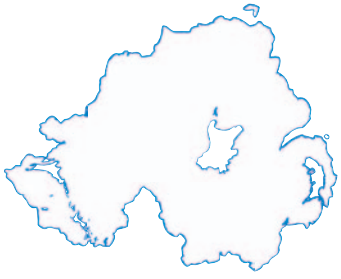
Air Quality Monitoring in Northern Ireland 2003



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Air Quality Monitoring in Northern Ireland, 2003

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

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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

Air quality has been steadily improving in Northern Ireland in recent years. However, given both our improved understanding of the air pollution problem and our lifestyles, we need to be vigilant if this positive trend is to continue.

Since the publication of the first Air Quality Monitoring Report in 2002, a lot of progress has been made. The legal framework is now firmly established; and funding has been provided to enable District Councils to carry out their local air quality management responsibilities. The first round of review and assessment of local air quality is almost complete. Areas at risk of exceeding air quality objectives have been identified and declared as Air Quality Management Areas. Where such areas have been declared, Councils and Relevant Authorities are beginning to draw up local action plans aimed at delivering air quality improvements.

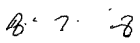
Government is reviewing the Air Quality Strategy. A revised strategy will be published later this year.

The European Commission is reviewing air quality policy as part of the Clean Air for Europe (CAFÉ) programme. It is expected that the CAFÉ thematic strategy will be published by mid-2005; it will set out the Commission's policy framework for the period up to 2020.

This report draws on all the results of air quality monitoring in Northern Ireland and provides a comprehensive view of air quality in 2003. It has been drawn up by the Environment and Heritage Service and 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



John Michael
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 2003. 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 2003, a summary of results for each pollutant, and an update on local air quality management.

Following the previous year's substantial increase in the number of monitoring sites in Northern Ireland, some further sites were commissioned during 2003. These were mostly intended to target areas where high pollutant concentrations were expected, and one new site, Dale's Corner in Londonderry, has highlighted a potential exceedence of an Air Quality Strategy (AQS) objective.

The AQS objectives for carbon monoxide, benzene and 1,3 butadiene have been met, by the due date of 31st December 2003, at each of the sites where they were monitored.

Carbon monoxide was monitored using automatic techniques at two sites (Belfast and Londonderry). Both met the EC 2nd Daughter Directive limit value and UK AQS objective for this pollutant in 2003.

Benzene was monitored at two sites, Belfast Centre and Belfast Roadside, using pumped tube samplers. Monitoring of 1,3-butadiene (using passive diffusion tubes) began at both sites in May 2003. Levels of both pollutants are within AQS objectives.

On the basis of results from 2003 and previous years, it is unlikely that Northern Ireland will have difficulty in meeting air quality objectives for sulphur dioxide or metallic elements. However, monitoring results indicate that the following pollutants may present a problem in meeting air quality objectives, in some parts of Northern Ireland: nitrogen dioxide, particulate matter as PM_{10}, ozone, and polycyclic aromatic hydrocarbons.

2003 was an unusual year in terms of weather conditions and air pollution episodes (although it was not considered to be exceptional). Factors including a very hot, sunny summer, long-range transport of Saharan dust particles, and long-range transport of ozone and its precursors from mainland Europe, resulted in several episodes of poor air quality (particularly in the summer), with many sites recording high levels of oxides of nitrogen, PM_{10}, and ozone.

Nitrogen dioxide was monitored using the automatic chemiluminescent technique at 14 sites. Results from some sites showed potential exceedences of AQS objectives. Belfast Westlink exceeded the 1st Daughter Directive limit and AQS objective of 200 $\mu g\ m^{-3}$ for the hourly mean more than the permitted 18 times during 2003. In addition, four sites exceeded the EC 1st Daughter Directive limit value and AQS objective for the annual mean nitrogen dioxide (40 $\mu g\ m^{-3}$). These were all roadside sites, near busy major roads: Belfast Westlink, Belfast Newtownards Road, Londonderry Dale's Corner, and Newry Trevor Hill. The Dale's Corner site began operation in November 2003, and data capture was just 11%. Further monitoring is therefore needed in order to accurately assess the annual mean, but 2004 data appear to confirm that this site may have difficulty meeting the annual mean NO_2 objective in 2005.

It is predicted that these four sites (and possibly other similar locations) may not meet the AQS objective for the annual mean by 2005. One (Belfast Westlink) may not meet the EC Daughter Directive limit value in 2010. However, these predictions may be pessimistic given that mean NO_2 levels were somewhat higher in 2003 than in previous recent years. Several sites showed higher concentrations of NO_2 in 2003 than in 2002, reflecting the generally higher levels of this pollutant measured throughout the UK.

Nitrogen dioxide was also monitored on a monthly basis using passive diffusion tube samplers at 260 sites in 2003. The EC 1st Daughter Directive limit value and AQS objective for the annual

mean (40 μg m^{-3}) was exceeded at eighteen roadside diffusion tube sites in 2003. These sites were situated beside busy roads in both major urban centres and smaller towns. On the basis of the 2003 results, it is predicted that 13 of these sites may not meet the AQS objective for the annual mean by the required date of 2005. Two (in central Belfast) are predicted not to meet the EC Daughter Directive limit value in 2010.

Sulphur dioxide (SO_2) was monitored using automatic techniques at 17 sites, of which three were new for 2003. All automatic sites met the 1st Daughter Directive limit values and AQS objectives. In particular, Belfast East met the AQS objectives for both the 15-minute mean and the 24-hour mean in 2003, only the second year in which it has done so. Where data were available for comparison, annual mean SO_2 concentrations for 2003 were similar to those measured in 2002 or slightly higher.

The number of sites monitoring suspended particulate matter as PM_{10} increased from 18 to 23 during 2003. All sites except one (Newry, Trevor Hill) met the AQS objective of 40 μg m^{-3} for the annual mean PM_{10}, as gravimetric equivalent. 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 Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill and Strabane Springfield Park. The first three of these are close to busy or congested roads, the fourth is on a housing estate where solid fuel use is prevalent, and dispersion can be poor.

Ozone was monitored at four sites: three using automatic techniques (Belfast, Londonderry and the rural Lough Navar) and one using diffusion tubes (in Fermanagh). Londonderry exceeded the target value of the AQS objective on more than the permitted ten days. This is the third time in four years that the Londonderry site has exceeded this objective. However, ozone is a transboundary pollutant and not easy to control by local action.

Polycyclic aromatic hydrocarbons were monitored at two sites: Lisburn Dunmurry and Belfast Clara Street. The 2003 annual mean benzo(a)pyrene (B(a)P) concentration at Belfast Clara Street was considerably lower than the previous year's value. The Belfast site met the new AQS objective of 0.25 ngm^{-3}. However, 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 (which is to be met by 2010). The major source of PAH around Lisburn is the widespread use of domestic solid fuels.

Twenty-five District Councils in Northern Ireland have now completed the first round of review and assessments of local air quality. Nine Councils have identified areas that are likely to exceed Air Quality Objectives of which six have now declared those areas as Air Quality Management Areas. A further two councils, Ards and Derry, have indicated their intention to declare. These areas have been designated officially by means of an "order". Armagh have submitted further information and have indicated that they will not be declaring an AQMA. At the time of writing, Newry and Mourne City Council had still to complete their first round assessment of local air quality.

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 2003. 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 considerable number of 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 2003. 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 2003, 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 2003.

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 will provide principal means of implementing the UK's commitments under this Directive. So far, three 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 19 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 13 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 12 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. Two years after publication the directive will be transposed into regulations. It is expected that work on regulations will begin during 2005.

2.1.1 Clean Air for Europe (CAFÉ)

The European Commission is reviewing air quality policy as part of the Clean Air for Europe (CAFE) programme which is one of the thematic strategies under the European Union's 6th Environmental Action programme. It is expected that the CAFE thematic strategy will be published by mid 2005. The aim of the strategy is to establish a framework for European policy on air quality up to 2020.

2.2 THE AIR QUALITY STRATEGY

The first Air Quality Strategy (AQS) was published in 1997, setting out policies for the management of ambient air quality and thus fulfilling the requirement of the Environment Act 1995 for a national air quality strategy. Pollutants originally covered by the strategy were: benzene, 1,3-butadiene, carbon monoxide, lead, oxides of nitrogen, particulate matter (as PM_{10}) 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 2005 for the air pollutants covered. The strategy was subsequently reviewed, and a revised Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in January 2000.

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 with the limits set by the 2nd Daughter Directive. In addition, further provisional PM_{10} objectives have been set for 2010 and for the first time, a provisional objective for polycyclic aromatic hydrocarbons (PAHs) has been added.

Following consultation on a PAH objective for Northern Ireland the Department of Environment in Northern issued a corrigendum to the Air Quality Strategy in 2003. The corrigendum sets a provisional air quality objective of 0.25ng m^{-3} for Northern Ireland to be achieved by 2010.

Defra and the Devolved Administrations are currently reviewing the Air Quality Strategy. The focus of this review will be more on process and polices that work toward delivering air quality objectives. The review will also consider links to climate change and the concept of "gap closure". It is expected that a draft revised strategy will be published for consultation during the summer of 2005.

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).

Twenty-five 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.

Table 2.1 Summary of 1st Round of Review and Assessment

Council	Pollutants Identified at 1st Stage requiring Stage 2 assessment	Pollutants Identified at 2nd Stage requiring Stage 3 assessment	Pollutants Identified at 3rd Stage at risk of exceeding Air Quality Objectives	AQMA Declared
Antrim	PM_{10},SO_2,NO_2	NO_2,SO_2	SO_2	Yes
Ards	PM_{10},SO_2, NO_2 CO	PM_{10},SO_2,NO_2	PM_{10}	No
Armagh	CO,Benzene PM_{10},SO_2,NO_2	PM_{10},SO_2	PM_{10}	No
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	None	No
Banbridge	PM_{10},SO_2,NO_2	PM_{10}	None	No
Belfast	PM_{10},SO_2,NO_2 CO, Lead	PM_{10},SO_2,NO_2	PM_{10},NO_2	Yes
Carrickfergus	PM_{10},SO_2,NO_2	PM_{10},SO_2	PM_{10}	Yes
Castlereagh	PM_{10},NO_2,SO_2 CO	PM_{10},SO_2,NO_2	None	No
Coleraine	PM_{10},SO_2,NO_2	PM_{10},SO_2	None	No
Cookstown	PM_{10},SO_2,NO_2	PM_{10},SO_2	None	No
Craigavon	PM_{10},SO_2,NO_2	NO_2	None	No
Derry City	PM_{10},SO_2,NO_2	PM_{10},SO_2,NO_2	NO_2	No
Down	PM_{10},SO_2,NO_2		None	No
Dungannon & South Tyrone	PM_{10},SO_2,NO_2	NO_2	None	No
Fermanagh	PM_{10},SO_2,NO_2	PM_{10}	None	No
Larne	PM_{10},SO_2,NO_2	PM_{10},SO_2,NO_2	None	No
Limavady	PM_{10},SO_2,NO_2	PM_{10}	None	No
Lisburn	PM_{10},SO_2,NO_2	PM_{10},SO_2,NO_2	None	No
Magherafelt	PM_{10},SO_2,NO_2	PM_{10},SO_2,NO_2	None	No
Moyle	PM_{10},SO_2	PM_{10},SO_2	None	No
Newry	PM_{10},SO_2,NO_2	PM_{10},SO_2,NO_2	Not Completed	No
Newtown-abbey	PM_{10},SO_2,NO, CO, 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	No
Omagh	PM_{10},SO_2,NO_2	PM_{10},SO_2	None	No
Strabane	PM_{10},SO_2	PM_{10}	PM_{10}	Yes

Nine Councils have identified areas that are likely to exceed Air Quality Objectives of which six have now declared those areas as Air Quality Management Areas (AQMA). A further two councils,

Ards and Derry, have indicated their intention to declare. These areas have been, or will be designated officially by means of an "order". Table 2.2 provides summary information in relation to AQMA's. Armagh have submitted further information and indicated that they will not be declaring an AQMA. Newry have still to complete their first round assessment of local air quality.

Table 2.2 District Council AQMAs

Council	Pollutant	Source	Date Declared	Number of Air Quality Management Areas
Antrim	SO_2	Domestic	31/10/04	1
Ards	PM_{10}	Domestic		1 (proposed)
Ballymena	PM_{10}	Domestic	1/11/04	2
Belfast	NO_2 & PM_{10}	Roads	31/8/04	4
Carrickfergus	PM_{10}	Domestic	7/9/04	2
Derry	NO_2	Roads		1 (proposed)
Newtownabbey	PM_{10}	Domestic	26/10/04	1
Strabane	PM_{10}	Domestic	30/6/04	3

2.3.1 Air Quality Management Action Plans

District Councils are required under the Environment (NI) Order 2002 to prepare written action plans in pursuit of the achievement of air quality objectives in AQMA's. There is also however a responsibility on other relevant authorities 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.

2.3.2 Local Air Quality Management Progress Reports

Statutory local air quality management progress report guidance LAQM PRG NI(04) was issued to all District Councils in Northern Ireland in November 2004. 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. District Councils will be expected to report any provisional monitoring data over the previous calendar year. The timetable set out in LAQM PRG NI (04) requires District Councils to submit progress reports to the Department by April 2005.

2.3.3 The Second Round of Review and Assessment

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

Updating and Screening Assessment (USA) for identifying those aspects that have changed since the first round of reviews and assessments, including lessons learnt from the first round that may require further assessment. 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 (DA) 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 Department's policy guidance LAQM PGNI(03). Updating and screening reports are required to be submitted to the Department by April 2006.

2.4 MONITORING

Following the substantial increase, during 2002, in the number of monitoring sites, seven additional new automatic monitoring sites came into operation during 2003. These sites have been set up as a consequence of the Environment and Heritage Service Local Air Quality Grant Scheme. The grant scheme provided approximately £2.5M over 2001–2004 to support District Councils in their review and assessment of local air quality. The number of NO_2 diffusion tube sites remained roughly the same. During 2003, many District Councils in Northern Ireland 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. Information on these monitoring networks can be found on the Air Quality Archive, at www.airquality.co.uk.

No monitoring of metallic air pollutants was undertaken in Northern Ireland during 2003. 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.

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, except that data ratification is carried out on a 6-monthly basis rather than 3-monthly).

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 Local Air Quality Management Technical Guidance (LAQM TG(03)[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

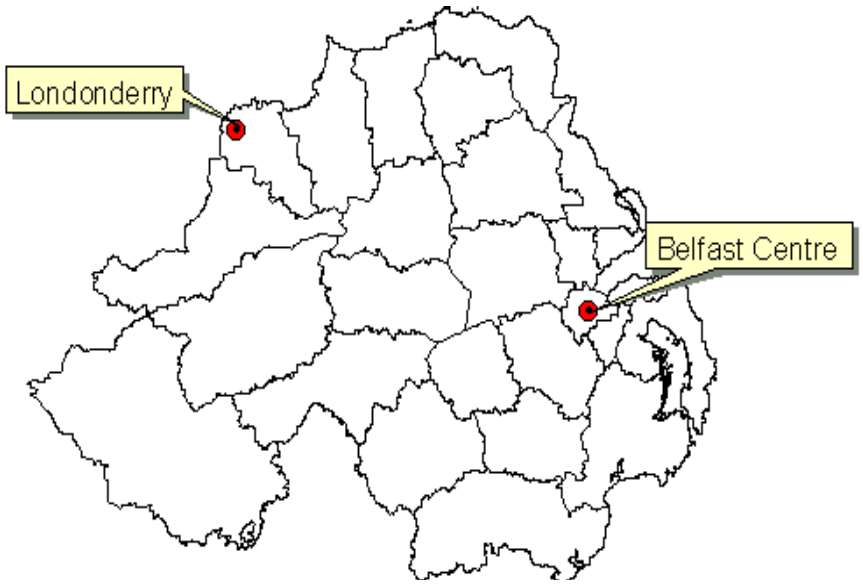


Figure 3.1 CO Monitoring Sites in Northern Ireland, 2003

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, 2003

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	79	0.2	2.7	0	0
Londonderry	98	0.2	1.7	0	0

Both sites currently meet the EC 2nd Daughter Directive limit value, and have achieved the Air Quality Strategy objective for this pollutant, with maximum daily running 8-hour mean below 10 mgm^{-3} since 1996. It should be noted that the sites have achieved the AQS objective by the due date of 31st December 2003.

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.

Trends are often shown more clearly by statistics based on longer periods, such as the annual mean. Figure 3.4 shows how the annual mean CO concentrations at the same sites have decreased since the early and mid 1990s. Both sites recorded a decrease between 2001 and 2002, after several years when annual mean CO concentrations had remained static. Based on a regression analysis (Theil's non-parametric regression analysis), there is a significant downward trend in the annual mean carbon monoxide concentration at both sites.

Emission inventory data for the UK (although not for Northern Ireland alone) are available from the National Atmospheric Emissions Inventory (NAEI), on the World Wide Web at www.naei.org.uk. Total UK emissions of carbon monoxide have reduced by 63% between 1990 and 2002, and the downward emission trend shows no sign of flattening off in recent years. An emission inventory study of Greater Belfast[2], based on 1997 data, calculated that around 23% of Belfast's CO emissions arise from domestic combustion; a much larger proportion than in other UK cities (for example around 10% in Swansea and Port Talbot[3], and less than 2% in Merseyside, Bristol and Southampton[3]) However, Belfast's total CO emissions are still dominated by road traffic (75%), and total UK emissions from domestic combustion are decreasing.

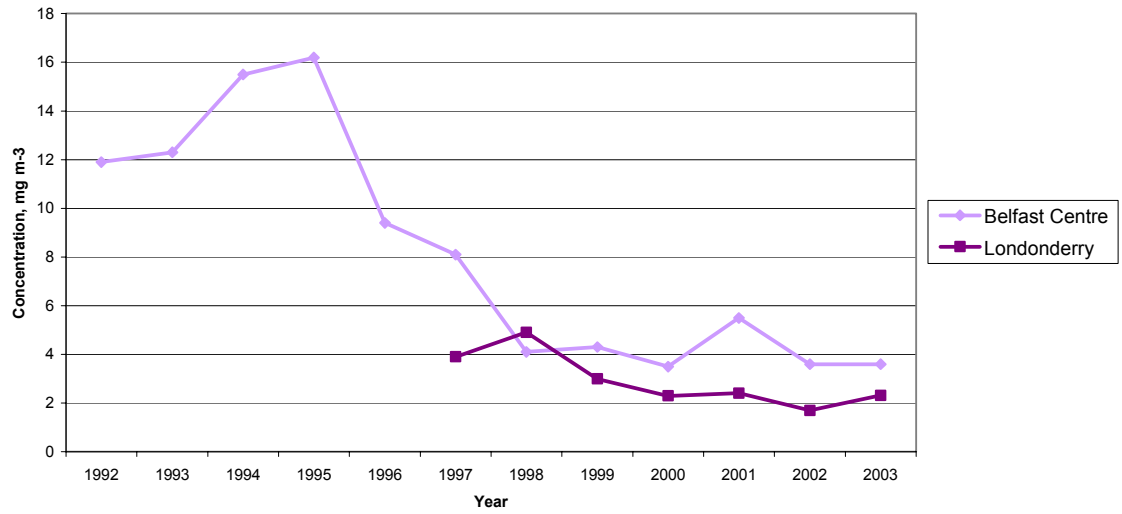


Figure 3.3 Maximum Running 8-hour Mean CO Concentration

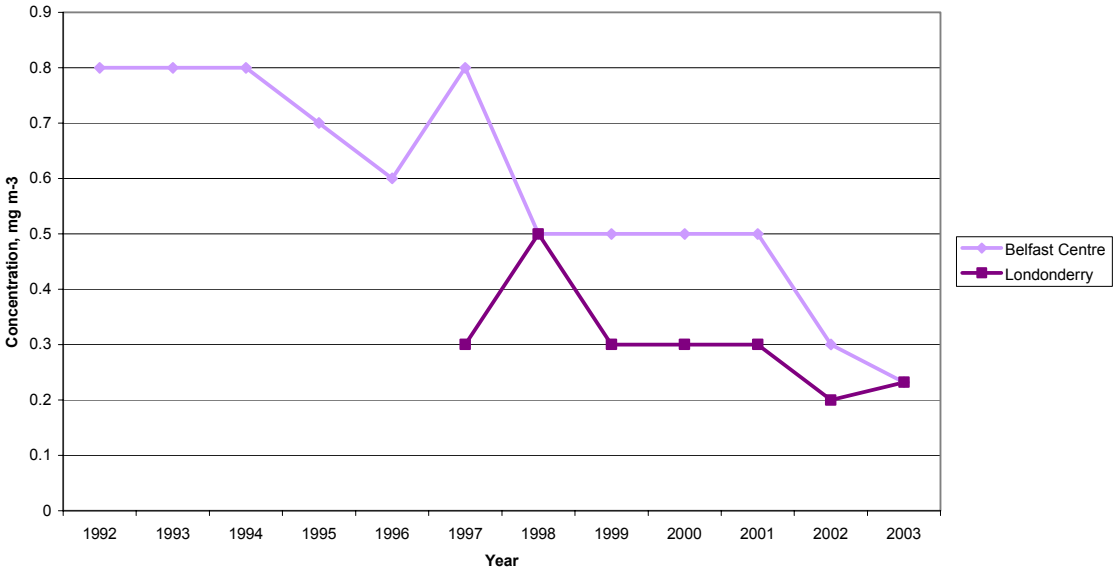


Figure 3.4 Annual Mean CO Concentrations

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, diffusion tubes. 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.

Four new automatic NO_2 monitoring sites started operation in Northern Ireland during 2003, taking the total number to fourteen. These are at Newtownabbey (Shore Road), Newtownabbey (Sandyknowes), Londonderry (Dale's Corner) and Holywood, North Down. These new sites, like those set up in 2002, are mostly located at roadside locations, 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
Belfast Centre, Lombard Street	J 339 744	Urban Centre	AURN
Armagh, Lonsdale Road	H 876 458	Roadside	Armagh
Belfast Westlink	J 330 737	Roadside	Belfast
Belfast, Upper Newtownards Rd.	J 385 739	Roadside	Belfast
Castlereagh, Loughview Drive	J 357 707	Roadside	Castlereagh
Craigavon, Castle Lane	J 082 584	Roadside	Craigavon
Holywood	J 396 792	Roadside	North Down
Lisburn (Lagan Valley Hospital)	J 265 637	Roadside	Lisburn
Londonderry, Brooke Park	C 429 172	Urban Background	AURN
Londonderry, Dale's Corner	C 441 167	Roadside	Derry
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
Newtownabbey, Shore Road	J 347 804	Roadside	Newtownabbey

CC = Calibration Club sites.

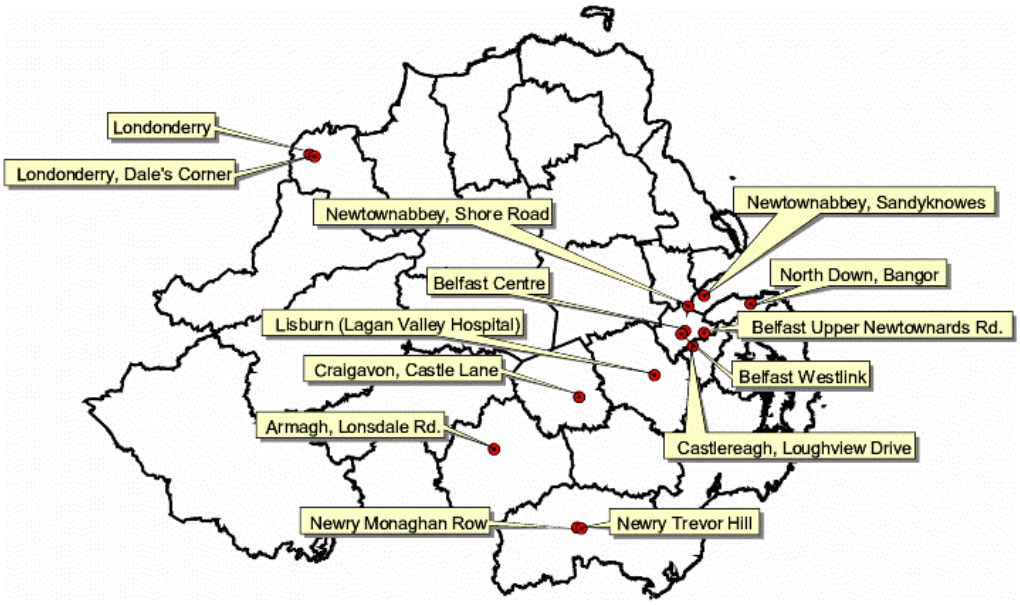


Figure 4.1 Automatic NO_2 Monitoring Sites 2003

One of the automatic NO_2 monitoring sites which began operation in 2003 was the roadside site at Shore Road, Newtownabbey: this new site is shown in Figure 4.2.

Figure 4.2 New Automatic Monitoring site for NO_x, Shore Road, Newtownabbey

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.

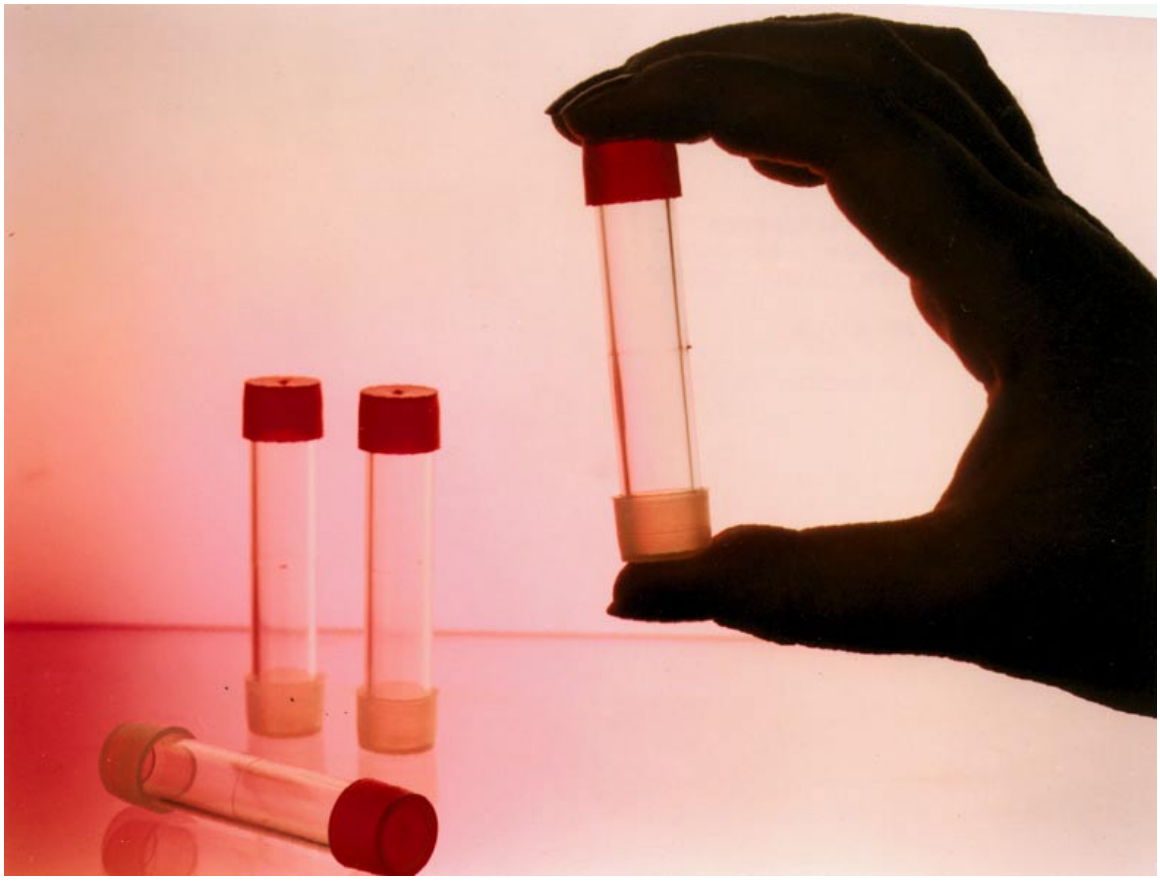


Figure 4.3 NO_2 Diffusion Tubes

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 2003 was 260 (just three more than the previous year). 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 2003

District Council	Number of sites	Number belonging to NO_2 Network (as of 2003)
Antrim	17	0
Ards	4	4
Armagh	8	4
Ballymena	13	4
Ballymoney	10	4
Banbridge	4	4
Belfast	17	4
Carrickfergus	11	3
Castlereagh	5	3
Coleraine	9	0
Cookstown	5	0
Craigavon	8	4
Down	8	4
Dungannon	5	4
Fermanagh	6	0
Larne	8	0
Limavady	8	0
Lisburn	8	4
Londonderry	18	5
Magherafelt	7	0
Moyle	8	0
Newry & Mourne	8	4
Newtownabbey	41	3
North Down	8	4
Omagh	11	3
Strabane	5	0
TOTAL	*260*	*65*

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 2003.

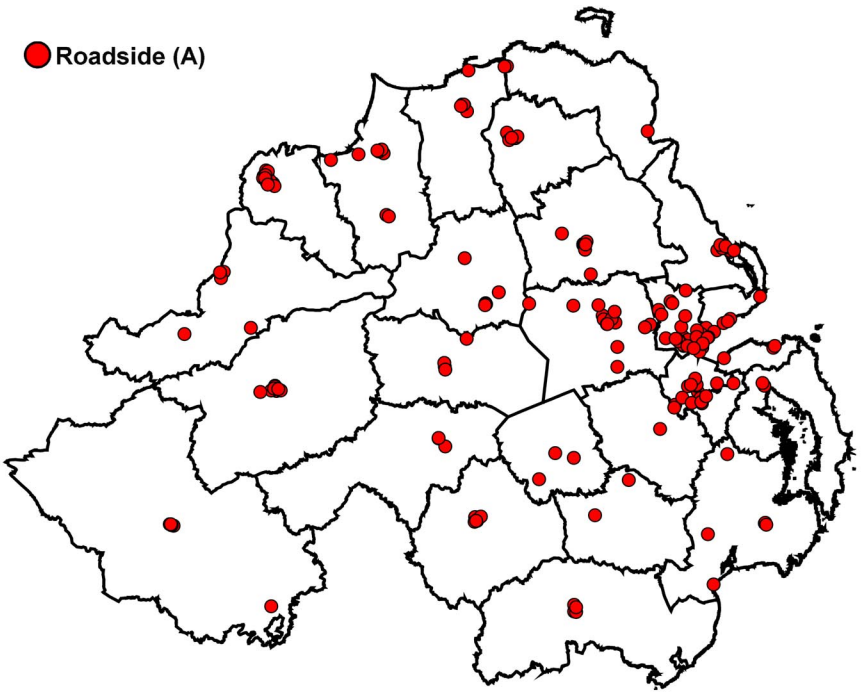


Figure 4.4 NO_2 Diffusion Tube Monitoring Sites 2003: Roadside

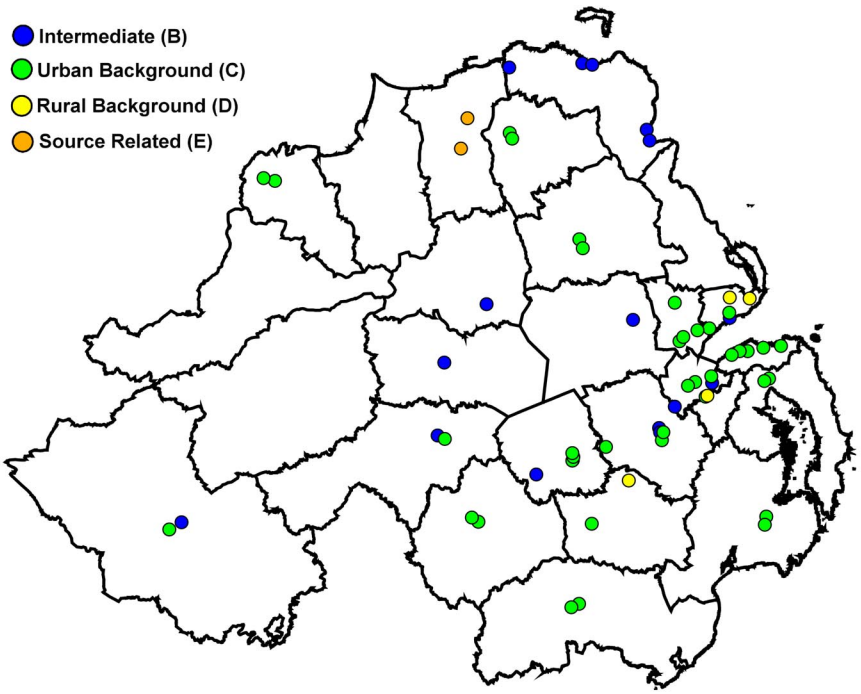


Figure 4.5 NO_2 Diffusion Tube Monitoring Sites 2003: Non-Roadside Categories

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 2003 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 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}.

Seven of the 14 sites achieved at least 90% data capture for 2003. Of those which did not, four were new sites, commissioned part way through the year. Data capture at Craigavon and Londonderry Dale's Corner was less than 20%: annual statistics from these sites may therefore not be representative and should be treated with caution.

Two sites, Armagh Lonsdale Road and Belfast Westlink, 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 2003, with a total of 27 exceedences.

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 seven 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 2003. 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, 2003

Site	2003 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	374	172	11	34	No
Belfast Centre, Lombard Street	95	170	109	0	32	No
Belfast - Newtownards Road	96	179	148	0	**45**	**Yes**
Belfast – Westlink	94	258	**210**	**27**	**53**	**Yes**
Castlereagh, Loughview Drive	63	149	117	0	34	No
Craigavon, Castle Lane	18 *	94	75	0	22	No
Holywood[3]	70	111	96	0	25	No
Lisburn, Lagan Valley Hospital	78	172	121	0	28	No
Londonderry, Brooke Park	95	96	73	0	17	No
Londonderry, Dale's Corner [1]	11 *	166	155	0	**48**	**Yes**
Newry, Monaghan Row	97	98	84	0	20	No
Newry, Trevor Hill	91	189	153	0	**50**	**Yes**
Newtownabbey, Sandyknowes [2]	68	164	119	0	30	No
Newtownabbey, Shore Road [2]	70	132	120	0	29	No

Footnotes:
1 – New site, in operation from Nov 2003
2 – New site in operation from Apr 2003
3 – New site in operation from Apr 2003
* - Very low data capture: annual statistics may not be representative.

Four sites measured 2003 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, Londonderry Dale's Corner and Newry Trevor Hill. Londonderry Dale's Corner is a new site, which started up in November 2003 and has only 11% data capture for the year – insufficient for a reliable annual mean. However, 2004 data from this site confirm that it may have difficulty in meeting the annual mean objective for NO_2. 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.

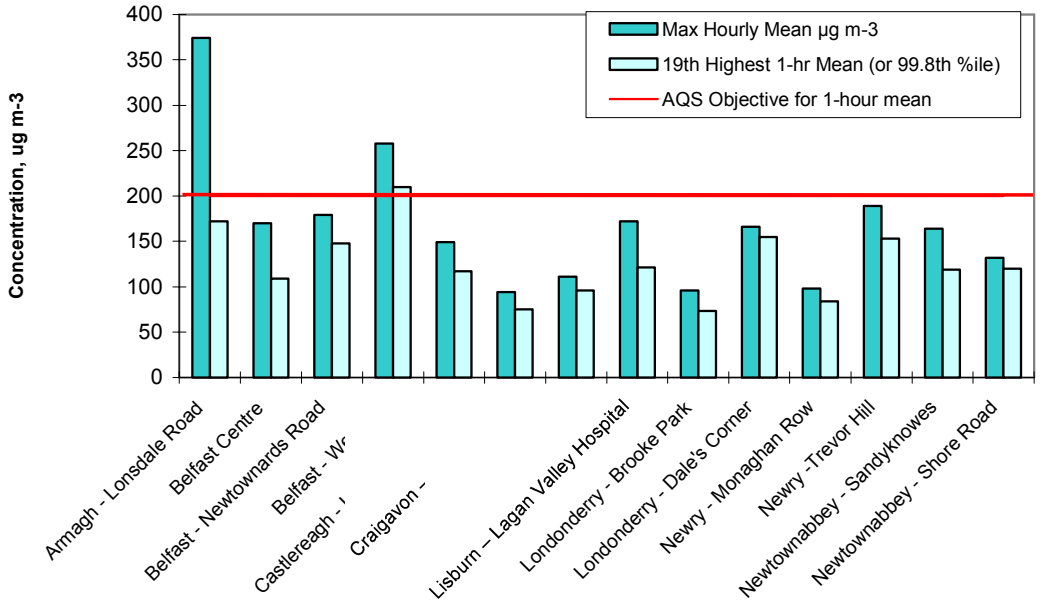


Figure 4.6 Comparison of 1-hour Mean NO_2 Concentrations (2003) with AQS 1-hour mean Objective. *Figure 4.6 shows the maximum hourly mean and the 19th highest hourly mean (or the 99.8th percentile of hourly means in cases where data capture was less than 90%). If the latter (shown by the lighter coloured 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.*

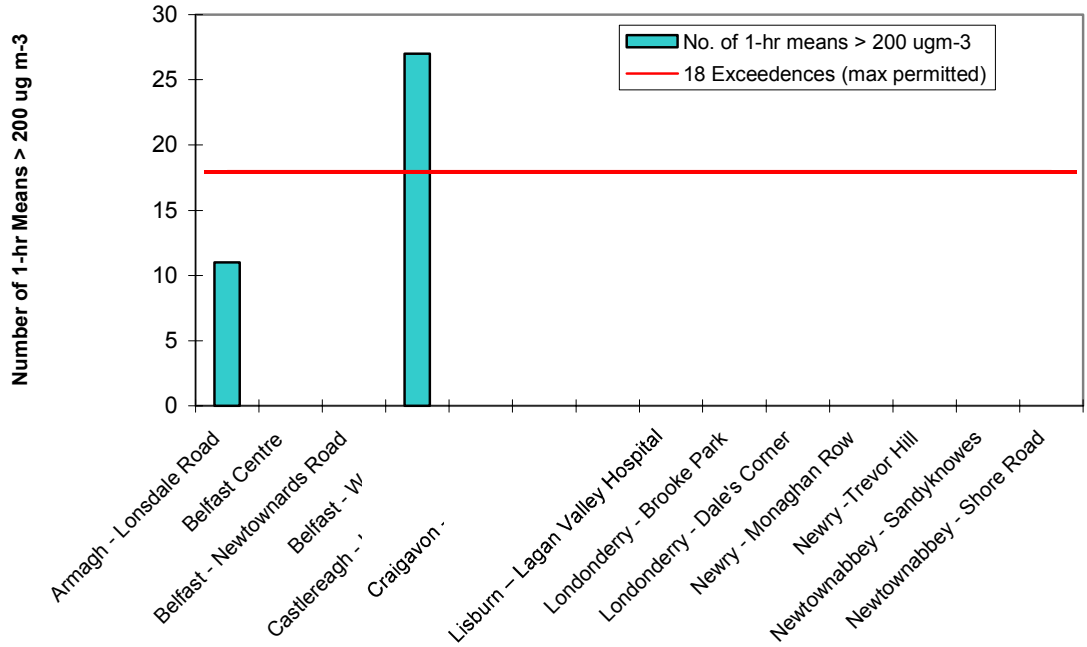


Fig. 4.7 Number of Exceedences of AQS Objective for 1-hour mean NO_2 Concentration. *Figure 4.7 shows the actual number of exceedences of the AQS objective at each site during 2003. A maximum of 18 exceedences is permitted: one site (Belfast Westlink) had more than this.*

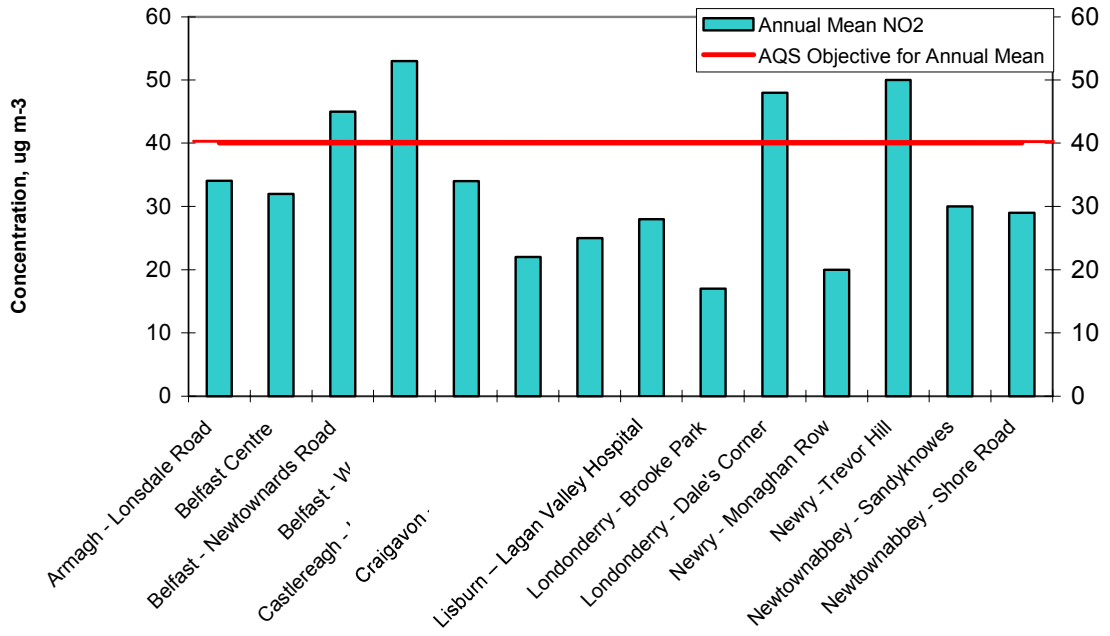


Figure 4.8 Comparison of Annual Mean NO_2 from Automatic Sites 2003 with AQS Objective. *Figure 4.8 shows that four sites exceeded the annual mean objective of 40 µg m^{-3} during 2003.*

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 2003 annual mean NO_2 concentration greater than 42.2 μg m^{-3} is likely to exceed the AQS objective of 40 μg m^{-3} in 2005. This is the case for Belfast Westlink, Belfast Newtownards Road, and Newry Trevor Hill. Using the same method, any roadside site with a 2003 annual mean NO_2 concentration greater than 51.2 μg m^{-3} is likely to have an annual mean NO_2 concentration greater than 40 μg m^{-3} in 2010. This is predicted to be the case for just one site - Belfast Westlink. However, it should be noted that levels of NO_2 measured in 2003 were particularly high at many sites, due to meteorological and other factors.

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 also to identify the laboratory used for supply and analysis of their diffusion tubes, and also to supply a bias adjustment factor, if possible. This has allowed us, for the first time in this series of reports, to carry out an analysis of bias-adjusted NO_2 diffusion tube data. If no bias adjustment factor was

available, 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. 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, 2003:**	**Average NO_2, 2003 $\mu g\ m^{-3}$** Not Adjusted for Bias	**Average NO_2, 2003 $\mu g\ m^{-3}$** Bias Adjusted
A (Roadside)	192	25	26
B (Intermediate)	16	16	16
C (Urban Background)	40	18	18
D (Rural Background)	3	10	10
E (Other: Source-related)	2	7	7

The application of the various laboratories' bias adjustment factors 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 small.

Bias-adjusted annual mean NO_2 concentrations for 2003 have been compared with the AQS objective of 40 $\mu g\ m^{-3}$. During 2003, 18 sites had annual mean NO_2 concentrations greater than the EC Directive limit and AQS objective of 40 $\mu g\ m^{-3}$. All but one were Roadside (type A), and are shown in Table 4.6.

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)

Site	Type	**Average NO_2, 2003 $\mu g\ m^{-3}$** Not Adjusted for Bias	**Average NO_2, 2003 $\mu g\ m^{-3}$** Bias Adjusted
Belfast, Great George's Street	A	47	55
Belfast, Westlink	A	45	52.7
Dungannon, Church St,	A	43.7	43.7
Londonderry, Brooke Park	C	42.8	40.3
Londonderry,3 Creggan Road,	A	42.8	40.3
Newry , Kilmorey Street	A	42.8	44.3
Cookstown, James St,	A	42	44.1
Newry, 20a Water Street	A	41.6	43.1
Cookstown, Church Street	A	41	43.1
Belfast City Hall, Donegall Square	A	41	48
Limavady, Irish Green St.	A	40.9	40.9
Belfast, Saintfield Road	A	38	44.5
Belfast, Milner Street	A	38	44.5
Belfast, Cromac Street (A),	A	38	44.5
Belfast, Black's Road	A	38	44.5
Belfast, 301 Ormeau Road	A	37	43.3
Belfast, Stockman's Lane	A	35	41
Belfast, Cromac Street (B)	A	35	41

As observed previously, exceedences of the annual mean limit for NO_2 appear to occur not only in large urban centres, but 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 2005 and 2010 can be estimated using current results. In the case of roadside sites, the 2005 annual mean is predicted to exceed 40 μg m^{-3} if the 2003 annual mean is greater than 42.2 μg m^{-3}. This is the case for 13 of the above sites. Similarly, the 2010 annual mean is predicted to exceed 40 μg m^{-3} if the 2003 annual mean is greater than 51.2 μg m^{-3}. Just two sites fall into this category – Westlink and Great Georges Street, both in Belfast. However, these predictions can only be approximate, as diffusion tubes are only considered an indicative technique.

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[2], 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 4.8 shows how annual mean NO_2 concentrations have changed at the automatic sites in Northern Ireland. Annual means are shown only where there is at least 75% data capture for the year, and sites are only included where there are two or more years for which this is the case. Only four sites meet these criteria, and of these, only two have been in operation for at least five years (the minimum considered necessary to assess trends) Belfast Centre and Londonderry AURN sites. 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.

Annual mean NO_2 concentrations at all four sites in Figure 4.8 showed an increase in 2003 compared to 2002. This reflects the increase in mean NO_2 concentration observed throughout the UK during 2003, by both automatic and non-automatic monitoring networks.

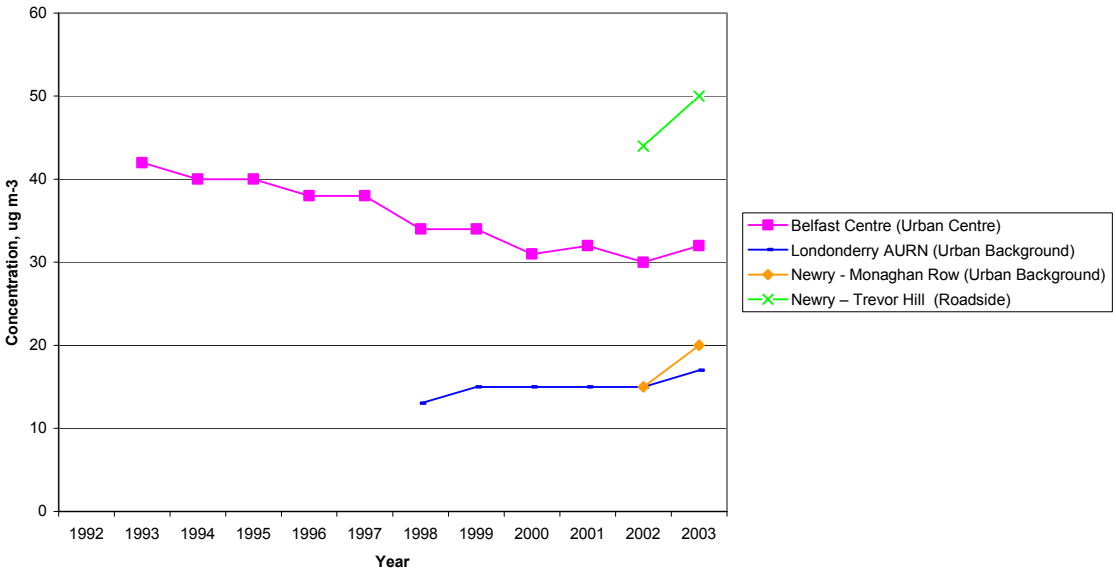


Figure 4.8 Annual Mean NO_2 Concentrations at Automatic Monitoring Sites (data capture at least 75%)

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 4.8 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 4.8 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 2003 data are used in this investigation of trends.

Table 4.8 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 [1]	-	14 [2]

Footnotes:
*1 – the unadjusted annual mean for **all** roadside sites in NI was 25 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 (over all the diffusion tube sites) appear to have remained stable from 2001 to 2003.

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 is a major source of SO_2. 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 (μg m^{-3}). To convert to parts per billion (ppb) if necessary, the following relationship should be used:

1 ppb = 2.66 μg 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. Three new automatic SO_2 monitoring sites started operation in Northern Ireland during 2003, at Armagh (Dobbin Street), Larne Harbour and North Down (Bangor). These bring the total to sixteen. 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
Ards, Glen Estate	J487 747	Urban Background	Ards
Armagh, Dobbin Street	H877 450	Urban Background	Armagh
Ballymena, Ballykeel	D120 026	Urban Background	Ballymena
Bangor	J 498 810	Urban Background	North Down
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
Castlereagh, Espie Way	J373 720	Urban Background	Castlereagh
Craigavon, Lord Lurgan Park	J079 592	Urban Background	Craigavon
Dungannon, Lambfield	H802 635	Urban Background	Dungannon
Larne – Larne Harbour	D414 016	Urban Background	Larne
Lisburn Island Civic Centre	J274 643	Urban Background	Lisburn
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, Springfield Park	H 351 972	Urban Background	Strabane (CC)

CC = Calibration Club member

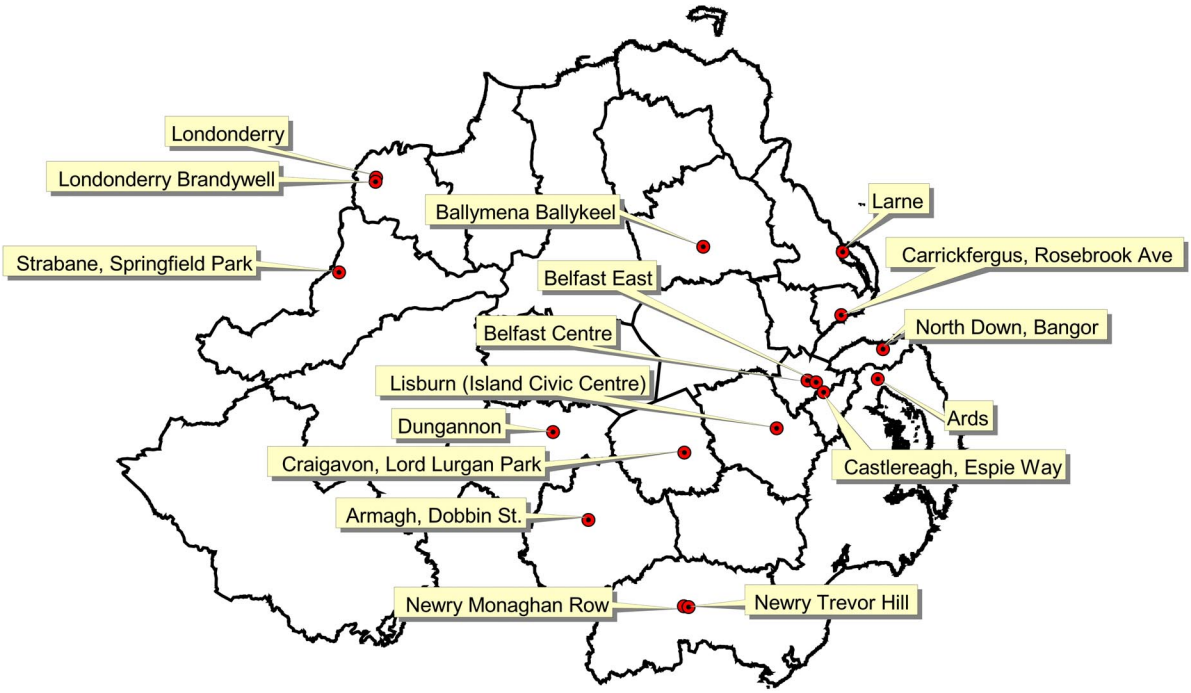


Figure 5.1 Automatic SO_2 Monitoring Sites

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

Figure 5.2 Automatic SO_2 Monitoring Site at Bangor, North Down

Despite the recent increase in the number of automatic monitoring sites, the most widespread method of measuring SO_2 in Northern Ireland remains the 8-port sampler apparatus. This also measures suspended particulate matter as black smoke (see Section 6). This technique technically measures total net acidity rather than sulphur dioxide, and is therefore an indicative method only for SO_2. However, it is widely used for low-cost indicative measurement of SO_2. A typical 8-port sampler is shown in Figure 5.3.

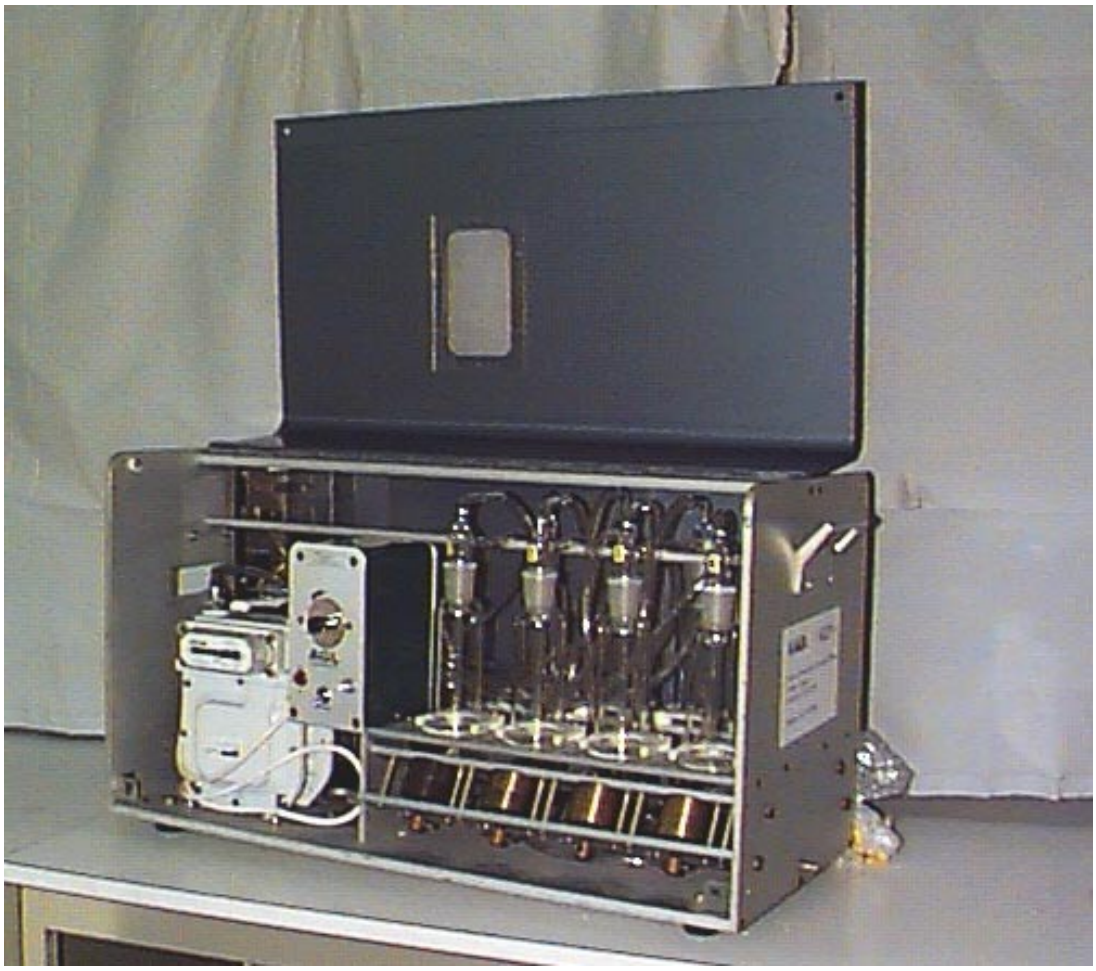


Figure 5.3 8-port Sampler for Smoke and SO_2

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 2003, there were 37 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). These are shown in Table 5.2 and Figure 5.4.

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
ARMAGH 1	H 877 450	Armagh	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 803 334	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
COLERAINE 3	C 861 328	Coleraine	Smoke & SO_2
COOKSTOWN 1	H 774 806	Cookstown	Smoke & SO_2
BUSHMILLS 1	C 940 409	Moyle	Smoke & SO_2
BUSHMILLS 2	C 940 407	Moyle	Smoke & SO_2
ANTRIM 1	J 162 869	Antrim	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.)

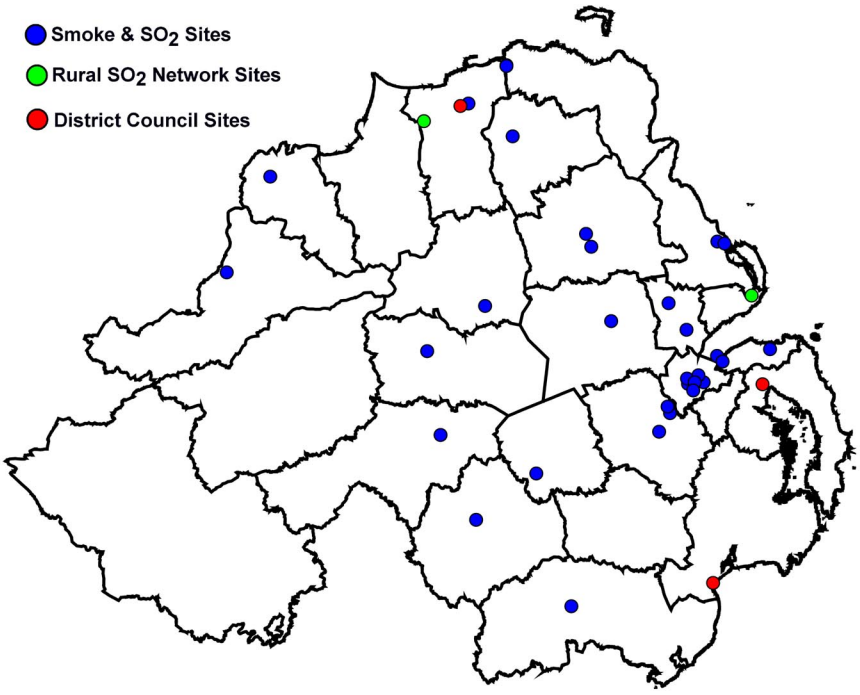


Figure 5.4 8-port Smoke and SO_2 Sampler Sites, 2003

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

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 remain in force until they are fully repealed in 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 2003. Previous years' data are provided in Appendix 2.

Of the 17 sites, 11 achieved at least 90% data capture. Of the six which did not, three (Armagh Dobbin Street, Larne and North Down, Bangor) were new sites, commissioned part way through 2003. Three sites (Armagh Dobbin Street, Ballymena Ballykeel and Craigavon Lord Lurgan Park) had less than 50% data capture for the year, so annual statistics from these sites may not be representative.

On the basis of the available data, all sites in Northern Ireland met the requirements of the 1st Daughter Directive, and the objectives of the Air Quality Strategy during 2003.

Two sites, Larne and Londonderry Brandywell, recorded one or more 15-minute means greater than the AQS objective of 266 μg m^{-3}. However, no sites exceeded this objective on more than the permitted 35 occasions. Where data capture is less than 90%, it is not valid to simply count the total number of exceedences of the 15-minute objective. Instead, according to the Technical Guidance[1] the 99.9th percentile of 15-minute means should be compared with the 15-minute SO_2 objective itself (266 μg m^{-3}). On this basis, the sites with less than 90% data capture all appeared to meet the AQS objective for 15-minute mean SO_2. Figure 5.5a shows a comparison of 15-minute mean SO_2 concentrations with the relevant objective, and Figure 5.5b shows the number of exceedences.

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: all the sites with less than 90% data capture met this condition. This is illustrated in Figure 5.6.

Also, 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 the sites with less than 90% data capture met this condition. This is illustrated in Figure 5.7.

2003 was the second year in which Belfast East met the objective for both the 15-minute and 24-hour average, and the first year in which this site had no 15-minute means greater than 266 μg m^{-3}. As reported in the previous (2002) report, many domestic properties in the area have switched from solid fuel to natural gas in recent years. This is the most likely reason for the decrease in SO_2 in the area.

Table 5.5 SO_2 Results from Automatic Monitoring Sites, 2003

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	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	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	Annual mean, µg m^{-3}
Ards, Glen Est.	93	221	0	109	192	0	85	55	0	42	9
Armagh, Dobbin St.	36	154	0	27	82	0	19	14	0	10	4
Ballymena, Ballykeel	49	98	0	56	51	0	40	35	0	14	8
Bangor	80	168	0	120	144	0	90	33	0	30	8
Belfast Centre, Lombard Street	91	229	0	114	186	0	88	54	0	40	8
Belfast East	97	213	0	125	194	0	85	69	0	41	8
Carrickfergus, Rosebrook Ave	97	226	0	104	176	0	72	48	0	27	8
Castlereagh, Espie Way	96	112	0	69	93	0	53	43	0	27	4
Craigavon, Ld. Lurgan Park.	17	80	0	69	67	0	63	29	0	25	10
Dungannon, Lambfield	96	141	0	ns	78	0	ns	35	0	ns	2
Larne - Harbour	73	295	1	122	128	0	69	42	0	18	4
Lisburn, Island Civic Centre	79	120	0	72	88	0	48	38	0	21	5
Londonderry, Brooke Park	97	263	0	98	125	0	69	45	0	37	11
Londonderry, Brandywell	98	293	4	160	293	0	120	89	0	54	15
Newry, Monaghan Row	96	154	0	75	109	0	56	35	0	29	7
Newry, Trevor Hill	97	96	0	51	59	0	43	28	0	27	8
Strabane, Springhill Pk	95	168	0	61	69	0	51	30	0	24	8

ns = not specified

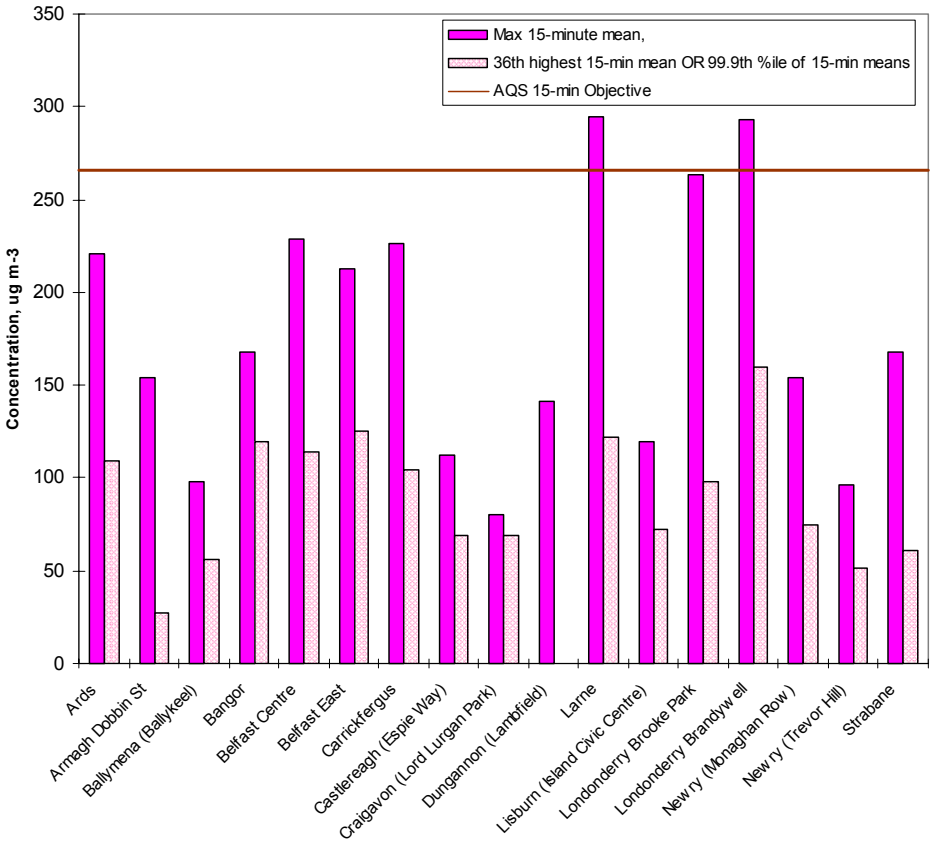


Figure 5.5a Comparison of 15-minute Mean SO_2 Data with AQS Objective

Figure 5.5a shows the maximum 15-min. mean and the 36th highest 15-min. mean (or 99.9th percentile where data capture was less than 90%). If the latter (shown by the lighter coloured bar) is greater than 266µg m^{-3}, the site has not met the objective. All sites met the 15-min. objective in 2003.

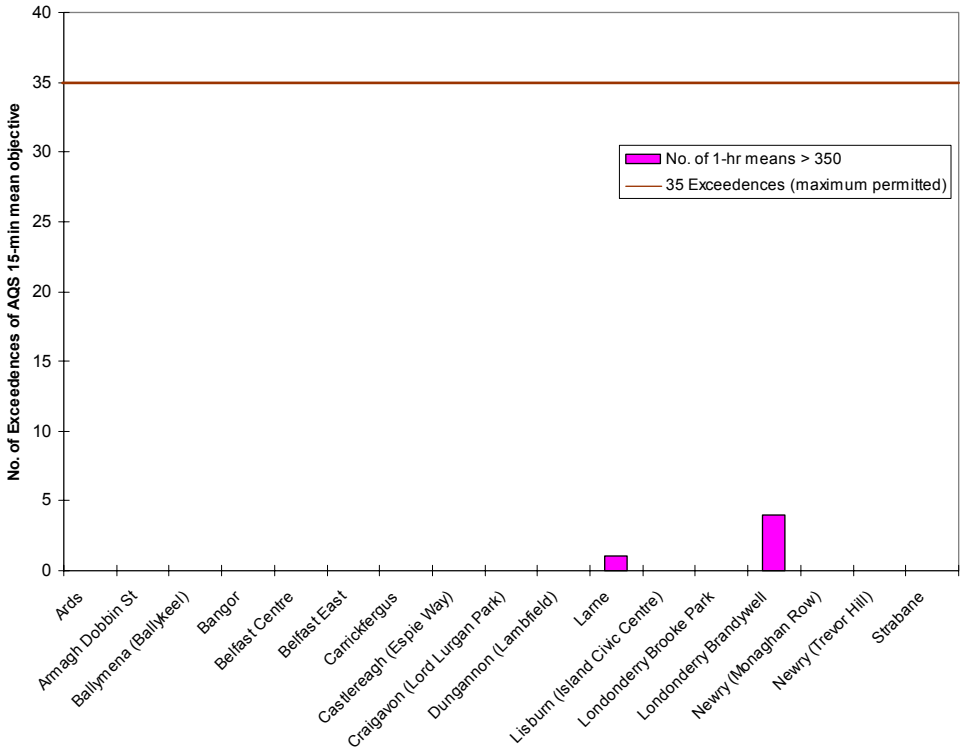


Figure 5.5b Number of Exceedences of 15-minute Mean SO_2 Objective

No sites recorded more than the permitted maximum of 35 exceedences.

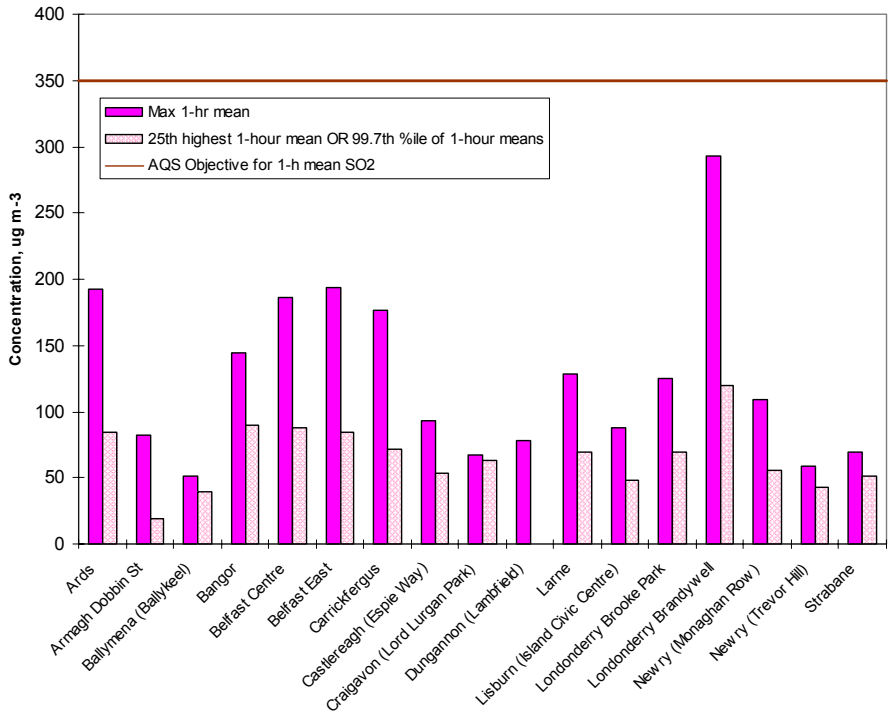


Fig. 5.6 Comparison of 1-hour Mean SO_2 Concentrations (2003) With AQS 1-hour Objective *Figure 5.6 shows the maximum 1-hour mean and the 25th 1-hour mean (or 99.7th percentile where data capture was less than 90%). If the latter (shown by the lighter coloured bar) is greater than 350µg m^{-3}, the site has not met the objective. All sites met the 1-hour objective in 2003.*

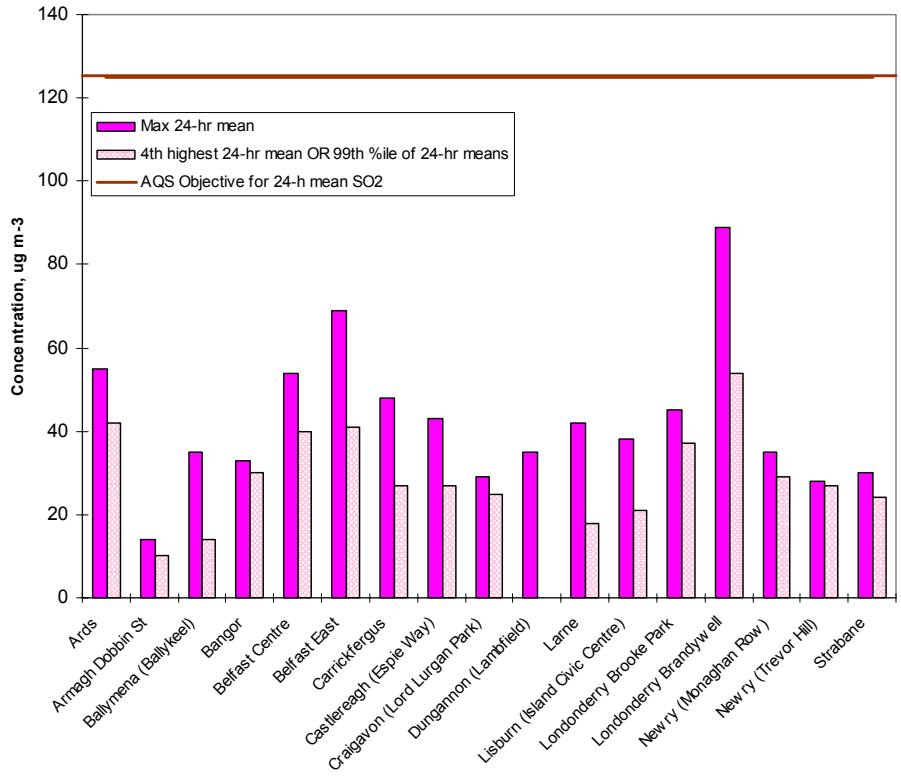


Fig. 5.7 Comparison of 24-hour Mean SO_2 Concentrations (2003) with AQS 24-hour Objective. *Shows the maximum and 4th highest 24-hr mean (or 99th percentile if data capture < 90%). The latter (shown by the lighter coloured bar) must not exceed 125µg m^{-3}. All sites met this objective in 2003.*

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 2003. 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 (as SO_2 equivalent) for all Smoke and SO_2 Network sites in Northern Ireland appears to be falling: from 27 μg m^{-3} in 2000, 20 μg m^{-3} in 2001, 18 μg m^{-3} in 2002 and 15 μg m^{-3} in 2003. (For comparison, the 2003 average for the whole UK was also 15 μg m^{-3}).

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 2003 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 2003 annual mean net acidity (as SO_2) concentrations at the non-network sites in Newcastle (operated by Down DC) and Newtownards (Ards DC) were 14 μg m^{-3} and 9 μg m^{-3} respectively. No annual mean was supplied for the non-Network site at Coleraine.

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

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. Based on 1997 Greater Belfast emissions information, domestic combustion accounts for an estimated 28% of total annual SO_2 emission in the Belfast area[2], 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, and it cannot be assumed that UK trends in either emissions or ambient concentrations are necessarily representative of Northern Ireland. However, UK emission data from the NAEI (www.naei.org.uk)show a decrease of 73% between 1990 and 2002.

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 5.8 shows annual mean SO_2 concentrations from 1992 onwards. Although there are now 17 automatic SO_2 sites in Northern Ireland, this chart shows data from only five sites. This is because
(i) annual means are only included where data capture is at least 75%, and
(ii) only sites with two or more valid annual means are shown.
The remaining 12 sites do not have more than one full year of data, and therefore, for clarity, they have not been included in the trend plot.

A minimum of five years' data are required in order to investigate trends: only two sites meet this criterion: 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 Londonderry AURN site have remained stable over the past four years of operation.

It is also noticeable that the 2003 annual mean SO_2 concentrations at Belfast Centre and the two Newry sites are slightly higher than those recorded for 2002.

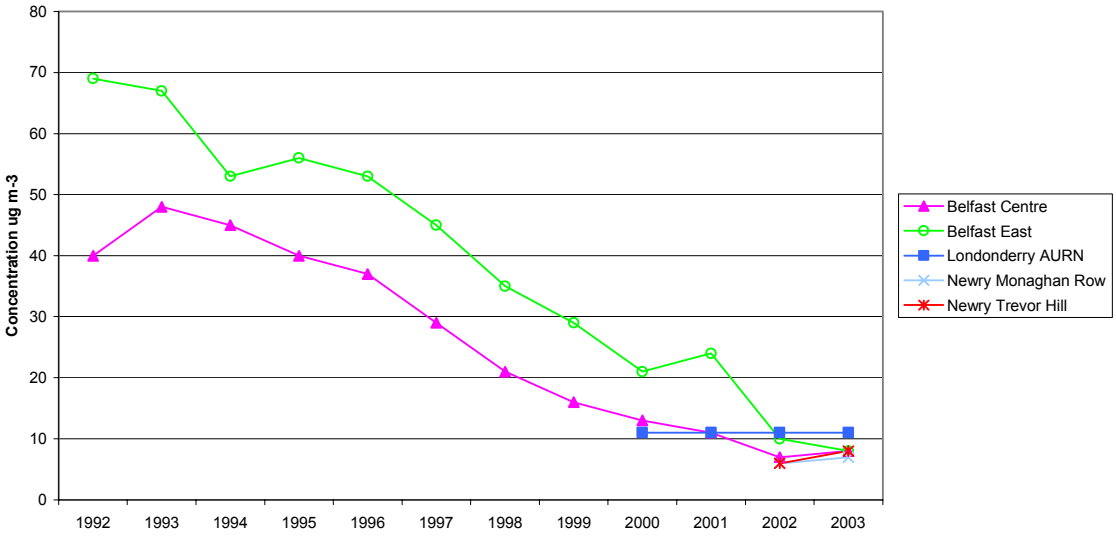


Figure 5.8 Annual Mean SO_2 concentrations at Automatic Sites (data capture at least 75%)

5.5.2 Trends at Non-Automatic Sulphur Dioxide sites

Most of the non-automatic (8-port sampler) sites belong to the Smoke and SO_2 Network, and many have a long-running historical dataset. Thus, it is possible to identify how concentrations of sulphur dioxide, as measured by the net acidity technique, have decreased since the early 1960s. This trend is shown in Figure 5.9, a graph of the average SO_2 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 μg m^{-3} in the 1960s to around 30 μg 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 5.9 also shows the trend in annual mean for three particular 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.

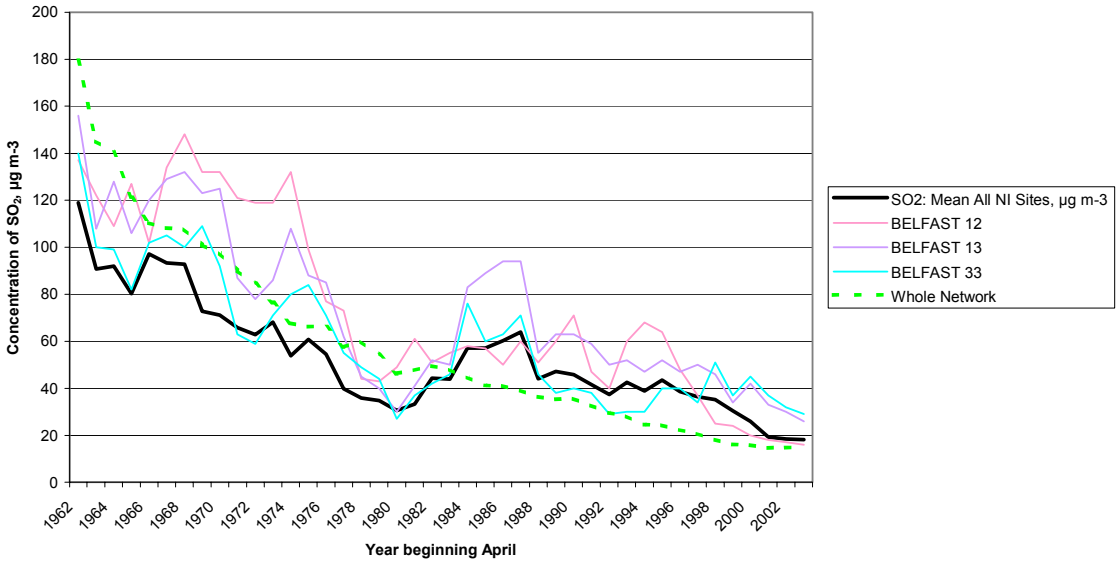


Figure 5.9 Annual Mean SO_2 Concentration at Smoke & SO_2 Sites in Northern Ireland. Network average and 3 long-running Belfast sites.

Figure 5.9 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.

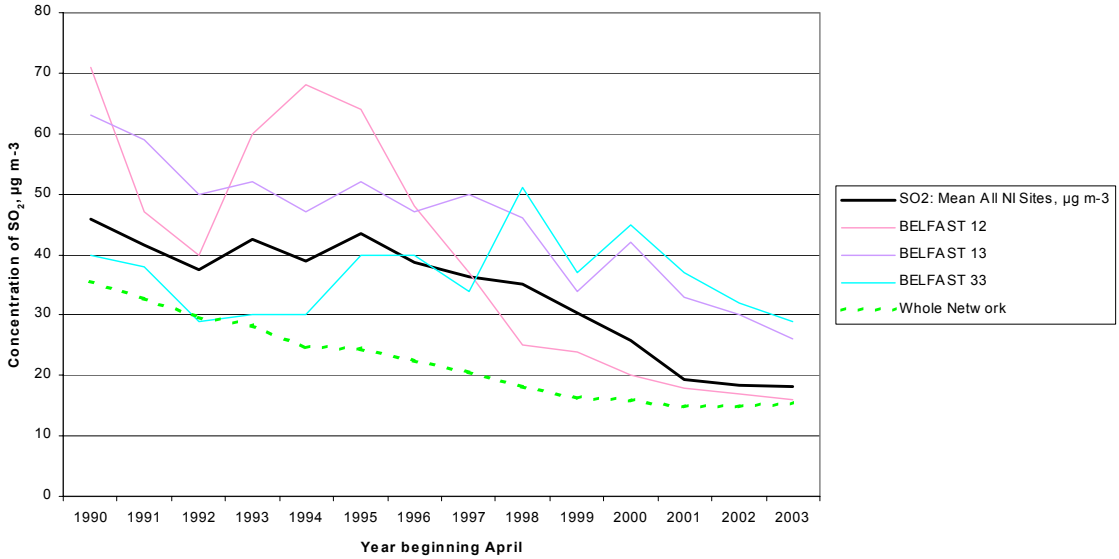


Figure 5.10 Annual Mean SO_2 Concentration at Smoke & SO_2 Sites in Northern Ireland. Network average and 3 long-running Belfast sites, 1990 onwards.

However, as natural gas becomes more available in Northern Ireland, the gap is closing. Figure 5.10 shows this: since 2001 the difference between the average for all Northern Ireland sites, and the Network as a whole, has been less than 5 μg m^{-3}.

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 (μg m^{-3}).

6.1 MONITORING OF PARTICULATE MATTER

6.1.1 PM_{10} Monitoring

Five new automatic monitoring sites for particulate matter as PM_{10} started up in Northern Ireland during 2003, taking the total from 18 to 23. 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 some 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) 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. One of the sites which began monitoring PM_{10} in 2003 is at Holywood, North Down - shown in Figure 6.2. 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 flowrate 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 2003, there were 35 sites in Northern Ireland measuring particulate as black smoke, 32 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, 2003

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
Bangor	J 498 810	Urban Background	TEOM	North Down
Belfast Centre, Lombard Street	J 339 744	Urban Centre	TEOM, KFG Gravimetric, Partisol Gravimetric	AURN
Belfast, Clara Street	J 360 734	Suburban	Beta Attenuation Monitor	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
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	Beta Attenuation Monitor	Larne
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, Monaghan Row	J 078 268	Urban Background (residential, smoke control)	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, Springfield Park	H 351 972	Urban Background (Residential)	Beta Attenuation Monitor	Strabane (CC)

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

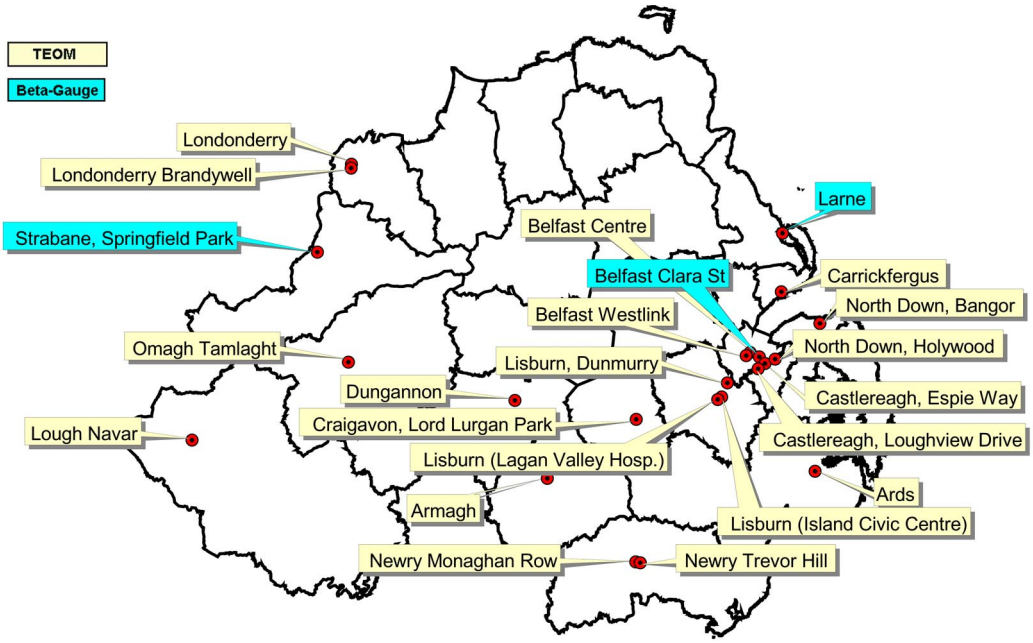


Figure 6.1 Locations of PM_{10} Monitoring Sites, 2003.

Figure 6.2 New 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.

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 2003 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 (To be 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 2003 data are included: the full historical dataset is provided in Appendix 2.

Table 6.4 2003 PM_{10} Results from Automatic Monitoring Sites
(μg m^{-3} Gravimetric Equivalent)

Site	2003 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	82	24	71	11	41	43	43
Armagh, Lonsdale Road	100	33	121	**46**	**54**	**54**	**54**
Bangor	57	27	86	12	38	45	45
Belfast Centre, Lombard Street	97	24	91	26	47	47	47
Belfast Clara Street	95	22	121	34	49	49	49
Belfast Westlink	98	36	105	**63**	**60**	-	**60**
Carrickfergus, Rosebrook Ave	76	25	71	13	40	44	44
Castlereagh, Loughview Drive	76	23	61	9	36	38	38
Castlereagh, Espie Way	67	19	53	4	29	31	31
Craigavon, Lord Lurgan Park	18	25	70	3	20	38	38
Dungannon, Lambfield	88	28	63	25	n/a	n/a	-
Holywood	71	27	68	11	41	44	44
Larne -Harbour	74	22	189	18	35	43	43
Lisburn, Dunmurry High School	16	28	70	6	22	48	48
Lisburn, Island Civic Centre	76	22	77	7	34	36	36
Lisburn, (LVH)	63	26	98	15	35	46	46
Londonderry, Brooke Park	97	24	90	20	41	41	41
Londonderry, Brandywell	99	29	114	34	50	50	50
Lough Navar	99	15	55	1	28	27	28
Newry, Monaghan Row	95	23	79	22	43	43	43
Newry, Trevor Hill	97	37	91	**71**	**62**	**62**	**62**
Omagh, Tamlaght	26	23	64	2	24	34	34
Strabane, Springfield Pk.	97	***43***	164	**101**	**78**	**78**	**78**

n/a = not available.

Ten of the 23 automatic PM_{10} monitoring sites achieved at least 90% data capture for the year. Of the 13 that did not, four (Larne, Bangor, Holywood and Omagh) were new sites which started operation part way through 2003. Three sites (Craigavon Lord Lurgan Park, Lisburn Dunmurry and Omagh) had data capture below 50%: in such cases annual statistics may not be representative.

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 Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill, and Strabane Springfield Park. 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 90^{th} 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.

Of these sites, Armagh Lonsdale Road, Belfast Westlink and Newry Trevor Hill are roadside sites near major or busy roads. The Strabane site is located on a housing estate where solid fuel use is prevalent, and where local topography is thought to impede dispersion: high concentrations of black smoke were identified at this site before automatic PM_{10} monitoring began.

Only one site (Strabane, Springfield Park) 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.

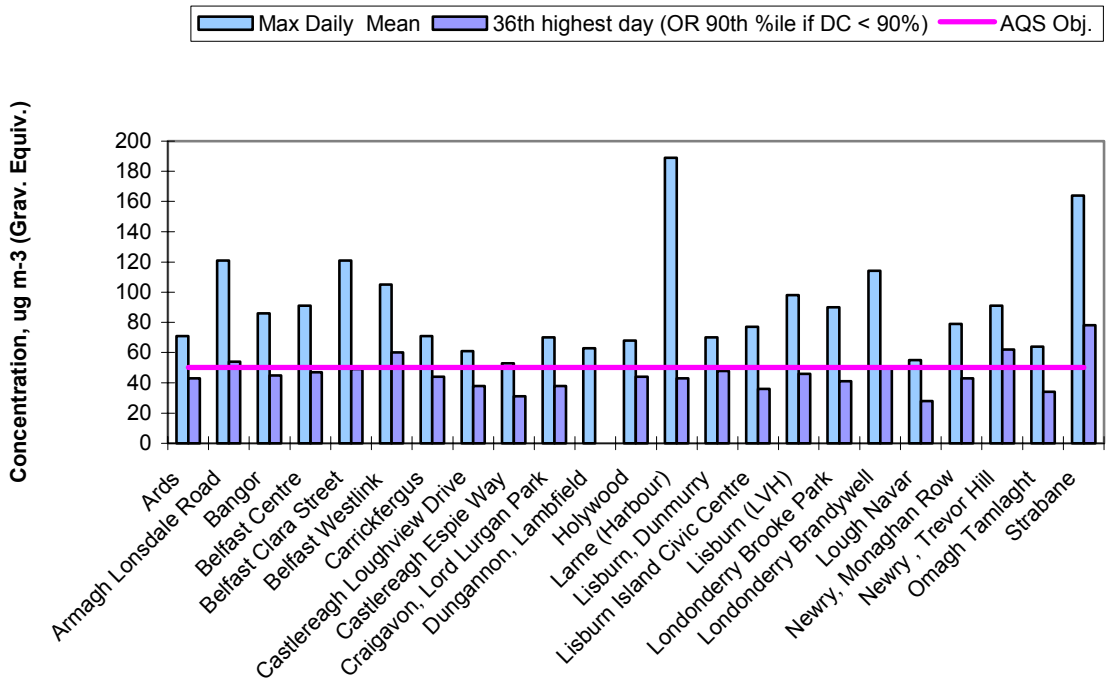


Figure 6.3a Comparison of 2003 PM_{10} Results from Automatic Sites with AQS 24-hour mean Objective. *Figure 6.3a shows the maximum, and the 36^{th} highest 24-hour mean (or 90^{th} percentile where data capture was less than 90%). If the latter (shown by the darker coloured bar) is greater than 50 $\mu g\ m^{-3}$, the site has not met the objective. Four sites did not meet the AQS 24-hour objective of 50$\mu g\ m^{-3}$ in 2003: Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill and Strabane Springhill Park.*

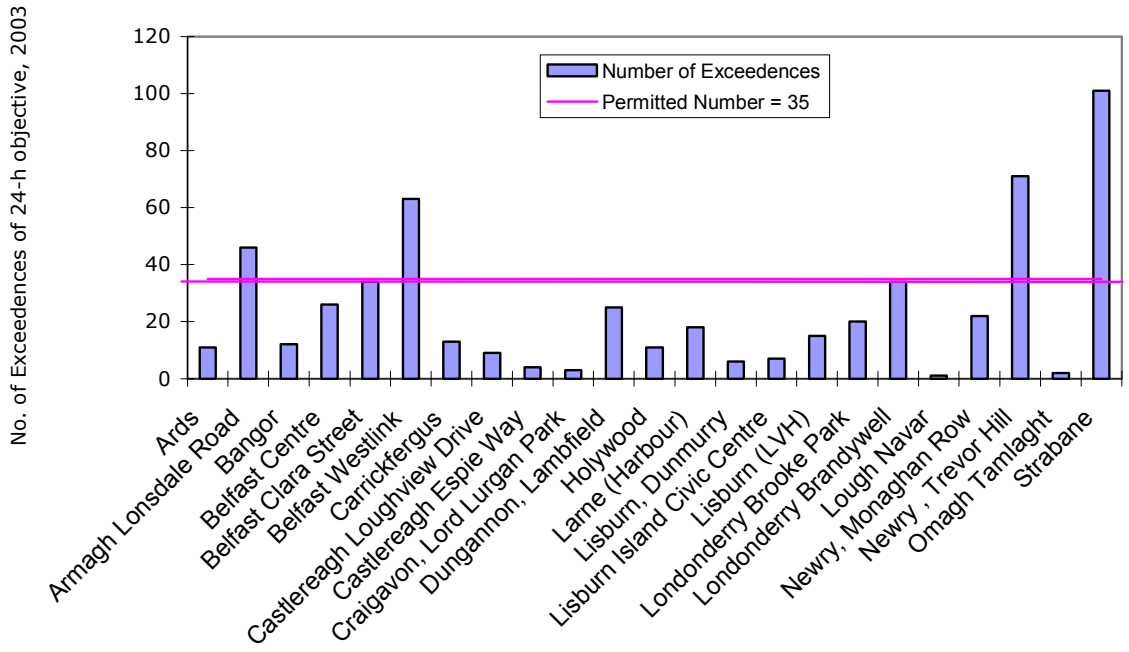


Figure 6.3b Number of Exceedences of 24-hour Mean AQS Objective for PM_{10}, 2003. 35 exceedences permitted per calendar year. *Figure 6.3b shows the number of exceedences of the 24-hour mean AQS objective for PM_{10}, compared with the maximum permitted total of 35.*

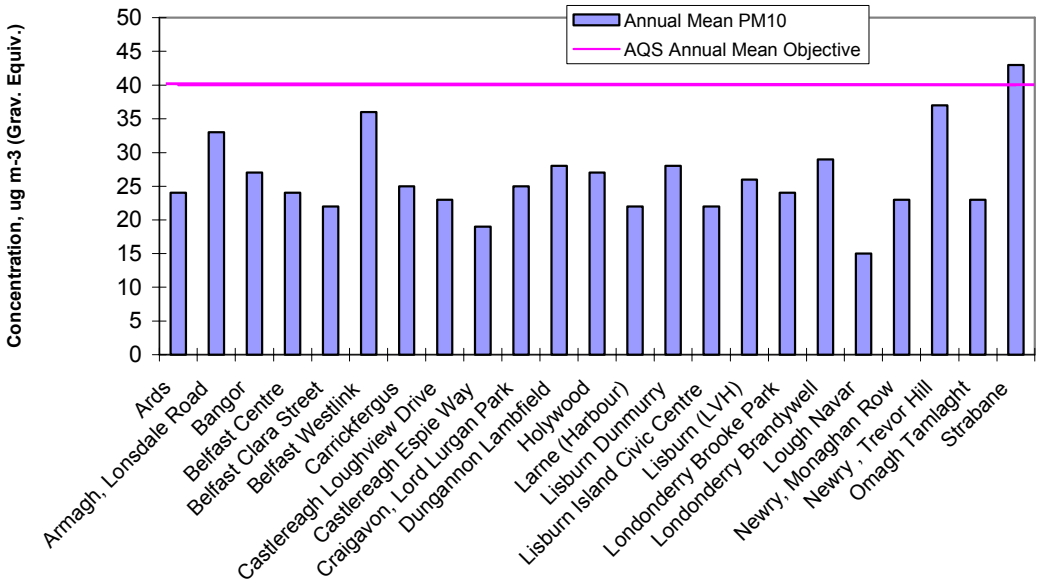


Figure 6.4 Comparison of Annual Mean PM_{10} with AQS Objective, 2003. *Only one site (Strabane, Springfield Park) exceeded the annual mean objective in 2003.*

Figure 6.4 shows a comparison of annual mean PM_{10} concentrations at all automatic sites, with the AQS objective of 40 $\mu g\ m^{-3}$ 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 Springfield 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.

6.3.2 Black Smoke Results

A summary of smoke data for calendar year 2003 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 2003 average for Northern Ireland was 9.3 μg m^{-3}; this is slightly higher than the 2003 average of 7.1 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.

However, the 2003 annual mean represents a substantial reduction on the annual mean smoke concentration of 27μg m^{-3} measured at this site over the previous year.

Two non-Network smoke sites reported annual mean smoke concentrations: these were Newtownstewart (operated by Strabane DC), and Newcastle (operated by Down DC). The 2003 annual mean smoke concentrations at these two sites were 13.1μg m^{-3} and 4.5μg m^{-3} respectively.

All the sites in Northern Ireland meet the limit values of 80/779/EEC for smoke, and have done so since 1990. During 2003, the annual arithmetic mean was well below the lower guide value of 34 μg m^{-3} at all sites in Northern Ireland. However, the maximum daily mean exceeded both the upper and lower 24-hour guide values at several sites in Northern Ireland.

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 2002, 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 two consecutive years' annual means are shown, and annual means have only been included where data capture is at least 75%. The majority of the 22 sites now in operation are not included as they do not yet have two valid annual means.

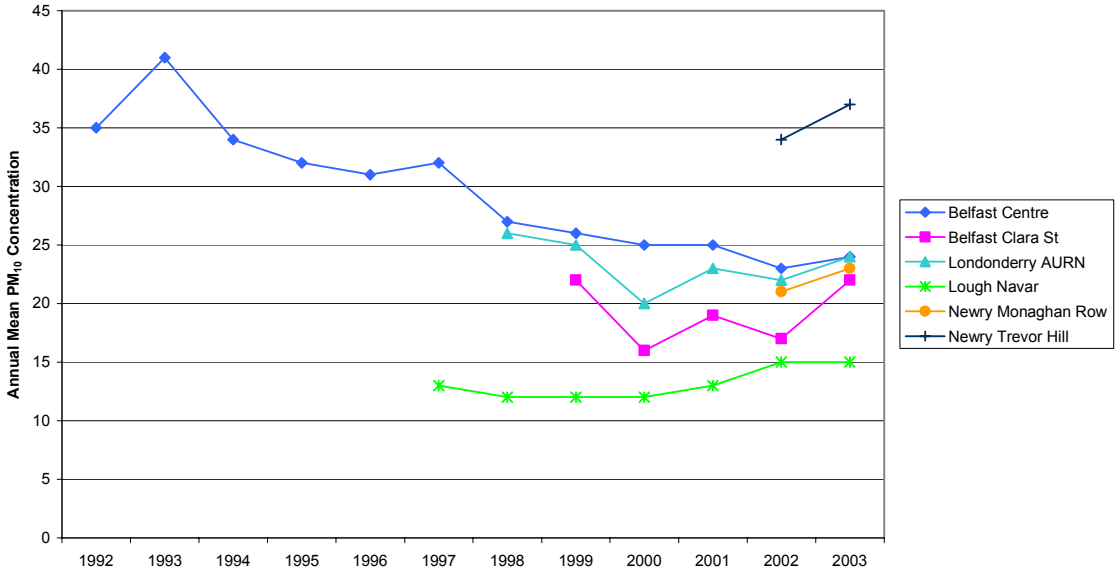


Figure 6.5 Annual Mean PM_{10}Concentrations at Automatic Monitoring Sites, Gravimetric Equivalent. (Data capture at least 75%).

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. However, there is no clear trend at Belfast Clara Street, Londonderry, Brooke Park, or Lough Navar. (At the two Newry sites there is not yet enough data to assess trends).

Despite the long-term decreasing trend evident from Belfast Centre, it is noticeable that annual mean PM_{10} concentrations at all these sites except Lough Navar were higher in 2003 than in 2002. This is likely to be due to meteorological conditions during 2003, which gave rise to several periods of high levels of particulate pollution, due to Saharan dust (April 2003) and long-range transport of pollution from mainland Europe (summer).

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 μg m^{-3} in the early 1960s to less than 10 μg m^{-3} in 2003.

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.

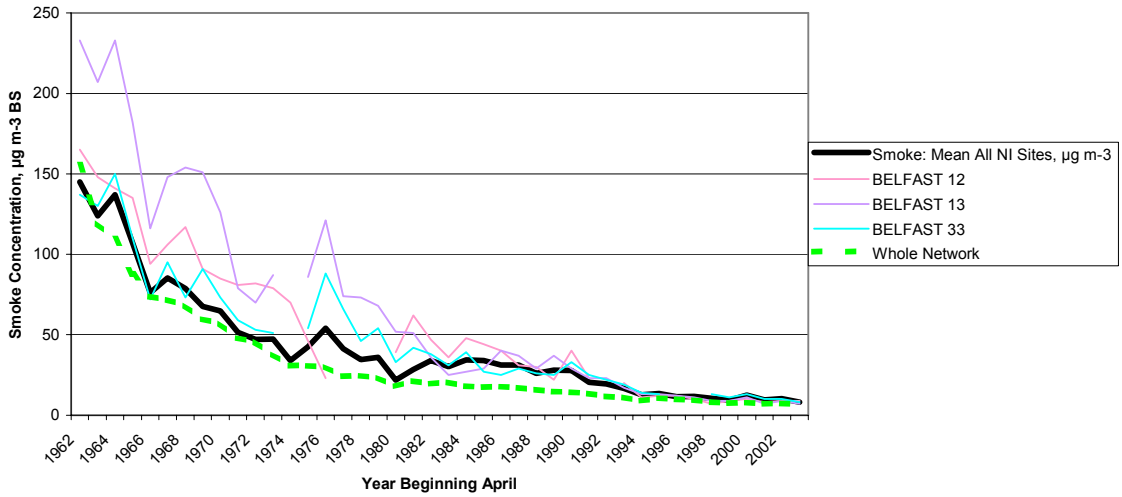


Figure 6.6 Trends in Black Smoke Concentration, Northern Ireland. NI average, UK Network average, and 3 long-running Belfast sites.

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.

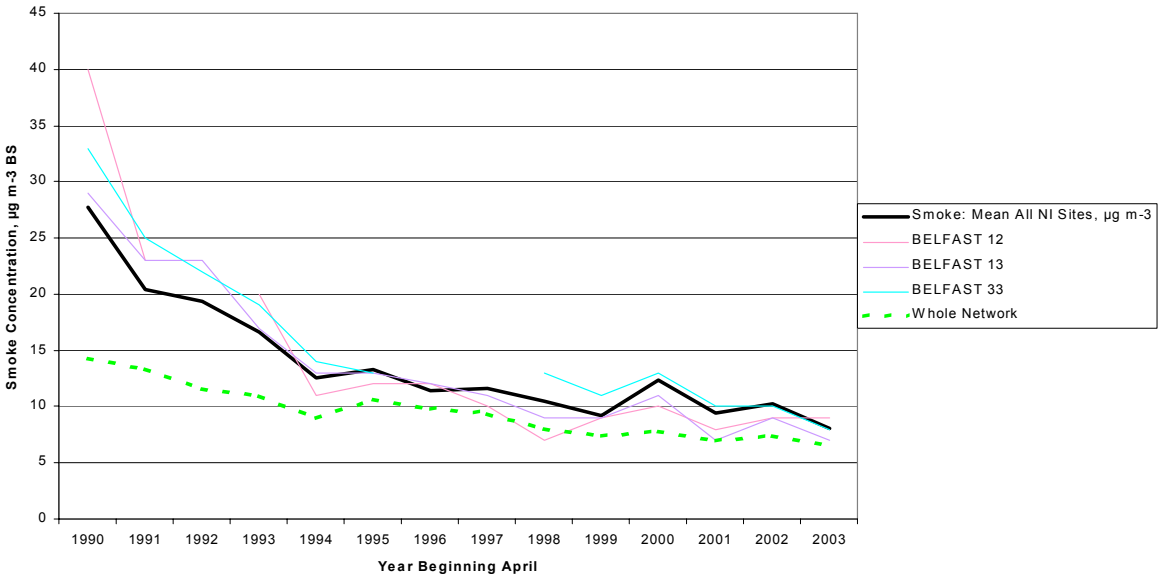


Figure 6.7 Trends in Black Smoke Concentration, Northern Ireland and UK Network average, 1990 onwards

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.

The summer of 2003 was particularly hot and sunny, and meteorological conditions gave rise to high levels of ozone throughout the UK and Europe. High levels of this pollutant were recorded as early as April and as late as September[5].

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

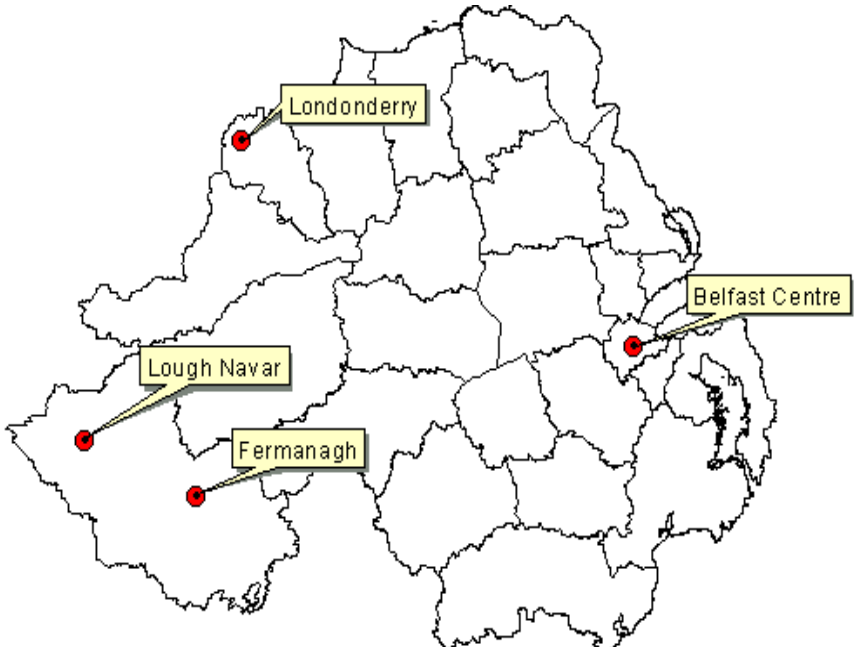


Figure 7.1 Location of Ozone Monitoring Sites

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 2003, 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 Belfast Centre and Lough Navar met the AQS objective for ozone in 2003. However, Londonderry, Brooke Park exceeded the AQS objective limit value for ozone on more than the permitted 10 days (for the second year running). 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 exceedences at Londonderry were spread over a period of several months, April to September. Levels of ozone were particularly high during the summer of 2003, due to the prolonged hot and sunny weather[5].

However, it should be noted that the Lough Navar site recorded no valid data during the period May to July, when highest ozone levels might be expected. It is therefore possible that some exceedences at this site went unrecorded, and that the annual statistics for 2003 at this site are under-estimated.

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 1998 to 2003, were compared with this AOT40 target value for protection of vegetation. Lough Navar met the target value.

The 2003 annual mean ozone concentration at the Fermanagh diffusion tube site was 86 μg m^{-3}. This is comparable with the annual means recorded at this site in 2001 and 2002, 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	97	118	9	42
Londonderry	93	149	***16***	52
Lough Navar	64	138	6	47

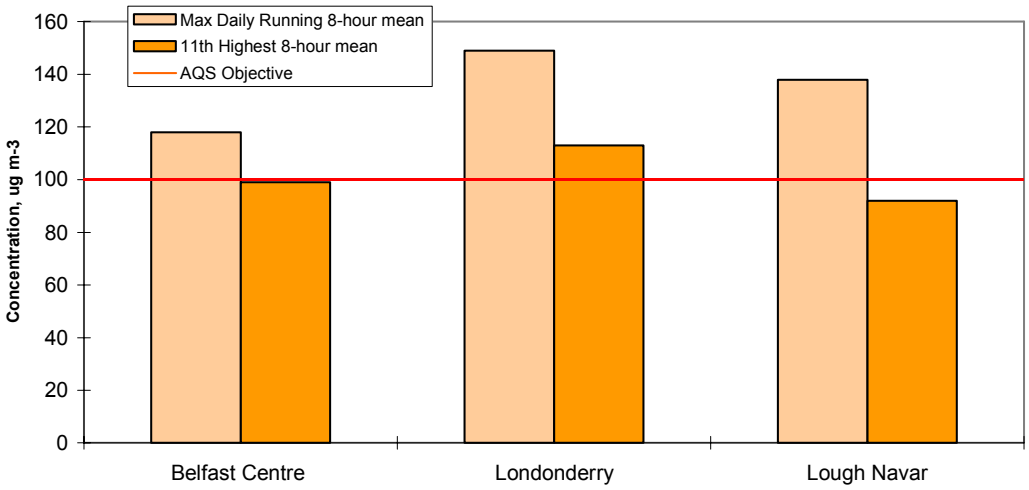


Figure 7.2 Comparison of 2003 Ozone Results from Automatic Sites with AQS Objective.

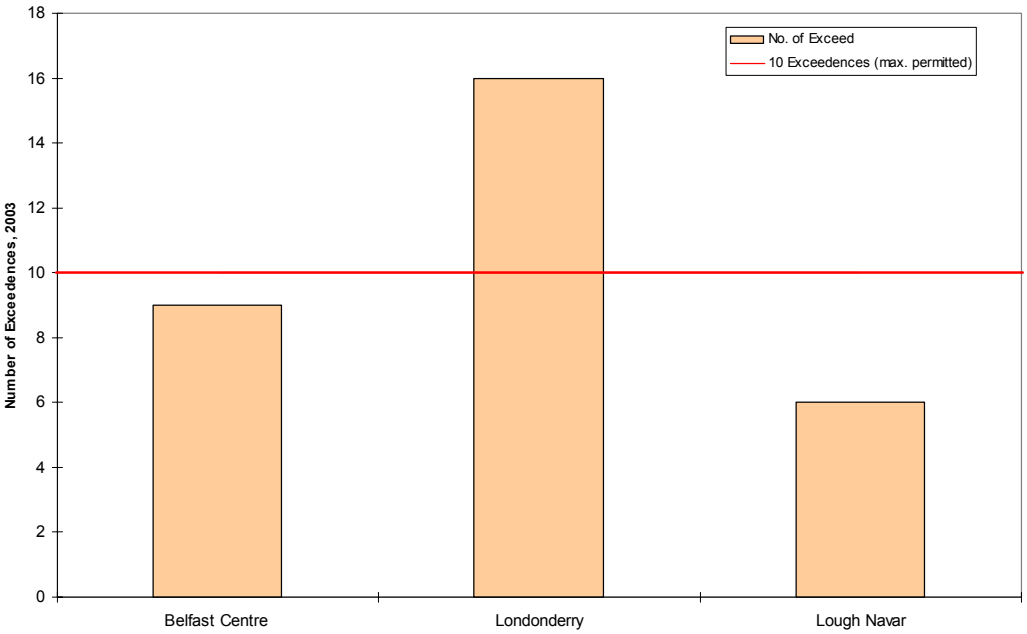


Figure 7.3 Number of Exceedences of AQS Objective for Ozone, 2003.

7.4 OZONE TRENDS

Figure 7.4 shows a time series plot of the annual mean ozone concentration. There appear to be no clear trends, 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.

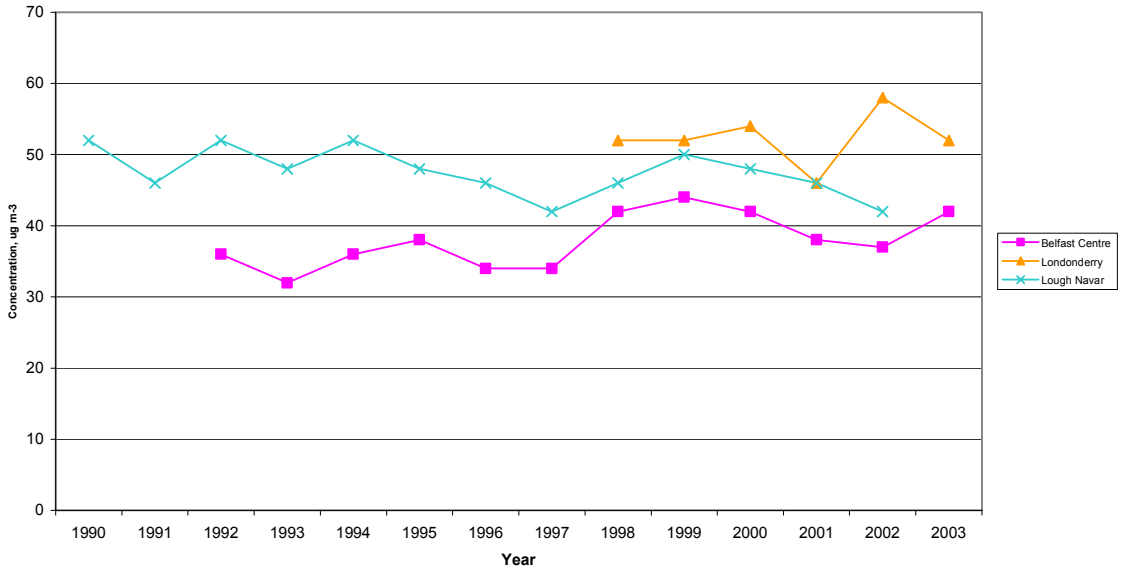


Figure 7.4 Trends in Annual Mean Ozone Concentration

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 2002 contributed 52% 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 Roadside, 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.

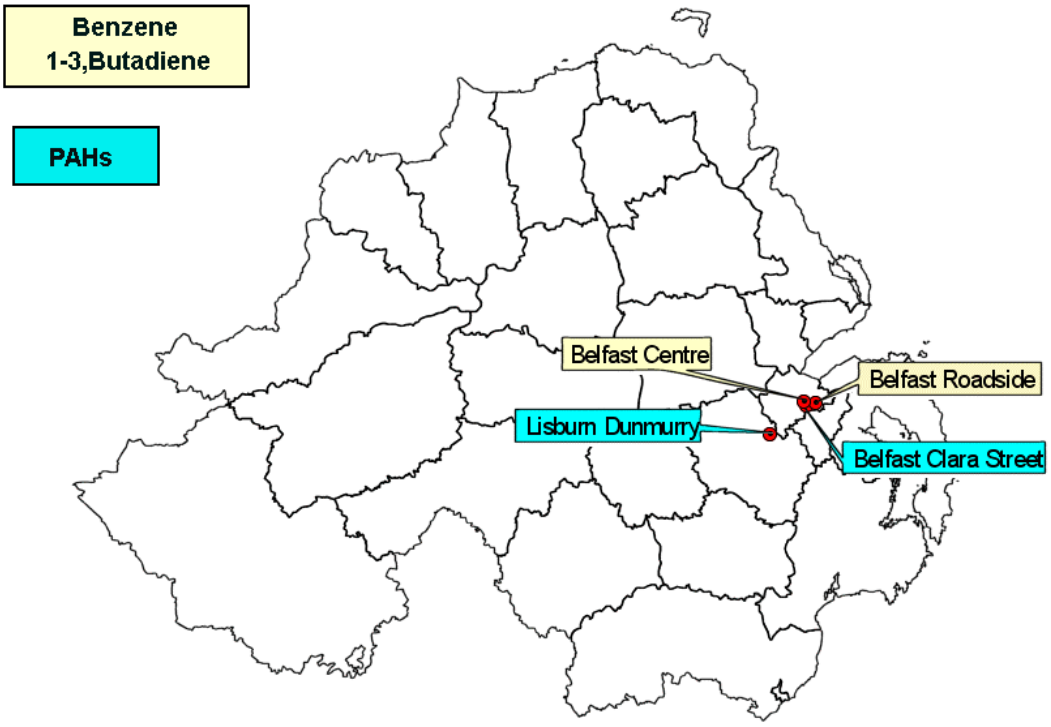


Figure 8.1 Locations of Hydrocarbon Monitoring Sites

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 Roadside	J 379 739	Roadside	Benzene, 1,3-butadiene	Non-Auto. Hydrocarbon
Lisburn (Dunmurry High School)	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 Roadside for 2003.

Table 8.3 Concentrations of Benzene, 2003

Site	Data Capture, %	Calendar Year Mean Concentration 2003, μg m^{-3}	Running Annual Mean Concentration 2003, μg m^{-3}
Belfast Centre	96	1.17	-
Belfast Roadside	100	2.62	-

The annual means for 2003 means of 1.17 μg m^{-3} and 2.62 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. Both sites have therefore achieved the AQS objectives for benzene and 1,3-butadiene by the due date of 31st December 2003. These results are also consistent with those obtained by the former Belfast South hydrocarbon site, at which annual mean benzene concentration was consistently below 5 μg m^{-3} since 1994.

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, 2003

Site	Data Capture, %	Calendar Year Mean Concentration 2003, μg m^{-3}	Running Annual Mean Concentration 2003, μg m^{-3}
Belfast Centre	50	0.073	-
Belfast Roadside	73	0.103	-

Although data capture is considerably less than 90%, the results indicate that levels of this pollutant at both sites are less than 0.2 μg m^{-3}, and therefore well within the applicable Air Quality Strategy objective of 2.25 μg m^{-3}. This is consistent with the findings from the former Belfast South hydrocarbon monitoring site, at which running annual mean concentrations of 1,3-butadiene were consistently less than 2.25 μg m^{-3} throughout its operational period of 1994 - 2000.

8.3.2 Polycyclic Aromatic Hydrocarbons

The 2003 annual mean benzo(a)pyrene concentration was 0.95 ngm^{-3} at Lisburn, Dunmurry, and 0.08 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 and Figure 8.2. The two sites in Northern Ireland are shown in ***bold italics***. In some cases, including Belfast, the annual mean was reported as "less than" a given value. In these cases, the annual mean has been shown as half that value in Figure 8.2.

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}
Ashington	Urban	0.17	0.2	0.15	0.19
Belfast	***Urban***	***-***	***0.37***	***0.13***	***< 0.08***
Birmingham	Urban	-	0.16	0.13	0.16
Bolsover	Urban	0.25	0.28	0.24	0.46
Brent	Urban	-	-	-	0.14
Bromley	Urban	-	-	0.25	0.21
Glasgow	Urban	0.12	0.12	0.12	< 0.065
Hazelrigg	Semi-Rural	0.06	0.08	0.04	< 0.043
High Muffles	Rural	0.04	0.05	0.04	0.045
Holyhead	Urban	0.11	0.15	0.25	0.14
Hove		-	-	-	0.1
Kinlochleven *	Urban	2.28	0.34	0.38	0.21
Leeds	Urban	-	0.16	0.18	0.21
Lisburn	***Urban***	***0.93***	***0.96***	***0.65***	***0.95***
London 2a	Urban	0.14	0.14	0.13	0.12
Manchester	Urban	0.24	0.34	0.12	0.24
Middlesbrough	Urban	0.28	0.37	0.15	0.24
Newcastle	Urban	-	0.11	0.12	0.16
Newport	Urban	0.35	0.36	0.19	0.11
Port Talbot	Urban	0.59	0.4	0.34	0.47
Scunthorpe	Urban	1.18	0.34	0.13	1.3
Speke	Urban	-	-	0.14	0.14
Stoke Ferry	Rural	0.09	0.09	0.08	0.08

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

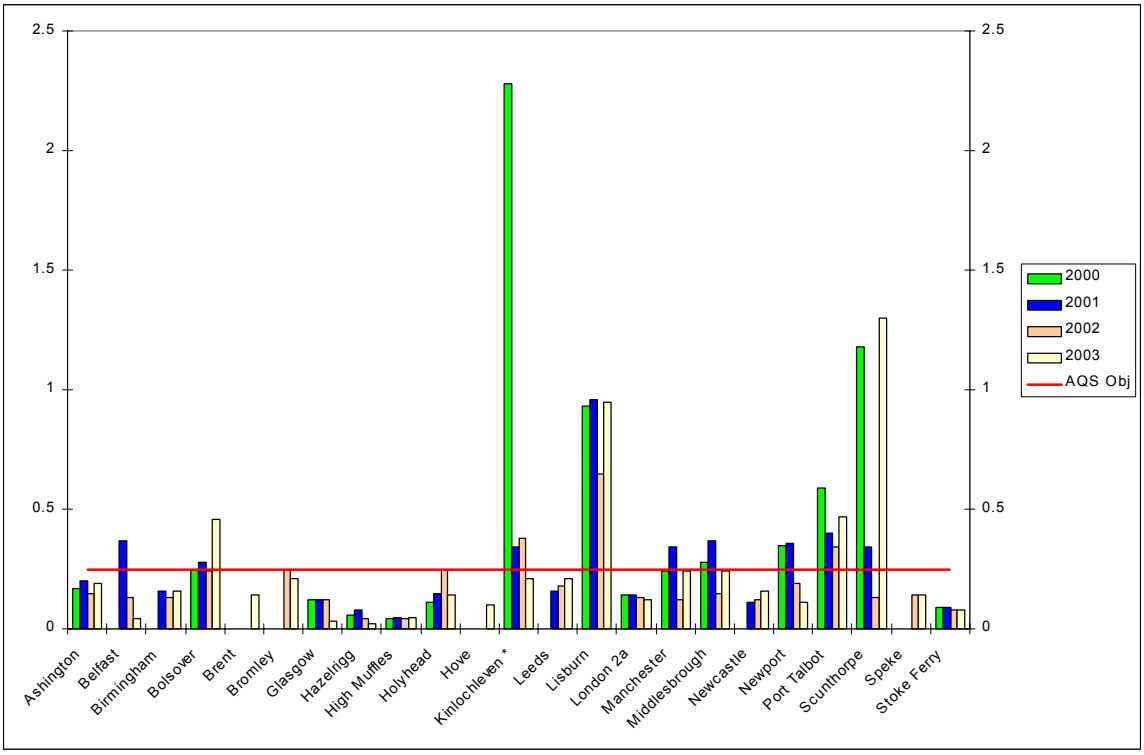


Figure 8.2 Annual Mean Benzo(a)pyrene Concentrations at HAPS Network sites, ng m^{-3} 2000 to 2003

Annual mean benzo(a)pyrene at rural sites (Hazelrigg, High Muffles, Stoke Ferry), ranged from less than 0.04 to 0.08 ngm^{-3}, well within the Air Quality Strategy's new 2010 objective of 0.25 ngm^{-3}. Urban sites (including Belfast Clara Street) typically had higher annual mean concentrations, ranging from less than 0.06 to 1.3 ngm^{-3}. Four sites out of 23 exceeded the AQS objective of 0.25 ngm^{-3}, compared with nine out of nineteen in 2001. One site (Scunthorpe, which is in an industrial area) exceeded the proposed EC limit value for benzo(a)pyrene of 1.0 ngm^{-3} . Annual mean benzo(a)pyrene concentrations for 2003 were higher than those reported for 2002 at several of the HAPS network sites.

The mean benzo(a)pyrene level at Belfast Clara Street in 2003 was measured as less than 0.08 ngm^{-3}. This is substantially lower than in the previous two years, and lower than at other city centre sites such as Birmingham, London and Manchester. Belfast Clara Street was well within the proposed AQS objective of 0.25 ngm^{-3}.

The 2003 mean benzo(a)pyrene concentration at the Lisburn was 0.95 ngm^{-3}. It therefore remains one of the highest in the HAPS network, comparable with sites in or near industrial areas such as Scunthorpe, Port Talbot and Bolsover. The Lisburn site does not currently meet the AQS objective of 0.25 ngm^{-3}, and approaches the proposed EC limit value for benzo(a)pyrene of 1.0 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.

As there are only four years' data for PAHs in Northern Ireland, it is not possible to assess trends. A study[4] 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.

8.4 HYDROCARBON TRENDS

As the two benzene and 1,3 butadiene 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. Meteorological conditions during 2003 contributed to higher UK levels (compared with recent years) of several pollutants including oxides of nitrogen, PM_{10} and ozone. This was reflected in the results obtained for some Northern Ireland sites.

Carbon Monoxide

2. Carbon Monoxide was measured at two sites: Belfast Centre and Londonderry. Both currently meet the EC limit value and the Air Quality Strategy objective for CO, and have achieved the AQS objective for CO by the due date of 31st December 2003. There is a significant downward trend in the annual mean CO at both sites.

Nitrogen Dioxide

3. Nitrogen Dioxide was monitored at fourteen automatic sites, of which four were new in 2003. 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 2003. Four roadside automatic sites (Belfast Westlink, Belfast Newtownards Road, Derry, Dale's Corner and Newry Trevor Hill) had annual mean NO_2 concentrations greater than the EC limit value and the Air Quality Strategy objective of 40 μg m^{-3}. (Dale's Corner began operation late in 2003 and data capture was limited; however, 2004 data from this site confirm that it may have difficulty in meeting the annual mean objective for NO_2).

4. It is predicted, using the methods set out in the Technical Guidance[1], that Belfast Westlink may not meet the EC limit value of 40 μg m^{-3} for annual mean NO_2 in 2010.

5. NO_2 was also monitored using diffusion tubes at 263 sites in 2003. After application of bias adjustment factors as set out in the Technical Guidance, 18 diffusion tube sites (mostly 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 13 may not meet the AQS objective by 2005, and two 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.

6. Annual mean NO_2 concentrations at long-running sites were higher during 2003 than the previous year, probably due to meteorological factors. This is in contrast to the longer-term downward trend identified for this pollutant in recent years.

Sulphur Dioxide

7. Sulphur Dioxide is monitored at seventeen automatic sites, of which three were new in 2003. All automatic sites met the requirements of the 1st Daughter Directive and the objectives of the Air Quality Strategy in 2003. No sites recorded *any* exceedences of the 1-hour or 24-hour mean objectives for SO_2. Belfast East, a long-running site that has until recently recorded relatively high SO_2 concentrations, now appears to meet objectives.

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, 2003 annual mean SO_2 concentrations at some sites were slightly higher than those measured in the previous year.

9. Net acidity data from the 38 urban non-automatic SO_2 (8-port sampler) sites also indicate that SO_2 levels in Northern Ireland are falling. In 2003, 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 second 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. The number of automatic sites monitoring particulate matter as PM_{10} increased from 18 to 23 during 2003. 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 Armagh Lonsdale Road, Belfast Westlink, Newry Trevor Hill, and Strabane Springfield Park.

11. Several PM_{10} monitoring sites had less than 90% data capture for the year, and were therefore assessed by comparing the 90th percentile of 24-hour means with the 24-hour objective (as specified by the Technical Guidance). However, all these sites met the 24-hour mean objective in 2003.

12. One site, Strabane Springfield Park, also exceeded the AQS objective of 40 μg 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.

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

14. Particulate matter as black smoke is measured at 35 sites, of which 33 are part of a long-running 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

15. Ozone is measured at three automatic sites in Northern Ireland: the AUN sites Belfast Centre and Londonderry and the rural site Lough Navar. The AQS objective (although not the less stringent EC 3rd Daughter Directive target) was exceeded on more than the permitted 10 days in 2003 at Londonderry. The majority of these days occurred during the summer.

Hydrocarbons

16. Benzene is monitored at Belfast Centre and Belfast Roadside. The 2003 annual means were well within the AQS objective and also within the EC 2nd Daughter Directive limit value, and have achieved the AQS objective for benzene by the due date of 31st December 2003.

17. 1,3-butadiene is also monitored at Belfast Centre and Belfast Roadside. The 2003 annual means were well within the applicable Air Quality Strategy objective of 2.25 μg m^{-3}, and have achieved the AQS objective for 1,3-butadiene by the due date of 31st December 2003.

18. Polycyclic aromatic hydrocarbons were monitored at two sites (Belfast Clara Street and Lisburn Dunmurry). Belfast Clara Street showed a substantial reduction in annual mean benzo(a)pyrene concentration in 2003, and now meets the 2010 AQS objective and proposed EC Target Value for B(a)P. However, Lisburn remains significantly above the AQS objective and is at risk of exceeding the proposed EC Target 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 25 District Councils. Nine Councils have identified areas likely to exceed AQS objectives of which six have declared Air Quality Management Areas. A further two Councils have indicated their intention to declare.

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

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

2. C Buckingham et al "Greater Belfast Atmospheric Emissions Inventory" report produced for DETR by London Research Centre & RSK Environment, April 1999.

3. C Buckingham et al "Atmospheric Emissions Inventories for Four Urban Areas" report produced for DETR by London Research Centre & RSK Environment, December 1997.

4. S Pye, K Vincent: "Determining the Impact of Domestic Solid Fuel Burning on Concentrations of PAHs and sulphur dioxide in Northern Ireland" AEAT/ENV/R/1498, June 2003. Available from www.airquality.co.uk/archive/reports/reports .

5. "UK Air Pollution" brochure produced by netcen, August 2004. Available from http://www.airquality.co.uk/archive/reports/cat05/0408161000_Defra_AQ_Brochure_2004_s.pdf

Appendices

CONTENTS

Appendix 1
Diffusion Tube Site Details and Data

CONTENTS

Local Authority	Location of Sampler	Grid Ref. Easting to nearest 100m,	Grid Ref. Northing to nearest 100m.	Part of NO2 Network?	NO2 Network Name if applicable	Site Classification	*No. of months data if < 12*	Uncorrected annual mean NO2, 2003, ug/m3	Bias-adjusted annual mean NO2, 2003, ug/m3	BAF	Lab used
Antrim	Ballycraigy Road/ Greystone Road	3171	3868	NO		A		33.0	31.7	0.96	Gradko *
Antrim	Ballymena Road /Stiles Way	3144	3883	NO		A		23.0	22.1	0.96	Gradko *
Antrim	Ballymena Road North of Dunsilly	3135	3905	NO		A		30.6	29.4	0.96	Gradko *
Antrim	Ballymena Road, Antrim	3146	3875	NO		A	*9*	**22.0**	**21.1**	**0.96**	**Gradko ***
Antrim	Ballymena Road, north of Dunsilly	3135	3905	NO		A		34.0	32.6	0.96	Gradko *
Antrim	Ballymena Road/Oriel Road junction (started Nov	3163	3876	NO		A		34.0	32.6	0.96	Gradko *
Antrim	Belfast Road/Ballyclare Road	3235	3859	NO		A		25.0	24.0	0.96	Gradko *
Antrim	Donegore Bridge, Antrim	3208	3874	NO		B		22.0	21.1	0.96	Gradko *
Antrim	Fountain St, Antrim	3153	3865	NO		A		28.0	26.9	0.96	Gradko *
Antrim	Fountain Street, Antrim	3154	3865	NO		A		22.6	21.7	0.96	Gradko *
Antrim	M2/Ballyclare Road	3244	3864	NO		A		25.0	24.0	0.96	Gradko *
Antrim	Main St, Crumlin	3169	3891	NO		A		**25.0**	24.0	0.96	Gradko *
Antrim	Main St, Randalstown	3082	3904	NO		A		37.0	35.5	0.96	Gradko *
Antrim	Main St, Randalstown	3082	3904	NO		A		34.2	32.8	0.96	Gradko *
Antrim	Main Street, Templepatrick	3233	3858	NO		A		31.8	30.5	0.96	Gradko *
Antrim	Oldstone Road/ A57	3175	3817	NO		A		32.0	30.7	0.96	Gradko *
Antrim	Tully Road, Crumlin	3175	3775	NO		A		**38.0**	36.5	0.96	Gradko *
Ards	19 Islandmore Avenue, Newtownards	3495	3750	YES	NEWTOWNARDS 6N	C		10.0	10.4	1.04	Ruddock & Sherratt *
Ards	7 Ashgrove, Newtownards	3485	3745	YES	NEWTOWNARDS 3N	C		11.0	11.4	1.04	Ruddock & Sherratt *
Ards	8 Court Street, Newtownards	3485	3735	YES	NEWTOWNARDS 1N	A		26.0	26.9	1.04	Ruddock & Sherratt *
Ards	Rear of Town Hall opposite 18 Frances Street, Ne	3481	3741	YES	NEWTOWNARDS 7N	A		30.0	31.1	1.04	Ruddock & Sherratt *
Armagh	17 Folly Lane, Armagh	2882	3448	YES	ARMAGH 4N	C		18.5	13.5	0.73	Harwell Scientifics *
Armagh	25 Railway Street, Armagh	2875	3458	YES	ARMAGH 1N	A		30.9	22.6	0.73	Harwell Scientifics *
Armagh	7 Desart Lane, Armagh	2868	3457	YES	ARMAGH 3N	C		18.0	13.1	0.73	Harwell Scientifics *
Armagh	Bridge House, Barrack Street, Armagh	2879	3450	YES	ARMAGH 5N	A		37.8	27.6	0.73	Harwell Scientifics *
Armagh	Lower Irish Street, Armagh	2874	3448	NO		A		35.1	25.7	0.73	Harwell Scientifics *
Armagh	Mallview Terrace	2879	3452	NO		A		24.0	17.5	0.73	Harwell Scientifics *
Armagh	Portadown Road, Armagh	2887	3459	NO		A		17.0	12.4	0.73	Harwell Scientifics *
Armagh	St Patricks Fold, Scotch Street, Armagh	2877	3450	NO		A		10.1	7.4	0.73	Harwell Scientifics *
Ballymena	29 Galgorm Road, Ballymena	3103	4032	YES	BALLYMENA 2N	A		26.4	27.7	1.05	Lambeth Scientific Services*
Ballymena	8 Ballyloughan Avenue, Ballymena	3095	4044	YES	BALLYMENA 4N	C		13.7	14.4	1.05	Lambeth Scientific Services
Ballymena	Ballymoney Street, Ballymena	3108	4035	YES	BALLYMENA 5N	A		26.8	28.1	1.05	Lambeth Scientific Services*
Ballymena	Cullybackey Road, Ballymena	3103	4034	NO		A		26.5	27.8	1.05	Lambeth Scientific Services*
Ballymena	George Street, Ballymena	3105	4032	NO		A		28.8	30.2	1.05	Lambeth Scientific Services*
Ballymena	Larne St, Ballymena	3106	4029	NO		A		23.4	24.6	1.05	Lambeth Scientific Services*
Ballymena	Leighmore Avenue, Ballymena	3102	4025	YES	BALLYMENA 1N	C		14.9	15.6	1.05	Lambeth Scientific Services
Ballymena	Lisnevenagh Road, Ballymena	3119	3970	NO		A		21.7	22.8	1.05	Lambeth Scientific Services*
Ballymena	Main Street, Cullybackey	3058	4056	NO		A		21.2	22.3	1.05	Lambeth Scientific Services*
Ballymena	North Road, Ballymena	3106	4030	NO		A		26.7	28.0	1.05	Lambeth Scientific Services*
Ballymena	Parkway, Ballymena	3110	4039	NO		A		23.0	24.2	1.05	Lambeth Scientific Services*
Ballymena	Queen Street, Ballymena	3107	4022	NO		A		26.9	28.2	1.05	Lambeth Scientific Services*
Ballymena	Wellington Street, Ballymena	3108	4033	NO		A		17.8	18.7	1.05	Lambeth Scientific Services*
Ballymoney	19 Linenhall Street, Ballymoney	2948	4259	YES	BALLYMONEY 1N	A		26.0	27.3	1.05	Lambeth Scientific Services
Ballymoney	2/4 Semicock Avenue, Ballymoney	2948	4268	YES	BALLYMONEY 4N	C		12.8	13.4	1.05	Lambeth Scientific Services
Ballymoney	31 Charles Street, Ballymoney	2946	4261	NO		A		21.8	22.9	1.05	Lambeth Scientific Services
Ballymoney	6 Church Street, Ballymoney	2948	4258	NO		A				1.05	Lambeth Scientific Services
Ballymoney	Adajacent 8 Ballybogey Road, Ballymoney	2942	4269	YES	BALLYMONEY 5N	A		18.3	19.2	1.05	Lambeth Scientific Services
Ballymoney	Ballymena Road, Ballymoney	2960	4257	NO		A				1.05	Lambeth Scientific Services
Ballymoney	Castle St,Gate End	2947	4253	NO		A				1.05	Lambeth Scientific Services
Ballymoney	Frosses Road / Kilraughts Road junction	2964	4261	NO		A				1.05	Lambeth Scientific Services
Ballymoney	Opposite 16 Armour Avenue, Ballymoney	2953	4256	YES	BALLYMONEY 3N	C		14.6	15.4	1.05	Lambeth Scientific Services
Ballymoney	Opposite 51 Queen Street, Ballymoney	2952	4258	NO		A		23.8	25.0	1.05	Lambeth Scientific Services
Banbridge	17 Springfields, Banbridge	3121	3444	NO		C				1.05	Lambeth Scientific Services
Banbridge	9 Fortfield, Dromore	3199	3535	NO		D				1.05	Lambeth Scientific Services
Banbridge	Dromore Street, Banbridge	3128	3462	NO		A		34.4	34.4	1.05	Lambeth Scientific Services
Banbridge	Fortfield, Dromore (fence beside dual carriageway	3199	3536	NO		A		32.8	32.8	1.05	Lambeth Scientific Services

Local Authority	Location of Sampler	Grid Ref. Easting to nearest 100m,	Grid Ref. Northing to nearest 100m.	Part of NO2 Network?	NO2 Network Name if applicable	Site Classification	*No. of months data if < 12*	Uncorrected annual mean NO2, 2003, ug/m3	Bias-adjusted annual mean NO2, 2003, ug/m3	BAF	Lab used
Belfast	301 Ormeau Road, Southern approaches	3345	3722	NO		A		37.0	43.3	1.17	Lambeth Scientific Services
Belfast	400 Ormeau Road, Southern approaches	3350	3709	NO		A		27.0	31.6	1.17	Lambeth Scientific Services
Belfast	Belfast City Hall, Donegall Square South	3338	3739	Yes	BELFAST 1N	A		41.0	48.0	1.17	Lambeth Scientific Services
Belfast	Black's Road	3297	3695	NO		A		38.0	44.5	1.17	Lambeth Scientific Services
Belfast	Cromac Street (A)	3341	3735	NO		A		38.0	44.5	1.17	Lambeth Scientific Services
Belfast	Cromac Street (B), Southern approaches	3342	3737	NO		A		35.0	41.0	1.17	Lambeth Scientific Services
Belfast	Great George's Street	3339	3750	NO		A		47.0	55.0	1.17	Lambeth Scientific Services
Belfast	Lombard Street	3339	3743	NO		C		32.0	37.4	1.17	Lambeth Scientific Services
Belfast	Milner Street	3324	3734	Yes	BELFAST 5N	A		38.0	44.5	1.17	Lambeth Scientific Services
Belfast	Primary School, North Road	3375	3741	Yes	BELFAST 4N	B		17.0	19.9	1.17	Lambeth Scientific Services
Belfast	Royal Victoria Hospital, 12 Grosvenor Road Belfa	3324	3735	Yes	BELFAST 3N	C		26.0	30.4	1.17	Lambeth Scientific Services
Belfast	Saintfield Road, Southern approaches	3353	3698	NO		A		38.0	44.5	1.17	Lambeth Scientific Services
Belfast	Station Road	3373	3755	NO		C		24.0	28.1	1.17	Lambeth Scientific Services
Belfast	Stockman's Lane	3312	3710	NO		A		35.0	41.0	1.17	Lambeth Scientific Services
Belfast	Upper Malone Road	3332	3699	NO		A		25.0	29.3	1.17	Lambeth Scientific Services
Belfast	Upper Newtownards Road (Ballyhackamore)	3385	3740	NO		A		34.0	39.8	1.17	Lambeth Scientific Services
Belfast	Westlink, near Grosvenor Road roundabout	3330	3737	NO		A		45.0	52.7	1.17	Lambeth Scientific Services
Carrickfergus	27 Upper Road, Greenisland	3362	3857	NO		A		17.9	18.5	1.04	Ruddock & Sherratt *
Carrickfergus	28 Bentra Road, Whitehead	3454	3919	NO		D	*10*	10.2	10.6	1.04	Ruddock & Sherratt *
Carrickfergus	32 Mullaghmore Park, Greenisland	3369	3856	YES	CARRICKFERGUS 3N	C		9.8	10.2	1.04	Ruddock & Sherratt *
Carrickfergus	42 Albert Road Carrickfergus	3413	3876	NO		A	*10*	17.1	17.7	1.04	Ruddock & Sherratt *
Carrickfergus	59 Shore Road, Greenisland	3379	3849	YES	CARRICKFERGUS 1N	A		18.3	18.9	1.04	Ruddock & Sherratt *
Carrickfergus	93 Belfast Road Carrickfergus	3399	3867	NO		A		17.3	17.9	1.04	Ruddock & Sherratt *
Carrickfergus	College North Road, Carrickfergus	3411	3889	YES	CARRICKFERGUS 4N?	C		14.9	15.4	1.04	Ruddock & Sherratt *
Carrickfergus	Islandmagee Road, Whitehead	3476	3923	NO		A		12.5	13.0	1.04	Ruddock & Sherratt *
Carrickfergus	Lough Road, Loughmourne	3412	3921	NO		D		7.2	7.5	1.04	Ruddock & Sherratt *
Carrickfergus	Model PS 4 Belfast Road Carrickfergus	3408	3871	NO		A	*9*	23.8	24.7	1.04	Ruddock & Sherratt *
Carrickfergus	Railway Station, Fergus Avenue, Carrickfergus	3412	3878	NO		B	*7*	11.8	12.2	1.04	Ruddock & Sherratt *
Castlereagh	2 Newtownbreda Road	3352	3701	NO		A		23.3	24.1	1.04	Ruddock & Sherratt *
Castlereagh	74 Downshire Park East	3365	3714	YES	CASTLEREAGH 6N	D		12.0	12.4	1.04	Ruddock & Sherratt *
Castlereagh	985 Upper Newtownards Road, Dundonald	3420	3740	NO		A		30.4	31.5	1.04	Ruddock & Sherratt *
Castlereagh	Council Offices, 368 Cregagh Road, BT6 9EZ	3362	3713	YES	CASTLEREAGH 1N	A		19.4	20.1	1.04	Ruddock & Sherratt *
Castlereagh	Lamp post, 17/19 Everton Drive, Castlereagh	3361	3712	YES	CASTLEREAGH 5N	C		13.0	13.5	1.04	Ruddock & Sherratt *
Coleraine	Crocknamuck Road / Dunluce Ave, Portrush	2861	4400	NO		A		17.2	17.8	1.04	Ruddock & Sherratt *
Coleraine	Dunnes car park / Coleraine Bridge, Coleraine	2846	4325	NO		A		14.9	15.4	1.04	Ruddock & Sherratt *
Coleraine	Lower Union Street / Minburn Road, Coleraine	2848	4328	NO		A		24.8	25.7	1.04	Ruddock & Sherratt *
Coleraine	Railway Road, Coleraine	2852	4327	NO		A		14.0	14.5	1.04	Ruddock & Sherratt *
Coleraine	Ring Road, Lodge Road Roundabout, Coleraine	2858	4314	NO		A		18.2	18.8	1.04	Ruddock & Sherratt *
Coleraine	Spanboard, Coleraine	2859	4299	NO		E		6.6	6.8	1.04	Ruddock & Sherratt *
Coleraine	University, Coleraine	2845	4235	NO		E		7.8	8.1	1.04	Ruddock & Sherratt *
Coleraine	Upper Union Street, Railway Road, Coleraine	2851	4328	NO		A		16.2	16.7	1.04	Ruddock & Sherratt *
Coleraine	Waterside traffic lights / Strand Road, Coleraine	2845	4325	NO		A		15.0	15.5	1.04	Ruddock & Sherratt *
Cookstown	Church St, Cookstown	2811	3775	NO		A		41.0	43.1	1.05	Lambeth Scientific Services *
Cookstown	High Street, Moneymore	2857	3834	NO		A		36.0	37.8	1.05	Lambeth Scientific Services *
Cookstown	James St, Cookstown	2810	3783	NO		A		42.0	44.1	1.05	Lambeth Scientific Services *
Cookstown	Killymoon St, Cookstown	2812	3769	NO		A		31.0	32.6	1.05	Lambeth Scientific Services *
Cookstown	William St, Moneymore	2810	3784	NO		B		37.0	38.9	1.05	Lambeth Scientific Services *
Craigavon	21 Ballyhannon Road, Portadown	3081	3578	YES	CRAIGAVON 8N	C		9.0	9.5	1.05	Lambeth Scientific Services *
Craigavon	36 Ardboe Drive, Lurgan	3080	3577	YES	CRAIGAVON 7N	C		17.0	17.9	1.05	Lambeth Scientific Services *
Craigavon	4 Cluandara, Derrymacash, Craigavon	3044	3593	No		A		25.0	26.3	1.05	Lambeth Scientific Services *
Craigavon	Ashgrove community centre, Garvaghy Road, Por	3004	3548	No		B		16.0	16.8	1.05	Lambeth Scientific Services *
Craigavon	Castle Lane (toilets), Lurgan	3082	3585	No		C		18.0	18.9	1.05	Lambeth Scientific Services *
Craigavon	Holmes Bakery, 16 West Street, Portadown	3010	3538	YES	CRAIGAVON 9N	A		28.0	29.4	1.05	Lambeth Scientific Services *
Craigavon	Lord Lurgan Park, Lurgan	3080	3593	No		C		13.0	13.7	1.05	Lambeth Scientific Services *
Craigavon	Town Hall, Union Street, Lurgan	3083	3583	YES	CRAIGAVON 5N	A		17.0	17.9	1.05	Lambeth Scientific Services *

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Derry	1 Simpson Brae, Derry	2442	4163	NO		A		23.1	21.8	0.94	Lambeth Scientific Services
Derry	123a Strand Road, Derry	2437	4182	NO		A	*8*	28.7	27.0	0.94	Lambeth Scientific Services
Derry	19 St Patricks Terrace, Derry	2434	4189	NO		A	*11*	31.1	29.3	0.94	Lambeth Scientific Services
Derry	26 Rossdowney Park (Irish St Lights)	2449	4162	NO		A		19.3	18.2	0.94	Lambeth Scientific Services
Derry	27 Park Avenue	2429	4177	NO		A		26.0	24.5	0.94	Lambeth Scientific Services
Derry	3 Creggan Road, Derry	2428	4173	YES	LONDONDERRY 8N	A	*9*	42.8	40.3	0.94	Lambeth Scientific Services
Derry	3 Farren park, Derry	2438	4187	NO		A	*11*	21.6	20.3	0.94	Lambeth Scientific Services
Derry	3 Glendermot Road, Derry	2443	4167	YES	LONDONDERRY 9N	A		28.1	26.4	0.94	Lambeth Scientific Services
Derry	3 Silverbirch Crescent, Derry	2453	4167	YES	LONDONDERRY 11N	C		15.9	14.9	0.94	Lambeth Scientific Services
Derry	34 Northland Terrace, Derry	2433	4179	NO		A		19.7	18.5	0.94	Lambeth Scientific Services
Derry	54 William Street	2433	4169	NO		A	*9*	21.2	20.0	0.94	Lambeth Scientific Services
Derry	6 Dacre Terrace	2436	4163	NO		A	*11*	21.2	20.0	0.94	Lambeth Scientific Services
Derry	67 Clarendon Street	2432	4173	NO		A		26.9	25.4	0.94	Lambeth Scientific Services
Derry	7 Harberton Park (Altnagelvin Lights)	2452	4156	NO		A	*10*	18.1	17.1	0.94	Lambeth Scientific Services
Derry	Brooke Park, Infirmary Road	2429	4173	YES	LONDONDERRY 10N	C	*9*	42.8	40.3	0.94	Lambeth Scientific Services
Derry	Brooke Park, Infirmary Road	2429	4173	YES	LONDONDERRY 10N	C		13.9	13.1	0.94	Lambeth Scientific Services
Derry	Brooke Park, Infirmary Road	2429	4173	YES	LONDONDERRY 10N	C		15.1	14.2	0.94	Lambeth Scientific Services
Derry	Spencer Road / Victoria Road Flats	2438	4159	NO		A	*11*	38.4	36.2	0.94	Lambeth Scientific Services
Down	11 Orchard Way, Strangford Road, Downpatrick, I	3489	3459	YES	DOWNPATRICK 4N	C		8.3	8.6	1.04	Ruddock & Sherratt *
Down	19 Church Street, Ballynahinch BT24 8AF	3366	3422	YES	BALLYNAHINCH 9N	A		23.7	24.5	1.04	Ruddock & Sherratt *
Down	4 Main Street, Newcastle	3378	3316	NO		A		21.6	22.4	1.04	Ruddock & Sherratt *
Down	5 St Patrick's Avenue, Downpatrick, BT30 6DW	3486	3445	YES		A		28.8	29.8	1.04	Ruddock & Sherratt *
Down	7 St Patrick's Drive, Downpatrick, BT30 6NR	3486	3442	YES	DOWNPATRICK 3N	C		11.1	11.5	1.04	Ruddock & Sherratt *
Down	9 Irish Street, Downpatrick, BT30 6BN	3487	3446	YES	DOWNPATRICK 1N	A		30.5	31.6	1.04	Ruddock & Sherratt *
Down	Main Street, Saintfield BT24 7AA	3407	3591	NO		A		18.7	19.4	1.04	Ruddock & Sherratt *
Down	Stream Street, Downpatrick BT30 6DD	3489	3442	NO		A		21.4	22.1	1.04	Ruddock & Sherratt *
Dungannon	11 Bushvale	2811	3623	YES	DUNGANNON 4N	C		9.7	10.0	1.04	Ruddock & Sherratt *
Dungannon	4 Ardgannon	2796	3630	YES	DUNGANNON 3N	B		15.1	15.6	1.04	Ruddock & Sherratt *
Dungannon	Church St	2798	3624	NO		A		43.7	45.3	1.04	Ruddock & Sherratt *
Dungannon	Howard Primary School, Moy Road	2812	3607	YES	DUNGANNON 5N	A		21.3	22.1	1.04	Ruddock & Sherratt *
Dungannon	Market Square	2798	3625	YES	DUNGANNON 1N	A		16.6	17.2	1.04	Ruddock & Sherratt *
Fermanagh DC	29 Henry St Enniskillen	2231	3443	NO		A		29.0	30.5	1.05	Lambeth Scientific Services
Fermanagh DC	Belmore Street, Enniskillen	2239	3440	NO		A		23.4	24.6	1.05	Lambeth Scientific Services
Fermanagh DC	Everglades, Tempo Road, Enniskillen	2256	3447	NO		B		6.8	7.1	1.05	Lambeth Scientific Services
Fermanagh DC	Rossole Road, Enniskillen	2230	3432	NO		C		6.7	7.0	1.05	Lambeth Scientific Services
Fermanagh DC	Town Hall, Enniskillen BT74 7BA	2235	3441	NO		A		16.2	17.0	1.05	Lambeth Scientific Services
Fermanagh DC	Westbridge House Anne St, Enniskillen	2233	3443	NO		A		22.3	23.4	1.05	Lambeth Scientific Services
Larne	Antiville Road/A8 junction	3386	4021	NO		A		18.6	21.4	1.15	Lambeth Scientific Services
Larne	Ballylumford Road	3421	4020	NO		A		13.6	15.6	1.15	Lambeth Scientific Services
Larne	Coastguard Road	3413	4017	NO		A		13.0	14.9	1.15	Lambeth Scientific Services
Larne	Larne Harbour Roundabout	3412	4020	NO		A		19.9	22.8	1.15	Lambeth Scientific Services
Larne	Main St	3402	4026	NO		A		20.3	23.3	1.15	Lambeth Scientific Services
Larne	Riverdale	3397	4025	NO		A		24.8	28.6	1.15	Lambeth Scientific Services
Larne	Upper Cairncastle Road	3392	4032	NO		A		19.7	22.6	1.15	Lambeth Scientific Services
Larne	Victoria Road/Agnew Street junction	3403	4029	NO		A		24.3	27.9	1.15	Lambeth Scientific Services
Limavady	Clooney Road, Greysteel	2571	4211	NO		A	*10*	17.1	16.4	0.96	Gradko *
Limavady	Greystone Road, Limavady	2682	4225	NO		A	*8*	24.0	23.0	0.96	Gradko *
Limavady	Irish Green St, Limavady	2672	4229	NO		A	*9*	40.9	39.2	0.96	Gradko *
Limavady	Junction of Ballyquin Road / Main St, Dungiven	2688	4095	NO		A	*11*	39.8	38.2	0.96	Gradko *
Limavady	Junction of Garvagh Road / Main St, Dungiven	2693	4092	NO		A	*11*	39.8	38.2	0.96	Gradko *
Limavady	Junction of Rathmore Road / Scroggy Road,Lima	2678	4233	NO		A	*10*	26.3	25.2	0.96	Gradko *
Limavady	Linenhall St, Limavady	2669	4231	NO		A	*4*				Gradko *
Limavady	Main St, Ballykelly	2629	4223	NO		A	*10*	30.1	28.9	0.96	Gradko *

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Lisburn	10 Beechlawn Park, Dunmurry	3296	3691	NO		B		19.7	20.4	1.04	Ruddock & Sherratt
Lisburn	18 Kingsway, Dunmurry	3295	3689	YES	LISBURN 7N	A		23.0	23.8	1.04	Ruddock & Sherratt
Lisburn	22 Ventnor Park, Lambeg	3269	3620	YES	LISBURN 3N	C		11.5	11.9	1.04	Ruddock & Sherratt
Lisburn	75 Edgewater, Lisburn	3272	3637	YES	LISBURN 6N	C		12.8	13.2	1.04	Ruddock & Sherratt
Lisburn	Antrim Road, Lisburn	3263	3646	NO		B		19.3	20.0	1.04	Ruddock & Sherratt
Lisburn	Lagan Valley Hospital grounds	3265	3637	No		B		16.6	17.2	1.04	Ruddock & Sherratt
Lisburn	Main Street, Moira	3151	3606	NO		C		27.1	28.0	1.04	Ruddock & Sherratt
Lisburn	Northern Bank, 62 Bow Street, Lisburn, BT28 1BN	3265	3644	YES	LISBURN 1N	A		25.8	26.7	1.04	Ruddock & Sherratt
Magherafelt	Boyne Row, Castledawson	2925	3932	NO		A		22.0	23.1	1.05	Lambeth Scientific Services *
Magherafelt	Church Street, Magherafelt	2897	3909	NO		A		37.0	38.9	1.05	Lambeth Scientific Services *
Magherafelt	Eel fishery, Toomebridge	2989	3908	NO		A		17.0	17.9	1.05	Lambeth Scientific Services *
Magherafelt	King St, Magherafelt	2898	3907	NO		A		26.0	27.3	1.05	Lambeth Scientific Services *
Magherafelt	Main Street, Maghera	2853	4004	NO		A		34.0	35.7	1.05	Lambeth Scientific Services *
Magherafelt	Queen Street, Magherafelt	2896	3905	NO		A		31.0	32.6	1.05	Lambeth Scientific Services *
Magherafelt	Wesleyan Mews, Magherafelt	2899	3907	NO		B		24.0	25.2	1.05	Lambeth Scientific Services *
Moyle	Bush/Dundarave estate entrance, Bushmills	2942	4409	NO		A		10.0	10.5	1.05	Lambeth Scientific Services *
Moyle	Elmwood car park, Bushmills	2947	4406	NO		B		9.0	9.5	1.05	Lambeth Scientific Services *
Moyle	Leyland Road, Ballycastle	3101	4415	NO		B		11.0	11.6	1.05	Lambeth Scientific Services *
Moyle	Light pole, Dunluce Road, Bushmills	2937	4408	NO		A		10.0	10.5	1.05	Lambeth Scientific Services *
Moyle	Middle Park Road, Cushendall	3239	4272	NO		A		8.0	8.4	1.05	Lambeth Scientific Services *
Moyle	Mill Street car park, Cushendall	3237	4275	NO		B		7.0	7.4	1.05	Lambeth Scientific Services *
Moyle	Sheskburn House, 7 Mary St, Ballycastle	3122	4412	NO		B		8.0	8.4	1.05	Lambeth Scientific Services *
Moyle	St Patricks' PS, 244 Garron Road, Glenariff	3243	4252	NO		B		10.0	10.5	1.05	Lambeth Scientific Services *
Newry & Mourne	19 Balmoral Park, Newry	3094	3275	YES	NEWRY 9N	C	*11*	14.8	15.3	1.04	Ruddock & Sherratt *
Newry & Mourne	20a Water Street, Newry, Alexander Hanna	3086	3265	YES	NEWRY 6N	A	*11*	41.6	43.1	1.04	Ruddock & Sherratt *
Newry & Mourne	Bridge Street, Main Dublin Road					A	*9*	37.0	38.3	1.04	Ruddock & Sherratt *
Newry & Mourne	Kildare Street					A	*8*	28.5	29.5	1.04	Ruddock & Sherratt *
Newry & Mourne	Kilmorey Street					A	*9*	42.8	44.3	1.04	Ruddock & Sherratt *
Newry & Mourne	Monaghan Row, Newry	3078	3268	YES	NEWRY 11N	C	*11*	15.3	15.8	1.04	Ruddock & Sherratt *
Newry & Mourne	Rathfriland Road, Newry					A	*7*	25.6	26.5	1.04	Ruddock & Sherratt
Newry & Mourne	Stone Bridge					A	*10*	30.2	31.3	1.04	Ruddock & Sherratt
Newry & Mourne	Trevor Hill, Newry	3088	3268	YES	NEWRY 10N	A	*8*	37.0	38.3	1.04	Ruddock & Sherratt *

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Newtownabbey	145 Jordanstown Road, Newtownabbey	3352	3844	NO		A		19.0	18.0	0.95	Lambeth Scientific Services
Newtownabbey	174 Monkstown Road, Newtownabbey	3343	3852	NO		A		16.0	15.2	0.95	Lambeth Scientific Services
Newtownabbey	189 Doagh Road, Newtownabbey	3344	3829	NO		A		22.0	20.9	0.95	Lambeth Scientific Services
Newtownabbey	44 Sandyknowes Av, Newtownabbey	3306	3827	NO		A		38.0	36.0	0.95	Lambeth Scientific Services
Newtownabbey	49 Main Street, Ballyclare	3288	3911	YES	NEWTOWNABBEY 1N	A		34.0	32.2	0.95	Lambeth Scientific Services
Newtownabbey	690 Shore Road, Newtownabbey	3367	3837	YES	NEWTOWNABBEY 12N	A		20.0	19.0	0.95	Lambeth Scientific Services
Newtownabbey	A8 motorway Sandyknowes, Newtownabbey	3305	3832	NO		A		32.0	30.3	0.95	Lambeth Scientific Services
Newtownabbey	Antrim Road, Sandyknowes, Newtownabbey	3306	3829	NO		C		26.0	24.6	0.95	Lambeth Scientific Services
Newtownabbey	Ballyclare Road/Manse Road roundabout, Newtov	3314	3838	NO		A		33.0	31.3	0.95	Lambeth Scientific Services
Newtownabbey	Bernice Road/Mallusk Road	3277	3835	NO		A		15.0	14.2	0.95	Lambeth Scientific Services
Newtownabbey	Braden Heights, Rathcoole, Newtownabbey	3339	3819	YES	NEWTOWNABBEY 13N	A		17.0	16.1	0.95	Lambeth Scientific Services
Newtownabbey	Burnthill Road, Newtownabbey	3315	3819	NO		A		26.0	24.6	0.95	Lambeth Scientific Services
Newtownabbey	Doagh Village, Doagh Road, Doagh	3262	3895	NO		A		19.0	18.0	0.95	Lambeth Scientific Services
Newtownabbey	Greenacres, Glebe Road, Newtownabbey	3324	3832	NO		A		21.0	19.9	0.95	Lambeth Scientific Services
Newtownabbey	Henryville Court, Ballyclare	3296	3910	NO		C		38.0	36.0	0.95	Lambeth Scientific Services
Newtownabbey	Hightown Road/Mallusk Road, Newtownabbey	3314	3821	NO		A		26.0	24.6	0.95	Lambeth Scientific Services
Newtownabbey	Hillhead Road/Mill Road junction	3291	3909	NO		A		23.0	21.8	0.95	Lambeth Scientific Services
Newtownabbey	Junction at A8 Doagh Road, Newtownabbey	3310	3859	NO		A		21.0	19.9	0.95	Lambeth Scientific Services
Newtownabbey	Longshot Road, Doagh, Newtownabbey	3268	3885	NO		A		17.0	16.1	0.95	Lambeth Scientific Services
Newtownabbey	M5 @ Shore Road, Newtownabbey	3354	3815	NO		A		32.0	30.3	0.95	Lambeth Scientific Services
Newtownabbey	Main Street, Ballynure,Ballyclare	3319	3936	NO		A		22.0	20.9	0.95	Lambeth Scientific Services
Newtownabbey	McMillan House, 323 Antrim Road, Glengormley	3318	3882	NO		A		31.0	29.4	0.95	Lambeth Scientific Services
Newtownabbey	Merville Garden Village	3348	3807	NO		A		24.0	22.8	0.95	Lambeth Scientific Services
Newtownabbey	Nortel, Doagh Road, Newtownabbey	3342	3838	NO		A		21.0	19.9	0.95	Lambeth Scientific Services
Newtownabbey	North End, Ballyclare	3287	3913	NO		A		19.0	18.0	0.95	Lambeth Scientific Services
Newtownabbey	Nox Analyser, Antrim Road	3305	3830	NO		A		17.0	16.1	0.95	Lambeth Scientific Services
Newtownabbey	Nox Analyser, Antrim Road	3305	3830	NO		A		24.0	22.8	0.95	Lambeth Scientific Services
Newtownabbey	Nox Analyser, Antrim Road	3305	3830	NO		A		24.0	22.8	0.95	Lambeth Scientific Services
Newtownabbey	Nox Analyser, Shore Road	3305	3830	NO		A		21.0	19.9	0.95	Lambeth Scientific Services
Newtownabbey	Nox Analyser, Shore Road	3305	3830	NO		A		25.0	23.7	0.95	Lambeth Scientific Services
Newtownabbey	Nox Analyser, Shore Road	3305	3830	NO		A		25.0	23.7	0.95	Lambeth Scientific Services
Newtownabbey	Oaklands, Old Carrick Road, Newtownabbey	3344	3852	NO		C		16.0	15.2	0.95	Lambeth Scientific Services
Newtownabbey	O'Neill Road/Doagh Road roundabout, Newtowna	3355	3823	NO		A		20.0	19.0	0.95	Lambeth Scientific Services
Newtownabbey	opposite 1A Jordanstown Road, Newtownabbey	3365	3836	NO		A		25.0	23.7	0.95	Lambeth Scientific Services
Newtownabbey	Prince Charles Way/Manse Road	3314	3838	NO		C		29.0	27.5	0.95	Lambeth Scientific Services
Newtownabbey	Roundabout @ bottom of Main St,Ballyclare	3291	3909	NO		A		20.0	19.0	0.95	Lambeth Scientific Services
Newtownabbey	Scullions Road, Mallusk, Newtownabbey	3304	3829	NO		A		29.0	27.5	0.95	Lambeth Scientific Services
Newtownabbey	St Bernards' Road School, Antrim Road, Newtowr	3323	3819	NO		A		27.0	25.6	0.95	Lambeth Scientific Services
Newtownabbey	Station Road, Newtownabbey	3355	3824	NO		A		26.0	24.6	0.95	Lambeth Scientific Services
Newtownabbey	Tudor Park, Newtownabbey	3298	3834	NO		A		16.0	15.2	0.95	Lambeth Scientific Services
Newtownabbey	Valley Leisure centre, Newtownabbey	3336	3814	NO		A		26.0	24.6	0.95	Lambeth Scientific Services
North Down	1 Rathmore Road, Bangor	3483	3815	YES	BANGOR NI 8N	C		11.7	12.1	1.04	Ruddock & Sherratt *
North Down	132 Main Street, Bangor	3504	3815	YES	BANGOR NI 6N	A		22.8	23.6	1.04	Ruddock & Sherratt *
North Down	52 Bingham Street, Bangor	3507	3819	YES	BANGOR NI 7N	A		22.1	22.9	1.04	Ruddock & Sherratt *
North Down	68 Groomsport Road, Bangor	3520	3819	YES	BANGOR NI 4N	C		10.8	11.2	1.04	Ruddock & Sherratt *
North Down	Bangor Road Ballyrobert	3450	3808	NO		C		25.1	26.0	1.04	Ruddock & Sherratt *
North Down	Bangor Road Seahill	3433	3808	NO		C		25.6	26.5	1.04	Ruddock & Sherratt *
North Down	Marine Parade Holywood	3400	3793	NO		A		28.2	29.2	1.04	Ruddock & Sherratt *
North Down	Station Road Cultra	3416	3800	NO		C		32.0	33.1	1.04	Ruddock & Sherratt *

Local Authority	Location of Sampler	Grid Ref. Easting to nearest 100m,	Grid Ref. Northing to nearest 100m.	Part of NO2 Network?	NO2 Network Name if applicable	Site Classification	*No. of months data if < 12*	Uncorrected annual mean NO2, 2003, ug/m3	Bias-adjusted annual mean NO2, 2003, ug/m3	BAF	Lab used
Omagh	Campsie Road, Omagh	2457	3727	NO		A		15.7	16.2	1.04	Ruddock & Sherratt *
Omagh	Dromore Road, Omagh	2445	3270	NO		A		33.9	35.1	1.04	Ruddock & Sherratt *
Omagh	Dublin Road, Omagh	2456	3724	YES	OMAGH 1N	A		11.7	12.1	1.04	Ruddock & Sherratt *
Omagh	Great Northern Road, Omagh	2453	3735	NO		A		10.3	10.7	1.04	Ruddock & Sherratt *
Omagh	Hospital Road, Omagh	2465	3725	NO		A		20.2	20.9	1.04	Ruddock & Sherratt *
Omagh	Lisanelly Avenue, Omagh	2452	3733	NO		A		25.8	26.7	1.04	Ruddock & Sherratt *
Omagh	McConnell Place, Omagh	2445	3725	YES	OMAGH 7N	A		13.3	13.8	1.04	Ruddock & Sherratt *
Omagh	Sedan Avenue, Omagh	2451	3729	NO		A		10.8	11.2	1.04	Ruddock & Sherratt *
Omagh	Swingbars Roundabout, Omagh	2460	3728	NO		A		18.1	18.7	1.04	Ruddock & Sherratt *
Omagh	Tamlaght Road, Omagh	2422	3722	YES	OMAGH 5N	A		14.9	15.4	1.04	Ruddock & Sherratt *
Strabane	Main St, Castlederg	2262	3844	NO		A		13.5	14.0	1.04	Ruddock & Sherratt *
Strabane	Main St, Newtownstewart	2402	3857	NO		A		12.0	12.4	1.04	Ruddock & Sherratt *
Strabane	Main St, Strabane	2345	3975	NO		A		14.9	15.4	1.04	Ruddock & Sherratt *
Strabane	Melmount Road, Strabane	2339	3962	NO		A		13.4	13.9	1.04	Ruddock & Sherratt *
Strabane	Urney Road, Strabane	2337	3974	NO		A		16.2	16.8	1.04	Ruddock & Sherratt *

Shaded text indicates new sites in 2003.

* In "Laboratory" column, asterisk indicates that the bias adjustment factor used was not supplied by the Local Authority, but has been obtained by Netcen from other sources, e.g. the Defra Review and Assessment Website.

A = kerbside, 1-5m from the kerb of a busy road
B = intermediate site, 20-30m from the same or an equivalent road
C = urban background site, greater than 50m from any busy road
D = rural background site
E = special site; monitoring air pollution from some industrial process, etc.

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 – 2003.

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
Londonderry, Brook Park					
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

Table A2.2 NO_2 Results from Automatic Monitoring Sites 1992 – 2003

Year	Data Capture	Max Hourly Mean $\mu g\ m^{-3}$	Annual Mean	No. of hourly means > 200 $\mu g\ m^{-3}$	Is Annual Mean > 40 $\mu g\ m^{-3}$
Armagh Lonsdale Road (Roadside)					
2002	44	125	34	0	No
2003	98	374	34	11	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
Belfast – Newtownards Road (Roadside)					
2002	66	212	**50**	2	**Yes**
2003	96	179	**45**	0	**Yes**
Belfast – Westlink (Roadside)					
2002	66	295	**56**	21	**Yes**
2003	94	258	**53**	27	**Yes**
Castlereagh Loughview Drive (Roadside)					
2002	50	132	28	0	No
2003	63	149	34	0	No
Craigavon – Castle Lane					
2002	75	157	13	0	No
2003	18	94	22	0	No
Holywood					
2003	70	111	25	0	No
Lisburn – Lagan Valley Hospital (Roadside)					
2002	45	221	**54**	1	**Yes**
2003	78	172	28	0	No
Londonderry Brook 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
Londonderry - Derry, Dale's Corner					
2003	11	166	**48**	0	**Yes**

...Continued over...

Table A2.2 – *continued:* NO_2 Results from Automatic Monitoring Sites 1992 – 2003

Year	Data Capture	Max Hourly Mean $\mu g\ m^{-3}$	Annual Mean	No. of hourly means > 200 $\mu g\ m^{-3}$	Is Annual Mean > 40 $\mu g\ m^{-3}$
Newry - Monaghan Row (Urban Background)					
2001	73	63	11	0	No
2002	91	105	15	0	No
2003	97	98	20	0	No
Newry – Trevor Hill (Roadside)					
2001	61	103	19	0	No
2002	98	208	**44**	1	**Yes**
2003	91	189	**50**	0	**Yes**
Newtownabbey – Sandyknowes					
2003	68	164	30	0	No
Newtownabbey - Shore Road					
2003	70	132	29	0	No

Table A2.3 SO_2 Results from Automatic Monitoring Sites 1992 - 2003

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}
Ards *								
2002	17	150	0	116	0	48	0	-
2003	93	221	0	192	0	67	0	9
Armagh (Dobbin Street)								
2003	36	154	0	82	0	14	0	4
Ballymena (Ballykeel)								
2002	41	142	0	77	0	36	0	6
2003	49	98	0	51	0	28	0	6
Bangor								
2003	80	168	0	144	0	35	0	8
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
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
Carrickfergus								
2002	50	51	0	49	0	17	0	3.3
2003	97	226	0	176	0	55	0	8
Castlereagh (Espie Way)								
2002	NS	74	0	48	0	24	0	NS
2003	96	112	0	93	0	44	0	4
Craigavon (Lord Lurgan Park)								
2002	74	146	0	96	0	38	0	7
2003	17	80	0	67	0	30	0	10

Table A2.3 *continued:* SO_2 Results from Automatic Monitoring Sites 1992 - 2003

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}
Dungannon (Lambfield)								
2002	18	94	0	38	0	24	0	-
2003	96	141	0	78	0	35	0	2
Larne								
2003	73	295	1	128	0	58	0	4
Lisburn (Island Civic Centre)								
2002	49	101	0	48	0	15	0	3.5
2003	79	120	0	88	0	42	0	5
Londonderry, Brook Park								
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
Londonderry Brandywell								
2002	65	229	0	229	0	74	0	16
2003	98	293	4	293	0	98	0	15
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
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
Strabane (Springfield Park)								
2002	64	253	0	90	0	28	0	11
2003	94	168	0	69	0	32	0	8

Table A2.4 PM_{10} Results from Automatic Monitoring Sites 1992 – 2003

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
Armagh, Lonsdale Road (TEOM, converted to gravimetric equivalent)				
2002	38	30	131	12
2003	100	33	121	46
Bangor (TEOM, converted to gravimetric equivalent)				
2003	57	27	86	12
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
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
Belfast Westlink (TEOM, converted to gravimetric equivalent)				
2002	50	34	108	32
2003	98	36	105	***63***
Carrickfergus (TEOM, converted to gravimetric equivalent)				
2002	50	17	51	1
2003	76	25	71	13
Castlereagh Loughview Drive (TEOM, converted to gravimetric equivalent)				
2002	48	34	112	8
2003	76	23	61	9
Castlereagh Espie Way (TEOM, converted to gravimetric equivalent)				
2002	48	26	74	3
2003	67	19	53	4
Craigavon, Lord Lurgan Park (TEOM, converted to gravimetric equivalent)				
2002	74	15	78	2
2003	18	25	70	3
Dungannon (TEOM, converted to gravimetric equivalent)				
2002	19	15	36	0
2003	88	28	63	25

Table A2.4 *continued* - PM_{10} Results from Automatic Monitoring Sites 1992 - 2003

Calendar Year	Data Capture %	Annual Mean $\mu g\ m^{-3}$	Max Daily Mean $\mu g\ m^{-3}$	No. of Daily means > 50 $\mu g\ m^{-3}$
Holywood (TEOM, converted to gravimetric equivalent)				
2003	71	27	68	11
Larne (TEOM, converted to gravimetric equivalent)				
2003	74	22	189	18
Lisburn Dunmurry High School				
2003	16	28	70	6
Lisburn Island Civic Centre (TEOM, converted to gravimetric equivalent)				
2002	36	16	37	0
2003	76	22	77	7
Lisburn (LVH) (TEOM, converted to gravimetric equivalent)				
2002	50	14	40	0
2003	63	26	98	15
Londonderry Brook 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
Londonderry Brandywell (TEOM, converted to gravimetric equivalent)				
2002	73	25	106	19
2003	99	29	114	34
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
Newry, old site (TEOM, converted to gravimetric equivalent)				
1998	42	24	90	9
1999	80	23	76	8
2000	93	22	114	5
Newry, Monaghan Row (TEOM, converted to gravimetric equivalent)				
2001	70	20	68	4
2002	95	21	78	8
2003	95	23	79	22
Newry , Trevor Hill (TEOM, converted to gravimetric equivalent)				
2001	61	34	86	26
2002	99	34	89	***38***
2003	97	37	91	***71***
Omagh Tamlaght (TEOM, converted to gravimetric equivalent)				
2003	26	23	64	2
Strabane (BAM)				
2002	67	38	147	***48***
2003	97	***43***	164	***101***

Table A2.5 Ozone Results from Automatic Monitoring Sites, 1990 - 2003

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
Londonderry				
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
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

** Lough Navar has operated since 1987, but only data from 1990 onwards are shown here.*

Appendix 3
Data from Smoke and SO_2 Sites

CONTENTS

The following two tables contain 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 Smoke and SO_2 Results for Northern Ireland, Calendar Year 2003. All concentrations in µg m^{-3}.

			Irish Grid Ref to 100m		Summary of Smoke Data 2003					Summary of SO_2 Data 2003				
Code	Site Name	Authority	East	North	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	NORTHERN IRELAND													
68851	ANTRIM 1	Antrim Borough Council	3162	3869	99	13	8	57	124	99	23	24	43	79
69701	ARMAGH 1	Armagh	2877	3450	61	20	18	48	63	59	12	13	19	19
160005	BALLYMENA 5	Ballymena	3109	4053	96	11	11	19	25	95	13	13	25	30
160006	BALLYMENA 6	Ballymena	3120	4026	95	11	10	22	28	94	15	13	31	37
161504	BALLYMONEY 4	Ballymoney	2954	4259	100	13	8	66	204	100	11	13	20	45
270012	BELFAST 12	Belfast	3324	3737	97	9	5	42	70	97	18	18	36	66
270013	BELFAST 13	Belfast	3357	3740	100	7	5	28	43	100	27	26	45	51
270033	BELFAST 33	Belfast	3346	3755	99	8	5	27	52	99	29	32	45	51
270042	BELFAST 42	Belfast	3322	3748	98	8	5	29	64	98	28	26	51	64
270044	BELFAST 44	Belfast	3338	3740	99	5	4	14	25	99	25	26	38	45
270045	BELFAST 45	Belfast	3335	3723	100	7	5	23	38	100	28	26	49	57
270046	BELFAST 46	Belfast	3803	3334	100	4	3	14	25	98	21	19	38	45
768003	COLERAINE 3	Coleraine	2861	4328	82	10	9	34	55	72	9	6	19	48
797501	COOKSTOWN 1	Cookstown	2774	3806	56	13	10	56	98	42	rejected			
2551506	PORTADOWN 6	Craigavon	3004	3548	45	6	4	23	58	52	10	12	30	36
1025001	DUNGANNON 1	Dungannon	2802	3629	80	5	4	14	24	79	17	18	31	45
1757704	LARNE 4	Larne	3386	4037	98	6	5	18	51	96	17	18	30	36
1757705	LARNE 5	Larne	3401	4033	100	7	6	24	43	97	18	20	27	40
1032503	DUNMURRY 3	Lisburn	3287	3875	84	8	5	24	82	84	21	20	36	48
1845003	LISBURN 3	Lisburn	3263	3636	85	9	7	30	109	84	19	19	34	41
3325001	TWINBROOK 1	Lisburn	3281	3689	24	7	5	16	17	24	20	18	29	29
2190014	LONDONDERRY 14	Derry City Council	2443	4174	47	4	3	11	14	37	16	13	45	58
2233501	MAGHERAFELT 1	Magherafelt	2896	3901	99	9	5	39	61	99	11	13	27	27
512601	BUSHMILLS 1	Moyle District Council	2941	4409	56	14	12	30	77	50	4	0	18	25
512602	BUSHMILLS 2	Moyle District Council	2941	4407	22	7	6	16	26	21	2	0	12	13
2410003	NEWRY 3	Newry and Mourne	3078	3268	98	3	1	23	60	95	4	0	13	13
2412503	NEWTOWNABBEY 3	Newtownabbey	3321	3851	73	8	6	24	88	55	4	0	13	14
2412504	NEWTOWNABBEY 4	Newtownabbey	3283	3907	99	8	4	37	59	81	4	6	13	19
165005	BANGOR (CO DOWN) 5	North Down	3497	3810	85	16	10	62	90	85	18	18	52	71
1517501	HOLYWOOD 1	North Down	3397	3784	62	9	7	32	112	62	16	14	28	47
3111502	STRABANE 2	Strabane	2351	3972	96	21	16	80	146	96	11	13	20	21

Net acidity data from COOKSTOWN 1 rejected due to suspected alkaline interference.