Directive). In the UK, the Air Quality Strategy contains an objective for CO, to be met by 31st December 2003. (The term "maximum daily 8-hour running mean" just means that the 8-hour period can be any 8 hours during the day – the start and end times are not specified. It is identical to "maximum running 8-hour mean".)

Table 3.2 Limit Values and Objectives for Carbon Monoxide

Averaging period	EC Limit or AQS Objective	No. of Permitted exceedences	To be achieved by
WHO (non-mandatory)			
15-minute	100 mgm^{-3}	-	-
30-minute	60 mgm^{-3}	-	-
1-hour	30 mgm^{-3}	-	-
8-hour	10 mgm^{-3}	-	-
EC 2nd Daughter Directive (2000/69/EC)			
Max. Daily 8-hour mean	10 mgm^{-3} (8.6 ppm)	-	1st January 2005
Air Quality Strategy (as currently adopted in Northern Ireland)			
Max running 8-hour mean	10 mgm^{-3} (8.6 ppm)	-	31st December 2003

3.3 CARBON MONOXIDE RESULTS

The results from the CO measuring sites are shown in Table 3.3 below. Annual data capture is shown as a percentage. (The historic dataset is shown in Appendix 2).

Table 3.3 Results from Automatic CO Monitoring Sites, 2004

Calendar Year	Data Capture %	Annual Mean mg m^{-3}	Max running 8-Hour Mean mg m^{-3}	Number of Exceedences of EC Limit Value	Number of Exceedences of AQS Objective
Belfast Centre	96	0.2	2.8	0	0
Londonderry	97	0.3	1.4	0	0

Both sites have achieved the AQS Objective by the due date of 31st December 2003, and the EC 2nd Daughter Directive limit value by the due date of 1st January 2005.

3.4 CARBON MONOXIDE TRENDS

Figure 3.3 illustrates the falling trend in maximum 8-hour running mean CO concentration for the two sites. Peak CO concentrations at both sites have decreased since the mid 1990s, despite a slight increase in 2001.

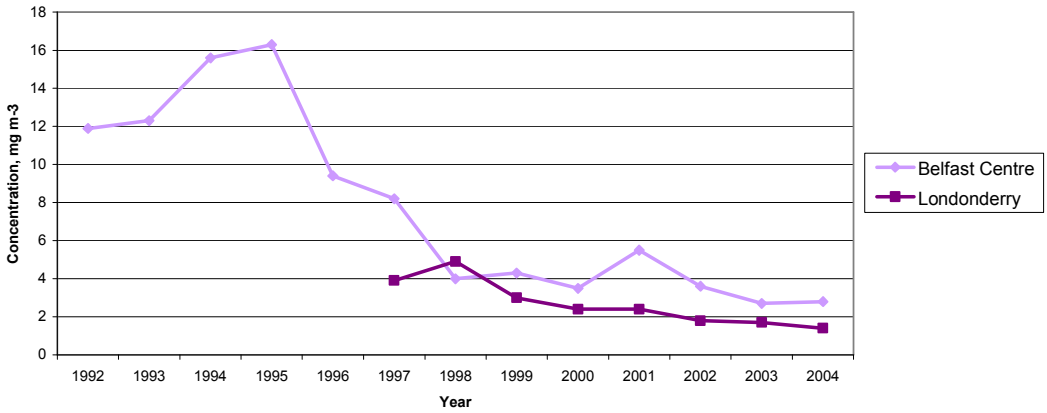

Figure 3.3 Maximum Running 8-hour Mean CO Concentration

4 Nitrogen Dioxide

Combustion processes (including vehicle engines) emit a mixture of nitrogen dioxide (NO_2) and nitric oxide (NO). This mixture of oxides of nitrogen is collectively termed NO_x. NO is subsequently oxidised to NO_2 in the atmosphere. NO_2 is an irritant to the respiratory system, and can affect human health. Ambient concentrations of NO_2 are likely to be highest in the most built-up areas, especially where traffic is congested, or buildings either side of the street create a "canyon" effect, impeding the dispersion of vehicle emissions.

In this report, concentrations of nitrogen dioxide are expressed as microgrammes (i.e. 10^{-6} grammes) per cubic metre ($\mu g\ m^{-3}$). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

1 ppb = 1.91 $\mu g\ m^{-3}$ for nitrogen dioxide at 293K (20°C) and 1013mb.

4.1 MONITORING OF NITROGEN DIOXIDE

Monitoring of NO_2 is carried out by two methods; automatic NOx analysers and NO_2 diffusion tubes. Automatic analysers are based on the chemiluminescent method, and provide continuous monitoring of NO, NO_2 and total NO_x. The results can be directly compared with air quality objectives based on short-term measurements such as the hourly mean. This technique is the reference method for the EC 1st Daughter Directive. However, this automatic equipment is expensive and is commonly supplemented by a low-cost indicative method, the diffusion tube. These are passive samplers, which work by absorbing the pollutant direct from the surrounding air and need no power supply. Tubes are exposed for periods of typically 2-5 weeks, providing an average result for the exposure period. Although diffusion tube data cannot be compared directly with air quality limit values based on short-term averages, the low cost of diffusion tubes means they can be used to give wide spatial coverage, and are useful for screening studies, identifying areas with high mean concentrations of NO_2, which can then be targeted for monitoring using more sophisticated techniques.

One new automatic NO_2 monitoring site, at Ballymena (North Road) started operation in 2004, taking the total number to fifteen. This new site, like most of those set up in recent years, is located at a roadside location, where levels of NO_2 are expected to be high. The sites are listed in Table 4.1, and their locations are shown in Figure 4.1. All of these sites use the chemiluminescent method.

Table 4.1 Automatic NO_2 Monitoring Sites

Site	Grid Ref.	Classification	Network
Armagh, Lonsdale Road	H 876 458	Roadside	Armagh
Ballymena, North Road	D 106 030	Roadside	Ballymena (CC)
Belfast Centre, Lombard Street	J 339 744	Urban Centre	AURN
Belfast Westlink	J 330 737	Roadside	Belfast (CC)
Belfast, Upper Newtownards Rd.	J 385 739	Roadside	Belfast (CC)
Castlereagh, Loughview Drive	J 357 707	Roadside	Castlereagh (CC)
Craigavon, Castle Lane	J 082 584	Roadside	Craigavon (CC)
Holywood	J 396 792	Roadside	North Down (CC)
Lisburn (Lagan Valley Hospital)	J 265 637	Roadside	Lisburn (CC)
Londonderry, Brooke Park	C 429 172	Urban Background	AURN
Londonderry, Dale's Corner	C 441 167	Roadside	Derry (CC)
Newry, Monaghan Row	J 078 268	Urban Background	Newry & Mourne (CC)
Newry, Trevor Hill	J 088 266	Roadside	Newry & Mourne (CC)
Newtownabbey, Sandyknowes	J 385 830	Roadside	Newtownabbey (CC)
Newtownabbey, Shore Road	J 347 804	Roadside	Newtownabbey (CC)

CC = Calibration Club sites.

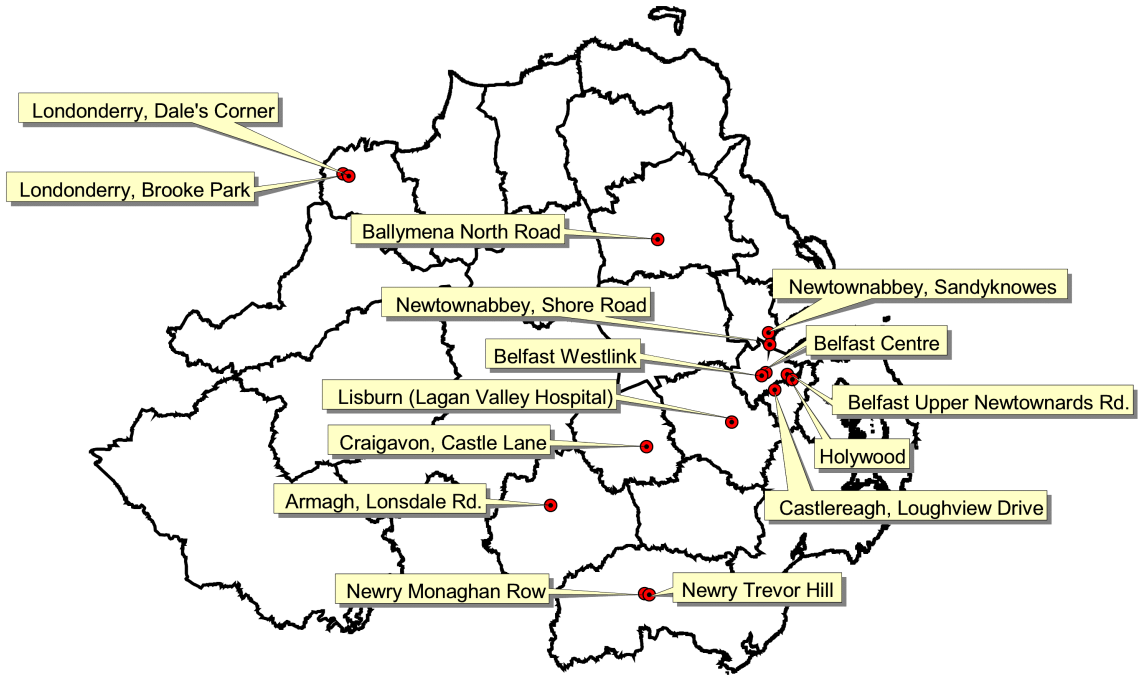

Figure 4.1 Automatic NO_2 Monitoring Sites 2004

The new site at Ballymena (North Road) is shown in Figure 4.2.

Figure 4.2 New Automatic Monitoring site for NO_x, Ballymena, North Road.

As mentioned above, many District Councils in Northern Ireland also carry out indicative monitoring of NO_2 using diffusion tubes, as pictured in Figure 4.3.

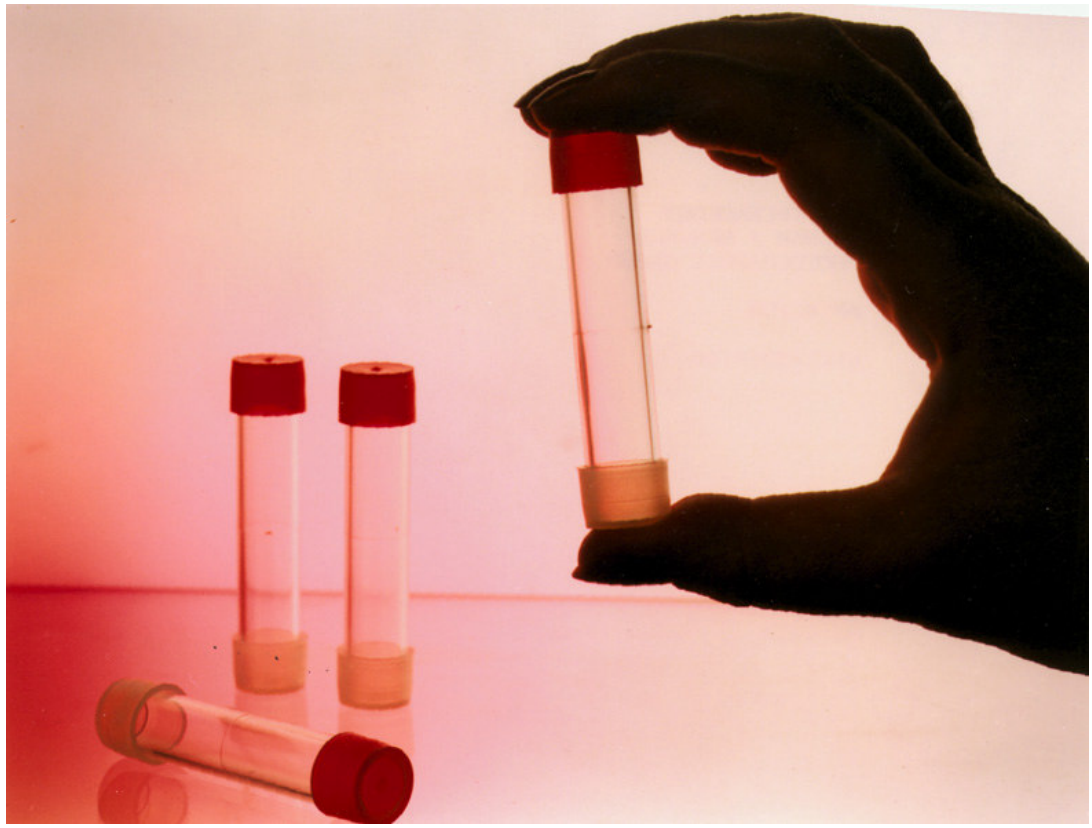

Figure 4.3 NO_2 Diffusion Tubes

District Councils usually operate several sites. Some District Councils participate in the national Nitrogen Dioxide Network, and submit monthly measurements from typically four locations within their area: two Roadside and two Urban Background. The total number of sites operated by each District Council, and the number belonging to the Nitrogen Dioxide Network, are listed in Table 4.2. The total number of NO_2 diffusion tube sites in 2004 was 276 (15 more than in 2003). As there are so many, full site details are provided in Appendix 1, Table A1.1.

Table 4.2 Diffusion Tube NO_2 Monitoring Sites 2004

District Council	Number of sites	Number belonging to NO_2 Network (as of 2004)
Antrim	6	0
Ards	6	4
Armagh	8	4
Ballymena	15	4
Ballymoney	9	4
Banbridge	4	4
Belfast	19	4
Carrickfergus	9	3
Castlereagh	5	3
Coleraine	12	0
Cookstown	5	0
Craigavon	8	4
Derry	33	4
Down	8	4
Dungannon	6	4
Fermanagh	6	0
Larne	8	0
Limavady	5	0
Lisburn	8	4
Magherafelt	7	0
Moyle	8	0
Newry & Mourne	9	4
Newtownabbey	48*	5
North Down	9	4
Omagh	10	0
Strabane	5	0
TOTAL	*276*	*63*

**Not all were operational throughout the whole year.*

NO_2 diffusion tube monitoring sites in Northern Ireland are categorised as follows:

- **(A) Roadside;** 1-5m from the kerb of a busy road.
- **(B) Intermediate;** 20-30m from the same or equivalent busy road. (This site type is now less widely used than in earlier years).
- **(C) Urban Background;** >50m from any busy road and typically in a residential area.
- **(D) Rural Background;** sites > 50m from any busy road, in a rural area.
- **(E) Other;** usually monitoring sites related to a specific industrial source.

Locations of the NO_2 diffusion tube monitoring sites in the Roadside category are shown in Figure 4.4, and NO_2 diffusion tube monitoring sites in other categories are shown in Figure 4.5. These figures show the locations of sites operating in 2004.

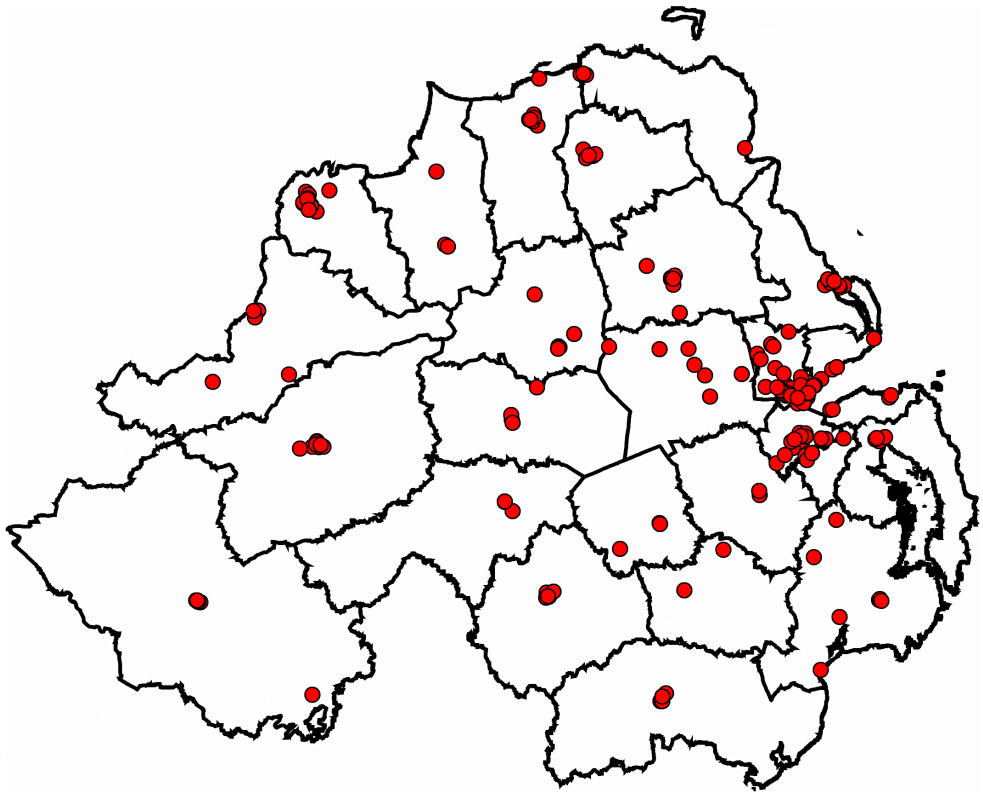

Figure 4.4 NO_2 Diffusion Tube Monitoring Sites 2004: Roadside

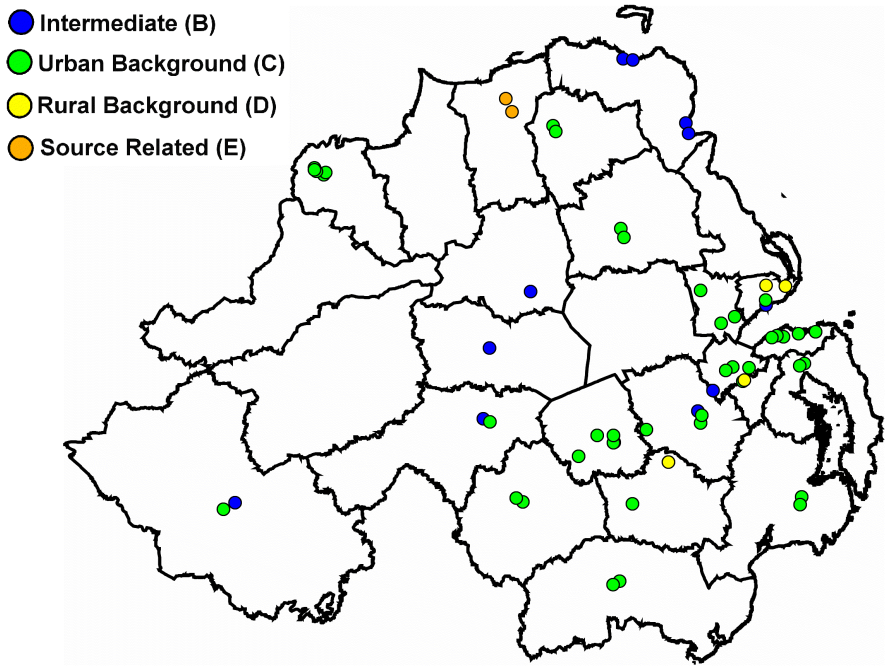

Figure 4.5 NO_2 Diffusion Tube Monitoring Sites 2004: Non-Roadside Categories

4.2 LIMIT VALUES AND OBJECTIVES FOR NITROGEN DIOXIDE

The World Health Organisation has set non-mandatory guide values for NO_2. Within Europe, NO_2 is covered by the 1st Daughter Directive, 1999/30/EC. In the UK, the Air Quality Strategy sets objectives for this pollutant, for protection of human health and ecosystems. Limit values and objectives for NO_2 are shown in Table 4.3.

Table 4.3 Limit Values and Objectives for Nitrogen Dioxide

Averaging period	EC Limit or AQS Objective	No. of Permitted exceedences	To be achieved by
WHO (non-mandatory)			
1 hour	200 μg m^{-3}	-	-
Annual Mean	40 μg m^{-3}	-	-
EC 1st Daughter Directive (1999/30/EC)			
1 hour	200 μg m^{-3}	18 per year	1st January 2010
Annual Mean	40 μg m^{-3}	-	1st January 2010
Annual Mean, for protection of vegetation	30 μg m^{-3} Total NOx	-	19th July 2001
Air Quality Strategy			
1 hour	200 μg m^{-3}	18 per year	31st December 2005
Annual Mean	40 μg m^{-3}	-	31st December 2005
Annual Mean, for protection of vegetation	30 μg m^{-3} Total NOx	-	31st December 2000

4.3 AUTOMATIC NITROGEN DIOXIDE RESULTS

Table 4.4 below shows NO_2 results from the automatic monitoring sites in Northern Ireland. To keep the table to a manageable size, only 2004 data are tabulated here: statistics for previous years are provided in Appendix 2. Table 4.4 shows the relevant parameters for comparison with the Air Quality Strategy Objectives:

(i) percentage data capture (based on hourly means) for the year
(ii) maximum one-hour mean
(iii) the 19th highest one-hour mean during the year (18 exceedences are permitted, so if the 19th highest 1-hour mean is 200 μg m^{-3} or less, the site meets the AQS 1-hour Objective for NO_2. Where the data capture is less than 90%, the 99.8th percentile of hourly means is shown instead, as specified by the Technical Guidance LAQM.TG(03)[1].
(iv) The number of hourly means greater than the hourly EC limit value and AQS Objective, i.e. 200 μg m^{-3}
(v) The annual mean, for which the EC limit value and AQS Objective is 40 μg m^{-3}.

Eleven of the 15 sites achieved at least 90% data capture for 2004. Only Ballymena North Road, Castlereagh Lough View Drive, Lisburn Lagan Valley Hospital and Londonderry Dale's Corner did not.

Two sites, Belfast Westlink and Londonderry Dale's Corner, recorded one or more maximum hourly mean NO_2 concentrations greater than the 1st Daughter Directive limit and AQS Objective of 200 μg m^{-3} for the hourly mean. However, only Belfast Westlink exceeded this objective more than the permitted 18 times during 2004, with a total of 20 exceedences. This is seven less than in 2003, but Belfast Westlink is clearly at risk of failing to meet the requirements of the objective in 2005.

Where data capture is less than 90%, it is not valid to simply count the total number of exceedences of the 1-hour objective. Instead, according to the Technical Guidance[1] the 99.8th percentile of 1-hour means should be compared with the 1-hour NO_2 objective itself (200 μg m^{-3}). On this basis, the sites with less than 90% data capture all appeared to meet the AQS Objective for 1-hour mean NO_2.

Comparison with the hourly mean objective is illustrated in Figure 4.6 and 4.7. Figure 4.6 shows hourly mean data, compared with the AQS 1-hour objective of 200 μg m^{-3}. The graph shows the maximum 1-hour mean and 19th highest (or 99.8th percentile where data capture is less than 90%) as bars, with the AQS Objective of 200 μg m^{-3} as horizontal line. A maximum of 18 exceedences of this objective are permitted in any one calendar year, so if the 19th highest 1-hour mean is greater than this value, the site has not met the objective in 2004. Figure 4.7 shows the actual number of 1-hour means which were greater than 200 μg m^{-3}, compared with the maximum permitted total (18 per calendar year) as a horizontal line.

Table 4.4 NO_2 Results from Automatic Monitoring Sites, 2004

Site	2004 Data Capture %	Highest 1-Hour Mean μg m^{-3}	19th Highest 1-hour mean (or 99.8th percentile of hourly means if DC < 90%)	No. of 1-hour means > 200 μg m^{-3}	Annual Mean μg m^{-3}	Annual Mean > 40 μg m^{-3} ?
Armagh Lonsdale Road	98	117	< 200	0	32	No
Ballymena North Road	42	199	156	0	40	No
Belfast Centre	92	153	105	0	28	No
Belfast - Newtownards Road	92	156	115	0	**42**	**Yes**
Belfast – Westlink	92	231	201	**20**	**46**	**Yes**
Castlereagh - Loughview Drive	89	128	99	0	26	No
Craigavon – Castle Lane	95	86	69	0	16	No
Holywood	96	128	97	0	23	No
Lisburn – Lagan Valley Hospital	88	128	111	0	27	No
Londonderry - Brooke Park	92	86	69	0	15	No
Londonderry - Dale's Corner	72	747	159	9	**45**	**Yes**
Newry - Monaghan Row	97	86	76	0	15	No
Newry -Trevor Hill	98	197	125	0	32	No
Newtownabbey - Sandyknowes	94	189	124	0	31	No
Newtownabbey - Shore Road	91	159	113	0	29	No

Three sites measured 2004 annual mean NO_2 concentrations greater than the AQS Objective of 40 μg m^{-3} (to be met by 2005). These were all roadside sites; Belfast Westlink, Belfast Newtownards Road, and Londonderry Dale's Corner. There is a risk that these three sites may not meet the AQS Objective for annual mean NO_2 by the due date of 31st December 2005.

One further site, Ballymena North Road, had an annual mean NO_2 concentration of 40 μg m^{-3} exactly. This site may therefore be considered "borderline" with respect to the AQS annual mean Objective for NO_2. However, data capture for 2004 was low (42%), and the majority of the data obtained were from the winter months, when NO_2 concentrations are often higher. Available data from 2005 so far (January to September) indicate that the 2005 annual mean will probably be less than 40 μg m^{-3}.

Figure 4.8 shows the annual mean NO_2 concentration at each site, compared with the AQS Objective of 40 μg m^{-3} for this parameter.

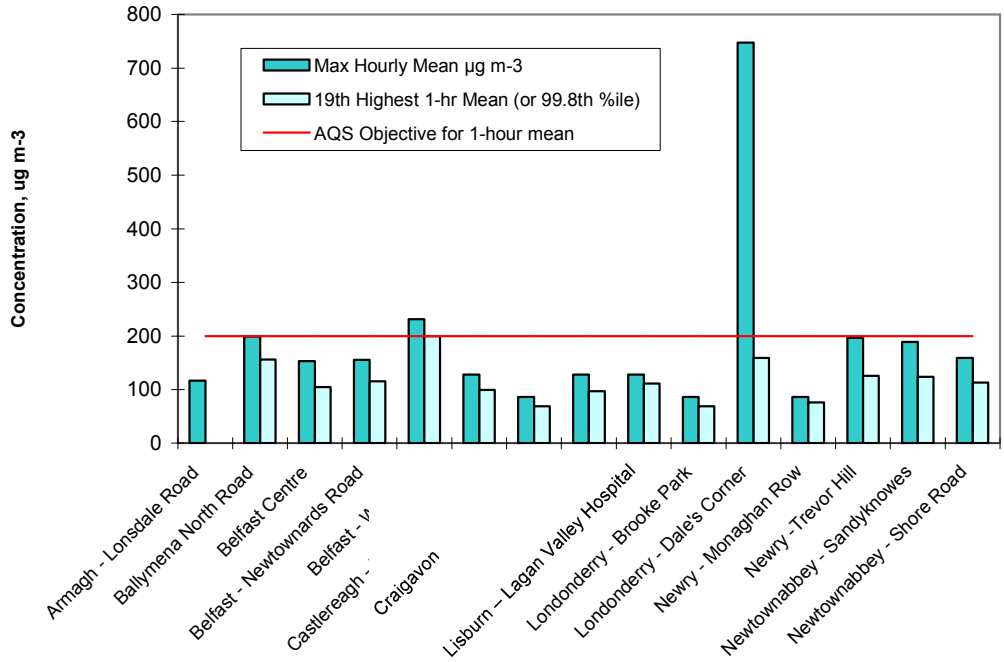

Figure 4.6 Comparison of 1-hour Mean NO_2 Concentrations (2004) with AQS 1-hour mean Objective. *Figure 4.6 shows the maximum hourly mean and the 19th highest hourly mean (or the 99.8th percentile of hourly means in cases where data capture was less than 90%). If the latter (shown by the lighter coloured bar) is greater than 200µg m^{-3}, the site has exceeded the objective, on more than the 18 permitted occasions. This was the case for just one site – Belfast Westlink, where the 19th highest hourly mean was 201 µg m^{-3}.*

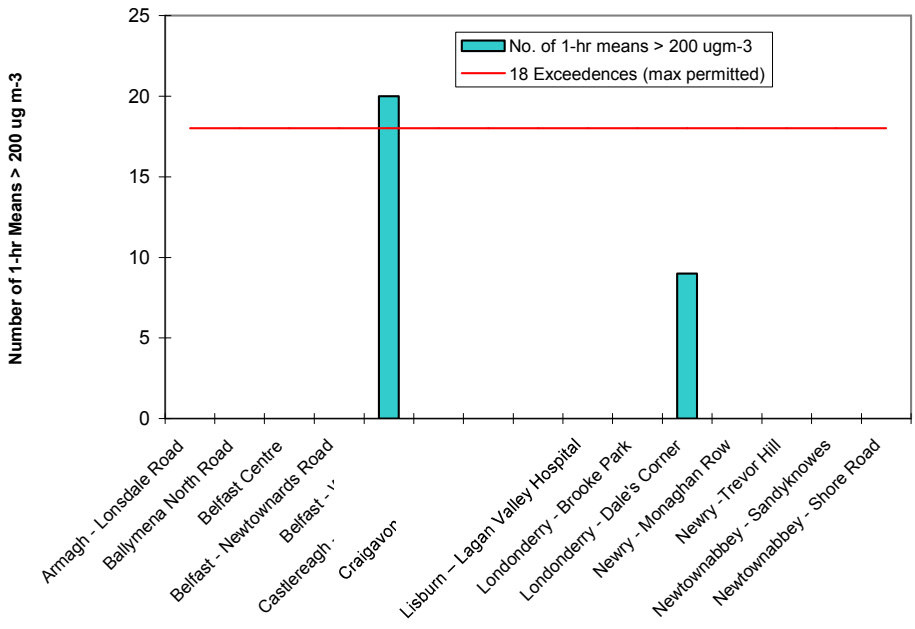

Fig. 4.7 Number of Exceedences of AQS Objective for 1-hour mean NO_2 Concentration. *Figure 4.7 shows the actual number of exceedences of the AQS Objective at each site during 2004. A maximum of 18 exceedences is permitted: one site (Belfast Westlink) had 20.*

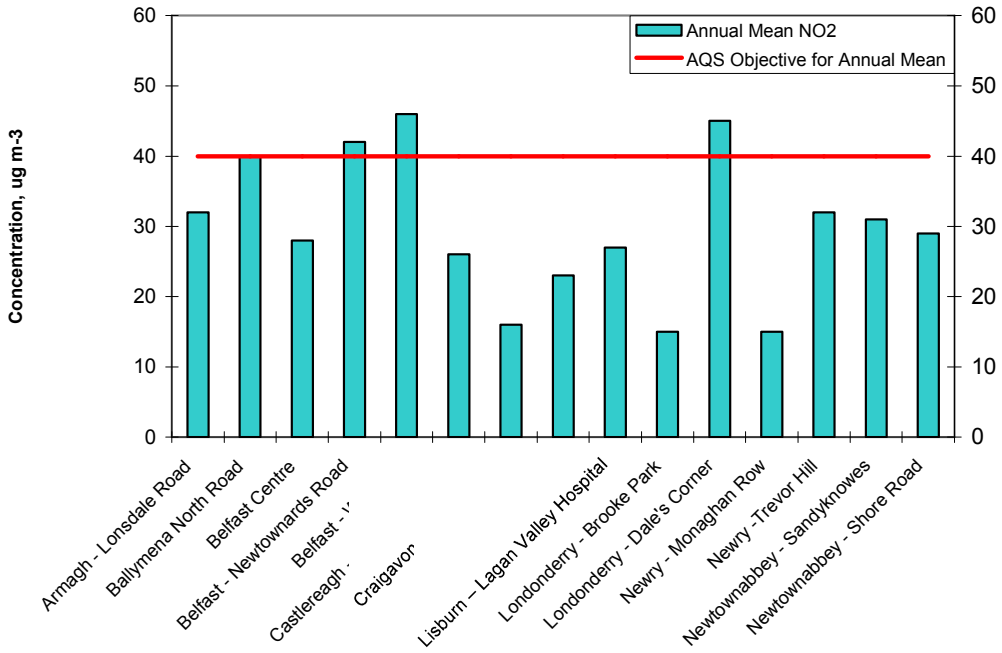

Figure 4.8 Comparison of Annual Mean NO_2 from Automatic Sites 2004 with AQS Objective. *Figure 4.8 shows that three sites exceeded the annual mean objective of 40 µg m^{-3} during 2004.*

The Technical Guidance LAQM.TG(03) provides a method for estimating annual mean NO_2 concentrations for future years at roadside sites (Box 6.6 of LAQM.TG(03)). Using this approach, it is predicted that any roadside site with a 2004 annual mean NO_2 concentration greater than 49.8 μg m^{-3} is likely to exceed the AQS Objective of 40 μg m^{-3} in 2010. This is not the case for any sites in Northern Ireland; however prediction methods such as this should be used with caution as they are based on UK-wide trends which may not be applicable at all sites.

The EC and AQS vegetation protection limit of 30 μg m^{-3} total NO_x is not applicable to any of the above sites, as they are all in built up areas.

4.4 DIFFUSION TUBE NITROGEN DIOXIDE RESULTS

4.4.1 Analysis of Bias-Adjusted Data

Diffusion tubes frequently exhibit bias (over- or under-read) relative to the chemiluminescence analyser (which has been defined as the reference technique for NO_2), and when using diffusion tubes in Local Air Quality Review and Assessment, the Technical Guidance LAQM.TG(03) states that it is necessary to correct for any such bias. This is usually done by co-locating diffusion tubes alongside an automatic NO_2 monitoring site for a minimum period of nine months: by comparing diffusion tube and automatic measurements of NO_2 from the site, it is possible to establish a "bias adjustment factor" (BAF), as set out in Box 6.4 of the Guidance. This is then applied to the annual mean diffusion tube measurements from the other sites in the survey. (It should be noted that diffusion tube bias can vary from site to site and month to month, so bias adjustment can only be approximate).

The Local Authorities who supplied the diffusion tube data presented in this report were asked to identify the laboratory used for supply and analysis of their diffusion tubes, and also to supply a bias adjustment factor, if possible. This allows us to carry out an analysis of bias-adjusted NO_2 diffusion tube data. If no bias adjustment factor was supplied by the Local Authority, we have used

either a combined bias adjustment factor (BAF) for the specified laboratory, from the Review and Assessment Website at http://www.uwe.ac.uk/aqm/review/diffusiontube240904.xls or, failing this, the factor reported by another Local Authority using the tubes from the same laboratory.

A substantial proportion of District Councils in Northern Ireland used tubes from the Ruddock and Sherratt laboratory during 2004. Unfortunately, none of them (as far as we are aware) carried out co-location studies using these tubes, so none have supplied their own BAF. Nor is there a combined BAF for Ruddock and Sherratt available via the Review and Assessment Website. Ruddock and Sherratt did not participate monthly in the NO_2 Network Field Intercomparison, opting instead to participate quarterly – the minimum for Network QA/QC. Therefore there is no valid BAF from this co-location study either; as stated above, a minimum of 9 months' data are required for a valid bias adjustment factor.

In the absence of a valid BAF (based on at least 9 months' co-location data) for Ruddock and Sherratt's diffusion tubes, we have calculated a BAF based on the four months' data available from Ruddock and Sherratt's quarterly participation in the Field Intercomparison. The value obtained, 1.15, is consistent with earlier years' results, which indicate that diffusion tubes from this laboratory tend to under-estimate, relative to the reference method (chemiluminescence analyser). (Note: Ruddock and Sherratt no longer analyse diffusion tubes in-house, as of January 2005).

Table 4.5 shows the average concentrations as measured by diffusion tubes, for each site type.

Table 4.5 Average NO_2 Concentrations in Northern Ireland Measured by Diffusion Tubes

Site Type	**Number of sites with valid annual mean, 2004:**	**Average NO_2, 2004 $\mu g\ m^{-3}$** Not Adjusted for Bias	**Average NO_2, 2004 $\mu g\ m^{-3}$** Bias Adjusted
A (Roadside)	194	24	27
B (Intermediate)	11	16	19
C (Urban Background)	42	16	18
D (Rural Background)	4	10	12
E (Other: Source-related)	2	6	7

The application of BAFs has scaled up some site's results, while scaling down others. The overall effect of this on the average of all Northern Ireland sites' results has been to scale the results up (i.e. the diffusion tubes used by many District Councils in Northern Ireland have a tendency to under-read). However, the lack of a reliable BAF for Ruddock and Sherratt, who analysed 28% of all NO_2 diffusion tubes used in Northern Ireland in 2004, means that the bias adjusted averages above should be treated with caution.

Bias-adjusted annual mean NO_2 concentrations for 2004 have been compared with the AQS Objective of 40 $\mu g\ m^{-3}$. During 2004, 22 sites had annual mean NO_2 concentrations greater than the EC Directive limit and AQS Objective of 40 $\mu g\ m^{-3}$. All but two were Roadside (type A), and are shown in Table 4.6. All these sites can be considered at risk of exceeding the AQS annual mean objective of 40 $\mu g\ m^{-3}$ in 2005.

Table 4.6 Diffusion Tubes Sites with Annual Mean NO_2 Concentrations greater than 40 $\mu g\ m^{-3}$ (after application of Bias Adjustment Factors)

District Council	Location of Sampler	Site Classification	Unadjusted Annual mean NO_2 for 2004, $\mu g\ m^{-3}$	Bias Adjusted Annual Mean NO_2 for 2004, $\mu g\ m^{-3}$
Derry	No 3 Creggan Road, Derry	A	44	**53**
Newry & Mourne	20a Water Street, Newry	A	45	**53**
Cookstown	William Street, Cookstown	B	42	**51**
Belfast	Great George's Street	A	40	**51**
Carrickfergus	Model PS 4 Belfast Road Carrickfergus	A	42	**49**
Newtownabbey	North End, Ballyclare	A	40	**48**
Limavady	Jct. of Ballyquin Rd/Main St, Dungiven	A	50	**48**
Ballymena	George Street, Ballymena	A	39	**47**
Belfast	Cromac Street (A)	A	37	**47**
Derry	5 Collon Terrace	A	38	**46**
Newry & Mourne	Kilmorey St	A	39	**46**
Magherafelt	Church Street, Magherafelt	A	37	**45**
Belfast	Victoria Street nr jct. W. High Street	A	35	**44**
Belfast	Westlink, near Grosvenor Rd rd.about	A	35	**44**
Magherafelt	Queen Street, Magherafelt	A	36	**44**
Belfast	Belfast City Hall, Donegall Sq South	A	34	**43**
Belfast	East Bridge Street	A	34	**43**
Belfast	Jct East Bridge Street / Short Strand	A	34	**43**
Derry	27 Park Avenue	C	35	**42**
Armagh	Mallview Terrace	A	55	**41**
Belfast	Milner Street	A	32	**41**
Belfast	Stockman's Lane	A	32	**41**

All sites in this table except three (those operated by Armagh, Carrickfergus and Limavady) have their tubes analysed by laboratories for which a reliable 2004 bias adjustment factor is available, either from the District Council's own co-location study, from the Review and Assessment website, or the NO_2 Network Field Intercomparison co-location study.

As observed previously, exceedences of the annual mean limit for NO_2 are not restricted to large urban centres, but may also occur also at roadside locations in smaller towns and cities with frequent heavy or waiting traffic, or street "canyon" effects.

Using the approach set out in (Box 6.6) of LAQM.TG(03) annual mean NO_2 concentrations for 2010 can be estimated using current results. In the case of roadside sites, the 2010 annual mean is predicted to exceed 40 $\mu g\ m^{-3}$ if the 2004 annual mean is greater than 49.8 $\mu g\ m^{-3}$. Just four sites fall into this category. However, these predictions can only be approximate, as diffusion tubes are only considered an indicative technique.

4.4.2 Diffusion Tube QA/QC Issues in 2004

An important part of the work of the NO_2 Network is the co-ordination of a centralised QA/QC scheme, for the laboratories that supply and analyse the diffusion tubes used by the participating Local Authorities. Any laboratory providing diffusion tube analysis for the NO_2 Network must demonstrate satisfactory performance in the Network's QA/QC programme.

Full details of this programme are given in Appendix A of the NO_2 Network report for 2003[2], but briefly, the two main testing programmes are as follows:

- **The Workplace Analysis Scheme for Proficiency (WASP) programme for NO_2 diffusion tube analysis.** This is an analytical performance testing scheme, operated independently by

the Health and Safety Laboratory (HSL). Participating laboratories are sent artificially doped diffusion tubes to analyse, on a monthly basis. This is a test of each laboratory's analytical performance.

- **The Field Intercomparison Exercise.** This complements the WASP scheme above, by testing not only the laboratories' analytical performance, but also how their tubes perform under actual exposure conditions (in terms of precision and accuracy). Three diffusion tubes per month, from each laboratory, are exposed simultaneously, co-located with a Defra AURN monitoring site. The tubes are returned to the laboratories for analysis after exposure. The results obtained by the laboratories are compared with the monthly mean concentration measured by the automatic analyser at the site, which provides a reference measurement, with which the diffusion tube results can be compared. In addition to its QA/QC function, the results from this co-location study can be used to calculate bias adjustment factors (see below).

The majority of District Councils in Northern Ireland who used diffusion tubes in 2004 obtained their tubes from one of two suppliers: Ruddock and Sherratt, and Lambeth Scientific Services. Together, these two laboratories supplied over 92% of all the NO_2 diffusion tubes used in Northern Ireland during 2004.

Unfortunately, neither of these two laboratories met the performance criteria set for the NO_2 Network in 2004. These were as follows:

- Ruddock and Sherratt, who failed to meet the required performance criteria in the Field Intercomparison because their results showed too much variation in comparison to the reference method.
- Lambeth Scientific Services, who failed to meet the required performance criteria of the WASP scheme, as they missed five of the twelve monthly rounds. It should be noted that this failure was on the grounds of insufficient participation in the QA/QC scheme, rather than the quality of their analyses.

4.5 NITROGEN DIOXIDE TRENDS

Emission inventory data from the National Atmospheric Emissions Inventory at www.naei.org.uk show that total estimated UK emissions of NOx have decreased by 43% between 1989 and 2000. This is attributed to a substantial decrease in emissions from road vehicles and from power stations. These figures relate to the whole UK, but as vehicle emissions account for 60% of Greater Belfast's total NOx emissions[3], a downward trend in ambient NO_2 in Northern Ireland would also be expected. Indeed the previous reports in this series have identified a significant downward trend in ambient concentrations of NO_2 at Belfast Centre.

4.5.1 Trends at Automatic Nitrogen Dioxide Sites

Figure 4.9 shows how annual mean NO_2 concentrations have changed at the automatic sites in Northern Ireland. It is generally considered that at least five years' data are required in order to assess trends in air quality. Although there are 15 automatic monitoring sites in Northern Ireland, only two have been in operation for at least five years; the Belfast Centre and Londonderry AURN sites. These are shown in Figure 4.9. Also shown are Newry Monaghan Row and Newry Trevor Hill, which have both been in operation for three years; no other sites have more than two consecutive valid annual means. Regression analysis (Theil's non-parametric analysis) shows a significant downward trend (at the 95% confidence level) in annual mean NO_2 concentration at Belfast Centre, but not at Londonderry.

The previous report in this series highlighted an increase in 2003, which reflected the increase in mean NO_2 concentration observed throughout the UK during that year, by both automatic and non-automatic monitoring networks. In 2004, NO_2 concentrations have decreased.

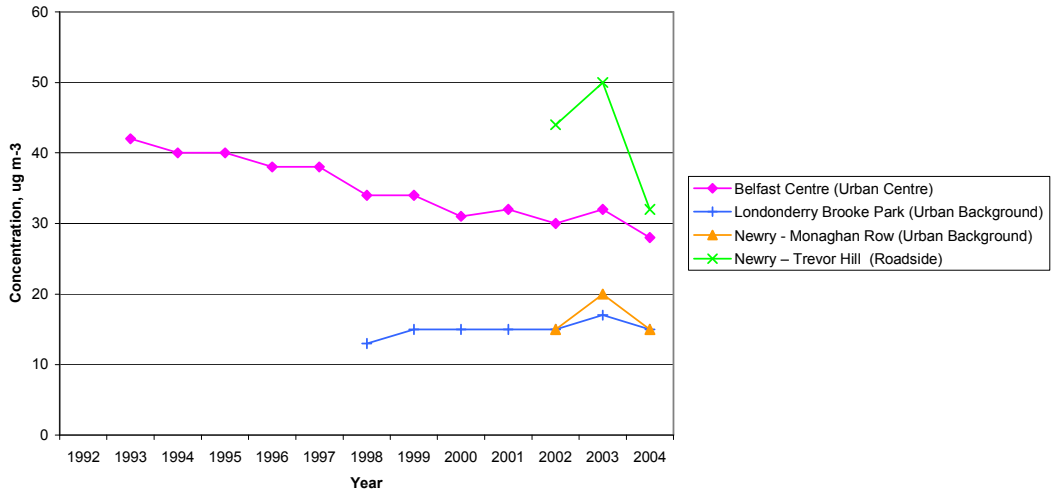

Figure 4.9 Annual Mean NO_2 Concentrations at Automatic Monitoring Sites (data capture at least 75%)

4.5.2 Trends at Diffusion Tube Nitrogen Dioxide Sites

Around 25% of the NO_2 diffusion tube sites operated by District Councils in Northern Ireland are also part of the NO_2 Network. (The proportion was higher in previous years, but has been reduced by the large number of new sites which began operation in 2002, most of which were set up for local monitoring purposes and are not part of the Network). One of the objectives of this Network is to investigate long-term trends in concentrations of this pollutant.

Table 4.7 shows annual mean NO_2 concentrations for Northern Ireland, based on data from the NO_2 Network. These statistics are based upon the Network sites only, for two reasons: firstly, very few of the non-Network sites have long-term datasets available, and secondly, the Network sites as a group are intended to be representative of Northern Ireland. By contrast many non-Network sites are located where NO_2 is known or suspected to be high.

The data in Table 4.7 are not bias-adjusted. In previous years, reliable bias adjustment has not been possible as there has been insufficient information: therefore, in order to compare like with like, uncorrected 2004 data are used in this investigation of trends.

Table 4.7 Average NO_2 Concentrations, NO_2 Network Diffusion Tube Sites in Northern Ireland (NOT bias-adjusted)

Year	Average Roadside $\mu g\ m^{-3}$	Average Intermediate $\mu g\ m^{-3}$	Average Urban Background $\mu g\ m^{-3}$
1993	38	24	19
1994	40	25	19
1995	42	24	18
1996	40	21	18
1997	36	20	16
1998	36	20	13
1999	33	21	14
2000	29	19	13
2001	27	-	14
2002	27	-	14
2003	27	-	14
2004	27[1]	-	13[2]

Footnotes:
*1 – the unadjusted annual mean for **all** roadside sites in NI was 24 µg m^{-3}*
*2 - the unadjusted annual mean for **all** urban background sites in NI was 16 µg m^{-3}*
The Intermediate site category ceased in 2000.

Average concentrations appear to have fallen since the mid 1990s. Regression analysis shows that this downward trend in average NO_2 concentration is significant (with 95% confidence limit) for all three site categories. However, average NO_2 concentrations appear to have remained stable in recent years, with the unadjusted mean roadside NO_2 concentration remaining at 27 $\mu g\ m^{-3}$ since 2001, and the unadjusted mean urban background concentration remaining between 13 and 14 $\mu g\ m^{-3}$ since 1999.

5 Sulphur Dioxide

Sulphur dioxide (SO_2) is formed during the combustion of fuels containing sulphur. Nationally, the most significant source of this pollutant is fossil fuelled power generation. In Northern Ireland, domestic solid fuel and oil burning has historically been a major source of SO_2, though this has decreased in recent years. Sulphur dioxide is a respiratory irritant, and is toxic at high concentrations. It is also damaging to ecosystems and a major precursor in the formation of acid rain.

In this report, concentrations of sulphur dioxide are expressed as microgrammes per cubic metre ($\mu g\ m^{-3}$). To convert to parts per billion (ppb) if necessary, the following relationship should be used: 1 ppb = 2.66 $\mu g\ m^{-3}$ for sulphur dioxide at 293K (20°C) and 1013mb.

5.1 MONITORING OF SULPHUR DIOXIDE

Monitoring of SO_2 is carried out by three methods: continuous automatic analysers, the non-automatic net acidity method (using the 8-port sampler) and diffusion tubes. Automatic analysers (based on the Ultraviolet Fluorescence method, which is the reference method for the EC 1st Daughter Directive, 1999/30/EC) provide continuous monitoring of SO_2, and the data can be compared with air quality limit values and objectives based on short-term and longer averaging periods. Two new automatic SO_2 monitoring sites started operation in Northern Ireland during 2004, at Antrim (Greystone Estate) and Cookstown. This brings the total to nineteen. These are listed in Table 5.1 and their locations are shown in Figure 5.1:

Table 5.1 Automatic SO_2 Monitoring Sites

Site	Grid Reference	Classification	Network
Antrim, Greystone Estate	J168 861	Urban Background	Antrim (CC)
Ards, Glen Estate	J487 747	Urban Background	Ards (CC)
Armagh, Dobbin Street	H877 450	Urban Background	Armagh (CC)
Ballymena, Ballykeel	D120 026	Urban Background	Ballymena (CC)
Bangor	J 498 810	Urban Background	North Down (CC)
Belfast Centre, Lombard Street	J339 744	Urban Centre	AURN
Belfast East, Templemore Ave	J357 740	Urban Background	AURN
Carrickfergus, Rosebrook Ave	J411 882	Urban Background	Carrickfergus (CC)
Castlereagh, Espie Way	J373 720	Urban Background	Castlereagh (CC)
Cookstown	H812 722	Urban Background	Cookstown
Craigavon, Lord Lurgan Park	J079 592	Urban Background	Craigavon (CC)
Dungannon	H802 635	Urban Background	Dungannon
Larne – Larne Harbour	D414 016	Urban Background	Larne (CC)
Lisburn Island Civic Centre	J274 643	Urban Background	Lisburn (CC)
Londonderry, Brooke Park	C429 172	Urban Background	AURN
Londonderry Brandywell	C428 163	Urban Background	AURN affiliated
Newry, Monaghan Row	J078 268	Urban Background	Newry & Mourne (CC)
Newry, Trevor Hill	J088 266	Roadside	Newry & Mourne(CC)
Strabane, Springhill Park	H 351 972	Urban Background	Strabane (CC)

CC = Calibration Club member

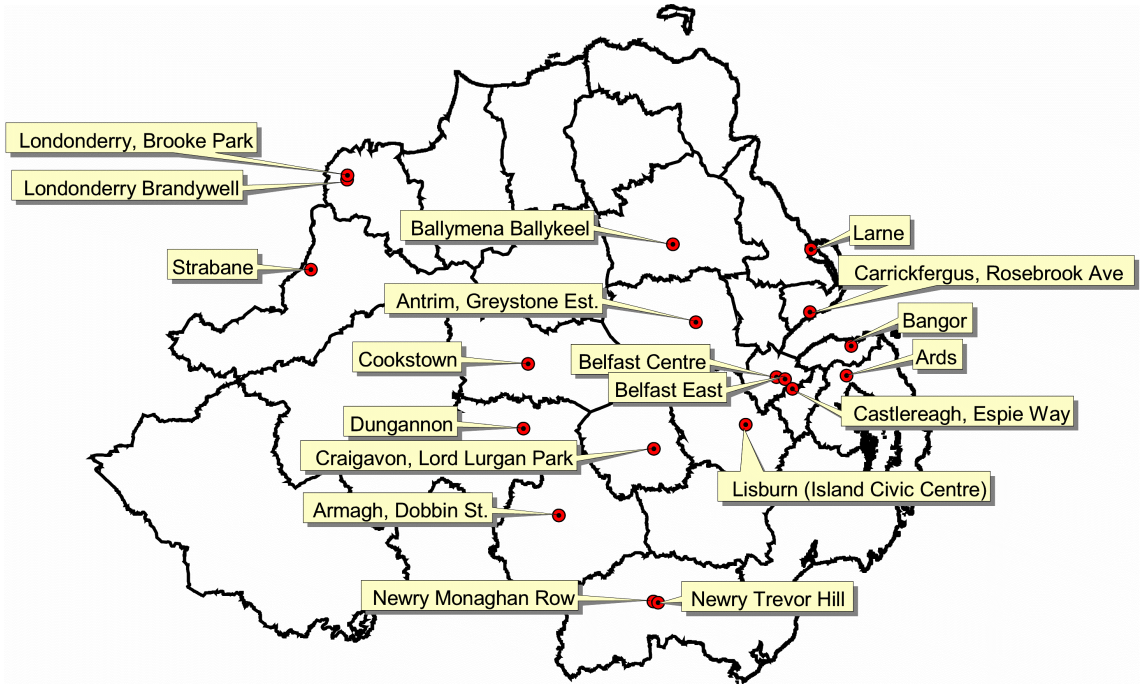

Figure 5.1 Automatic SO_2 Monitoring Sites

One of the new automatic SO_2 monitoring sites is located at Antrim. This urban background site is shown in Figure 5.2.

Figure 5.2 Automatic SO_2 Monitoring Site at Antrim

Despite the recent increase in the number of automatic monitoring sites, the traditional 8-port sampler remains widely used throughout Northern Ireland as an indicative method for measurement of SO_2, together with suspended particulate matter as black smoke (see Section 6). This technique technically measures total net acidity rather than sulphur dioxide, and is therefore not specific to SO_2. A typical 8-port sampler is shown in Figure 5.3.

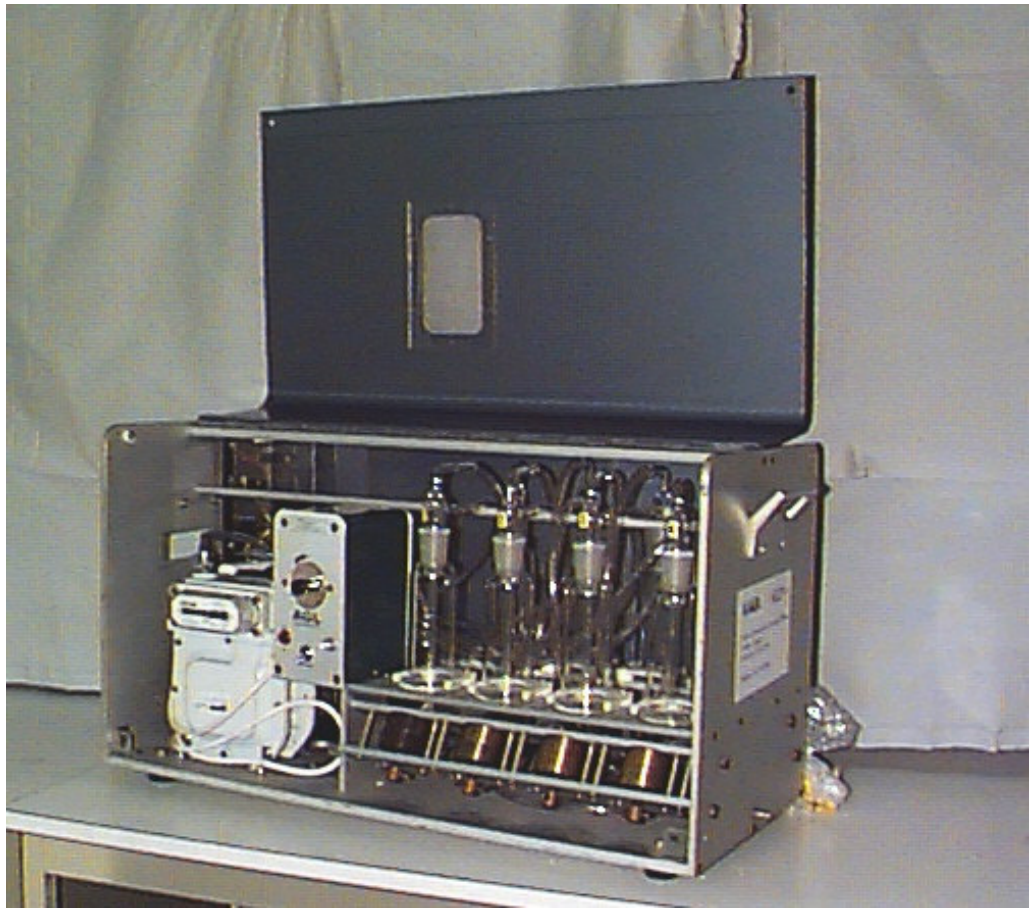

Figure 5.3 8-port Sampler for Smoke and SO_2

This non-automatic method samples on a 24-hour basis, so results are not suitable for comparison with air quality objectives based on shorter periods. However, it has been in widespread use since the early 1960's, so there is an extensive historical dataset which can be used to assess trends. During 2004, there were 33 urban smoke and SO_2 monitoring sites operating in Northern Ireland, all but three belonging to the Smoke and SO_2 Network. A further two sites (Bentra and Fermoyle) were part of the Rural SO_2 Network, monitoring SO_2 only (with analysis by ion chromatography rather than the net acidity method), and one other site monitoring smoke. These are shown in Table 5.2 and Figure 5.4.

The Smoke and SO_2 Network is to cease operation at the end of 2005 although some district councils may wish to continue monitoring independently.

Table 5.2 Non-Automatic Smoke and SO_2 Monitoring Sites

Site name	Grid Ref.	District Council	Network
ANTRIM 1	J 162869	Antrim	Smoke & SO_2
BALLYMENA 5	D 109 053	Ballymena	Smoke & SO_2
BALLYMENA 6	D 120 026	Ballymena	Smoke & SO_2
BALLYMONEY 4	C 954 259	Ballymoney	Smoke & SO_2
BELFAST 12	J 324 737	Belfast	Smoke & SO_2
BELFAST 13	J 357 740	Belfast	Smoke & SO_2
BELFAST 33	J 346 755	Belfast	Smoke & SO_2
BELFAST 42	J 322 748	Belfast	Smoke & SO_2
BELFAST 44	J 338 740	Belfast	Smoke & SO_2
BELFAST 45	J 335 723	Belfast	Smoke & SO_2
BELFAST 46	J 385 796	Belfast	Smoke & SO_2
PORTADOWN 6	J 004 548	Craigavon	Smoke & SO_2
LONDONDERRY 14	C 443 174	Derry	Smoke & SO_2
DUNGANNON 1	H 802 629	Dungannon	Smoke & SO_2
LARNE 4	D 386 037	Larne	Smoke & SO_2
LARNE 5	D 401 033	Larne	Smoke & SO_2
DUNMURRY 3	J 287 875	Lisburn	Smoke & SO_2
LISBURN 3	J 263 636	Lisburn	Smoke & SO_2
TWINBROOK 1	J 281 689	Lisburn	Smoke & SO_2
MAGHERAFELT 1	H 896 901	Magherafelt	Smoke & SO_2
NEWRY 3	J 078 268	Newry and Mourne	Smoke & SO_2
NEWTOWNABBEY 3	J 321 851	Newtownabbey	Smoke & SO_2
NEWTOWNABBEY 4	J 283 907	Newtownabbey	Smoke & SO_2
BANGOR (CO DOWN) 5	J 497 810	North Down	Smoke & SO_2
HOLYWOOD 1	J 397 784	North Down	Smoke & SO_2
STRABANE 2	H 351 972	Strabane	Smoke & SO_2
NEWTOWNSTEWART *	H 400 855	Strabane	Strabane
COLERAINE 3	C 861 328	Coleraine	Smoke & SO_2
BUSHMILLS 2	C 940 407	Moyle	Smoke & SO_2
NEWTOWNARDS	J 481 736	Ards	Local Auth.
NEWCASTLE	J 377 317	Down	Local Auth.
COLERAINE (Pates Lane)	C 844 323	Coleraine	Local Auth.
BENTRA	J 458 923	Defra	Rural SO_2
FERMOYLE	C 767 291	Defra	Rural SO_2

(Rural SO_2 sites monitor SO_2 only, not smoke.)
* smoke only

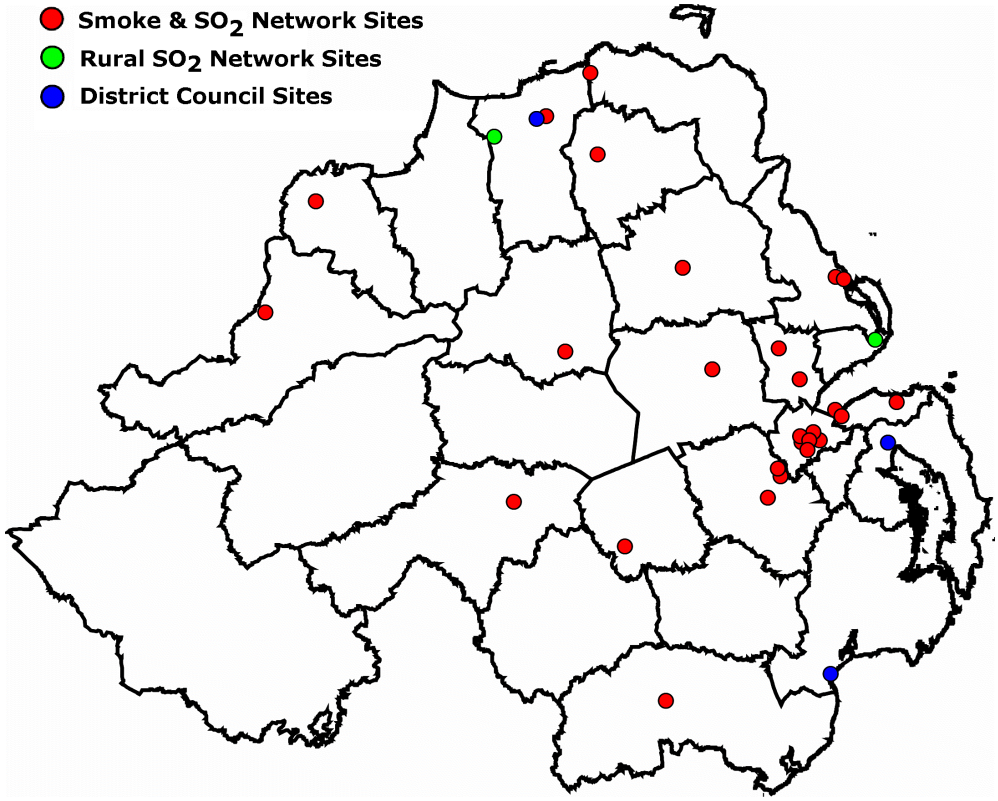

Figure 5.4 8-port Smoke and SO_2 Sampler Sites, 2004

5.2 LIMIT VALUES AND OBJECTIVES FOR SULPHUR DIOXIDE

Sulphur dioxide is covered by the following limit values and objectives as shown in Table 5.3. All these limits are for protection of human health except where stated.

Table 5.3 Limit Values and Objectives for Sulphur Dioxide

Averaging period	EC Limit or AQS Objective	No. of Permitted exceedences	To be achieved by
WHO (non-mandatory)			
10 minute	500 $\mu g\ m^{-3}$	-	-
24 hour	125 $\mu g\ m^{-3}$	-	-
Year	50 $\mu g\ m^{-3}$	-	-
EC 1st Daughter Directive (1999/30/EC)			
1 hour	350 $\mu g\ m^{-3}$	24 per year	1 January 2005
24 hour	125 $\mu g\ m^{-3}$	3 per year	1 January 2005
Calendar year and winter (1st October – 31st March), for protection of vegetation (relevant in rural areas)	20 $\mu g\ m^{-3}$	-	19 July 2001
Air Quality Strategy			
15 minute	266 $\mu g\ m^{-3}$	35 per year	31 December 2005
1 hour	350 $\mu g\ m^{-3}$	24 per year	31 December 2004
24 hour	125 $\mu g\ m^{-3}$	3 per year	31 December 2004
Calendar year and winter (1st October – 31st March), for protection of vegetation (relevant in rural areas)	20 $\mu g\ m^{-3}$	-	31 December 2000

2004 was a significant year for this pollutant, as the due date for achievement of two AQS Objectives for the 1-hour and 24-hour means was 31st December 2004. (The due date for the 15-minute mean objective is one year later.) Although the date specified for the corresponding EC 1st Daughter Directive Limit Values is 1st January 2005, this has been clarified to mean that Member States have until the end of 2005 to achieve them.

Before the 1st Daughter Directive came into force, SO_2 was covered by EC Directive 80/779/EEC on Sulphur Dioxide and Suspended Particulates. This Directive has been superseded by the 1st Daughter Directive. Although the limits of this older Directive remained in force until they were fully repealed on 1st January 2005, they are less stringent than those in the later 1st Daughter Directive and have been fully met in Northern Ireland since the early 1990s. The current report therefore compares current SO_2 results with the limit values of the 1st Daughter Directive, rather than Directive 80/779/EEC.

5.3 AUTOMATIC SULPHUR DIOXIDE RESULTS

Table 5.4 shows results from the automatic SO_2 monitoring sites, for 2004. Previous years' data are provided in Appendix 2.

Of the 19 sites, 15 achieved at least 90% data capture. Of the four that did not, one (Antrim Greystone Estate) was a new site, commissioned towards the end of 2004. Data capture at Ballymena Ballykeel was particularly low (59%), so annual statistics from this site should be used with caution.

2004 was a significant year, as two of the AQS Objectives for SO_2 were to be met by the end of this year. **All sites in Northern Ireland met the 1-hour and 24-hour AQS Objectives for SO_2 by the due date of 31st December 2004**.

(i) **All sites met the AQS Objective for the 15-minute mean SO_2 concentration, in advance of the due date of 31st December 2005.** Only one site (Larne) recorded one 15-minute mean greater than the AQS Objective of 266 μg m^{-3}. Therefore, no sites exceeded this objective on more than the permitted 35 occasions. Where data capture is less than 90%, according to the Technical Guidance[1] the 99.9th percentile of 15-minute means should not exceed the 15-minute SO_2 objective (266 μg m^{-3}). On this basis, the four sites with less than 90% data capture were all well within the AQS Objective for 15-minute mean SO_2.

(ii) **All sites met the AQS Objective for the 1-hour mean SO_2 concentration by the due date of 31st December 2004.** *No* sites recorded *any* exceedences of the 1-hour mean objective of 350 μg m^{-3}. Where data capture is less than 90%, according to the Technical Guidance[1] the 99.7th percentile of 1-hour means must not exceed the 1-hour objective: the four sites with less than 90% data capture met this condition without difficulty.

(iii) **All sites met the AQS Objective for the 24-hour mean SO_2 concentration by the due date of 31st December 2004.** *No* sites recorded *any* exceedences of the 24-hour mean objective (125 μg m^{-3}). Where data capture is less than 90%, the Technical Guidance[1] states that the 99th percentile of 24-hour means must not exceed the relevant objective: again, all four sites with less than 90% data capture met this condition without difficulty.

2004 was the third consecutive year in which Belfast East met all AQS Objectives for SO_2. Concentrations of SO_2 at this site have shown a marked decrease in recent years. As explained in previous reports in this series, many domestic properties in the area have switched from solid fuel to natural gas during this period, and this is the most likely reason for the decrease in SO_2 in the area.

The only District Council that has declared an AQMA for SO_2 is Antrim. The Antrim, Greystone Estate site was started up relatively late in 2004, so data capture for 2004 is only 9%. However, data from 2005 so far available (January to October 2005) indicate that this site is likely to meet all the AQS Objectives for this pollutant, without difficulty.

Table 5.5 SO_2 Results from Automatic Monitoring Sites, 2004

Site	% Data Capture	Max 15-minute mean, µg m^{-3}	No. of 15-minute means > 266 µg m^{-3}	36th highest 15-min mean OR 99.9th %ile of 15-min means µg m^{-3}	Max 1-hr mean µg m^{-3}	No. of 1-hr means > 350 µg m^{-3}	25th highest 1-hour mean OR 99.7th %ile of 1-hour means µg m^{-3}	Max 24-hr mean µg m^{-3}	No. of 24-hour means > 125 µg m^{-3}	4th highest 24-hr mean OR 99th %ile of 24-hr means µg m^{-3}	Annual mean, µg m^{-3}
Antrim	9	242	0	221	184	0	152	62	0	61	25
Ards	90	160	0	93	146	0	67	42	0	31	7
Armagh Dobbin St	97	43	0	16	32	0	13	9	0	7	1
Ballymena (Ballykeel)	59	136	0	88	96	0	59	29	0	27	6
Bangor	100	138	0	98	125	0	74	38	0	31	6
Belfast Centre	95	122	0	90	117	0	74	43	0	34	7
Belfast East	97	144	0	90	125	0	67	33	0	28	6
Carrickfergus	100	144	0	72	120	0	56	26	0	23	5
Castlereagh (Espie Way)	100	64	0	35	43	0	21	13	0	11	2
Cookstown	81	97	0	0	58	0	-	14	0	_	4
Craigavon (L.L. Park)	95	74	0	48	53	0	40	20	0	18	5
Dungannon	96	237	0	0	115	0	-	60	0	-	12
Larne	96	333	1	98	162	0	53	30	0	18	2
Lisburn (Island Civic Centre)	82	88	0	56	72	0	43	27	0	20.04	4
Londonderry Brandywell	98	141	0	77	101	0	61	35	0	32	9
Londonderry Brook Park	96	144	0	72	106	0	53	33	0	27	11
Newry (Mon. Row)	95	168	0	64	106	0	43	32	0	21	6
Newry (Trevor Hill)	94	90	0	56	74	0	45	28	0	23	9
Strabane	95	98	0	64	74	0	48	30	0	26	7

5.4 NON-AUTOMATIC SULPHUR DIOXIDE RESULTS

A summary of results from all Smoke and SO_2 Network sites in Northern Ireland is provided in Appendix 3, for year 2004. Relatively high concentrations of net acidity have been measured in Northern Ireland, particularly Belfast, for many years. The historically limited availability of natural gas in previous years has led to greater domestic use of solid fuels and oil. This has led to higher concentrations of pollutants such as SO_2, particularly in residential areas. However, the average annual mean net acidity (expressed as SO_2 equivalent) for all Smoke and SO_2 Network sites in Northern Ireland has fallen considerably in recent years. The annual mean net acidity for all sites in Northern Ireland in 2004 was 17 μg m^{-3}, compared with a mean of 14 μg m^{-3} for the whole UK.

The 8-port sampler produces daily 24-hour averages, which are not comparable with air quality limits based on shorter averaging periods. Nor is it relevant to compare data from urban sites with the annual and winter mean limit values set for the protection of ecosystems. However, data from such samplers can be compared with the limit value and objective of 125 μg m^{-3} for the 24-hour mean (not to be exceeded more than 3 times per calendar year) set by the EC 1st Daughter Directive, and the Air Quality Strategy.

No Smoke and SO_2 Network sites in Northern Ireland had more than three days during calendar year 2004 when the 24-hour average net acidity was greater than the Daughter Directive limit value and AQS objective for SO_2 of 125 μg m^{-3}.

The 2004 annual mean net acidity (as SO_2) concentrations at the three non-network sites in Newtownards (Ards DC), Newcastle (operated by Down DC), and Coleraine were 9 μg m^{-3}, 14 μg m^{-3} and 10 μg m^{-3} respectively.

Annual and winter mean sulphur dioxide concentrations at the two Rural SO_2 Network sites (Bentra and Fermoyle) were less than 5 μg m^{-3}: well within the limit of 20 μg m^{-3} set for protection of vegetation in rural areas.

5.5 SULPHUR DIOXIDE TRENDS

UK emissions of sulphur dioxide have fallen considerably over the past few decades. Data from the NAEI (www.naei.org.uk) show that in 2003, the UK's total SO_2 emission was 979 kilotonnes: this is 26% of the UK's total SO_2 emission in 1990, and just 15% of the 1970 total.

It cannot be assumed that UK trends in either emissions or ambient concentration are necessarily representative of Northern Ireland: for reasons outlined in Sections 1.1 and 5.4, widespread reliance on solid fuels and oil for domestic heating continued throughout the 1970s, 1980s and 1990s. In 1997, it was estimated that domestic combustion accounted for an estimated 28% of total annual SO_2 emission in the Greater Belfast area[3], compared with 4% of total annual SO_2 emission in the UK as a whole. Sulphur dioxide emissions and source distribution have been different in Northern Ireland than in other parts of the UK for many years. However, with the increased availability of natural gas in recent years, it is likely that Northern Ireland's emissions of this pollutant have decreased.

New legislation on the sulphur content of solid fuel and fuel oils came into force on 15th October 1998 and 11th March 2002 respectively. The Sulphur Content of Solid Fuel Regulations (Northern Ireland) came into force on 15 October 1998 and apply to Northern Ireland only. Under the regulations it is prohibited for any person to sell by retail or deliver for the purpose of retail, any solid fuel with a sulphur content of more than 2 percent. The Sulphur Content of Liquid Fuels Regulations (Northern Ireland) make it an offence, from 1st January 2003, to burn fuel oil with a sulphur content of greater than 1% by mass, with some derogations. In addition, it is an offence from 11 March 2002 to use any gas oil, or marine gas oil, with a sulphur content greater than 0.2% by mass. This limit will be further tightened to 0.1% by mass as of 1 January 2008.

This legislation will reduce emissions of sulphur dioxide from industrial and domestic premises burning fuel oil, and domestic premises burning solid fuel and are expected to lead to a reduction in ambient concentrations of SO_2.

5.5.1 Trends at Automatic Sulphur Dioxide Sites

Figure 5.5 shows annual mean SO_2 concentrations from 1992 onwards. It is usually accepted that at least five years' data are required in order to assess trends in air quality. Although there are now 19 automatic SO_2 sites in Northern Ireland, only three have been in operation for five years. Figure 5.4 shows data from five sites – those with at least three consecutive annual means.

Of the three sites with sufficient data to investigate trends, Belfast Centre and Belfast East. Both sites show a clear downward trend in annual mean SO_2 concentration. By contrast, mean SO_2 concentrations at the Londonderry AURN site (located at Brooke Park) have remained stable over its five years of operation.

Annual means from the two Newry sites (Newry Monaghan Row and Newry Trevor Hill) are also shown. Annual mean SO_2 concentrations at Newry Trevor Hill appear to have increased over the past three years; although the site appears not to be at risk of exceeding any AQS Objectives, this observed increase is highlighted for further investigation.

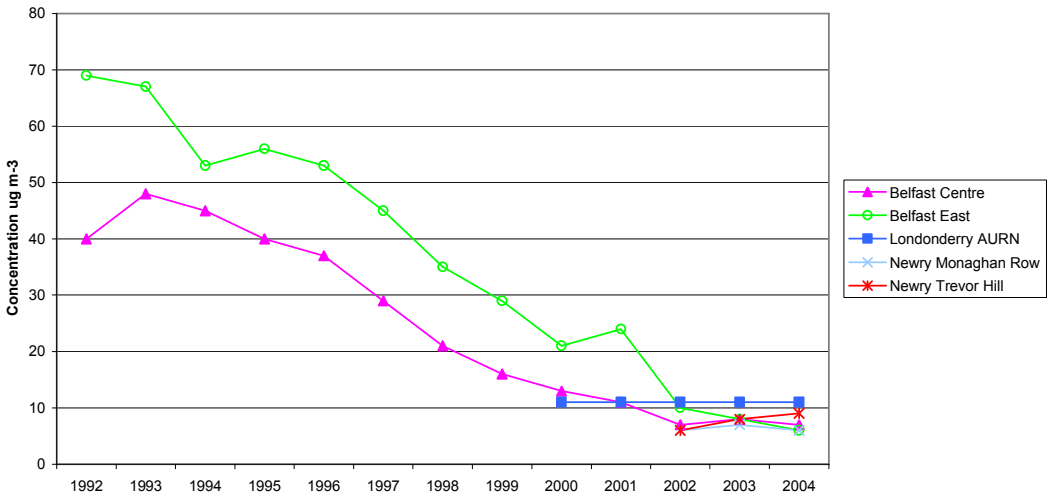

Figure 5.5 Annual Mean SO_2 concentrations at Automatic Sites (data capture at least 75%)

5.5.2 Trends at Non-Automatic Sulphur Dioxide sites

Data from long-running sites in the non-automatic Smoke and SO_2 Network can be used to identify how concentrations of sulphur dioxide, (as measured by the indicative net acidity technique), have decreased since the early 1960s. This trend is shown in Figure 5.6, a graph of the average net acidity (as SO_2 equivalent) concentration at all Network sites in Northern Ireland since 1962. For historical reasons the annual averaging periods run April -March. The annual mean is based only upon sites with at least 75% data capture for the year, which in most years totalled between 14 and 27.

The annual average concentration of SO_2 has fallen, from over 80 $\mu g\ m^{-3}$ in the 1960s to around 30 $\mu g\ m^{-3}$ in 1980. From 1980 – 1987, average concentrations rose before the downward trend continued again from the late 1980s. A possible explanation for the rise in the early 1980s is that it may have resulted from a rise in coal and oil burning, as the use of town gas was phased out. Town gas use decreased through the late 1970s and early 1980s, and the eventual shut-down of the supply began in 1984 and was completed in 1988.

Figure 5.6 also shows the trend in annual mean for three long-running sites in Belfast: BELFAST 12 (at the Royal Victoria Hospital), BELFAST 13 (at Templemore Avenue, co-located with the Belfast East automatic monitoring site) and BELFAST 33 (Dufferin Road, an industrial area of the city centre). All of these have been in continuous operation since the early 1960s. These three individual sites show a similar pattern to the average, including the period during the early 1980s when the general downward trend appeared to be reversed.

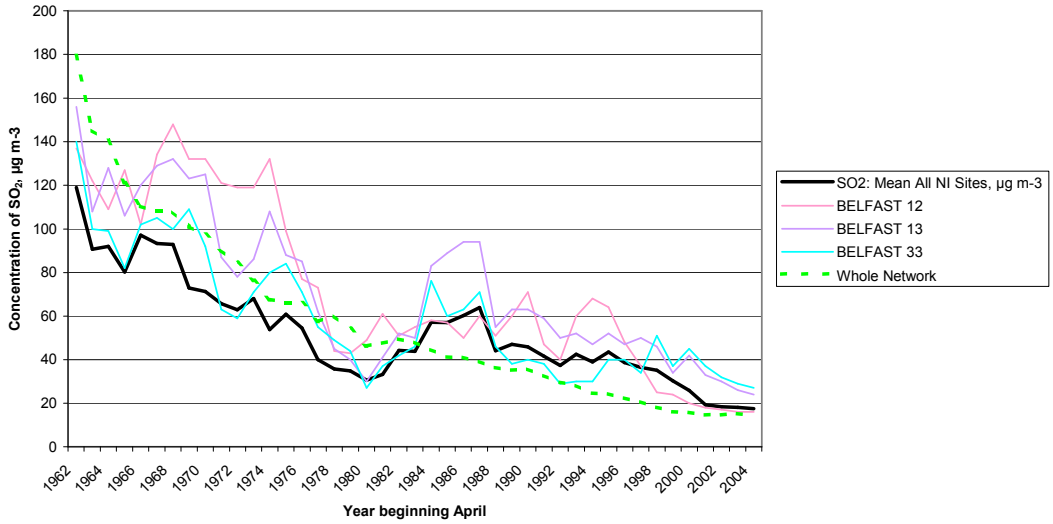

Figure 5.6 Annual Mean SO_2 Concentration at Smoke & SO_2 Sites in Northern Ireland. Network average and 3 long-running Belfast sites.

Figure 5.6 also shows the annual means for the UK as a whole. It is noticeable that since the mid 1980s, Northern Ireland's average SO_2 levels have typically been higher than the UK average, due to continued reliance on oil and coal. However, as natural gas becomes more available in Northern Ireland, the gap is closing.

Figure 5.7 shows part of the same time series for 1990 onwards. This clearly illustrates how the difference between the average for all Northern Ireland sites, and the Network as a whole, has decreased since 2000, and is now just 2 μg m^{-3}.

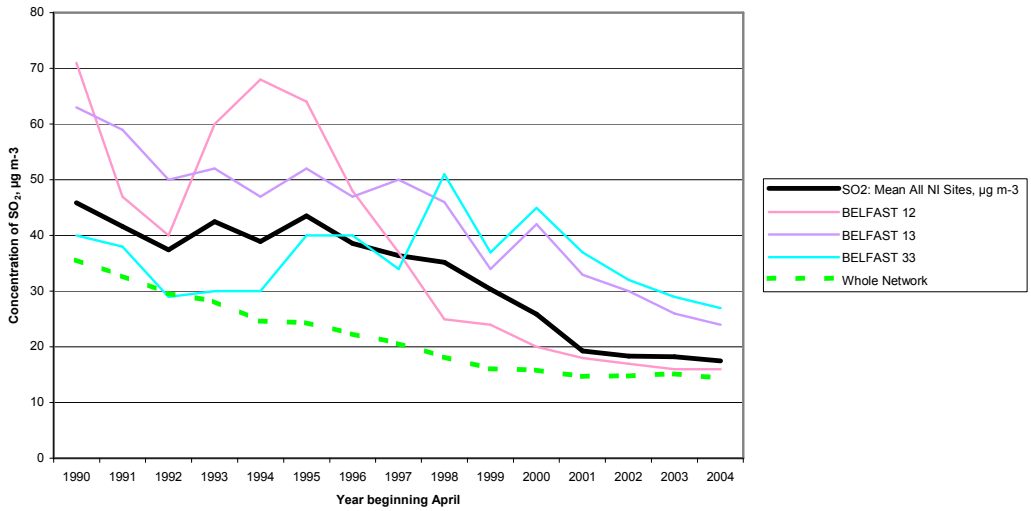

Figure 5.7 Annual Mean SO_2 Concentration at Smoke & SO_2 Sites in Northern Ireland. Network average and 3 long-running Belfast sites, 1990 onwards.

6 Particulate Matter

Ambient suspended particulate matter consists of a "primary" component (i.e. emitted directly into the atmosphere and therefore usually local to source), and a "secondary" component (formed in the atmosphere by chemical reactions, and therefore often a long-range pollutant). The primary component mostly consists of combustion related particles (emitted from sources such as vehicles, domestic and industrial coal and fuel oil burning), but includes other material such as entrained dust, and salt from sea spray. The secondary material consists mostly of sulphate and nitrate particles formed by oxidation of sulphur dioxide and oxides of nitrogen, and ammonium salts. Ambient particulate matter, when inhaled, can affect human health, particularly in sensitive individuals.

The two particulate metrics most widely used in the UK are PM_{10} and Black Smoke. The term "PM_{10}" refers to the mass fraction of particles collected by a sampler with a 50% cut-off at aerodynamic diameter 10 μm. PM_{10} is measured by automatic techniques, such as the Tapered Element Oscillating Microbalance (TEOM), gravimetric samplers and Beta Attenuation Monitors (BAM). The term "black smoke" refers to any fine dark suspended particulate which can be measured by the smoke stain technique, not necessarily particulate resulting from combustion sources. Black smoke is defined by the ISO standard for the method (ISO 9835) as "strongly light absorbing particulate material suspended in the ambient atmosphere.... The major contributor to black smoke is soot particles; i.e. particles containing carbon in its elemental form". Concentrations of particulate matter are expressed as micrograms per cubic metre ($\mu g\ m^{-3}$).

6.1 MONITORING OF PARTICULATE MATTER

6.1.1 PM_{10} Monitoring

Four new automatic monitoring sites for particulate matter as PM_{10} started up in Northern Ireland during 2004, taking the total from 23 to 27. The new sites are located at Ballymoney, Cookstown, Limavady and Newry (Kilkeel). All site details and monitoring techniques are shown in Table 6.1 and Figure 6.1. The most widely used automatic PM_{10} monitoring technique is the Tapered Element Oscillating Microbalance (TEOM), but Beta Attenuation Monitors (BAM or Beta Gauge) are also in use at four sites.

The reference method for PM_{10} is the gravimetric technique, in which the ambient concentration of PM_{10} is calculated from the mass of particulate matter collected on a filter. The more widely-used TEOM has been found to underestimate relative to this reference method. Therefore, by convention PM_{10} concentrations measured using the TEOM (or using a Beta Attenuation Monitor, if it has a heated inlet – though this is not the case for any of the sites in Northern Ireland using this technique) must be multiplied by a factor of 1.3 to convert to gravimetric equivalent, before comparison with EC Directive or AQS limit values. *All TEOM measurements in this report have been converted to gravimetric equivalent.*

The locations of all sites are shown in Figure 6.1. Figure 6.2 shows a typical example of a PM_{10} monitoring site, at Holywood, North Down. This roadside site also monitors oxides of nitrogen.

6.1.2 Black Smoke Monitoring

The principle of the smoke stain method involves drawing air at a constant, measured flow rate through a paper filter. Suspended particulate matter is collected on the filter, forming a dark stain. An instrument known as a reflectometer is used to measure the darkness of the stain, and this reflectometer measurement is then used to calculate the concentration of particulate matter in the sampled air from a standard calibration. The sampler inlet funnel has a 50% cut-off at around 4.5 μm; thus black smoke can be considered an approximation to dark PM_5. During 2004, there were 30 sites in Northern Ireland measuring particulate as black smoke, 27 of which were part of the Smoke and SO_2 Network.

Black smoke is monitored using the same 8-port sampler apparatus as non-automatic SO_2, shown in Figure 5.3 (Section 5.1). Site details are therefore identical to those presented in Table 5.3 and Figure 5.4 (for SO_2) in Section 5.1, (with the exception of the Rural SO_2 Network sites, which monitor SO_2 only). Many of these black smoke monitoring sites have been in operation since the 1960s or 1970s: hence there is an extensive historical dataset for smoke.

Table 6.1 Automatic PM_{10} Monitoring Sites, 2004

Site	Grid Ref.	Classification	Technique	Network/ operator
Ards, Glen Estate	J 487 747	Urban Background *	TEOM	Ards
Armagh, Lonsdale Road	H 876 458	Roadside	TEOM	Armagh
Ballymoney	D 106 030	Urban Background	BAM	Ballymoney
Bangor	J 498 810	Urban Background	TEOM	North Down
Belfast Centre	J 339 744	Urban Centre	TEOM, KFG Gravimetric, Partisol Gravimetric	AURN
Belfast, Clara Street	J 360 734	Suburban	BAM	AURN
Belfast, Westlink	J 330 737	Roadside	TEOM	Belfast
Carrickfergus, Rosebrook Avenue	J 411 882	Urban Background *	TEOM	Carrickfergus
Castlereagh, Loughview Drive	J 357 570	Roadside	TEOM	Castlereagh
Castlereagh, Espie Way	J 373 719	Urban Background *	TEOM	Castlereagh
Cookstown	H812 772	Urban Background	TEOM	Cookstown
Craigavon, Lord Lurgan Park	J 079 592	Urban Background *	TEOM	Craigavon
Dungannon, Lambfield	J 802 635	Urban Background *	TEOM	Dungannon
Holywood	J 396 792	Roadside	TEOM	North Down
Larne – Harbour	D414 016	Urban Background	BAM	Larne
Limavady Coolessan	C 267 229	Urban Background	TEOM	Limavady
Lisburn, Island Civic Centre	J 274 643	Urban Background *	TEOM	Lisburn
Lisburn, Lagan Valley Hospital	J 265 637	Roadside	TEOM	Lisburn
Lisburn, Dunmurry	J 287 675	Urban Background	TEOM	Lisburn
Londonderry, Brooke Park	C 429 172	Urban Background	TEOM	AURN
Londonderry, Brandywell	C 428 163	Urban Background	TEOM	AURN Affiliated
Lough Navar	H 065 545	Rural	TEOM	Rural
Newry Kilkeel	J 303 147	Urban Background	TEOM	Newry & Mourne (CC)
Newry, Monaghan Row	J 078 268	Urban Background	TEOM	Newry & Mourne (CC)
Newry, Trevor Hill	J 088 266	Roadside, town centre	TEOM	Newry & Mourne (CC)
Omagh, Tamlaght	H 422 722	Roadside	TEOM	Omagh
Strabane, Springhill Park	H 351 972	Urban Background (Residential)	BAM	Strabane (CC)

CC = Calibration Club member.
* in a coal burning residential area.

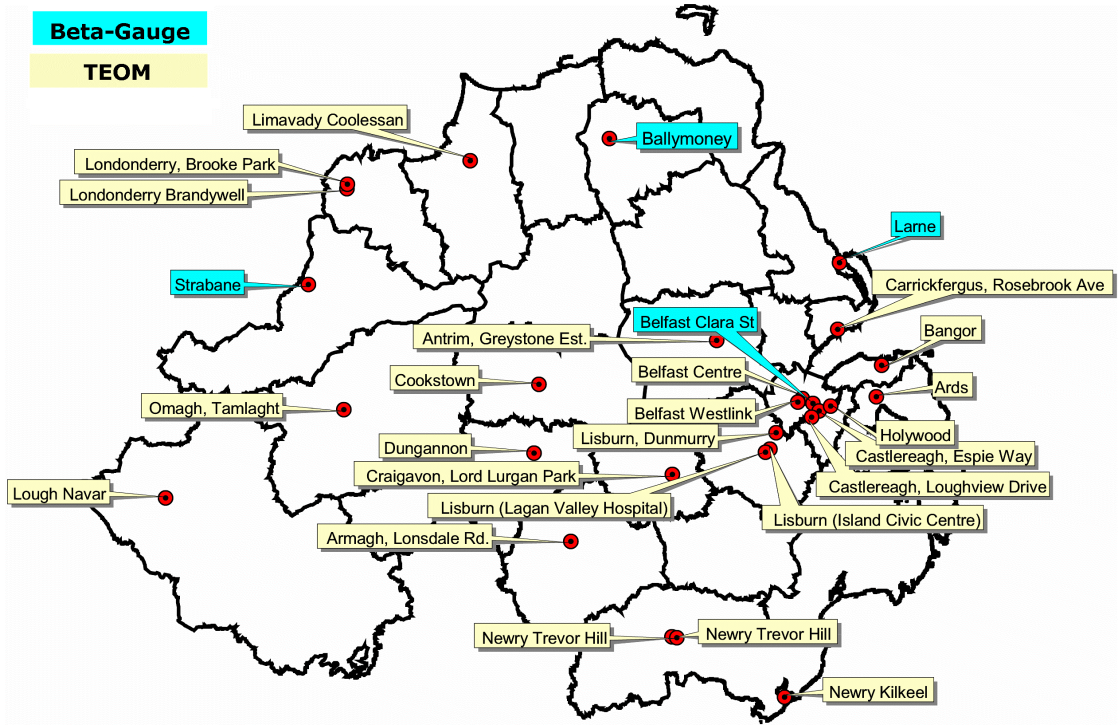

Figure 6.1 Locations of PM_{10} Monitoring Sites, 2004.

Figure 6.2 Roadside Monitoring Site at Holywood, North Down for PM_{10} (and NO_x)

6.2 LIMIT VALUES AND OBJECTIVES FOR SUSPENDED PARTICULATE MATTER

6.2.1 Limit Values and Objectives for PM_{10}

Particulate matter, when measured as PM_{10}, is covered by the EC 1st Daughter Directive (1999/30/EC), which contains a two-stage set of limit values. The UK Air Quality Strategy sets objectives for PM_{10} that are almost identical to the first stage limit values set by the EC Daughter Directive. These are outlined in Table 6.2.

Table 6.2 Limit Values and Objectives for Particulate Matter as PM_{10}

Averaging period	EC Limit or AQS Objective	Number of Permitted exceedences	To be achieved by
EC 1st Daughter Directive (1999/30/EC) Stage 1			
24 hour	50 μg m^{-3}	35 per year	1st January 2005
Annual Mean	40 μg m^{-3}	-	1st January 2005
EC 1st Daughter Directive (1999/30/EC) Stage 2 (to be confirmed)			
24 hour	50 μg m^{-3}	7 per year	1st January 2010
Annual Mean	20 μg m^{-3}	-	1st January 2010
Air Quality Strategy (as currently adopted in Northern Ireland)			
24 hour	50 μg m^{-3}	35 per year	31st December 2004
24 hour *	50 μg m^{-3}	7 per year	31st December 2010
Annual Mean	40 μg m^{-3}	-	31st December 2004
Annual Mean *	20 μg m^{-3}	-	31st December 2010

** not prescribed in regulations for the purposes of local air quality management.*
All limit values refer to gravimetric equivalent measurements.

As in the case of sulphur dioxide, the date of "1st January 2005" specified for the EC Limit Values has been clarified as meaning that 2005, not 2004, is the first year for which the Limit Values must be met.

6.2.2 Limits and Guide Values for Black Smoke

Before the 1st Daughter Directive and Air Quality Strategy set objectives for PM_{10}, smoke was covered by EC Directive 80/779/EEC on sulphur dioxide and suspended particulates. This Directive has been superseded by the 1st Daughter Directive; however, the limits relating to smoke were in force until 1st January 2005, and the new Daughter Directive deals only with PM_{10}. The current report therefore compares 2004 results with the smoke limits and guidelines of Directive 80/779/EEC. The limit values are presented in Table 6.3 below, along with the non-mandatory guide values.

Table 6.3 EC Directive 80/779/EEC Limit Values For Smoke (fully repealed 1st Jan 2005)

Limit Values (mandatory)	Smoke μg m^{-3} BS	Sulphur Dioxide μg m^{-3}
YEAR (median of daily values)	68	if smoke ≤ 34:120 if smoke > 34: 80
WINTER (median of daily values, October-March)	111	if smoke ≤ 51: 180 if smoke > 51: 130
YEAR (Peak, i.e. 98th Percentile of daily values)	213	if smoke ≤ 128: 350 if smoke > 128: 250
Guide Values (advisory only)		
YEAR (arithmetic mean of daily values)	34 to 51	40 to 60
24 HOURS (daily mean value)	85 to 128	100 to 150

NOTE: The Limit and Guide Values given above for smoke according to the BS calibration are calculated from the original OECD calibration figures given in the EC Directive using the relationship: BS concentration = OECD concentration multiplied by 0.85

6.3 PARTICULATE MATTER RESULTS

6.3.1 PM_{10} Results

Table 6.4 presents data from the automatic PM_{10} monitoring sites. TEOM data have been converted to gravimetric equivalent by multiplying by the appropriate factor of 1.3. Figures in **bold** indicate more than the permitted number of exceedences of the relevant limit or objective. To keep the table to a manageable size, only 2004 data are included: the full historical dataset is provided in Appendix 2.

Table 6.4 2004 PM_{10} Results from Automatic Monitoring Sites *(μg m^{-3} Gravimetric Equivalent)*

Site	2004 Data Capture %	Annual Mean μg m^{-3}	Max Daily Mean μg m^{-3}	No. of Daily means > 50 μg m^{-3}	36th Highest Day	90th %ile of daily means	36th highest day (OR 90th %ile if DC < 90%)
Ards, Glen Estate	96	21	66	2	33	33	33
Armagh, Lonsdale Road	99	33	76	15	n/s	n/s	<50
Ballymoney	70	37	133	***56***	56	64	64
Bangor	97	25	82	15	40	40	40
Belfast Centre, Lombard Street	96	21	78	10	35	35	35
Belfast Clara Street	92	13	66	5	29	29	29
Belfast Westlink	92	30	109	***41***	40	n/s	40
Carrickfergus, Rosebrook Ave	98	21	61	4	32	32	32
Castlereagh, Loughview Drive	91	18	55	2	30	30	30
Castlereagh, Espie Way	93	22	57	1	32	33	32
Cookstown	90	22	67	6	n/s	n/s	<50
Craigavon, Lord Lurgan Park	91	20	59	4	31	32	31
Dungannon, Lambfield	81	14	34	0	n/s	26	26
Holywood	99	26	78	15	43	41	43
Larne Harbour	91	20	91	8	31	32	31
Limavady Coolessan	23	17	36	0	17	26	26
Lisburn, Dunmurry High School	56	20	74	5	27	33	33
Lisburn, Island Civic Centre	82	21	69	8	32	33	33
Lisburn, (LVH)	82	25	72	14	39	42	42
Londonderry, Brooke Park	86	23	63	9	35	36	36
Londonderry, Brandywell	97	20	78	3	30	30	30
Lough Navar	99	10	29	0	15	15	15
Newry Kilkeel	69	20	48	0	28	31	31
Newry, Monaghan Row	96	19	65	6	31	31	31
Newry, Trevor Hill	91	33	94	***39***	53	54	53
Omagh, Tamlaght	27	25	73	4	26	38	38
Strabane	97	**42**	125	***86***	62	62	62

n/s = not supplied.

18 of the 27 automatic PM_{10} monitoring sites achieved at least 90% data capture for the year. Of the nine that did not, three (Ballymoney, Limavady Coolessan and Newry Kilkeel) were new sites which started operation part way through 2004.

2004 was a significant year, because the AQS contains objectives for the 24-hour and annual mean to be met by 31st December 2004. The first year in which the corresponding 1st Stage EC Limit Values for PM_{10} are to be met is 2005.

Four sites exceeded the AQS Objective of 50 μg m^{-3} (gravimetric equivalent) for the 24-hour mean, on more than the permitted 35 occasions: these were Ballymoney, Belfast Westlink, Newry Trevor Hill, and Strabane. These sites have failed to meet the AQS Objective for 24-hour mean PM_{10}, by the due date. However, as explained above they still have a year in which to achieve compliance with the EC Limit Value.

Where data capture is less than 90%, rather than counting the total number of exceedences of the Objective, the Technical Guidance[1] states that the 90th percentile of 24-hour means should be compared with the objective itself (50 μg m^{-3}). On this basis, the sites with less than 90% data capture all appeared to meet the AQS Objective for 24-hour mean PM_{10}. Figures 6.3a and 6.3b illustrate how data from the monitoring sites compares with applicable AQS Objectives.

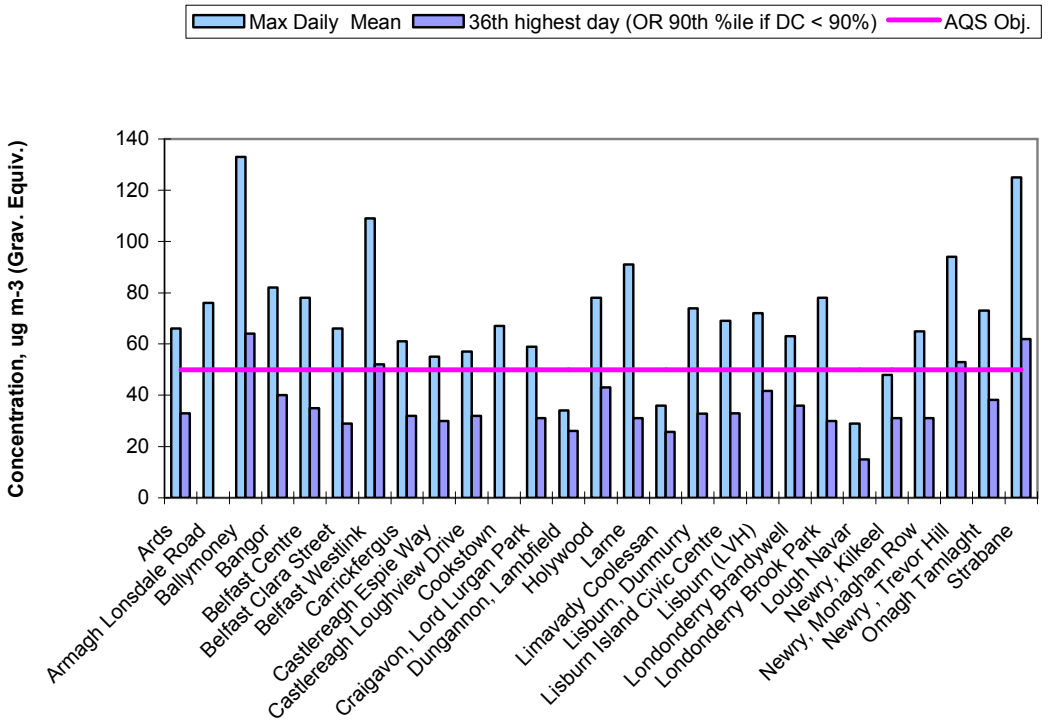

Figure 6.3a Comparison of 2004 PM_{10} Results from Automatic Sites with AQS 24-hour mean Objective. *Figure 6.3a shows the maximum, and the 36th highest 24-hour mean (or 90th percentile where data capture was less than 90%). If the latter (shown by the darker coloured bar) is greater than 50 µg m^{-3}, the site has not met the objective. Four sites did not meet the AQS 24-hour objective of 50µg m^{-3} by the due date of 31st Dec. 2004: Ballymoney, Belfast Westlink, Newry Trevor Hill and Strabane Springhill Park.*

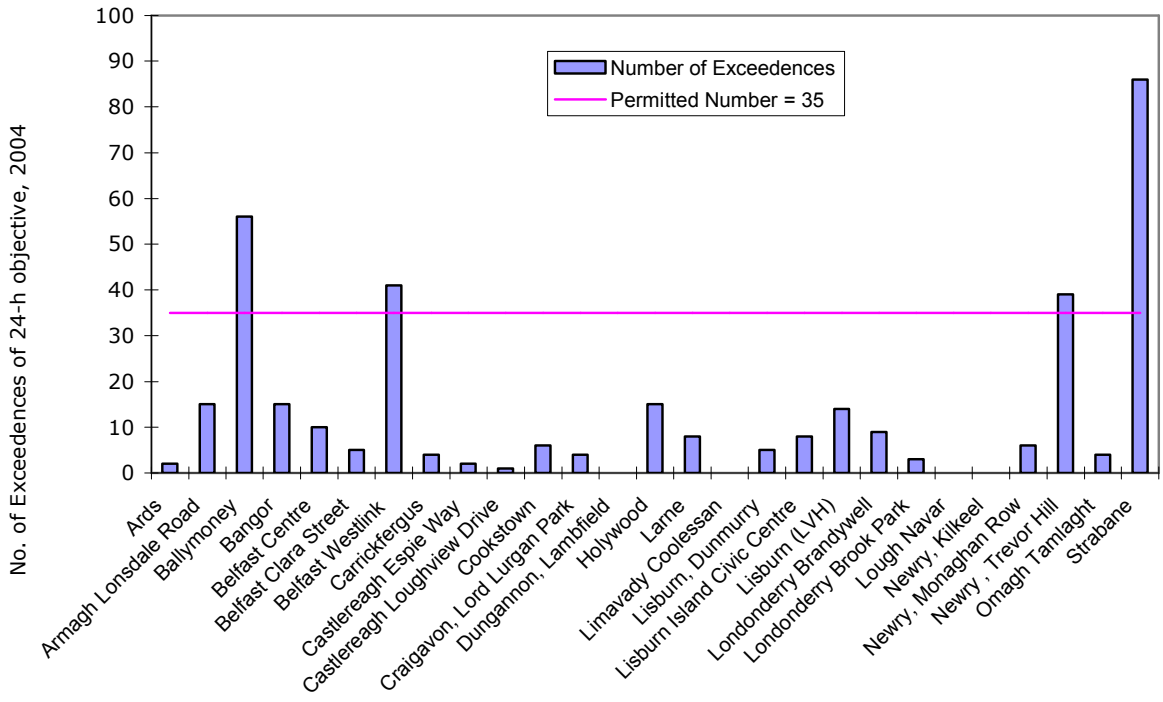

Figure 6.3b Number of Exceedences of 24-hour Mean AQS Objective for PM_{10}, 2004. 35 exceedences permitted per calendar year. *Figure 6.3b shows the number of exceedences of the 24-hour mean AQS Objective for PM_{10}, compared with the maximum permitted total of 35.*

Of the four sites which did not meet the objective, Belfast Westlink and Newry Trevor Hill are roadside sites near major or busy roads. Ballymoney and Strabane Springhill Park sites are located on housing estates where solid fuel use is prevalent. In the case of Strabane, local topography is also thought to impede dispersion: high concentrations of black smoke were identified at this site before automatic PM_{10} monitoring began. There is still a black smoke sampler at the site, and this continues to record higher mean concentrations of black smoke than any other site in Northern Ireland. In the case of Ballymoney, the situation is less clear: there is a black smoke monitoring site within 500m of the PM_{10} monitoring site, but, in contrast to the situation in Strabane, black smoke concentrations are not unusually high.

The AQS Objective for annual mean PM_{10} is 40 μg m^{-3}. Only one site (Strabane) recorded an annual mean PM_{10} concentration in excess of the AQS Objective of 40 μg m^{-3}. Comparison with the annual mean objective is shown in Figure 6.4; this shows a comparison of annual mean PM_{10} concentrations at all automatic sites, with the AQS Objective of 40 μg m^{-3} for the annual mean PM_{10}, as gravimetric equivalent. Although (as noted above) data capture was less than 90% for some sites, on the basis of the available data, it appears that all sites meet this AQS Objective, with the exception of Strabane Springhill Park. As noted above, the Strabane site is in an area where domestic solid fuel use is prevalent: high concentrations of black smoke were identified at this site before automatic PM_{10} monitoring began.

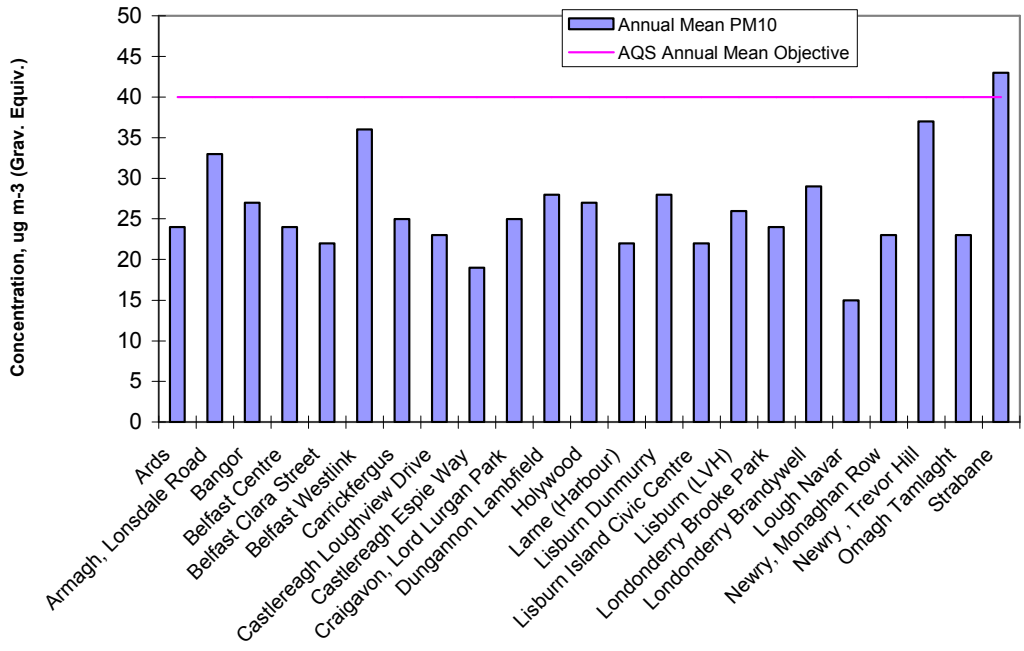

Figure 6.4 Comparison of Annual Mean PM_{10} with AQS Objective, 2004. *Only one site (Strabane, Springhill Park) has failed to meet this AQS Objective by the due date.*

6.3.2 Black Smoke Results

A summary of smoke data for calendar year 2004 for all Smoke and SO_2 Network sites in Northern Ireland is shown in Appendix 3. Annual mean smoke concentrations in Northern Ireland ranged from 3μg m^{-3} to 21μg m^{-3}. The 2004 average for Northern Ireland was 9 μg m^{-3}; this is slightly higher than the 2004 average of 6 μg m^{-3} obtained for the Network as a whole.

The highest annual mean smoke concentration of 21μg m^{-3} was measured at STRABANE 2. This site is of particular interest as it is;

(i) co-located with the automatic PM_{10} monitor at Springhill Park, which also recorded high concentrations, and
(ii) on a housing estate with considerable domestic coal and oil burning,
(iii) in a location where it is thought that local topography may impede dispersion.

Black smoke concentrations at Strabane had apparently been decreasing; however the 2004 annual mean of 21μg m^{-3} is the same as that measured in 2003.

Two non-Network smoke sites reported annual mean smoke concentrations: these were Newtownstewart (operated by Strabane DC), and Newcastle (operated by Down DC). The 2004 annual mean smoke concentrations at these two sites were 14μg m^{-3} and 4.5μg m^{-3} respectively Both these results were within 1 μg m^{-3} of the previous year's annual means.

All the sites in Northern Ireland meet the limit values of 80/779/EEC for smoke, and have done so since 1990. During 2004, the annual arithmetic mean was well below the lower guide value of 34 μg m^{-3} at all sites in Northern Ireland.

The maximum daily mean exceeded the lower 24-hour guide value on 19th February 2004 at STRABANE 2, and the upper guide value on 2nd December 2004 at ANTRIM 1: however, such high smoke concentrations are now rare.

6.4 PARTICULATE MATTER TRENDS

In the Greater Belfast area, the contribution to primary PM_{10} emissions from domestic contribution is around 26%[3], a substantially higher proportion than in most UK cities. Therefore, trends in PM_{10} and black smoke emissions for Northern Ireland will not necessarily be the same as for other regions. However, UK data from the NAEI (www.naei.org.uk) show a substantial decrease of almost 50% in total UK PM_{10} emissions between 1990 and 2003, so it is not unreasonable to expect a decreasing trend for Northern Ireland.

6.4.1 PM_{10} Trends

Figure 6.5 shows annual mean PM_{10} concentrations for the longer-running sites in Northern Ireland. Only sites with at least three consecutive years' annual means are shown, and annual means have only been included where data capture is at least 75%. The majority of the 27 sites now in operation are not included as they do not yet have three valid annual means.

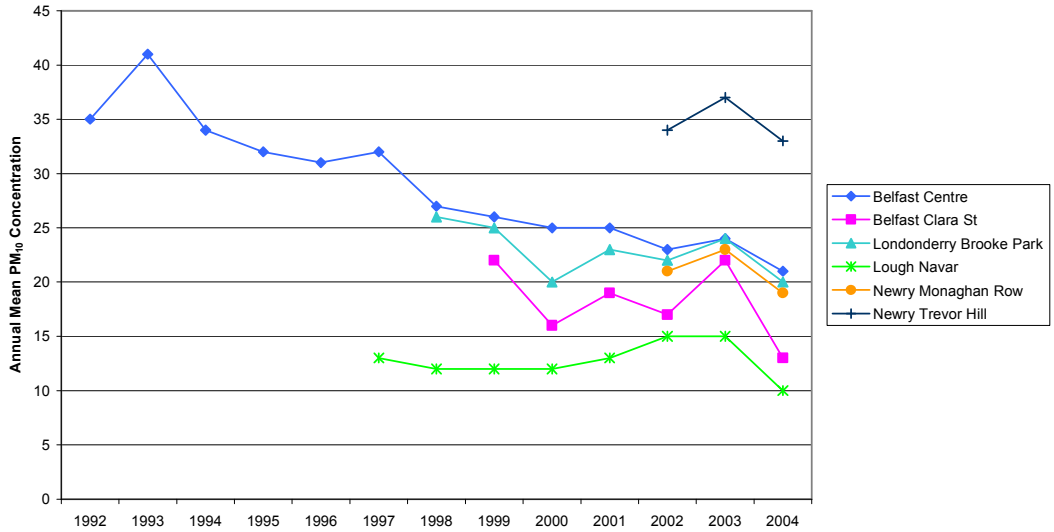

Figure 6.5 Annual Mean PM_{10}Concentrations at Automatic Monitoring Sites, Gravimetric Equivalent. (Data capture at least 75%).

Five years' data are usually required to assess trends in air quality. The longest running site is Belfast Centre, which has been in operation since 1992. The annual mean PM_{10} concentration at this site has shown a steady decrease over this period, and there is a significant downward trend (identified by Theil's non-parametric analysis). A significant downward trend has also been identified for the first time at Londonderry Brooke Park (the AURN site). However, there remains no significant trend in annual mean PM_{10} concentration at Belfast Clara Street, or Lough Navar. (None of the Newry sites have sufficient years' data to assess trends).

6.4.2 Black Smoke Trends

The long-running historical dataset for the Smoke and SO_2 Network gives an indication of how concentrations of fine suspended primary particulate, as measured by this technique, have decreased since the early 1960s. This trend is shown in Figure 6.6, a graph of the average smoke concentration at all Network sites in Northern Ireland since 1962. For historical reasons the annual averaging periods run April -March. The annual mean is based only upon sites with at least 75% data capture for the year, which in most years totalled between 14 and 24. The annual average concentration of smoke has fallen, from over 100 $\mu g\ m^{-3}$ in the early 1960s to 7.2 $\mu g\ m^{-3}$ in 2004.

Figure 6.6 shows the trend in annual mean for three particular sites in Belfast: BELFAST 12 (at the Royal Victoria Hospital), BELFAST 13 (the suburban Templemore Avenue) and BELFAST 33 (the industrial centre Dufferin Road), all of which have been in continuous operation since the early 1960s. These three individual sites show a similar pattern.

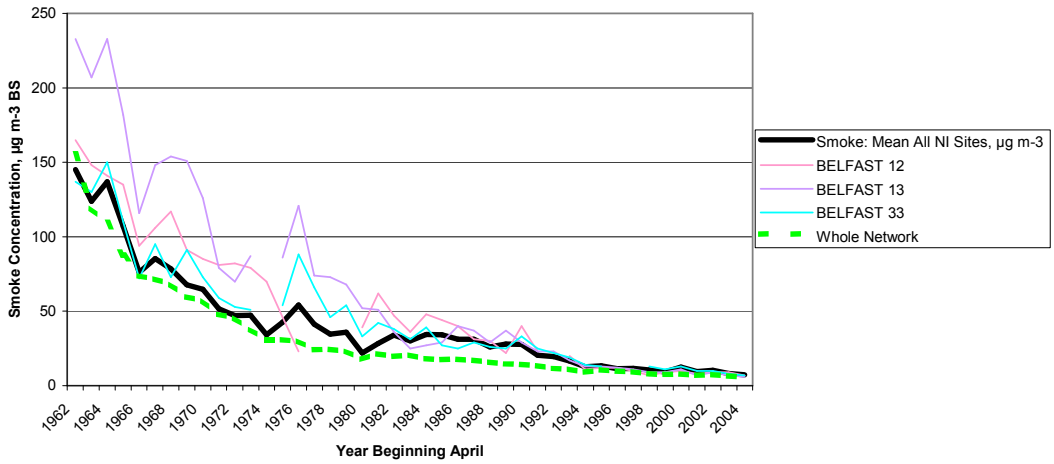

Figure 6.6 Trends in Black Smoke Concentration, Northern Ireland. NI average, UK Network average, and 3 long-running Belfast sites.

Figure 6.6 also shows the annual means for the UK as a whole, as a dotted line. Throughout the Network's operation, Northern Ireland's average levels of black smoke have typically been slightly higher than the UK average. However, since the mid 1990s the difference has been very small, and this is illustrated by Figure 6.7, which shows trends from 1990 onwards.

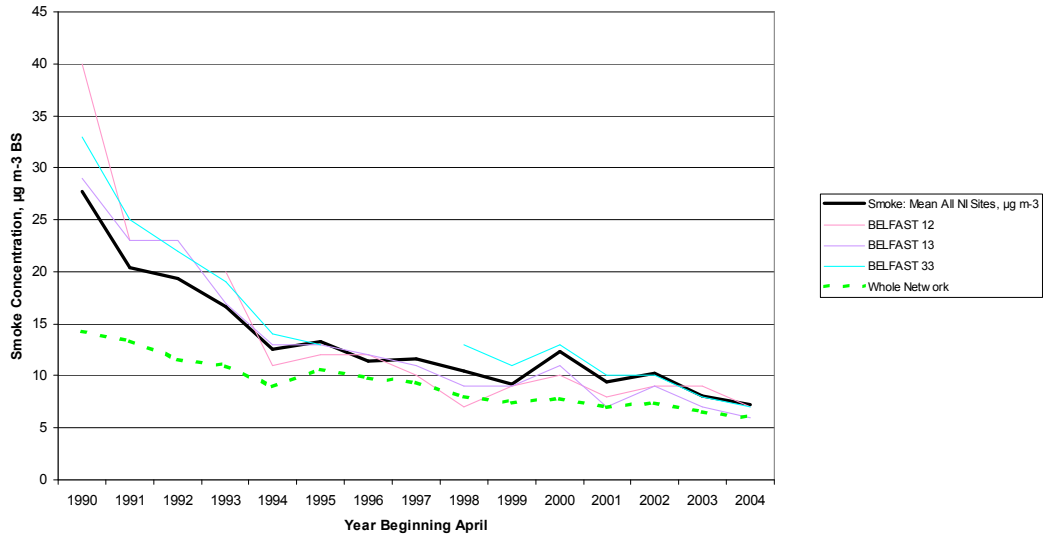

Figure 6.7 Trends in Black Smoke Concentration, Northern Ireland and UK Network average, 1990 onwards

7 Ozone

Ozone (O_3) is a form of oxygen, with three atoms per molecule (unlike normal oxygen, O_2, which has two). In the upper atmosphere it is beneficial, forming the "ozone layer" which protects living things from harmful UV radiation. However, at ground level it is a pollutant, having an irritant effect on the respiratory system.

Ground level ozone is not emitted directly from source, but formed by chemical reactions involving the action of sunlight and high temperatures on oxides of nitrogen and volatile organic compounds (VOCs). These reactions may happen over several hours, so the highest ozone concentrations may occur a long distance downwind of the sources of the primary pollutants. Also, O_3 may persist for several days. Ozone pollution can therefore be a transboundary problem, and difficult to control by local action. Ambient concentrations of ozone depend on year-to-year variations in weather.

O_3 concentrations are usually therefore lowest in towns, and highest in the rural areas downwind of them. Because ozone formation requires sunlight, concentrations are highest in the summer, and during daylight hours.

In this report, concentrations of ozone are expressed as microgrammes per cubic metre ($\mu g\ m^{-3}$). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

1 ppb = 2.0 $\mu g\ m^{-3}$ for ozone at 293K (20°C) and 1013mb.

7.1 MONITORING OF OZONE

Monitoring of O_3 in Northern Ireland is carried out largely using continuous automatic analysers. Diffusion tubes are also available for this pollutant, but are used routinely at only one site in Northern Ireland, which is operated by Fermanagh District Council. Monitoring of ozone is carried out at the sites shown in Table 7.1 below, and in Figure 7.1.

Table 7.1 Automatic O_3 Monitoring Sites

Site	Method	Grid Ref.	Classification	Network
Belfast Centre	Automatic	J 339 744	Urban Centre	AURN
Londonderry, Brooke Park	Automatic	C 429 172	Urban Background	AURN
Lough Navar	Automatic	H 065 545	Rural	AURN (Rural)
Fermanagh	Diff. tube	H 232 429	Urban Background	Fermanagh

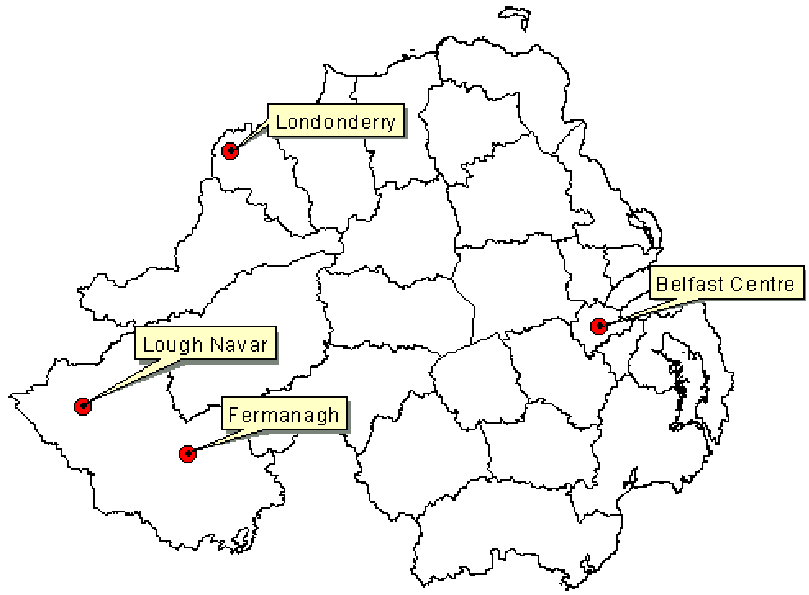

Figure 7.1 Location of Ozone Monitoring Sites

7.2 LIMIT VALUES AND OBJECTIVES FOR OZONE

Ozone is covered by the target values and objectives in Table 7.2. The third Daughter Directive, 2002/3/EC, which sets "target values" rather than limits, was transposed into Northern Ireland's legislation in July 2003 by the Air Quality (Ozone) Regulations (Northern Ireland) 2003. The AQS Objective, with its objective of 100 μg m^{-3} for the maximum daily 8-hour mean, is more stringent than the EC target value for this statistic, so if a site meets the AQS Objective it will also meet the EC target value for human health.

Table 7.2 Target Values and Objectives for Ozone

Averaging period	Target or Objective	Number of Permitted exceedences	To be achieved by
WHO (non-mandatory guide)			
Day	O_3 concentrations not to exceed 120 μg m^{-3} for more than eight hours per day.		
EC Ozone Directive (2002/3/EC)			
Max. daily 8-hour mean. Compliance assessment to be based on the average number of days exceedence over 3 consecutive years.	120 μg m^{-3}	25 days per calendar year	Averaged over 3 years, beginning 2010.
AOT40[a], calculated from 1h values May- July. *For protection of vegetation.*	18,000 μg m^{-3} h	-	Averaged over 5 years, beginning 2010
Air Quality Strategy [b]			
Max. daily running 8-hour mean	100 μg m^{-3}	10 days per year	31 December 2005

a) AOT 40 is the sum of the differences between hourly concentrations greater than 80 µg m^{-3} (=40ppb) and 80 µg m^{-3}, over a given period using only the 1-hour averages measured between 0800 and 2000.

b) Not included in the Air Quality Regulations.

7.3 OZONE RESULTS

Table 7.3 shows the annual maximum daily 8-hour running mean ozone concentration for each site during 2004, and also the number of days during the year on which this parameter exceeded 100 μg m^{-3}. The historic dataset is included in Appendix 2.

Where the AQS Objective was exceeded on more than 10 days, this is highlighted in ***bold italics.*** Table 7.3 shows that no sites exceeded the AQS Objective limit value for ozone on more than the permitted 10 days. (The Londonderry AURN site at Brooke Park just met the objective, with exceedences on a total of 10 days). This objective is to be met by 31 December 2005.

No sites in Northern Ireland exceeded the less stringent EC 3rd Daughter Directive target of 120μg m^{-3}, not to be exceeded on more than 25 days.

The EC 3rd Daughter Directive also sets a target value for protection of vegetation, based on the AOT40 statistic. This is only applicable in rural locations, so of the three automatic sites, it is only applicable to Lough Navar. Ozone data from Lough Navar, for the five years 1999 to 2004, were compared with this AOT40 target value for protection of vegetation. Lough Navar met the target value.

The 2004 annual mean ozone concentration at the Fermanagh diffusion tube site was 84 μg m^{-3}. This is consistent with the annual means recorded at this site between 2001 and 2003, but very high compared with the automatic analyser results.

Table 7.3 O_3 Results from Automatic Monitoring Sites

Calendar Year	Data Capture, %	Max Daily 8 Hour Mean μg m^{-3}	Days with max. daily 8hr mean > 100 μg m^{-3}	Annual Mean μg m^{-3}
Belfast Centre	96	108	5	43
Londonderry	98	116	10	57
Lough Navar	75	116	3	53

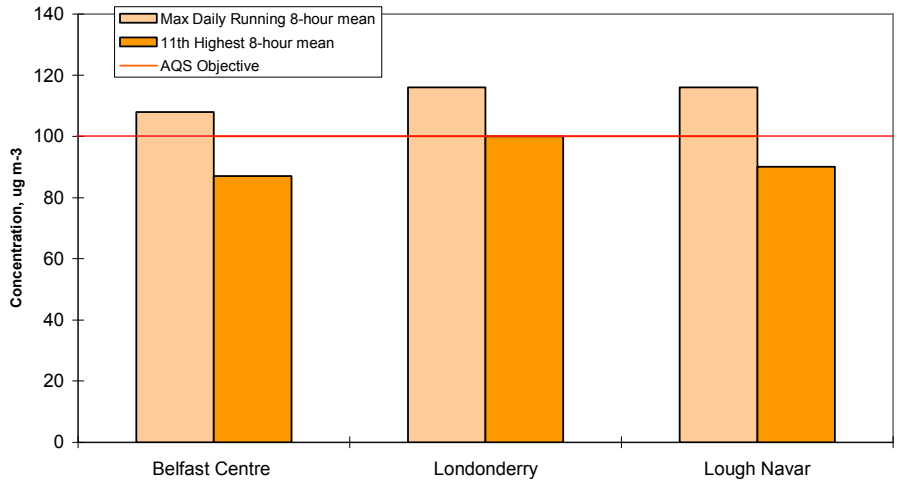

Figure 7.2 Comparison of 2004 Ozone Results from Automatic Sites with AQS Objective.

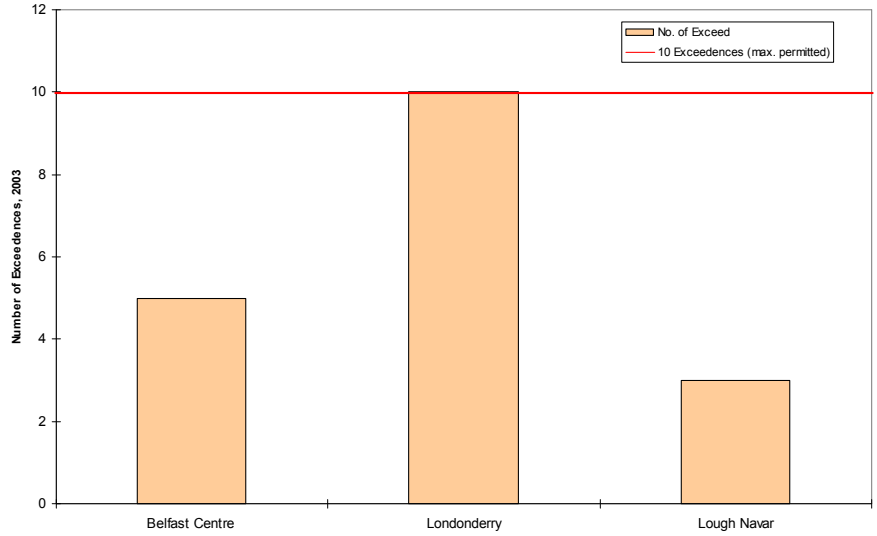

Figure 7.3 Number of Exceedences of AQS Objective for Ozone, 2004.

7.4 OZONE TRENDS

Figure 7.4 shows a time series plot of the annual mean ozone concentration (annual means shown only where data capture is at least 70%). As reported in previous years, there appear to be no clear trends at any of Northern Ireland's ozone monitoring sites, although there is some year-to-year variation. If ozone concentrations remain around their current levels, occasional exceedences of the AQS Objective may continue to occur, such as that observed at Londonderry in 2002 and 2003.

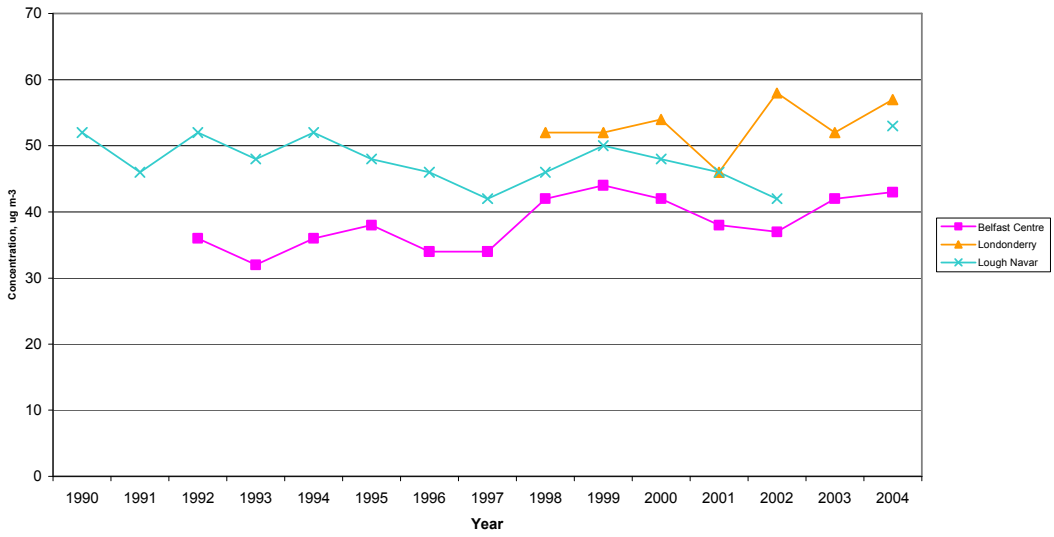

Figure 7.4 Trends in Annual Mean Ozone Concentration

8 Hydrocarbons

There are many hydrocarbon compounds that have the potential to be pollutants when released into the atmosphere. Some occur naturally, others are man-made.

(i) Benzene and 1,3-butadiene

A range of hydrocarbons is found in vehicle fuel, and occurs in vehicle emissions. In most urban areas, vehicle emissions constitute a major source of hydrocarbons, including benzene and 1,3-butadiene. Also, there is the potential that they may be released to the air from facilities where fuels are stored or handled.

Benzene is of most concern, as it is a known human carcinogen; long-term exposure can cause leukaemia. It is found in petrol and other liquid fuels, in small concentrations. In urban areas, the major source is vehicle emissions.

1,3-butadiene is also found in vehicle emissions: although not actually present in petrol or diesel, it is formed as these fuels undergo combustion. 1,3-butadiene is a suspected human carcinogen and therefore an air quality objective has been set for it.

In this report, concentrations of benzene and 1,3-butadiene are expressed as microgrammes per cubic metre (μg m^{-3}). To convert to parts per billion (ppb) if necessary, the following relationships should be used:

1 ppb = 3.25 μg m^{-3} for benzene at 293K (20°C) and 1013mb.

1 ppb = 2.25 μg m^{-3} for 1,3-butadiene at 293K (20°C) and 1013mb.

(ii) Polycyclic Aromatic Hydrocarbons

Another class of organic pollutants is the polycyclic aromatic hydrocarbons, (PAHs). These include the following compounds: Acenapthene, Acenapthylene, Anthracene, Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(ghi)perylene, Benzo(k)fluoranthene, Chrysene, Dibenz(ah)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Napthalene, Phenanthrene, Pyrene. They are all, to varying degrees, toxic or carcinogenic, and are therefore classified as Hazardous Air Pollutants. Concentrations of these hazardous compounds in ambient air are usually very small, and are reported as nanogrammes (i.e. 10^{-9} grammes) per cubic metre (ngm^{-3}).

According to the NAEI website (www.naei.org.uk), the largest source of PAHs in the UK at present is road transport, which in 2003 contributed 60% to the total UK PAH emissions. Non-ferrous metal processes such as aluminium smelting can also be a significant source, although there are no aluminium smelting plant in Northern Ireland at present. However, there is one significant source particularly relevant to parts of Northern Ireland: domestic solid fuel combustion. For this reason, it is important to continue monitoring PAH in areas where domestic solid fuel use is widespread.

PAHs can be adsorbed onto the surface of fine particulate: therefore they are monitored in the particulate phase, by sampling the PM_{10} fraction and analysing for the compounds of concern.

8.1 MONITORING OF HYDROCARBONS

From 1993 until 2000, a range of 27 hydrocarbons including benzene and 1,3-butadiene were monitored at a site named Belfast South. However, this site ceased operation at the end of 2000. Benzene and 1,3-butadiene data from Belfast South are reported in previous reports in this series.

In July 2002, monitoring of benzene, using pumped samplers commenced at two sites in Belfast. These are the existing Belfast Centre AURN site at Lombard Street, and a new site, Belfast Upper Newtownards Road, located on the Upper Newtownards Road in Ballyhackamore. In May 2003, monitoring of 1,3-butadiene also commenced at the same two sites, using passive samplers. Hydrocarbon monitoring at these sites is carried out by NPL.

A range of polycyclic aromatic hydrocarbons (PAHs) in the particulate phase is monitored at two sites in Northern Ireland as part of Defra's Hazardous Air Pollutants (HAPS) Network. These are Belfast (at Clara Street) and Lisburn (at Dunmurry High School). The sites are shown in Table 8.1 below, and site locations are shown in Figure 8.1.

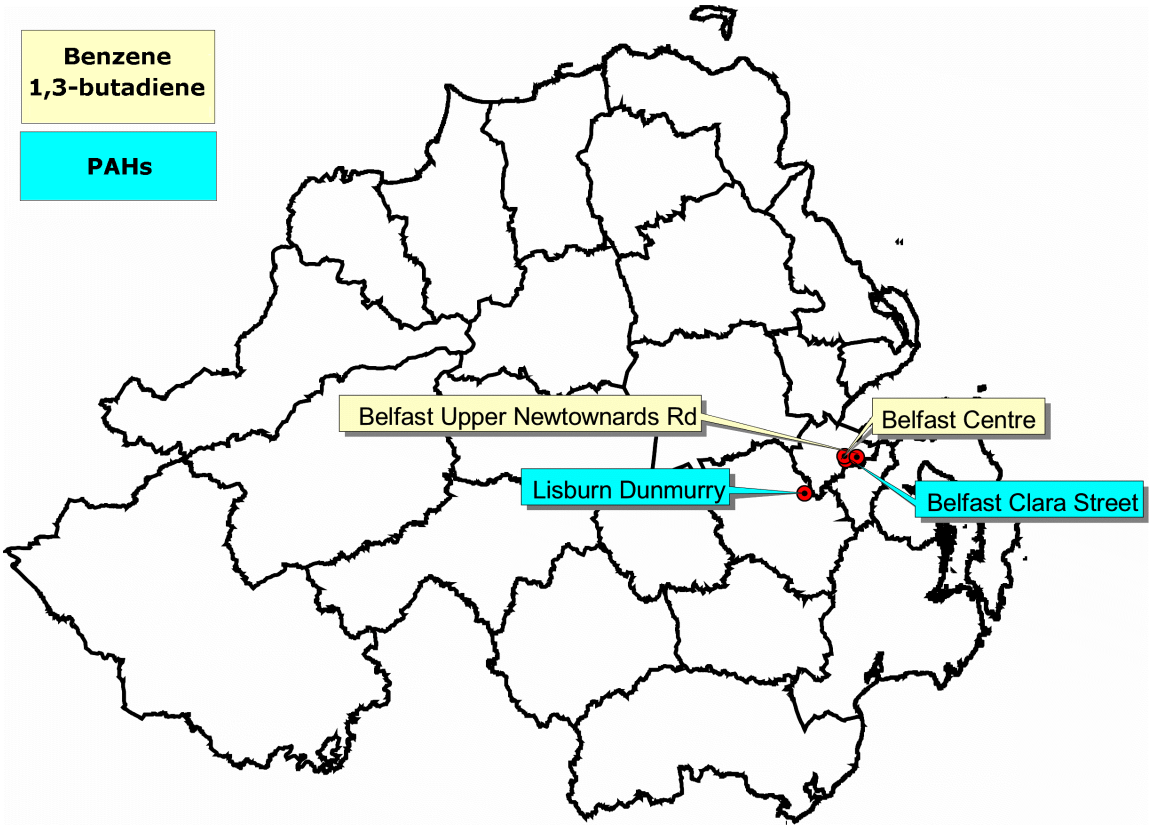

Figure 8.1 Locations of Hydrocarbon Monitoring Sites

Table 8.1 Hydrocarbon Monitoring Sites

Site	Grid Ref.	Classification	Pollutants	Network
Belfast Centre	J 339 744	Urban Centre	Benzene, 1,3-butadiene	Non-Auto. Hydrocarbon
Belfast Upper Newtownards Road	J 379 739	Roadside	Benzene, 1,3-butadiene	Non-Auto. Hydrocarbon
Lisburn (Dunmurry)	J 287 675	Urban Background	Range of PAH	Hazardous Air Pollutants
Belfast (Clara Street)	J 360 734	Suburban	Range of PAH	Hazardous Air Pollutants

All these sites are part of national monitoring networks and are subject to appropriate QA/QC programmes.

8.2 LIMIT VALUES AND OBJECTIVES FOR HYDROCARBONS

Within the European Community, benzene is covered by EC Directive 2000/69/EC (the 2nd Daughter Directive). In February 2003, Defra and the Devolved Administrations published an addendum to the Air Quality Strategy. The addendum brings into line objectives for carbon monoxide and benzene set by the 2nd Daughter Directive. An objective was added for PAHs. In Northern Ireland a corrigendum was issued in 2003 which adopted a PAH objective of 0.25 ng m^{-3} to be met by 31st December 2010. EC limits and AQS Objectives for these three hydrocarbon pollutants are summarised in Table 8.2:

Table 8.2 Limit Values and Objectives for Hydrocarbons

Averaging period	EC Limit or AQS Objective	To be achieved by
EC 2nd Daughter Directive (2000/69/EC)		
BENZENE: Calendar Year Mean	5 μg m^{-3}	1st January 2010
Air Quality Strategy		
BENZENE: Running annual mean * Calendar Year Mean	16.25 μg m^{-3} 3.25 μg m^{-3}	31st December 2003 31st December 2010
1,3 BUTADIENE: Running annual mean *	2.25 μg m^{-3}	31st December 2003
Air Quality Strategy for PAH		
PAHs *(using B(a)P as an indicator)* Calendar year mean	0.25 ng m^{-3}	31st December 2010

**The running annual mean and the calendar year mean are equivalent in this case.*

PAHs are to be covered by a fourth Daughter Directive, still under discussion. This specifies a range of PAHs to be monitored, but proposes a target value for just one PAH compound, benzo(a)pyrene, which will be used as a marker of carcinogenic risk from PAHs in ambient air. The proposed 2010 target value for benzo(a)pyrene (B(a)P) is 1 ngm^{-3} for the annual mean total benzo(a)pyrene in the PM_{10} particulate fraction. This target value is not a mandatory limit value, but rather "must be attained as far as possible and without entailing excessive costs". Industrial installations would be required to employ Best Available Techniques (BAT) to minimise their PAH emissions, but no measures beyond this (such as closing down plant) would be imposed. However, the draft Directive does specifically "require Member States to take all cost-effective abatement measures in the relevant sectors, e.g. domestic heating by solid fuels".

8.3 HYDROCARBON RESULTS

8.3.1 Benzene and 1,3 Butadiene

Table 8.3 shows calendar year mean concentrations of benzene at Belfast Centre and Belfast Upper Newtownards Road for 2004.

Table 8.3 Concentrations of Benzene, 2004

Site	Data Capture, %	Calendar Year Mean Concentration 2004, μg m^{-3}	Running Annual Mean Concentration 2004, μg m^{-3}
Belfast Centre	93	1.18	Not available
Belfast Upper Newtownards Road	93	2.69	Not available

The annual means for 2004 means of 1.18 μg m^{-3} and 2.69 μg m^{-3} for the two sites respectively are within the 2003 Air Quality Strategy Objective for the region (16.25 μg m^{-3}), also the 2010 Objective of 3.25 μg m^{-3}, and the EC 2nd Daughter Directive limit value of 5 μg m^{-3} for this

pollutant. These sites both met the AQS Objectives for benzene by the due date of 31st December 2003, and continue to do so.

1,3-butadiene monitoring began in May 2003. Table 8.4 shows calendar year mean concentrations of this pollutant.

Table 8.4 Concentrations of 1,3-Butadiene, 2004

Site	Data Capture, %	Calendar Year Mean Concentration 2004, μg m^{-3}	Running Annual Mean Concentration 2004, μg m^{-3}
Belfast Centre	90	0.057	-
Belfast Upper Newtownards Road	86	0.073	-

Annual mean levels of this pollutant at both sites are well within the applicable Air Quality Strategy Objective of 2.25 μg m^{-3}. These sites both met the AQS Objectives for 1,-butadiene by the due date of 31st December 2003, and continue to do so.

8.3.2 Polycyclic Aromatic Hydrocarbons

The 2004 annual mean benzo(a)pyrene concentration was 0.62 ngm^{-3} at Lisburn, Dunmurry, and 0.15 ngm^{-3} at Belfast Clara Street. Both sites are therefore within the proposed EC target value of 1.0 ngm^{-3} for this PAH. The 2010 AQS Objective for benzo(a)pyrene is 0.25 ngm^{-3}. Lisburn currently exceeds this value by a considerable margin.

To put these values into context, they should be compared with results from other sites in the HAPS Network – see Table 8.5. The two sites in Northern Ireland are shown in ***bold italics***.

Table 8.5 Annual Mean Benzo(a)pyrene Concentrations at all HAPS Network Sites

Site	Type	2000 ng m^{-3}	2001 ng m^{-3}	2002 ng m^{-3}	2003 ng m^{-3}	2004 ng m^{-3}
Ashington	Urban	0.17	0.2	0.15	0.19	0.15
Belfast	**Urban**	**-**	**0.37**	**0.13**	**< 0.08**	**0.15**
Birmingham	Urban	-	0.16	0.13	0.16	-
Bolsover	Urban	0.25	0.28	0.24	0.46	0.22
Brent	Urban	-	-	-	0.14	0.095
Bromley	Urban	-	-	0.25	0.21	0.19
Cardiff 2	Urban	-	-	-	-	0.069
Edinburgh	Urban	-	-	-	-	0.035
Glasgow	Urban	0.12	0.12	0.12	< 0.065	0.071
Hazelrigg	Semi-Rural	0.06	0.08	0.04	< 0.043	<0.02
High Muffles	Rural	0.04	0.05	0.04	0.045	<0.026
Holyhead	Urban	0.11	0.15	0.25	0.14	-
Hove		-	-	-	0.1	0.094
Kinlochleven *	Urban	2.28	0.34	0.38	0.21	0.32
Leeds	Urban	-	0.16	0.18	0.21	-
Lisburn	**Urban**	**0.93**	**0.96**	**0.65**	**< 0.95**	**0.62**
London 2a	Urban	0.14	0.14	0.13	0.12	<0.076
Manchester	Urban	0.24	0.34	0.12	0.24	0.11
Middlesbrough	Urban	0.28	0.37	0.15	0.24	0.14
Newcastle	Urban	-	0.11	0.12	0.16	0.064
Newport	Urban	0.35	0.36	0.19	0.11	0.1
Port Talbot	Urban	0.59	0.4	0.34	0.47	0.29
Scunthorpe	Urban	1.18	0.34	0.13	1.3	-
Speke	Urban	-	-	0.14	0.14	0.1
Stoke Ferry	Rural	0.09	0.09	0.08	0.08	<0.043

**Kinlochleven site (Scotland) was near an aluminium smelter, which closed in July 2000, hence the reduced annual mean in 2001.*

2004 annual mean benzo(a)pyrene at rural sites (Hazelrigg, High Muffles, Stoke Ferry) were all below 0.05 ngm^{-3}, and well within the Air Quality Strategy's new 2010 Objective of 0.25 ngm^{-3}. Sub urban sites (including Belfast Clara Street) had higher annual mean concentrations, ranging from 0.035 to 0.32 ngm^{-3}. Only three sites out of 25 exceeded the AQS Objective of 0.25 ngm^{-3} during 2004, and none exceeded the proposed EC limit value for benzo(a)pyrene of 1.0 ngm^{-3} .

The mean benzo(a)pyrene level at Belfast Clara Street in 2004 was measured as 0.15 ngm^{-3}. This is comparable with many other suburban sites such as Bromley, Manchester and Middlesbrough. Belfast Clara Street was well within the proposed AQS Objective of 0.25 ngm^{-3}.

The 2004 mean benzo(a)pyrene concentration at the Lisburn was 0.62 ngm^{-3}, the highest in the HAPS network. This is even higher than sites in or near industrial areas such as Kinlochleven, Port Talbot and Bolsover. The Lisburn site (along with Kinlochleven and Port Talbot) does not currently meet the AQS Objective of 0.25 ngm^{-3}. Lisburn Dunmurry is in a non-industrial residential area, and it is likely that domestic fuel burning is the dominant source of PAHs.

There are now five years' PAH data for the Lisburn site, making it possible to assess trends for the first time. There is, however, no statistically significant downward trend in annual mean B(a)P concentration at Lisburn. A study[6] carried out by **netcen** for Defra has predicted that the continued high use of solid fuels in Northern Ireland for domestic purposes may result in some urban areas exceeding the AQS Objective of 0.25 ngm^{-3} for benzo(a)pyrene in 2010. Exceedences result from domestic solid fuel use and other local activities. These sources could be addressed, by measures based upon Local Air Quality Management, such as the extension of smoke control orders. The study predicts that the continuation of the Northern Ireland Housing Executive's ongoing programme to replace solid fuel use with gas or oil will reduce ambient levels of benzo(a)pyrene to below the target value in most parts of Northern Ireland, as well as reducing ambient SO_2 and PM_{10}.

8.4 HYDROCARBON TRENDS

As the two benzene and 1,3butadiene monitoring sites in Belfast only began operation in 2002, there are insufficient data to assess trends.

However, the former Belfast South hydrocarbon site, which operated over the period 1994-2000, produced a long time series of data, from which trends for this period could be assessed. This information is presented fully in a previous report in this series, "Air Quality in Northern Ireland 2000-2001". A brief summary is provided here:

- Average benzene concentrations at Belfast South clearly decreased over the 8 years of monitoring.
- A regression analysis (Theil's non-parametric analysis) confirmed a downward trend in the annual mean benzene concentration, statistically significant at the 95% confidence level.
- For 1,3-butadiene, by contrast, regression analysis identified no statistically significant trend in the annual mean. However, levels were low and did not appear to be rising.

Thus, trend data from this former site indicated that concentrations of both benzene and 1,3, butadiene were low and likely to remain low.

9 Conclusions

1. 2004 was a significant year, as the Air Quality Strategy contains objectives for sulphur dioxide, lead and PM_{10} which were to be achieved by the end of this year.

Carbon Monoxide

2. Carbon Monoxide was measured at two sites: Belfast Centre and Londonderry. Having achieved the EC limit value and AQS Objective for CO by the due date of 31st December 2003, both sites continue to meet these objectives. There is a significant downward trend in the annual mean CO concentration at both sites.

Nitrogen Dioxide

3. Nitrogen Dioxide was monitored at fifteen automatic sites, following the addition of one new site in 2004. Only one, Belfast Westlink (which is beside a major urban road) had more than the permitted 18 exceedences of the 1-hour mean objective of 200 μg m^{-3} during 2004. However, three roadside automatic sites (Belfast Westlink, Belfast Upper Newtownards Road, and Derry, Dale's Corner) had annual mean NO_2 concentrations greater than the EC limit value and the Air Quality Strategy Objective of 40 μg m^{-3}. These sites may have difficulty in meeting the AQS Objective for annual mean NO_2 by the due date of 31st December 2005.

4. Nitrogen Dioxide was also monitored using diffusion tubes at 276 sites in 2004. After application of bias adjustment factors as set out in the Technical Guidance, 22 diffusion tube sites (all but two of which were roadside) had annual mean NO_2 concentrations greater than the EC Directive and AQS Objective of 40 μg m^{-3}. Of these, it is predicted that four may not meet the EC limit value by 2010. However, it must be emphasised that diffusion tube monitoring should only be considered indicative. The application of bias adjustment factors is subject to considerable uncertainty; more so than usual during 2004 as there was no reliable bias adjustment factor for diffusion tubes from one widely-used laboratory in 2004.

5. The previous report in this series highlighted an increase in annual mean NO_2 concentrations during 2003, probably due to meteorological factors. In 2004, annual mean NO_2 concentrations at most automatic sites returned to their 2002 levels or lower. Few automatic sites have sufficient years' data to assess trends, and of those that do, only Belfast Centre shows a statistically significant downward trend.

6. Annual mean NO_2 concentrations for all NO_2 Network diffusion tube sites in Northern Ireland indicate that, while there was a decreasing trend in NO_2 concentrations in the region during the mid to late 1990s, this has levelled off in recent years. Mean NO_2 concentrations appear to be stable, but not decreasing.

Sulphur Dioxide

7. Sulphur Dioxide was monitored at nineteen automatic sites in 2004. 2004 was significant, as two AQS objectives for SO_2 were to be met by the end of this year. All sites in Northern Ireland met the requirements of the objectives of the Air Quality Strategy for 1-hour and 24-hour mean SO_2 concentration, by the due date of 31st December 2004. The corresponding EC Limit Values, and the AQS Objective for 15-minute mean SO_2 concentration must be met by the end of 2005; these, too, are likely to be achieved without difficulty.

8. Data from long-running sites indicate that SO_2 levels in Northern Ireland are decreasing, with significant downward trends in annual mean SO_2 concentration at Belfast Centre and Belfast East. However, annual mean SO_2 concentrations at the Londonderry AURN site (situated at Brooke Park) are stable rather than decreasing.

9. Indicative net acidity data from the 33 urban non-automatic SO_2 (8-port sampler) sites also indicate that SO_2 levels in Northern Ireland continue to fall. In 2004, no sites exceeded the EC limit value and AQS Objective for the 24-hour mean on more than the permitted three occasions. This is the third consecutive year for which this has been the case. The historical dataset from this network show a clear decrease in annual mean SO_2 concentrations since the 1960s, which remains evident in recent years' data.

Particulate Matter

10. There are now 27 automatic sites monitoring particulate matter as PM_{10} in Northern Ireland. 2004 was a significant year for this pollutant, as the AQS Objectives for PM_{10} were to be met by 31st December 2004. Four sites exceeded the AQS Objective of 50 $\mu g\ m^{-3}$ (gravimetric equivalent) for the 24-hour mean, on more than the permitted 35 occasions: these were Ballymoney (a new site), Belfast Westlink, Newry Trevor Hill, and Strabane Springhill Park. These four sites have therefore failed to achieve the AQS Objective for 24-hour mean PM_{10} by the due date. The sites have until the end of 2005 to achieve the corresponding EC Limit Value for this parameter.

11. One site, Strabane Springhill Park, also exceeded the AQS Objective of 40 $\mu g\ m^{-3}$ for the annual mean PM_{10}, as gravimetric equivalent. This site is on a housing estate where coal and oil burning is prevalent. This site has failed to achieve the AQS Objective for annual mean PM_{10} by the due date. It has until the end of 2005 to meet the EC Limit Value.

12. Of the long-running sites, Belfast Centre and Londonderry (though not Belfast East or the rural Lough Navar) show a significant downward trend in annual mean PM_{10} concentrations.

13. Particulate matter as black smoke is measured at 33 sites, of which 30 are part of the long-running Smoke and SO_2 network. The historical dataset from this network show a clear and consistent decrease in annual mean smoke concentrations from the 1960s to the mid 1990s; however the downward trend has levelled off in the past five years. There is a black smoke site co-located with the Strabane PM_{10} monitor: this smoke sampler confirms that levels of suspended particulate are high at this location.

Ozone

14. Ozone is measured at three automatic sites in Northern Ireland: the AURN sites at Belfast Centre and Londonderry and the rural site Lough Navar. The AQS Objective, and the less stringent EC 3rd Daughter Directive target were not exceeded on more than the permitted 10 days in 2004 at any sites. The Londonderry AURN site had exactly 10 days' exceedence, so only just met the objective. This site has recorded more than 10 days' exceedence in previous years.

Hydrocarbons

15. Benzene is monitored at Belfast Centre and Belfast Upper Newtownards Road. The 2004 annual means were well within the AQS Objective and also within the EC 2nd Daughter Directive limit value. Having achieved the AQS Objective for benzene last year, both sites continue to meet the objective.

16. 1,3-butadiene is also monitored at Belfast Centre and Belfast Upper Newtownards Road. The 2004 annual means were well within the applicable Air Quality Strategy Objective of 2.25 $\mu g\ m^{-3}$. Having achieved the AQS Objective for 1,3-butadiene by the due date last year, both sites continue to meet the objective.

17. Polycyclic aromatic hydrocarbons were monitored at two sites (Belfast Clara Street and Lisburn Dunmurry). Belfast Clara Street's annual mean benzo(a)pyrene concentration was comparable with the annual means measured at other urban centre sites, and the site meets the 2010 AQS Objective and proposed EC Target Value for B(a)P. Lisburn remains significantly above the AQS Objective, but below the proposed EC Target Value.

18. The AQS Objective and EC Limit Value for annual mean ambient lead concentration were also to be met by the end of 2004. As set out in earlier reports in this series, a previous monitoring

study concluded that, even in industrial locations, annual mean ambient lead concentrations were well within the Limit Value.

Local Air Quality Management

19. Good progress has been made by District Councils in implementing local air quality management. Review and assessments have been completed by all 26 District Councils. Eleven Councils have identified areas likely to exceed AQS Objectives of which nine have declared Air Quality Management Areas.

10 Acknowledgements

Netcen would like to thank the District Councils and other organisations that carried out the air quality measurements detailed in this report.

11 References

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Appendices

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Appendix 1
Diffusion Tube Site Details and Data

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Table A1.1 NO2 Diffusion Tube Data 2004

Local Authority	Location of Sampler	Grid Ref., Easting	Grid Ref., Northing	NO_2 Network name (if part of NO_2 Network)	Site Class .	Unadjusted Annual mean NO_2 for 2004, ug m^{-3}	No. of month's data, if < 12	Bias Adjustment factor	Bias Adjusted Annual Mean NO_2 for 2004, ug m^{-3}	Lab Used	BAF Obtained from
Antrim	Ballymena Rd, Antrim	314600	387500		A	23		0.81	19	Casella	R&A Website
Antrim	Ballymena Rd., North of Dunsilly	313500	390500		A	29.3		0.81	24	Casella	R&A Website
Antrim	Belfast Rd/Oldstone Rd	316600	385600		A	38.8		0.81	31	Casella	R&A Website
Antrim	Main St, Randalstown	308200	390400		A	35.1		0.81	28	Casella	R&A Website
Antrim	Main Street, Templepatrick	323300	385800		A	33		0.81	27	Casella	R&A Website
Antrim	Oldstone Rd/ Ballyrobin Rd	317500	381700		A	30.3		0.81	25	Casella	R&A Website
Ards	19 Islandmore Avenue, Newtownards	349500	375005	NEWTOWNARDS 6N	C	8		1.15	9	Ruddock & Sherratt	Netcen, 4 months only
Ards	7 Ashgrove, Newtownards	348502	374489	NEWTOWNARDS 3N	C	9		1.15	10	Ruddock & Sherratt	Netcen, 4 months only
Ards	8 Court Street, Newtownards	348497	373494	NEWTOWNARDS 1N	A	29		1.15	33	Ruddock & Sherratt	Netcen, 4 months only
Ards	Donaghadee/Bangor Rds roundabout on A20	349607	374267		A	14		1.15	16	Ruddock & Sherratt	Netcen, 4 months only
Ards	roundabout before Ards shopping centre	347879	373846		A	19		1.15	22	Ruddock & Sherratt	Netcen, 4 months only
Ards	Rear of Town Hall opposite 18 Frances St.	348100	374094	NEWTOWNARDS 7N	A	30		1.15	35	Ruddock & Sherratt	Netcen, 4 months only
Armagh	17 Folly Lane, Armagh	288200	344800	ARMAGH 4N	C	20		0.74	15	Harwell Scientifics	Harwell Scientifics
Armagh	25 Railway Street, Armagh	287500	345800	ARMAGH 1N	A	32		0.74	24	Harwell Scientifics	Harwell Scientifics
Armagh	7 Desert Lane, Armagh	286800	345700	ARMAGH 3N	C	13		0.74	10	Harwell Scientifics	Harwell Scientifics
Armagh	Bridge House, Barrack Street, Armagh	287900	345000	ARMAGH 5N	A	38		0.74	28	Harwell Scientifics	Harwell Scientifics
Armagh	Lower Irish Street, Armagh	287400	344800		A	33		0.74	24	Harwell Scientifics	Harwell Scientifics
Armagh	Mallview Terrace	287900	345200		A	55		0.74	41	Harwell Scientifics	Harwell Scientifics
Armagh	Portadown Road, Armagh	288700	345900		A	32		0.74	24	Harwell Scientifics	Harwell Scientifics
Armagh	St Patricks Fold, Scotch Street, Armagh	287730	345080		A	18		0.74	13	Harwell Scientifics	Harwell Scientifics
Ballymena	29 Galgorm Road, Ballymena	310340	403200	BALLYMENA 2N	A	26.2		1.21	32	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	8 Ballyloughan Avenue, Ballymena	309550	404450	BALLYMENA 4N	C	14.3		1.21	17	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Ballymoney Street, Ballymena	310810	403520	BALLYMENA 5N	A	22.7		1.21	27	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Cullybackey Road, Ballymena	310350	403440		A	22.6		1.21	27	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	George Street, Ballymena	310590	403230		A	38.9		1.21	47	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Larne St, Ballymena	310600	402920		A	21.9		1.21	26	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Leighmore avenue, Ballymena	310230	402540	BALLYMENA 1N	C	12.6		1.21	15	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Linenhall St, Ballymena					31.8	6	1.21	38	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Lisnevenagh Road, Ballymena	311900	397000		A	16.2		1.21	20	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Main Street, Cullybackey	305840	405600		A	21.4		1.21	26	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	North Road, Ballymena	310640	403000		A	20		1.21	24	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	North Road, Ballymena	310640	403000		A	15.4		1.21	19	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Parkway,Ballymena	311030	403900		A	17.5		1.21	21	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Queen Street, Ballymena	310750	402200		A	22.9		1.21	28	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymena	Wellington Street, Ballymena	310770	403300		A	25.7		1.21	31	Lambeth Sci. Serv.	R&A Website, Sep 2005
Ballymoney	19 Linenhall Street, Ballymoney	294820	425930	BALLYMONEY 1N	A	26		1.08	28	Lambeth Sci. Serv.	R&A website
Ballymoney	2/4 Semicock Avenue, Ballymoney	294800	426860	BALLYMONEY 4N	C	16		1.08	17	Lambeth Sci. Serv.	R&A website
Ballymoney	31 Charles Street, Ballymoney	294640	426120		A	19		1.08	21	Lambeth Sci. Serv.	R&A website
Ballymoney	Adjacent 8 Ballybogey Road, Ballymoney	294220	426940	BALLYMONEY 5N	A	16		1.08	17	Lambeth Sci. Serv.	R&A website
Ballymoney	Ballymena Rd, Ballymoney	295990	425760		A			1.08		Lambeth Sci. Serv.	R&A website
Ballymoney	Castle St, Gate End	294740	425340		A			1.08		Lambeth Sci. Serv.	R&A website
Ballymoney	Frosses Rd/Kilraughts Road junction	296370	426100		A			1.08		Lambeth Sci. Serv.	R&A website
Ballymoney	Opposite 16 Armour Avenue, Ballymoney	295370	425660	BALLYMONEY 3N	C	14		1.08	15	Lambeth Sci. Serv.	R&A website
Ballymoney	Opposite 51 Queen Street, Ballymoney	295210	425860		A	22		1.08	24	Lambeth Sci. Serv.	R&A website
Banbridge	17 Springfields, Banbridge	312100	344400		C	12.6		1.05	13	Lambeth Sci. Serv.	R&A website
Banbridge	9 Fortfield, Maypole Hill, Dromoe	319900	353500		D	13		1.05	14	Lambeth Sci. Serv.	R&A website
Banbridge	A1 Dromore Bypass	319900	353600		A	26.7		1.05	28	Lambeth Sci. Serv.	R&A website
Banbridge	Dromore Street, Banbridge,7 Hillview Terrace	312800	346200		A	25.3		1.05	27	Lambeth Sci. Serv.	R&A website

Table A1.1 NO2 Diffusion Tube Data 2004

Local Authority	Location of Sampler	Grid Ref., Easting	Grid Ref., Northing	NO_2 Network name (if part of NO_2 Network)	Site Class .	Unadjusted Annual mean NO_2 for 2004, ug m^{-3}	No. of month's data, if < 12	Bias Adjustment factor	Bias Adjusted Annual Mean NO_2 for 2004, ug m^{-3}	Lab Used	BAF Obtained from
Belfast	301 Ormeau Road, Southern approaches	334500	372200		A	30		1.27	38	Lambeth Sci. Serv.	Source not identified
Belfast	400 Ormeau Road, Southern approaches	335000	370900		A	26		1.27	33	Lambeth Sci. Serv.	Source not identified
Belfast	Belfast City Hall, Donegall Square South	333800	373900	BELFAST 1N	A	34		1.27	43	Lambeth Sci. Serv.	Source not identified
Belfast	Black's Road	329700	369500		A	29		1.27	37	Lambeth Sci. Serv.	Source not identified
Belfast	Cromac Street (A)	334100	373500		A	37		1.27	47	Lambeth Sci. Serv.	Source not identified
Belfast	East Bridge Street	338747	373906		A	34		1.27	43	Lambeth Sci. Serv.	Source not identified
Belfast	Great George's Street	333900	375000		A	40		1.27	51	Lambeth Sci. Serv.	Source not identified
Belfast	Junction of East Bridge Street / Short Strand	335061	374967		A	34		1.27	43	Lambeth Sci. Serv.	Source not identified
Belfast	Lisburn Road	332697	372250		A	25		1.27	32	Lambeth Sci. Serv.	Source not identified
Belfast	Lombard Street	333900	374300		C	27		1.27	34	Lambeth Sci. Serv.	Source not identified
Belfast	Milner Street	332400	373400	BELFAST 5N	A	32	6	1.27	41	Lambeth Sci. Serv.	Source not identified
Belfast	Primary School, North Road	337500	374100	BELFAST 4N	C	20		1.27	25	Lambeth Sci. Serv.	Source not identified
Belfast	Royal Victoria Hospital, 12 Grosvenor Road Belfast	332400	373500	BELFAST 3N	C	18		1.27	23	Lambeth Sci. Serv.	Source not identified
Belfast	Short Strand (Jct Bridge End / Sydenham Flyover)	335020	374367		A	28		1.27	36	Lambeth Sci. Serv.	Source not identified
Belfast	Stockman's Lane	331200	371000		A	32		1.27	41	Lambeth Sci. Serv.	Source not identified
Belfast	Upper Newtownards Road (Ballyhackamore)	337916	373985		A	29		1.27	37	Lambeth Sci. Serv.	Source not identified
Belfast	Victoria Street near to junction with High Street	334209	374474		A	35		1.27	44	Lambeth Sci. Serv.	Source not identified
Belfast	Westlink, near Grosvenor Rd roundabout	332975	373812		A	35		1.27	44	Lambeth Sci. Serv.	Source not identified
Belfast	Whitewell Road	333572	380464		A	25		1.27	32	Lambeth Sci. Serv.	Source not identified
Carrickfergus	28 Bentra Road, Whitehead	345400	391900		D	10.5		1.15	12	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	42 Albert Road Carrickfergus	341317	341317		A	27.3		1.15	31	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	59 Shore Road, Greenisland	337900	384900	CARRICKFERGUS 1N	A	30.3		1.15	35	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	93 Belfast Road Carrickfergus	339900	386700		A	28.4		1.15	33	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	College North Road, Carrickfergus	341100	388900	CARRICKFERGUS 4N	C	14.9		1.15	17	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	Islandmagee Road, Whitehead	347600	392300		A	16.9		1.15	19	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	Lough Road, Loughmourne	341200	392100		D	7.4		1.15	8	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	Model PS 4 Belfast Road Carrickfergus	340776	387116		A	42.4		1.15	49	Ruddock & Sherratt	Netcen, 4 months only
Carrickfergus	Railway Station, Fergus Avenue, Carrickfergus	341200	387800		B	18.7		1.15	21	Ruddock & Sherratt	Netcen, 4 months only
Castlereagh	2 Newtownbreda Road	335246	370061		A	21.3		1.15	24	Ruddock & Sherratt	Netcen, 4 months only
Castlereagh	74 Downshire Park East	336474	371400	CASTLEREAGH 6N	D	10.8		1.15	12	Ruddock & Sherratt	Netcen, 4 months only
Castlereagh	985 Upp N'ards Road, Dundonald	341998	374009		A	27.2		1.15	31	Ruddock & Sherratt	Netcen, 4 months only
Castlereagh	Council Offices, 368 Cregagh Road, BT6 9EZ	336257	371278	CASTLEREAGH 1N	A	19		1.15	22	Ruddock & Sherratt	Netcen, 4 months only
Castlereagh	Lamp post, 17/19 Everton Drive, Castlereagh	336132	371141	CASTLEREAGH 5N	C	11.9		1.15	14	Ruddock & Sherratt	Netcen, 4 months only
Coleraine	Castlerock Rd, Coleraine	284300	432500		A	19.8	10	1.15	23	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Crocknamack Rd/Dunluce Av, Portrush	286100	440000		A	15.9		1.15	18	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Dunnes Car park/Coleraine Bridge, Coleraine	284600	432500		A	12.1		1.15	14	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Lower Union Street/Minburn Rd, Coleraine	284800	432800		A	22.8		1.15	26	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Portstewart Rd, Coleraine	285100	433400		A	14.8	10	1.15	17	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Railway Rd, Coleraine	285200	432700		A	12.9		1.15	15	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Ring Road, Lodge Rd Roundabout, Coleraine	285800	431400		A	15.7		1.15	18	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Spanboard, Coleraine, Castleroe Rd	285900	429900		E	5.5		1.15	6	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Tesco, Hanover Place, Coleraine	284900	432100		A	18.4	10	1.15	21	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	University, Coleraine	284500	432800		E	6.6		1.15	8	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Upper Union Street, Railway Rd, Coleraine	285100	432800		A	14.7		1.15	17	Ruddock & Sherratt *	Netcen, 4 months only
Coleraine	Waterside traffic lights/Strand Rd, Coleraine	284500	432500		A	14.3		1.15	16	Ruddock & Sherratt *	Netcen, 4 months only
Cookstown	Church St, Cookstown	281100	377500		A	27		1.21	33	Lambeth Sci. Serv.	R&A Website
Cookstown	High Street, Moneymore	285700	383400		A	29		1.21	35	Lambeth Sci. Serv.	R&A Website
Cookstown	James St, Cookstown	281000	378300		A	32		1.21	39	Lambeth Sci. Serv.	R&A Website
Cookstown	Killymoon St, Cookstown	281200	376900		A	21		1.21	25	Lambeth Sci. Serv.	R&A Website
Cookstown	William Street, Cookstown	281000	378400		B	42		1.21	51	Lambeth Sci. Serv.	R&A Website

Table A1.1 NO2 Diffusion Tube Data 2004

Local Authority	Location of Sampler	Grid Ref., Easting	Grid Ref., Northing	NO_2 Network name (if part of NO_2 Network)	Site Class .	Unadjusted Annual mean NO_2 for 2004, ug m^{-3}	No. of month's data, if < 12	Bias Adjustment factor	Bias Adjusted Annual Mean NO_2 for 2004, ug m^{-3}	Lab Used	BAF Obtained from
Craigavon	27 Ballyhammon Road, Portadown	308100	357800	CRAIGAVON 8N	C	10.5		1.08	11	Lambeth Sci. Serv.	R&A Website
Craigavon	36 Ardboe Drive, Lurgan	308000	357700	CRAIGAVON 7N	C	13.9		1.08	15	Lambeth Sci. Serv.	R&A Website
Craigavon	4 Cluandara, Derrymacash, Craigavon	304400	359300		C	15		1.08	16	Lambeth Sci. Serv.	R&A Website
Craigavon	Ashgrove centre, Garvaghy Rd, Portadown	300400	354800		C	10		1.08	11	Lambeth Sci. Serv.	R&A Website
Craigavon	Castle Lane(toilets), Lurgan	308200	358500		A	15		1.08	16	Lambeth Sci. Serv.	R&A Website
Craigavon	Holmes Bakery, 16 West Street, Portadown	301000	353800	CRAIGAVON 9N	A	15		1.08	16	Lambeth Sci. Serv.	R&A Website
Craigavon	Lord Lurgan Park, Lurgan	308000	359300		C	13		1.08	14	Lambeth Sci. Serv.	R&A Website
Craigavon	Town Hall, Union Street, Lurgan	308300	358300	CRAIGAVON 5N	A	18		1.08	19	Lambeth Sci. Serv.	R&A Website
Derry	1 Simpson Brae, Derry	244200	416300		A			1.21		Lambeth Sci. Serv.	R&A Website
Derry	1 Temple Road, Derry	247600	419500		A			1.21		Lambeth Sci. Serv.	R&A Website
Derry	10 Windsor Terrace	242900	417200		A	22		1.21	27	Lambeth Sci. Serv.	R&A Website
Derry	123a Strand Road, Derry	243700	418200		A			1.21		Lambeth Sci. Serv.	R&A Website
Derry	14 Creggan Road	242900	417200		A	25		1.21	30	Lambeth Sci. Serv.	R&A Website
Derry	19 St Patricks Terrace, Derry	243400	418900		A	27		1.21	33	Lambeth Sci. Serv.	R&A Website
Derry	2 Farren Park, Derry	243800	418700		A	11		1.21	13	Lambeth Sci. Serv.	R&A Website
Derry	22A Creggan Road	242900	417100		A	26		1.21	31	Lambeth Sci. Serv.	R&A Website
Derry	26 Rossdowney Park(Irish St Lights)	244900	416200		C	21		1.21	25	Lambeth Sci. Serv.	R&A Website
Derry	27 Park Avenue	242900	417700		C	35		1.21	42	Lambeth Sci. Serv.	R&A Website
Derry	3 Farren Park, Derry	243800	418700		A	22		1.21	27	Lambeth Sci. Serv.	R&A Website
Derry	3 Glendermot Road, Derry	244300	416700	LONDONDERRY 9N	A	27		1.21	33	Lambeth Sci. Serv.	R&A Website
Derry	3 Silverbirch Crescent, Derry	245300	416700	LONDONDERRY 11N	C	24		1.21	29	Lambeth Sci. Serv.	R&A Website
Derry	34 Northland Terrace, Derry	243300	417900		A	31		1.21	38	Lambeth Sci. Serv.	R&A Website
Derry	5 Collon Terrace	243500	418800		A	38		1.21	46	Lambeth Sci. Serv.	R&A Website
Derry	5 Farren park, Derry	243800	418700		A	19		1.21	23	Lambeth Sci. Serv.	R&A Website
Derry	5 Glendermott Road	244300	416700		A	18		1.21	22	Lambeth Sci. Serv.	R&A Website
Derry	52 Clooney terrace	244200	416700		A	12		1.21	15	Lambeth Sci. Serv.	R&A Website
Derry	53 Messines Park	243400	419100		A	17		1.21	21	Lambeth Sci. Serv.	R&A Website
Derry	54 William Street	243300	416900		C			1.21		Lambeth Sci. Serv.	R&A Website
Derry	57 Messines Park	243300	419200		A	22		1.21	27	Lambeth Sci. Serv.	R&A Website
Derry	6 Dacre Terrace	243600	416300		A			1.21		Lambeth Sci. Serv.	R&A Website
Derry	6 Marleborough Terrace	242800	417100		A	32		1.21	39	Lambeth Sci. Serv.	R&A Website
Derry	67 Clarendon Street	243200	417300		A	25		1.21	30	Lambeth Sci. Serv.	R&A Website
Derry	7 Harberton Park (Altnagelvin Lights)	245200	415600		A	18		1.21	22	Lambeth Sci. Serv.	R&A Website
Derry	9 Farren park, Derry	243800	418700		A	21		1.21	25	Lambeth Sci. Serv.	R&A Website
Derry	99 Strand Road	243600	418000		A	26		1.21	31	Lambeth Sci. Serv.	R&A Website
Derry	Brooke Park, Infirmary Road, Derry	242900	417300	LONDONDERRY 10N	C	13		1.21	16	Lambeth Sci. Serv.	R&A Website
Derry	Brooke Park, Infirmary Road, Derry	242900	417300	LONDONDERRY 10N	C	15		1.21	18	Lambeth Sci. Serv.	R&A Website
Derry	Brooke Park, Infirmary Road, Derry	242900	417300	LONDONDERRY 10N	C	8		1.21	10	Lambeth Sci. Serv.	R&A Website
Derry	Dales Corner, Waterside	244200	416600		A	18.5		1.21	22	Lambeth Sci. Serv.	R&A Website
Derry	Dales Corner, Waterside	244200	416600		A	24.5		1.21	30	Lambeth Sci. Serv.	R&A Website
Derry	Dales Corner, Waterside	244200	416600		A	24.2		1.21	29	Lambeth Sci. Serv.	R&A Website
Derry	No 3 Creggan Road, Derry	242800	417300	LONDONDERRY 8N	A	31		1.21	38	Lambeth Sci. Serv.	R&A Website
Derry	No 3 Creggan Road, Derry	242800	417300	LONDONDERRY 8N	A	44		1.21	53	Lambeth Sci. Serv.	R&A Website
Derry	Rockmills, Strand Road	243500	417900		A	18		1.21	22	Lambeth Sci. Serv.	R&A Website
Derry	Spencer Rd/Victoria Rd Flats	243800	415900		A	28		1.21	34	Lambeth Sci. Serv.	R&A Website
Down	11 Orchard Way, Strangford Road, Downpatrick	348930	345903	DOWNPATRICK 4N	C	5.6		1.15	6	Ruddock & Sherratt	Netcen, 4 months only
Down	19 Church Street, Ballynahinch BT24 8AF	336592	352216	BALLYNAHINCH 9N	A	23		1.15	26	Ruddock & Sherratt	Netcen, 4 months only
Down	4 Main Street, Newcastle	337818	331601		A	17.1		1.15	20	Ruddock & Sherratt	Netcen, 4 months only
Down	5 St Patrick's Avenue, Downpatrick	348542	344448		A	24.6		1.15	28	Ruddock & Sherratt	Netcen, 4 months only
Down	7 St Patrick's Drive, Downpatrick	348605	344205	DOWNPATRICK 3N	C	8.6		1.15	10	Ruddock & Sherratt	Netcen, 4 months only
Down	9 Irish Street, Downpatrick, BT30 6BN	348702	344600	DOWNPATRICK 1N	A	30.6		1.15	35	Ruddock & Sherratt	Netcen, 4 months only
Down	Main Street, Saintfield BT24 7AA	340715	359111		A	16.1		1.15	19	Ruddock & Sherratt	Netcen, 4 months only
Down	Stream Street, Downpatrick BT30 6DD	348915	344207		A	18.2		1.15	21	Ruddock & Sherratt	Netcen, 4 months only

Table A1.1 NO2 Diffusion Tube Data 2004

Local Authority	Location of Sampler	Grid Ref., Easting	Grid Ref., Northing	NO_2 Network name (if part of NO_2 Network)	Site Class .	Unadjusted Annual mean NO_2 for 2004, ug m^{-3}	No. of month's data, if < 12	Bias Adjustment factor	Bias Adjusted Annual Mean NO_2 for 2004, ug m^{-3}	Lab Used	BAF Obtained from
Dungannon	11 Bushvale, Dungannon	281100	362300		C	9.4		1.08	10	Lambeth Sci. Serv.	Lambeth Scientific Services
Dungannon	4 Ardgannon Dungannon	279600	363000		B	17		1.08	18	Lambeth Sci. Serv.	Lambeth Scientific Services
Dungannon	Church St, Dungannon	279800	362380		A			0.75		Harwell Scientifics	Harwell Scientifics
Dungannon	Church St, Dungannon	279800	362380		A	31		0.75	23	Harwell Scientifics	Harwell Scientifics
Dungannon	Howard Primary School, Moy Road	281200	360700		A	22.4		1.08	24	Lambeth Sci. Serv.	Lambeth Scientific Services
Dungannon	Market Square, Dungannon	279800	362500		A	21.3		1.08	23	Lambeth Sci. Serv.	Lambeth Scientific Services
Fermanagh DC	29 Henry St Enniskillen	223100	344300		A	32.9		0.79	26	Ruddock & Sherratt	Netcen, 4 months only
Fermanagh DC	Belmore Street, Enniskillen	223900	344000		A	23		0.79	18	Ruddock & Sherratt	Netcen, 4 months only
Fermanagh DC	Everglades, Tempo Road, Enniskillen	225600	344700		B	5.3		0.79	4	Ruddock & Sherratt	Netcen, 4 months only
Fermanagh DC	Rossole Road, Enniskillen	223000	343200		C	6.8		0.79	5	Ruddock & Sherratt	Netcen, 4 months only
Fermanagh DC	Town Hall, Enniskillen BT74 7BA	223500	344100		A	15		0.79	12	Ruddock & Sherratt	Netcen, 4 months only
Fermanagh DC	Westbridge House Anne St, Enniskillen	223300	344300		A	20.9		0.79	17	Ruddock & Sherratt	Netcen, 4 months only
Larne	Antiville Rd/A8 junction	338600	402100		A	22.35		1.15	26	Lambeth Sci. Serv.	Source not identified
Larne	Ballylumford Rd	342100	402000		A	13.4		1.15	15	Lambeth Sci. Serv.	Source not identified
Larne	Coastguard Rd	341300	401700		A	10.1		1.15	12	Lambeth Sci. Serv.	Source not identified
Larne	Larne Harbour Roundabout	341200	402000		A	16.7		1.15	19	Lambeth Sci. Serv.	Source not identified
Larne	Main St	340200	402600		A	15.9		1.15	18	Lambeth Sci. Serv.	Source not identified
Larne	Riverdale	339700	402500		A	16.6		1.15	19	Lambeth Sci. Serv.	Source not identified
Larne	Upper Cairncastle Rd	339200	403200		A	18.1		1.15	21	Lambeth Sci. Serv.	Source not identified
Larne	Victoria Rd/Agnew Street junction	340300	402900		A	23.7		1.15	27	Lambeth Sci. Serv.	Source not identified
Limavady	Council car park, Connell St, Limavady	0	0		A	11.1		0.95	11	Enviro technology	R&A Website
Limavady	Irish Green St, Limavady	267200	422900		A	31.9		0.95	30	Enviro technology	R&A Website
Limavady	Junction of Ballyquin Rd/Main St, Dungiven	268800	409500		A	50.3		0.95	48	Enviro technology	R&A Website
Limavady	Junction of Garvagh Rd/Main St, Dungiven	269300	409200		A	33.85		0.95	32	Enviro technology	R&A Website
Limavady	Recreation Centre				A	7.81		0.95	7	Enviro technology	R&A Website
Lisburn	10 Beechlawn Park, Dunmurry	329610	369105		B	19.7		1.15	23	Ruddock & Sherratt	Netcen, 4 months only
Lisburn	18 Kingsway, Dunmurry	329502	386915	LISBURN 7N	A	23		1.15	26	Ruddock & Sherratt	Netcen, 4 months only
Lisburn	22 Ventor Park, Lambeg	326900	362013	LISBURN 3N	C	11.5		1.15	13	Ruddock & Sherratt	Netcen, 4 months only
Lisburn	75 Edgewater, Lisburn	327202	363718	LISBURN 6N	C	12.8		1.15	15	Ruddock & Sherratt	Netcen, 4 months only
Lisburn	Antrim Road, Lisburn	326313	364621		B	19.3		1.15	22	Ruddock & Sherratt	Netcen, 4 months only
Lisburn	lagan valley hospital grounds	326585	363671		A	16.6		1.15	19	Ruddock & Sherratt	Netcen, 4 months only
Lisburn	Main Street, Moira	315100	360621		C	27.1		1.15	31	Ruddock & Sherratt	Netcen, 4 months only
Lisburn	Northern Bank, 62 Bow Street, Lisburn	326507	364415	LISBURN 1N	A	25.8		1.15	30	Ruddock & Sherratt	Netcen, 4 months only
Magherafelt	Boyne row, Castledawson	292500	393200		A	16		1.21	19	Lambeth Sci. Serv.	R&A Website
Magherafelt	Church Street, Magherafelt	289700	390900		A	37		1.21	45	Lambeth Sci. Serv.	R&A Website
Magherafelt	Eel fishery, Toomebridge	298900	390800		A	15		1.21	18	Lambeth Sci. Serv.	R&A Website
Magherafelt	King St, Magherafelt	289800	390700		A	18		1.21	22	Lambeth Sci. Serv.	R&A Website
Magherafelt	Main Street, Maghera	285300	400400		A	30		1.21	36	Lambeth Sci. Serv.	R&A Website
Magherafelt	Queen Street, Magherafelt	289600	390500		A	36		1.21	44	Lambeth Sci. Serv.	R&A Website
Magherafelt	Wesleyan Mews, Magherafelt	289900	390700		B	22		1.21	27	Lambeth Sci. Serv.	R&A Website
Moyle	Church on Main Street, Bushmills	294700	440600		A	13.6		1.21	16	Lambeth Sci. Serv.	R&A Website
Moyle	Leyland Rd, Ballycastle	310100	441500		B	8.7		1.21	11	Lambeth Sci. Serv.	R&A Website
Moyle	Light pole, Dunluce Rd, Bushmills	293700	440800		A	9.8		1.21	12	Lambeth Sci. Serv.	R&A Website
Moyle	Lower Main St, Bushmills	294200	440900		A	10.2		1.21	12	Lambeth Sci. Serv.	R&A Website
Moyle	Middle Park Rd, Cushendall	323900	427200		A	7.8		1.21	9	Lambeth Sci. Serv.	R&A Website
Moyle	Mill St car park, Cushendall	323700	427500		B	10		1.21	12	Lambeth Sci. Serv.	R&A Website
Moyle	Sheskburn House, 7 Mary St, Ballycastle	312200	441200		B	10.5		1.21	13	Lambeth Sci. Serv.	R&A Website
Moyle	St Patricks' Pr. Sch. 244 Garron Rd, Glenariff	324300	425200		B	7.7		1.21	9	Lambeth Sci. Serv.	R&A Website

Table A1.1 NO2 Diffusion Tube Data 2004

Local Authority	Location of Sampler	Grid Ref., Easting	Grid Ref., Northing	NO_2 Network name (if part of NO_2 Network)	Site Class .	Unadjusted Annual mean NO_2 for 2004, ug m^{-3}	No. of month's data, if < 12	Bias Adjustment factor	Bias Adjusted Annual Mean NO_2 for 2004, ug m^{-3}	Lab Used	BAF Obtained from
Newry & Mourne	19 Balmoral Park, NEWRY	309313	327552	NEWRY 9N	C	14.3		1.18	17	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	20a Water Street, NEWRY, Alexander Hanna	308684	326596	NEWRY 6N	A	44.8		1.18	53	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	Bridge St, main Dublin Rd	308420	325870		A	33.4		1.18	39	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	Kildare St	308709	326733		A	29		1.18	34	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	Kilmorey St	308729	325871		A	38.7		1.18	46	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	Monaghan Row, NEWRY	307852	326757	NEWRY 11N	C	12.1		1.18	14	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	Rathfriland Rd, NEWRY	309397	327275		A	25.8		1.18	30	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	Stone Bridge	308709	326733		A	31		1.18	37	Lambeth Sci. Serv.	Own Co-location study
Newry & Mourne	Trevor Hill, NEWRY	308709	326733	NEWRY 10N	A	27		1.18	32	Lambeth Sci. Serv.	Own Co-location study
Newtownabbey	145 Jordanstown Rd, N'abbey	335200	384400		A	18	6	1.21	22	Lambeth Sci. Serv.	R&A website
Newtownabbey	174 Monkstown Road,	334200	385200		A	16	6	1.21	19	Lambeth Sci. Serv.	R&A website
Newtownabbey	189 Doagh Rd, N'abbey	334400	382900		A	25	6	1.21	30	Lambeth Sci. Serv.	R&A website
Newtownabbey	44 Sandyknowes Av, N'Abbey	330600	382700		A	24	10	1.21	29	Lambeth Sci. Serv.	R&A website
Newtownabbey	49 Main Street, Ballyclare	328800	391100	NEWTOWNABBEY 1N	A	27	11	1.21	33	Lambeth Sci. Serv.	R&A website
Newtownabbey	690 Shore Road,	336700	383700	NEWTOWNABBEY 12N	A	19	6	1.21	23	Lambeth Sci. Serv.	R&A website
Newtownabbey	A8 motorway Sandyknowes,	330500	383200	NEWTOWNABBEY 11N	A	26		1.21	31	Lambeth Sci. Serv.	R&A website
Newtownabbey	Abbots Cross				A			1.21		Lambeth Sci. Serv.	R&A website
Newtownabbey	Antrim Rd, Elmfield				A	30	6	1.21	36	Lambeth Sci. Serv.	R&A website
Newtownabbey	Antrim Rd, Sandyknowes, N'Abbey	330600	382900		A	25	6	1.21	30	Lambeth Sci. Serv.	R&A website
Newtownabbey	B&Q				A			1.21		Lambeth Sci. Serv.	R&A website
Newtownabbey	Ballyclare Road/Manse Road rd.about	331400	383800		A	23	6	1.21	28	Lambeth Sci. Serv.	R&A website
Newtownabbey	Bernice Rd/Mallusk Rd	327700	383500		A	13	6	1.21	16	Lambeth Sci. Serv.	R&A website
Newtownabbey	Bernice Rd/Mallusk Rd	327700	383500		A	11	6	1.21	13	Lambeth Sci. Serv.	R&A website
Newtownabbey	Braden Heights, Rathcoole, N'Abbey	333900	381900	NEWTOWNABBEY 13N	A	12		1.21	15	Lambeth Sci. Serv.	R&A website
Newtownabbey	Burnthill Rd, N'Abbey	331500	381900		A	18	6	1.21	22	Lambeth Sci. Serv.	R&A website
Newtownabbey	Collinbridge Rd				A			1.21		Lambeth Sci. Serv.	R&A website
Newtownabbey	Doagh Village, Doagh Road, Doagh	326200	389500		A	22	10	1.21	27	Lambeth Sci. Serv.	R&A website
Newtownabbey	Greenacres, Glebe Rd, N'Abbey	332400	383200		A	17	6	1.21	21	Lambeth Sci. Serv.	R&A website
Newtownabbey	Henryville Court, Ballyclare	326900	391000		C	13	6	1.21	16	Lambeth Sci. Serv.	R&A website
Newtownabbey	Hightown Rd/Mallusk Rd, N'Abbey	331400	382100		A	28	6	1.21	34	Lambeth Sci. Serv.	R&A website
Newtownabbey	Hillhead Rd/Mill Rd junction	329100	390900		A	18	6	1.21	22	Lambeth Sci. Serv.	R&A website
Newtownabbey	Junction at A8 Doagh Road,	331000	385900		A	14	6	1.21	17	Lambeth Sci. Serv.	R&A website
Newtownabbey	Langley Hall				A	16	6	1.21	19	Lambeth Sci. Serv.	R&A website
Newtownabbey	Longshot Road, Doagh,	326800	388500		A	19	6	1.21	23	Lambeth Sci. Serv.	R&A website
Newtownabbey	M5 @ Shore Rd, N'abbey	335400	381500		A	28	6	1.21	34	Lambeth Sci. Serv.	R&A website
Newtownabbey	Main Street, Ballynure, Ballyclare	331900	393600		A	23	7	1.21	28	Lambeth Sci. Serv.	R&A website
Newtownabbey	Main Street, Ballynure, Ballyclare	331900	393600		A	19	6	1.21	23	Lambeth Sci. Serv.	R&A website
Newtownabbey	McMillan House, 323 Antrim Road, Glengormley	331800	382300		A	26		1.21	31	Lambeth Sci. Serv.	R&A website
Newtownabbey	Merville Garden Village	334800	380700		A	20	6	1.21	24	Lambeth Sci. Serv.	R&A website
Newtownabbey	Nortel, Doagh Rd, N'abbey	334200	383800		A	16	6	1.21	19	Lambeth Sci. Serv.	R&A website
Newtownabbey	North End, Ballyclare	328700	391300		A	40	6	1.21	48	Lambeth Sci. Serv.	R&A website
Newtownabbey	Nox Analyser, Antrim Road	330500	383000		A	26		1.21	31	Lambeth Sci. Serv.	R&A website
Newtownabbey	Nox Analyser, Antrim Road	330500	383000		A	26		1.21	31	Lambeth Sci. Serv.	R&A website
Newtownabbey	Nox Analyser, Antrim Road	330500	383000		A	23		1.21	28	Lambeth Sci. Serv.	R&A website
Newtownabbey	Nox Analyser, Antrim Road	330500	383000		A	19	10	1.21	23	Lambeth Sci. Serv.	R&A website

Table A1.1 NO2 Diffusion Tube Data 2004

Local Authority	Location of Sampler	Grid Ref., Easting	Grid Ref., Northing	NO_2 Network name (if part of NO_2 Network)	Site Class .	Unadjusted Annual mean NO_2 for 2004, ug m^{-3}	No. of month's data, if < 12	Bias Adjustment factor	Bias Adjusted Annual Mean NO_2 for 2004, ug m^{-3}	Lab Used	BAF Obtained from
Newtownabbey	Nox Analyser, Shore Road	334700	380500		A	21	11	1.21	25	Lambeth Sci. Serv.	R&A website
Newtownabbey	Nox Analyser, Shore Road	334700	380500		A	25	10	1.21	30	Lambeth Sci. Serv.	R&A website
Newtownabbey	Oaklands, Old Carrick Rd, N'Abbey	334400	385200		C	20	6	1.21	24	Lambeth Sci. Serv.	R&A website
Newtownabbey	Oneill Road/Doagh Road roundabout,	335500	382300		A	18	6	1.21	22	Lambeth Sci. Serv.	R&A website
Newtownabbey	opposite 1A Jordanstown Road,	336500	383600		A	22	6	1.21	27	Lambeth Sci. Serv.	R&A website
Newtownabbey	Prince Charles Way/Manse Rd	331400	383800		C	21	6	1.21	25	Lambeth Sci. Serv.	R&A website
Newtownabbey	Roundabout @ bottom of Main St, Ballyclare	329100	390900		A	19	6	1.21	23	Lambeth Sci. Serv.	R&A website
Newtownabbey	Scullions Rd, Mallusk, N'abbey	330400	382900		A	20	6	1.21	24	Lambeth Sci. Serv.	R&A website
Newtownabbey	St Bernards' Rd School, Antrim Rd, N'Abbey	332300	381900		A	26	6	1.21	31	Lambeth Sci. Serv.	R&A website
Newtownabbey	Station Road,	335500	382400		A	21	6	1.21	25	Lambeth Sci. Serv.	R&A website
Newtownabbey	Tudor Park, N'Abbey	329800	383400		A	10	6	1.21	12	Lambeth Sci. Serv.	R&A website
Newtownabbey	Valley Leisure centre, N'Abbey	333600	381400		A	22	6	1.21	27	Lambeth Sci. Serv.	R&A website
North Down	1 Rathmore Road, Bangor	348300	381526	BANGOR NI 8N	C	11.7		1.15	13	Ruddock & Sherratt	Netcen, 4 months only
North Down	132 Main Street, Bangor	350402	381521	BANGOR NI 6N	A	22.8		1.15	26	Ruddock & Sherratt	Netcen, 4 months only
North Down	52 Bingham Street, Bangor	350707	381905	BANGOR NI 7N	A	22.1		1.15	25	Ruddock & Sherratt	Netcen, 4 months only
North Down	68 Groomsport Road, Bangor	352002	381910	BANGOR NI 4N	C	10.8		1.15	12	Ruddock & Sherratt	Netcen, 4 months only
North Down	Bangor Rd Ballyrobert	345002	380823		C	25.1		1.15	29	Ruddock & Sherratt	Netcen, 4 months only
North Down	Bangor Rd Seahill	343545	381102		C	25.6		1.15	29	Ruddock & Sherratt	Netcen, 4 months only
North Down	Marine Parade ,Holywood	339600	379229			22		1.15	25	Ruddock & Sherratt	Netcen, 4 months only
North Down	Marine Parade Holywood	340000	379313		A	28.2		1.15	32	Ruddock & Sherratt	Netcen, 4 months only
North Down	Station Rd Cultra	342475	380672		C	32		1.15	37	Ruddock & Sherratt	Netcen, 4 months only
Strabane	Main St, Castlederg	226200	384400		A			1.15		Ruddock & Sherratt	Netcen, 4 months only
Strabane	Main St, Newtownstewart	240200	385700		A			1.15		Ruddock & Sherratt	Netcen, 4 months only
Strabane	Main St, Strabane	234500	397500		A			1.15		Ruddock & Sherratt	Netcen, 4 months only
Strabane	Melmount Rd, Strabane	233900	396200		A			1.15		Ruddock & Sherratt	Netcen, 4 months only
Strabane	Urney Rd, Strabane	233700	397400		A			1.15		Ruddock & Sherratt	Netcen, 4 months only

**Coleraine used Ruddock and Sherratt for 10 months of 2004, Lambeth Sci. Serv. for the other two. Bias adjustment factor applied is that of Ruddock and Sherratt.*

Only available BAF for Ruddock & Sherratt is based on 4 months co-location data only, so should be treated with caution.

None of Omagh DC's 10 sites were in operation during 2004.

Appendix 2
Historic Datasets for CO, NO_2, SO_2 PM_{10} and O_3

CONTENTS

Table A2.1 CO Results from Automatic Monitoring Sites 1992 – 2004.

Calendar Year	Data Capture %	Annual Mean mg m^{-3}	Max running 8-Hour Mean Mg m^{-3}	Number of Exceedences of EC Limit Value	Number of Exceedences of AQS Objective
Belfast Centre					
1992	79	0.9	11.9	5	5
1993	97	0.8	12.3	1	1
1994	97	0.8	15.6	2	2
1995	95	0.7	16.3	4	4
1996	96	0.6	9.4	0	0
1997	96	0.8	8.2	0	0
1998	91	0.5	4.0	0	0
1999	94	0.5	4.3	0	0
2000	81	0.4	3.5	0	0
2001	60	0.4	5.5	0	0
2002	97	0.3	3.6	0	0
2003	79	0.2	2.7	0	0
2004	96	0.2	2.8	0	0
Londonderry, Brooke Park (AURN)					
1997	60	0.4	3.9	0	0
1998	92	0.5	4.9	0	0
1999	93	0.4	3.0	0	0
2000	97	0.4	2.4	0	0
2001	96	0.3	2.4	0	0
2002	93	0.2	1.8	0	0
2003	98	0.2	1.7	0	0
2004	97	0.3	1.4	0	0

Table A2.2 NO_2 Results from Automatic Monitoring Sites 1992 – 2004

Year	Data Capture %	Max Hourly Mean μg m^{-3}	Annual Mean μg m^{-3}	No. of hourly means > 200 μg m^{-3}	Is Annual Mean > 40 μg m^{-3} ?
Armagh Lonsdale Road (Roadside)					
2002	44	125	34	0	No
2003	98	374	34	11	No
2004	98	117	32	0	No
Ballymena - North Road (Roadside)					
2004	42	199	40	0	No
Belfast Centre (Urban Centre)					
1992	61	249	**44**	3	**Yes**
1993	97	356	**42**	6	**Yes**
1994	95	191	40	0	No
1995	95	381	40	15	No
1996	97	251	38	3	No
1997	96	164	38	0	No
1998	93	163	34	0	No
1999	97	142	34	0	No
2000	81	124	31	0	No
2001	86	335	32	3	No
2002	95	258	30	3	No
2003	95	170	32	0	No
2004	92	153	28	0	No
Belfast – Newtownards Road (Roadside)					
2002	66	212	**50**	2	**Yes**
2003	96	179	**45**	0	**Yes**
2004	92	156	**42**	0	**Yes**
Belfast – Westlink (Roadside)					
2002	66	295	**56**	21	**Yes**
2003	94	258	**53**	27	**Yes**
2004	92	231	**46**	20	**Yes**
Castlereagh Loughview Drive (Roadside)					
2002	50	132	28	0	No
2003	63	149	34	0	No
2004	89	128	26	0	No
Craigavon – Castle Lane					
2002	75	157	13	0	No
2003	18	94	22	0	No
2004	95	86	16	0	No
Holywood (Roadside)					
2003	70	111	25	0	No
2004	96	128	23	0	No
Lisburn – Lagan Valley Hospital (Roadside)					
2002	45	221	**54**	1	**Yes**
2003	78	172	28	0	No
2004	88	128	27	0	No

...Continued over...

Table A2.2 – *continued:* NO_2 Results from Automatic Monitoring Sites 1992 – 2004

Year	Data Capture %	Max Hourly Mean $\mu g\ m^{-3}$	Annual Mean $\mu g\ m^{-3}$	No. of hourly means > 200 $\mu g\ m^{-3}$	Is Annual Mean > 40 $\mu g\ m^{-3}$?
Londonderry Brooke Park (Urban Background)					
1997	47	130	21	0	-
1998	79	94	13	0	No
1999	87	94	15	0	No
2000	96	73	15	0	No
2001	93	75	15	0	No
2002	95	94	15	0	No
2003	95	96	17	0	No
2004	92	86	15	0	No
Londonderry - Derry, Dale's Corner (Roadside)					
2003	11	166	**48**	0	**Yes**
2004	72	747	**45**	9	**Yes**
Newry - Monaghan Row (Urban Background)					
2001	73	63	11	0	No
2002	91	105	15	0	No
2003	97	98	20	0	No
2004	97	86	15	0	No
Newry – Trevor Hill (Roadside)					
2001	61	103	19	0	No
2002	98	208	**44**	1	**Yes**
2003	91	189	**50**	0	**Yes**
2004	98	197	32	0	No
Newtownabbey – Sandyknowes					
2003	68	164	30	0	No
2004	94	189	31	0	No
Newtownabbey - Shore Road					
2003	70	132	29	0	No
2004	91	159	29	0	No

Table A2.3 SO_2 Results from Automatic Monitoring Sites 1992 - 2004

Year	Data Capture %	Max 15-minute mean, µg m^{-3}	No. of 15-minute means > 266 µg m^{-3}	Max 1-hr mean µg m^{-3}	No. of 1-hr means > 350 µg m^{-3}	Max 24-hr mean µg m^{-3}	No. of 24-hour means > 125 µg m^{-3}	Annual Mean µg m^{-3}
Antrim - Greystone Estate								
2004	9	242	0	184	0	62	0	-
Ards								
2002	17	150	0	116	0	48	0	-
2003	93	221	0	192	0	67	0	9
2004	90	160	0	146	0	42	0	7
Armagh - Dobbin Street								
2003	36	154	0	82	0	14	0	4
2004	97	43	0	32	0	9	0	1
Ballymena - Ballykeel								
2002	41	142	0	77	0	36	0	6
2003	49	98	0	51	0	28	0	6
2004	59	136	0	96	0	29	0	6
Bangor								
2003	80	168	0	144	0	35	0	8
2004	100	138	0	125	0	38	0	6
Belfast Centre								
1992	78	1256	***316***	1024	***43***	307	***12***	40
1993	97	867	***436***	766	***53***	355	***13***	48
1994	97	1046	***388***	934	***52***	389	***8***	45
1995	96	1317	***346***	963	***54***	406	***9***	40
1996	97	945	***326***	740	***45***	299	***10***	37
1997	96	607	***141***	426	8	171	***4***	29
1998	89	471	***47***	394	3	136	2	21
1999	95	378	5	338	0	89	0	16
2000	80	436	16	322	0	67	0	13
2001	90	301	2	253	0	70	0	11
2002	97	370	2	216	0	63	0	7
2003	91	229	0	186	0	69	0	8
2004	95	122	0	117	0	43	0	7
Belfast East								
1992	98	1650	***1176***	1448	***179***	489	***50***	69
1993	99	1267	***824***	1150	***125***	412	***35***	67
1994	99	1070	***453***	958	***59***	545	***18***	53
1995	92	1514	***579***	1402	***106***	705	***14***	56
1996	99	1176	***656***	1070	***108***	362	***22***	53
1997	99	774	***500***	636	***58***	245	***20***	45
1998	89	833	***199***	636	19	218	***9***	35
1999	99	601	***98***	487	5	152	***5***	29
2000	99	479	***38***	466	2	112	0	21
2001	94	450	***139***	399	13	226	***5***	24
2002	97	365	5	314	0	115	0	10
2003	97	213	0	194	0	77	0	8
2004	97	144	0	125	0	33	0	6

Continued over...

Table A2.3 *continued:* SO_2 Results from Automatic Monitoring Sites 1992 - 2004

Year	Data Capture %	Max 15-minute mean, µg m^{-3}	No. of 15-minute means > 266 µg m^{-3}	Max 1-hr mean µg m^{-3}	No. of 1-hr means > 350 µg m^{-3}	Max 24-hr mean µg m^{-3}	No. of 24-hour means >125 µg m^{-3}	Annual Mean µg m^{-3}
Carrickfergus - Rosebrook Ave.								
2002	50	51	0	49	0	17	0	3.3
2003	97	226	0	176	0	55	0	8
2004	100	144	0	120	0	26	0	5
Castlereagh -Espie Way								
2002	NS	74	0	48	0	24	0	NS
2003	96	112	0	93	0	44	0	4
2004	100	64	0	43	0	13	0	2
Cookstown								
2004	81	97	0	58	0	14	0	4
Craigavon -Lord Lurgan Park								
2002	74	146	0	96	0	38	0	7
2003	17	80	0	67	0	30	0	10
2004	95	74	0	53	0	20	0	5
Dungannon - Lambfield								
2002	18	94	0	38	0	24	0	-
2003	96	141	0	78	0	35	0	2
2004	96	237	0	115	0	60	0	12
Larne								
2003	73	295	1	128	0	58	0	4
2004	96	333	1	162	0	30	0	2
Lisburn - Island Civic Centre								
2002	49	101	0	48	0	15	0	3.5
2003	79	120	0	88	0	42	0	5
2004	82	88	0	72	0	27	0	4
Londonderry - Brandywell								
2002	65	229	0	229	0	74	0	16
2003	98	293	4	293	0	98	0	15
2004	98	141	0	101	0	35	0	9
Londonderry - Brooke Park AURN								
1998	54	1088	31	734	3	130	1	13
1999	73	258	0	218	0	46	0	11
2000	96	649	19	383	1	73	0	11
2001	96	197	0	136	0	44	0	11
2002	95	136	0	101	0	35	0	11
2003	97	263	0	125	0	49	0	11
2004	96	144	0	106	0	33	0	11
Newry, Monaghan Row								
2001	73	506	1	138	0	36	0	7
2002	95	146	0	114	0	39	0	6
2003	96	154	0	109	0	42	0	7
2004	95	168	0	106	0	32	0	6

Table A2.3 *continued:* SO_2 Results from Automatic Monitoring Sites 1992 - 2004

Year	Data Capture %	Max 15-minute mean, µg m^{-3}	No. of 15-minute means > 266 µg m^{-3}	Max 1-hr mean µg m^{-3}	No. of 1-hr means > 350 µg m^{-3}	Max 24-hr mean µg m^{-3}	No. of 24-hour means >125 µg m^{-3}	Annual Mean µg m^{-3}
Newry, Trevor Hill								
2001	61	128	0	74	0	29	0	8
2002	97	577	4	306	0	24	0	6
2003	97	96	0	59	0	31	0	8
2004	94	90	0	74	0	28	0	9
Strabane (Springhill Park)								
2002	64	253	0	90	0	28	0	11
2003	94	168	0	69	0	32	0	8
2004	95	98	0	74	0	30	0	7

Table A2.4 PM_{10} Results from Automatic Monitoring Sites 1992 – 2004

Calendar Year	Data Capture %	Annual Mean $\mu g\ m^{-3}$	Max Daily Mean $\mu g\ m^{-3}$	No. of Daily means > 50 $\mu g\ m^{-3}$
Ards (TEOM, converted to gravimetric equivalent)				
2002	17	30	53	1
2003	82	24	71	11
2004	96	21	66	2
Armagh, Lonsdale Road (TEOM, converted to gravimetric equivalent)				
2002	38	30	131	12
2003	100	33	121	46
2004	99	33	76	15
Ballymoney (Beta Attenuation Monitor)				
2004	70	37	133	***56***
Bangor (TEOM, converted to gravimetric equivalent)				
2003	57	27	86	12
2004	97	25	82	15
Belfast Centre (TEOM, converted to gravimetric equivalent)				
1992	79	35	322	***44***
1993	96	***41***	156	***86***
1994	95	34	248	***38***
1995	95	32	190	35
1996	95	31	145	***44***
1997	96	32	110	***41***
1998	94	27	87	20
1999	97	26	84	15
2000	81	25	69	8
2001	81	25	108	15
2002	98	23	83	8
2003	97	24	91	26
2004	96	21	78	10
Belfast Clara Street (Beta Attenuation Monitor)				
1999	95	22	71	12
2000	93	16	69	2
2001	92	19	128	14
2002	94	17	99	8
2003	95	22	121	34
2004	92	13	66	5
Belfast Westlink (TEOM, converted to gravimetric equivalent)				
2002	50	34	108	32
2003	98	36	105	***63***
2004	95	***41***	109	30
Carrickfergus (TEOM, converted to gravimetric equivalent)				
2002	50	17	51	1
2003	76	25	71	13
2004	98	21	61	4

Table A2.4 *continued* - PM_{10} Results from Automatic Monitoring Sites 1992 – 2004

Calendar Year	Data Capture %	Annual Mean $\mu g\ m^{-3}$	Max Daily Mean $\mu g\ m^{-3}$	No. of Daily means > 50 $\mu g\ m^{-3}$
Castlereagh - Espie Way (TEOM, converted to gravimetric equivalent)				
2002	48	26	74	3
2003	67	19	53	4
2004	91	18	55	2
Castlereagh - Loughview Drive (TEOM, converted to gravimetric equivalent)				
2002	48	34	112	8
2003	76	23	61	9
2004	93	22	57	1
Cookstown (TEOM, converted to gravimetric equivalent)				
2004	90	22	67	6
Craigavon - Lord Lurgan Park (TEOM, converted to gravimetric equivalent)				
2002	74	15	78	2
2003	18	25	70	3
2004	93	22	57	1
Dungannon - Lambfield (TEOM, converted to gravimetric equivalent)				
2002	19	15	36	0
2003	88	28	63	25
2004	81	34	14	0
Holywood (TEOM, converted to gravimetric equivalent)				
2003	71	27	68	11
2004	99	26	78	15
Larne (TEOM, converted to gravimetric equivalent)				
2003	74	22	189	18
2004	91	20	91	8
Limavady- Coolessan				
2004	23	17	36	0
Lisburn Dunmurry High School				
2003	16	28	70	6
2004	56	20	74	5
Lisburn Island Civic Centre (TEOM, converted to gravimetric equivalent)				
2002	36	16	37	0
2003	76	22	77	7
2004	82	21	69	8
Lisburn – Lagan Valley Hospital (TEOM, converted to gravimetric equivalent)				
2002	50	14	40	0
2003	63	26	98	15
2004	82	25	72	14
Londonderry Brandywell (TEOM, converted to gravimetric equivalent)				
2002	73	25	106	19
2003	99	29	114	34
2004	86	23	63	9

Table A2.4 *continued* - PM_{10} Results from Automatic Monitoring Sites 1992 – 2004

Calendar Year	Data Capture %	Annual Mean $\mu g\ m^{-3}$	Max Daily Mean $\mu g\ m^{-3}$	No. of Daily means > 50 $\mu g\ m^{-3}$
Londonderry - Brooke Park (TEOM, converted to gravimetric equivalent)				
1997	60	28	90	13
1998	96	26	157	18
1999	96	25	111	11
2000	96	20	84	6
2001	97	23	130	15
2002	96	22	80	9
2003	97	24	90	20
2004	97	20	78	3
Lough Navar (TEOM, converted to gravimetric equivalent)				
1996	<50	13	27	0
1997	96	13	38	0
1998	98	12	44	0
1999	96	12	38	0
2000	99	12	35	0
2001	96	13	41	0
2002	96	15	58	2
2003	99	15	55	1
2004	99	10	29	0
Newry, old site (TEOM, converted to gravimetric equivalent)				
1998	42	24	90	9
1999	80	23	76	8
2000	93	22	114	5
Newry - Kilkeel (TEOM, converted to gravimetric equivalent)				
2004	69	20	48	0
Newry- Monaghan Row (TEOM, converted to gravimetric equivalent)				
2001	70	20	68	4
2002	95	21	78	8
2003	95	23	79	22
2004	96	19	65	6
Newry- Trevor Hill (TEOM, converted to gravimetric equivalent)				
2001	61	34	86	26
2002	99	34	89	***38***
2003	97	37	91	***71***
2004	91	33	94	***39***
Omagh Tamlaght (TEOM, converted to gravimetric equivalent)				
2003	26	23	64	2
2004	27	25	73	4
Strabane (BAM)				
2002	67	38	147	***48***
2003	97	***43***	164	***101***
2004	97	***42***	125	***86***

Table A2.5 Ozone Results from Automatic Monitoring Sites, 1990 - 2004

Calendar Year	Data Capture, %	Max Daily 8 Hour Mean $\mu g\ m^{-3}$	Days with max. daily 8hr mean > 100 $\mu g\ m^{-3}$	Annual Mean $\mu g\ m^{-3}$
Belfast Centre				
1992	81	108	2	36
1993	97	88	0	32
1994	95	106	2	36
1995	96	136	***11***	38
1996	96	130	5	34
1997	95	124	6	34
1998	94	112	3	42
1999	96	126	7	44
2000	81	130	2	42
2001	90	130	2	38
2002	96	98	0	37
2003	97	118	9	42
2004	96	108	5	43
Londonderry – Brooke Park				
1997	59	152	6	44
1998	90	108	2	52
1999	94	154	4	52
2000	97	120	***11***	54
2001	94	104	2	46
2002	92	114	***19***	58
2003	93	149	***16***	52
2004	98	116	10	57
Lough Navar (1990 onwards) *				
1990	96	170	***21***	52
1991	99	158	***14***	46
1992	87	160	***19***	52
1993	98	112	5	48
1994	99	132	7	52
1995	93	148	***20***	48
1996	97	118	6	46
1997	97	140	5	42
1998	95	112	3	46
1999	88	118	6	50
2000	90	124	7	48
2001	99	130	9	46
2002	88	102	1	42
2003	64	138	6	47
2004	75	116	3	53

** Lough Navar has operated since 1987, but only data from 1990 onwards are shown here. The full dataset is available from www.airquality.co.uk .*

Appendix 3
Data from Smoke and SO_2 Sites

CONTENTS

The following table contains smoke and SO_2 data from Smoke and SO_2 Network sites in Northern Ireland. These pollutants are monitored simultaneously on a daily basis, using the 8-port sampler apparatus. All the sites shown are part of the Smoke and SO_2 Network. Grid references are in 8-figure format, to the nearest 100m. There are a further three sites of this type, which are not part of the Network: annual mean smoke and SO_2 concentrations for these are presented in the main report.

Table A3.1 Summary of Non-Automatic Smoke and Net Acidity, 2004. All concentrations in μg m^{-3}.

		Irish Grid Ref to nearest 100m			Summary of Smoke Data in 2004					Summary of Net Acidity (SO_2 Equiv.) Data 2004				
Code	Site Name	East	North	Local Authority	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
68851	ANTRIM 1	3162	3869	Antrim	98	13	8	68	213	98	22	24	37	43
160005	BALLYMENA 5	3109	4053	Ballymena	98	11	11	20	27	98	17	19	26	28
161504	BALLYMONEY 4	2954	4259	Ballymoney	98	8	7	21	55	98	9	6	19	27
270012	BELFAST 12	3324	3737	Belfast	100	8	5	37	71	100	16	12	36	66
270013	BELFAST 13	3357	3740	Belfast	98	7	5	29	51	98	26	26	50	64
270033	BELFAST 33	3346	3755	Belfast	100	8	5	29	64	100	29	26	51	90
270042	BELFAST 42	3322	3748	Belfast	84	7	4	39	58	84	27	26	45	71
270044	BELFAST 44	3338	3740	Belfast	98	5	4	23	43	98	25	26	45	58
270045	BELFAST 45	3335	3723	Belfast	100	7	4	29	40	100	26	26	45	64
270046	BELFAST 46	3385	3796	Belfast	87	4	3	16	23	87	22	19	38	51
768003	COLERAINE 3	2861	4328	Coleraine	100	12	11	17	19	97	10	6	37	56
2551506	PORTADOWN 6	3004	3548	Craigavon	27	4	3	10	15	27	11	12	24	24
2190014	LONDONDERRY 14	2443	4174	Derry	19	9	9	21	27	*No data*				
1025001	DUNGANNON 1	2802	3629	Dungannon	35	7	6	22	26	35	15	12	31	31
1757704	LARNE 4	3386	4037	Larne	96	7	5	18	45	97	17	18	30	36
1757705	LARNE 5	3401	4033	Larne	98	7	6	22	33	98	18	20	28	48
1032503	DUNMURRY 3	3287	3875	Lisburn	89	10	6	47	73	90	15	13	27	31
1845003	LISBURN 3	3263	3636	Lisburn	92	10	7	46	68	93	15	13	26	32
3325001	TWINBROOK 1	3281	3689	Lisburn	49	8	6	36	81	49	18	19	26	31
2233501	MAGHERAFELT 1	2896	3901	Magherafelt	98	6	4	28	47	100	9	7	13	20
512602	BUSHMILLS 2	2941	4407	Moyle	91	3	1	14	20	89	1	0	12	12
2410003	NEWRY 3	3078	3268	Newry & Mourne	57	3	2	15	16	56	6	7	13	14
2412503	NEWTOWNABBEY 3	3321	3851	Newtownabbey	99	5	3	20	71	*No data- smoke only site*				
2412504	NEWTOWNABBEY 4	3283	3907	Newtownabbey	81	6	3	28	48	*No data- smoke only site*				
165005	BANGOR (CO DOWN) 5	3497	3810	North Down	100	12	9	48	74	100	11	6	37	55
1517501	HOLYWOOD 1	3397	3784	North Down	93	6	5	22	61	93	9	6	24	35
3111502	STRABANE 2	2351	3972	Strabane	94	21	15	58	109	95	14	14	21	27