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Air Quality Review and Assessment - Stage 2

A report produced for Ballymoney Borough Council

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Executive Summary

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality, which culminated in the Environment Act, 1995 in Great Britain. The National Air Quality Strategy provides a framework for air quality control through air quality management and air quality standards. New national air quality standards have been proposed by the Expert Panel on Air Quality Standards (EPAQS) for the UK. These and other air quality standards and their objectives have been enacted through the Air Quality Regulations in England, Wales and Scotland (2000). The GB Environment Act 1995 requires Local Authorities to undertake an air quality review. In areas where air quality objectives are not anticipated to be met by the specified date, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

In Northern Ireland there are at present no equivalent Air Quality Regulations. However, there is a duty to meet the Air Quality limit values set within the European Commission Air Quality Framework Directive on which the UK national air quality objectives are based. Consequently, Councils in Northern Ireland have proceeded with the review and assessment process of air quality on a non-statutory basis.

The first step in this process is to undertake a review of current and potential future air quality in a three staged approach. Ballymoney Borough Council have completed a Stage 1 review and assessment which concluded that a Stage 2 review and assessment was required for the pollutants nitrogen dioxide, sulphur dioxide and particulate matter.

This report is equivalent to a stage two air quality review as outlined in the Government's published guidance. The air quality review investigates current and potential future air quality through an examination of the location and size of principal emission sources, emissions modelling exercises and by reference to monitored air quality data.

The conclusions of the report are as follows:

The air quality objectives for the following pollutants are likely to be met and a third stage review is not required of emissions from vehicular and industrial sources:

- Nitrogen dioxide
- PM_{10}
- Sulphur dioxide

Contents

Acronyms and definitions

AQS	Air Quality Strategy
AADTF	annual average daily traffic flow
APEG	Airborne Particles Expert Group
AQMA	Air Quality Management Area
AUN	Automatic Urban Network
CHP	Combined Heat and Power plant
CNS	central nervous system
CO	Carbon monoxide
CRI	Chemical Release Inventory (now the Pollution Inventory)
DEFRA	Department of the Environment, Food and Rural Affairs.
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
HA	Highways Agency
HFO	heavy fuel oil
HDV	heavy duty vehicle
IPPC	Integrated Pollution Prevention and Control
M	mega ($1x10^6$)
MoD	Ministry of Defence
NAEI	National Atmospheric Emission Inventory
NETCEN	National Environmental Technology Centre
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
PG	Process Guidance (notes)
PI	pollution inventory
ppb	parts per billion
ppm	parts per million
PSG	Pollutant Specific Guidance (see Reference section)
SO_2	Sulphur dioxide
SoS	Secretary of State
SSAQR	Second Stage Air Quality Review
TEOM	tapered element oscillating microbalance
VOC	volatile organic compound

1 Introduction to the air quality review

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality, which culminated in the Environment Act, 1995 in Great Britain. The National Air Quality Strategy provides a framework for air quality control through air quality management and air quality standards. New national air quality standards have been proposed by the Expert Panel on Air Quality Standards (EPAQS) for the UK. These and other air quality standards and their objectives have been enacted through the Air Quality Regulations in England, Wales and Scotland (2000). The GB Environment Act 1995 requires Local Authorities to undertake an air quality review. In areas where air quality objectives are not anticipated to be met by the specified date, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

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1.1 PURPOSE OF THE STUDY

NETCEN was commissioned by Ballymoney Borough Council to complete a Second Stage Air Quality Review (SSAQR) within their area for road vehicular and industrial sources of air pollution. The review:

- Investigates present and potential future air quality in the Ballymoney Borough Council area
- Identifies any actions that are likely to be required by Ballymoney Borough Council under Part IV of the GB Environment Act, 1995
- Recommends actions, if necessary, to control the subsequent air quality within the Ballymoney Borough Council area

1.2 APPROACH TAKEN

The approach taken in this study was to:

1. Identify the principal sources of pollutant emissions affecting air quality in the Ballymoney Borough Council area.
2. Model expected present and potential future levels of pollutant concentrations in the Ballymoney Borough Council area and identify the areas of the district which are likely to experience the highest concentrations of pollutants.
3. Indicate whether present and predicted future air quality in the Borough is likely to comply with the requirements of the UK Air Quality Strategy.
4. Identify areas for further investigation.

In preparing this report the latest version of the Government Pollutant Specific Guidance has been used (LAQM TG4(00)).

This report is structured in the following way: Chapter 1 introduces the UK Air Quality Strategy (AQS) and the local data used in this review and assessment. Chapter 2 provides more details on the local air quality management process. Chapters 3 to 5 consider the pollutants specified in the AQS and give an overview including the AQS objectives, the national perspective and the input required for this review. Data from national concentration maps, monitoring studies, road traffic, and local and distant point sources are then considered. Each chapter closes with an indication of whether the relevant AQS objective is expected to be met, or whether further work is required. Chapter 6 summarises all the findings and recommendations of the work.

1.3 INFORMATION PROVIDED BY ANTRIM BOROUGH COUNCIL TO SUPPORT THIS ASSESSMENT

- The following information from Ballymoney Borough Council that was used to complete this review and assessment: Local air quality monitoring data
- Proposed developments
- Part A and B processes under the Industrial Pollution Control (Northern Ireland) Order 1997
- Traffic flow and speed data
- Transport strategy
- Large combustion sources

1.3.1 Ballymoney and its environs

Ballymoney borough council covers 41,855 hectares and has a population of approximately 25,000. It is predominately rural in character and is bounded to the west by the river Bann and to the east by the uplands of the Ballymoney Plateau. The town of Ballymoney is its main centre, and there are numerous small villages in the rural hinterland. Farming and the food industry are the mainstays of the local economy but there are also manufacturing businesses associated with medical supplies and light engineering.

1.3.1.1 Industrial and Transport Development in Ballymoney Borough Council

Some developments may have an important impact on air quality in the future and are therefore considered in the Stage 2 Review and Assessment.

1.3.2 Local air quality monitoring data

1.3.2.1 Extent of data available

Ballymoney Borough Council have been monitoring nitrogen dioxide at seven sites using passive diffusion tube samplers. There has been monitoring of sulphur dioxide at one site. Appendix 1 gives more information about the local air quality monitoring.

1.3.2.2 Quality Assurance/Quality control of data

The diffusion tubes were analysed by Lambeth Scientific Services Limited, which participate in the laboratory intercomparison exercises for the UK National NO_2 Diffusion Tube Network. The results in this report have therefore been corrected for analyst bias as advised in the GB Government Pollutant Specific Guidance.

1.3.3 Traffic data

Appendix 2 summarises the traffic information used in the assessment.

1.3.3.1 Flow and speed

Ballymoney Borough Council provided traffic flow measurements at a range of locations within Ballymoney and in the surrounding area taken at varying times. Average traffic speeds and HGV percentages were also supplied.

1.3.3.2 Traffic growth

The national air quality objectives are targets for 2004 or 2005. Ballymoney Borough Council provided estimates of the expected vehicle flows in 2005.

1.3.3.3 Fraction of HGVs

The model requires estimates of the fraction of HGVs on the roads to predict the pollutant concentrations. This data was not available from Ballymoney Borough Council. Therefore a conservative estimate of 7.3% has been used in this assessment. This figure was obtained from the Northern Ireland Road Services census which found the average % HDV on 141 of the roads studied was 7.3%.

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

The model which is used to predict the roadside concentrations requires estimates of both the distance of the receptor and the distance of the kerbside from the centrepoint of the road. This information was available from Ballymoney Borough Council either directly or in the form of maps (scale 1:1250) on which the required distances could be measured.

1.3.4 Part A and B process and >5 MW (thermal) combustion plants

Part A and B processes can contribute a range of pollutants to ambient air. In Ballymoney Borough Councils Stage one review and assessment, one industry, Ballymoney Foods was identified as needing a further assessment in a stage 2 review and assessment.

1.3.5 Pollutants and Sources requiring review and assessment in this stage two

The pollutants and their sources that have been studied in this Stage 2 Report for Ballymoney are:

- Nitrogen dioxide

An assessment of traffic emissions at four busy road junctions and six shopping streets in the borough has been undertaken using DMRB.

- PM_{10}

An assessment of traffic emissions at four busy road junctions and six shopping streets in the borough has been undertaken using DMRB. In addition the impact of domestic coal burning in the region has been considered.

- SO_2

One industry (Ballymoney Foods Ltd) have been studied in more detail in this review and assessment.

2 The updated Air Quality Strategy

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

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

Table 2.1 Major elements of the Environment Act 1995

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

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

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

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

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

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

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

2.1.1 National Air Quality Standards

At the centre of the AQS is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2003 and 2008 are shown in Table 2.2. The table shows the standards in ppb and $\mu g\ m^{-3}$ with the number of exceedences that are permitted (where applicable) and the equivalent percentile.

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

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

Pollutant	Concentration limits		**Averaging period**	**Objective** [number of permitted exceedences a year and equivalent percentile]	
	($\mu g\ m^{-3}$)	(ppb)		($\mu g\ m^{-3}$)	date for objective
Benzene	16.25	5	**running annual** mean	**16.25**	by 31.12.2003
1,3-butadiene	2.25	1	**running annual** mean	**2.25**	by 31.12.2003
CO	11,600	10,000	**running 8-hour** mean	**11,600**	by 31.12.2003
Pb	0.5	-	**annual** mean	**0.5**	by 31.12.**2004**
	0.25	-	**annual** mean	**0.25**	by 31.12.**2008**
NO_2 (see note)	200	105	**1 hour** mean	**200** [maximum of 18 exceedences a year or equivalent to the 99.8th percentile]	by 31.12.2005
	40	21	**annual** mean	**40**	by 31.12.2005
PM_{10} (**gravimetric**) (see note)	50	–	**24-hour** mean	**50** [maximum of 35 exceedences a year or ~ equivalent to the 90th percentile]	by 31.12.2004
	40	–	**annual** mean	**40**	by 31.12.2004
	266	100	**15 minute** mean	**266** [maximum of 35 exceedences a year or equivalent to the 99.9th percentile]	by 31.12.2005
SO_2	350	132	**1 hour** mean	**350** [maximum of 24 exceedences a year or equivalent to the 99.7th percentile]	by 31.12.2004
	125	47	**24 hour** mean	**125** [maximum of 3 exceedences a year or equivalent to the 99th percentile]	by 31.12.2004

Notes

1. Conversions of ppb and ppm to ($\mu g\ m^{-3}$) correct at 20°C and 1013 mb.
2. The objectives for nitrogen dioxide are provisional.
3. PM_{10} measured using the European gravimetric transfer standard or equivalent. The Government and the devolved administrations see this new 24-hour mean objective for particles as a staging post rather than a final outcome. Work has been set in hand to assess the prospects of strengthening the new objective.

2.1.2 Policies in place to allow these objectives to be achieved

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

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

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

2.1.3 Timescales to achieve the objectives

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

2.2 AIR QUALITY REVIEWS

A range of Technical Guidance has been issued to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This includes the Technical Guidance Note LAQM.TG4(98), and the latest version LAQM.TG4(00) May 2000, on 'Review and Assessment: Pollutant Specific Guidance'. This review and assessment has considered the procedures set out in the latest consultation draft.

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet national air quality objectives and ensure that air quality is considered in local authority decision making processes. The complexity and detail required in a review depends on the risk of failing to achieve air quality objectives and it has been proposed therefore that reviews should be carried out in three stages. All three stages of review and assessment may be necessary and every authority is expected to undertake at least a first stage review and assessment of air quality in their authority area. The Stages are briefly described in the following table, Table 2.3.

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

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

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

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

Local authorities are expected to have completed review and assessment of air quality by December 2000. A further review will also need to be completed for the purposes of the Act before the target date of 2003.

2.3 LOCATIONS THAT THE REVIEW AND ASSESSMENT MUST CONCENTRATE ON

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

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

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

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

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

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

Key Points

- The GB Environment Act 1995 has required the development of a National Air Quality Strategy for the control of air quality.
- A central element in the Strategy is the use of air quality standards and associated objectives based on human health effects that have been included in the Air Quality Regulations.
- The Strategy uses a local air quality management approach in addition to existing national and international legislation. It promotes an integrated approach to air quality control by the various actors and agencies involved.
- Air quality objectives, with the exception of ozone, are to be achieved by specified dates up to the end of 2005 (2008 for one lead objective).
- A number of air quality reviews are required in order to assess compliance with air quality objectives. The number of reviews necessary depends on the likelihood of achieving the objectives.

3 Review and assessment of nitrogen dioxide

3.1 INTRODUCTION

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

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

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

3.1.1 Standards and objectives for nitrogen dioxide

The national air quality objectives for NO_2 are:

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

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

3.1.2 The National Perspective

All combustion processes produce some NO_x, but only NO_2 is associated with adverse effects on human health. The main sources of NO_x in the United Kingdom are road transport, which, in 1997 accounted for about half of the emissions, power generation (20%), and domestic sources (4%). In urban areas, the proportion of local emissions due to road transport sources is larger.

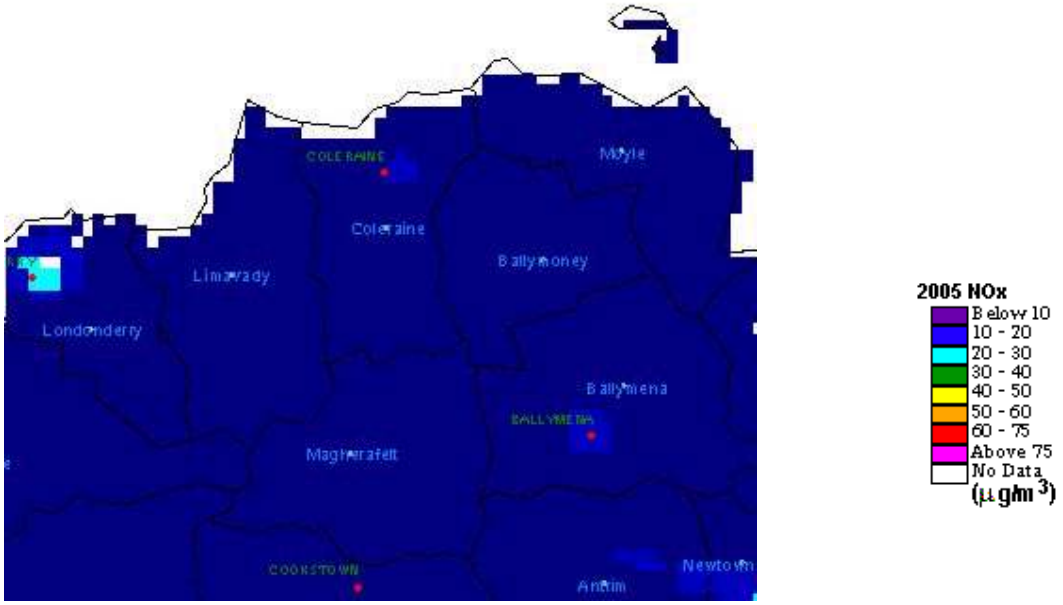
The results of the analysis set out in the National Air Quality Strategy suggest that for NO_2 a reduction in NO_x emissions over and above that achievable by national measures will be required to ensure that air quality objectives are achieved everywhere by the end of 2005. Local authorities with

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

~~1.2~~3.2 BACKGROUND CONCENTRATIONS OF NITROGEN OXIDES

Background concentrations were obtained for the Ballymoney area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html (Figure 3.2).

Figure 3.2 Background NO_x concentrations 2005



A maximum background NOx estimate of 7.4 µg/m^3 has been estimated for 2005 in the Ballymoney Borough Council region.

~~1.3~~3.3 MONITORING OF NITROGEN DIOXIDE

3.3.1 Diffusion tube data

Monthly average concentrations of NO_2 have been measured with diffusion tubes at seven sites in Ballymoney during 2001. The data are summarised in Table 3.1 and monthly average data are presented in Appendix 1. For six of the sites, the monitoring period is representative of a full year and therefore the period average concentrations can be compared with the annual mean objective. Concentrations recorded by diffusion tubes exposed on Ozone Avenue and Ballybogey Road are not shown as less than a years data is available. Analysis of the tubes was carried out by Lambeth Scientific Services Limited which was found to have a bias of negative 9.8% in 2001 relative to an automatic

analyser (Loader 2001). (In 2001, diffusion tubes were compared for two periods. Lambeth Scientific Services showed a marked difference between their results for the 2 exposure periods in the intercomparison; bias +8.8% in the 1st period, -28.4% in the 2nd. Therefore the mean bias of -9.8% has been used in this assessment as it is felt that this provides the best estimate.)

Table 3.1 Annual average concentrations in 2001 measured at locations in the Ballymoney area and predictions for 2005.

Site Name	Site Type	Average NO_2 μgm^{-3} uncorrected for bias	Average NO_2 μgm^{-3} corrected for bias	NO_2 Prediction in 2005
Linenhall Street	K	18.7	20.5	18.6
Armour Avenue	B	17.6	19.2	16.9
Semicock Avenue	B	13.6	14.9	13.1
Church Street	K	12.8	14	12.7
Charles Street	K	19.1	21	19.1
Queen Street	K	21.2	23.3	21.2

K=kerbside 1-5m from a busy road
B = background in a residential area more than 50 metres from a busy road.

None of the diffusion tubes placed at background and kerbside locations exceeded the annual mean air quality standard for nitrogen dioxide of 40 $\mu g/m^3$ in 2001. In 2005, the highest predicted NO_2 concentration is 21.2 $\mu g/m^3$ on Queen Street.

3.4 IMPACT OF ROAD TRAFFIC ON CONCENTRATIONS OF OXIDES OF NITROGEN

The Stage one Review and Assessment for Ballymoney Borough Council identified four road junctions and six roads as needing further study in a Stage two assessment. The concentrations at these kerbside locations were estimated using the Design Manual for Roads and Bridges (DMRB) using the traffic flow data provided by Ballymoney Borough Council. Ballymoney Borough Council have assumed a traffic growth rate of 2.8% per annum. Traffic flow details are given in Appendix 2. The model has been used to predict nitrogen dioxide concentrations for 2005

Concentrations have been assessed at traffic speeds (20 kph at road junctions and 32 kph on single roads) which may be lower than those considered representative. The speed of 20 kph is representative of traffic congestion in the city centre. Therefore this will give a conservative estimate. The distance from the receptor to the centre of the road and from the receptor to the kerb of the road are required by DMRB. These distances were estimated from maps provided by Ballymoney Borough Council. The % HDV was not available for any of the roads in the borough. Therefore an estimate of 7.3% has been used. This figure was obtained from the Northern Ireland Road Services Census of 141 roads in NI.

Table 3.4 lists the annual average and 99.8th percentile of maximum hourly average kerbside concentrations (equivalent to 18 exceedences per year) of nitrogen dioxide predicted for 2005 in the Ballymoney Borough Council area. Following advice given in GB Government Guidance LAQM

TG4(00), the 99.8th percentile of hourly averages has been estimated as 3.5 times the annual mean for roadside locations. For 2005, annual average concentrations of nitrogen dioxide are predicted to be less than 40μg m^{-3} at all road junctions modelled. At all the locations the NO_2 99.8th percentile of hourly averages is anticipated to be met.

Table 3.4 Nitrogen dioxide concentrations at roadside locations in Ballymoney Borough Council

Description of Link	Distance to nearest receptor from kerbside (m)	NO_2 Annual mean (μg m^{-3}) 2005	NO_2 99.8th percentile of hourly averages (μg m^{-3}) 2005
Portruch Rdbt	30	23.3	81.4
Rodeing Foot rdbt	8.8	33.0	115.5
Charles St / Linenhall St	2.5	35.7	124.9
Technical college rdbt	4.4	36.4	127.3
Main St	2.5	16.2	56.7
Victoria St	2.5	23.6	82.7
Linenhall St	2.5	21.1	74.0
High St	3.8	13.0	45.6
Charles St	2.5	20.6	72.1
Queen's St	2.5	21.7	75.9

Diffusion tubes were exposed on Charles Street and Queen's Street in Ballymoney Borough Council in 2001. The predicted annual average concentrations at these locations in 2005 are 19.2 μg/m^3 and 21.2 μg/m^3 respectively. DMRB at this location predicted an annual average concentration of 20.6 μg/m^3 and 21.7 μg/m^3 in 2005. Therefore the diffusion tube measurements and the results of DMRB are in good agreement.

3.5 CONCLUSIONS FOR NITROGEN DIOXIDE CONCENTRATIONS IN THE BALLYMONEY BOROUGH COUNCIL AREA

Emissions arising from road transport in the Ballymoney Borough Council area are not predicted to lead to an exceedence of the nitrogen dioxide objective and therefore there is no need to proceed to a stage 3 review and assessment for this source.

4 Review and assessment of PM_{10}

4.1 INTRODUCTION

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

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

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

4.1.1 Standards and objectives for particulate matter

The Air Quality Strategy objectives to be achieved by 31st December 2004 are:

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

4.1.2 The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 184,000 tonnes in 1997. Of this total, around 25% was derived from road transport sources. It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

The Government established the Airborne Particles Expert Group (APEG) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999)[5]. APEG concluded that a significant proportion of the current annual average PM_{10} is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. These are regional scale pollutants and the annual concentrations do not vary greatly over a scale of tens of kilometres. There are also natural or semi-natural sources such as wind-blown dust and sea salt particles. The impact of local urban sources is superimposed on this regional background. Such local sources are generally responsible for winter

episodes of hourly mean concentrations of PM_{10} above 100 μg m^{-3} associated with poor dispersion. However, it is clear that many of the sources of PM_{10} are outside the control of individual local authorities and the estimation of future concentrations of PM_{10} are in part dependent on predictions of the secondary particle component.

~~1.2~~4.2 MONITORING OF PM_{10}

There has been no monitoring of PM_{10} concentrations in the Ballymoney Borough Council area. However there has been black smoke monitoring at one location in 2001 as part of the UK national network (Site code 161504) at the Robinson Hospital on the Glebeside estate on the southern periphery of the densest coal burning area. The results are shown in Table 4.2 below:

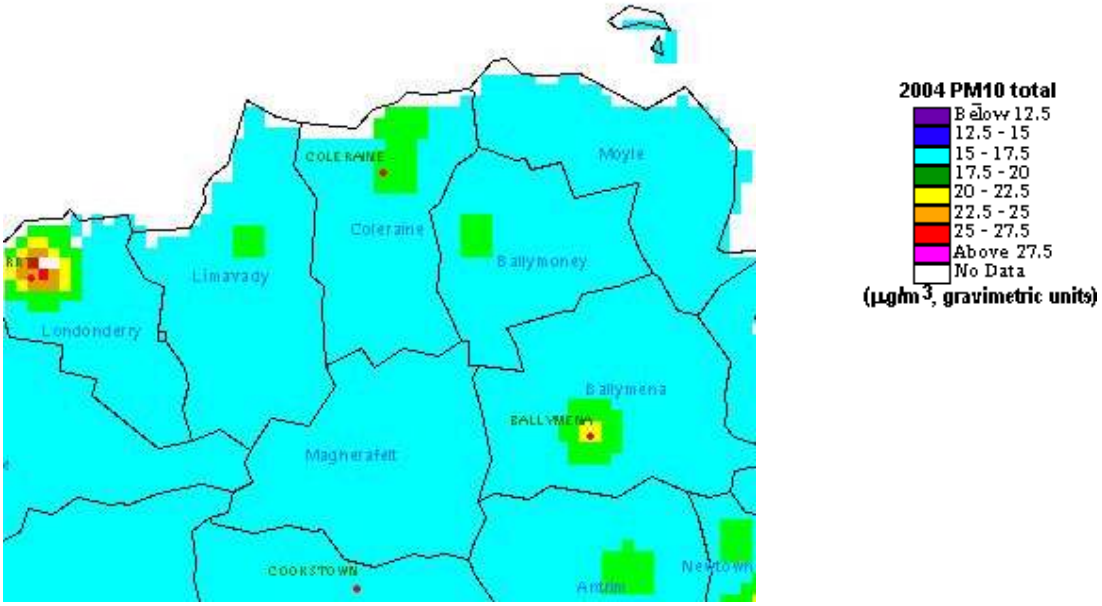
Table 4.2 Monthly average black smoke concentrations recorded at the Robinson Hospital in 2001

Month	**Concentration (μg/m^3)**
January	16
February	30
March	22
April	19
May	13
June	6
July	7
August	8
September	13
October	10
November	18
December	41
Average	**17**

~~1.3~~4.3 BACKGROUND CONCENTRATIONS OF PM_{10}

Estimates of background concentrations of PM_{10} were obtained for the Ballymoney Borough Council area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. The maximum annual average background concentration for 2004 in the Ballymoney Borough Council area was estimated to be 17.9 μg/m^3.

Figure 4.3 Background PM_{10} concentrations 2004 ($\mu g\ m^{-3}$)



4.4 IMPACT OF ROAD TRAFFIC ON PM_{10}

As recommended in Government Guidance LAQM.TG4 (00) DMRB has been used to predict PM_{10} concentrations for 2004 from road traffic. The estimated maximum background concentration for 2004 of 17.9 µg m^{-3} for the Ballymoney Borough Council area has then been added to provide total predicted PM_{10} concentrations. Estimated traffic flows for 2004 have been calculated using a growth rate of 2.8% as recommended by Ballymoney Borough Council.

GB Government Guidance LAQM.TG4(00) states that the 24-hour objective is highly unlikely to be exceeded if the annual mean concentration is below 28 µg m^{-3}, gravimetric.

Table 4.4 shows the 2004 predictions that may be compared against the objectives. For 2004, the method predicts annual average concentrations of PM_{10} less than 28 µg m^{-3} at all of the locations modelled.

Table 4.4 Predicted PM_{10} concentrations at roadside locations in the Ballymoney Borough Council region.

Description of Link	PM_{10} Annual mean (µg m^{-3}) 2004
Portruch Rdbt	19.2
Rodeing Foot rdbt	20.0
Crossroads	20.6
Technical college rdbt	20.5
Main St	18.6
Victoria St	19.2
Linenhall St	19.0
High St	18.3
Charles St	19.0
Queen's St	19.0

4.5 CONCLUSIONS FOR PM_{10} CONCENTRATIONS IN THE BALLYMONEY BOROUGH COUNCIL AREA

Emissions from traffic are not predicted to lead to an exceedence of the PM_{10} objectives in 2004.

5 Review and assessment of sulphur dioxide

5.1 INTRODUCTION

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

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

5.1.1 Standards and objectives for sulphur dioxide

Two new objectives have been introduced for SO_2 in the AQS based on the limit values in the Air Quality Daughter Directive, and the three objectives are:

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

The 15 minute mean objective is the most stringent; the other two objectives will not be exceeded if this objective is not exceeded.

5.1.2 The National Perspective

Sulphur dioxide is emitted in the combustion of coal and oil. Emissions today are dominated by fossil-fuelled power stations which in 1997 accounted for 62% of the national total emission. Emissions from road transport are a very small fraction of the national total: 2%.

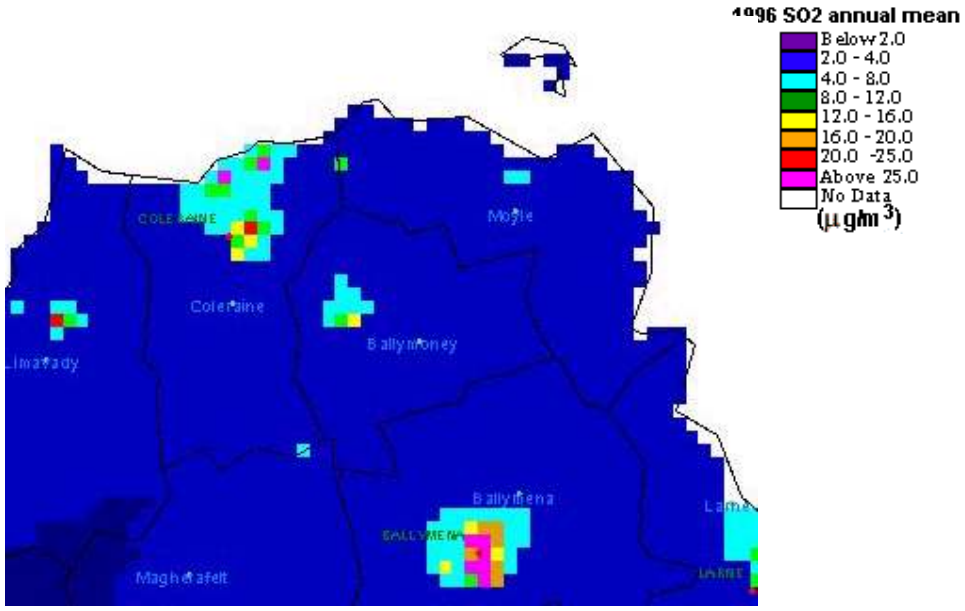
Exceedences of the 15-minute air quality standard currently occur near industrial processes for which the stack heights were designed to meet previous air quality standards and downwind of large combustion plant such as power stations. Exceedences are also possible in areas where significant quantities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

are elevated at the kerbside but not sufficiently to exceed the air quality standard in the absence of other sources.

5.2 BACKGROUND CONCENTRATIONS OF SULPHUR DIOXIDE

Estimates of background concentrations were obtained for the Ballymoney Borough Council area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. Figure 5.2 shows the most recent estimates available, for 1996. The maximum background concentration for 1996 in the Ballymoney Borough Council area was 15.2 μg m^{-3}. In the majority of the borough the annual mean in 1996 was less than 4μg m^{-3}. GB Government Guidance LAQM.TG4(00) assumes that the annual mean at the end of 2004 and 2005 will be half the 1996 annual mean. However, due to the high proportion of domestic households burning coal in Ballymoney the estimated annual mean background concentration for the majority of Ballymoney Borough Council in 2004 has been estimated to be 3 μg m^{-3} (4*0.75) and the maximum 11.4 μg m^{-3}.

Figure 5.2 Background SO_2 concentrations 1996



~~1.25.3~~MONITORING OF SULPHUR DIOXIDE

There has been monitoring of sulphur dioxide at one location in the Ballymoney Borough Council area as part of the UK national network operated by NETCEN. This site is in a residential area where a high proportion of the households burn domestic coal. The average monthly concentrations obtained between January and December 2001 are shown in Table 5.3 below:

Table 5.3 Average SO_2 concentrations recorded at the Robinson Hospital in Ballymoney in 2001.

Month	Concentration ($\mu g/m^3$)
January	9
February	13
March	8
April	12
May	16
June	14
July	16
August	15
September	15
October	15
November	10
December	7
Average	**12.5**

The GB Government Guidance suggests that the most stringent of the sulphur dioxide objectives is not likely to be exceeded if the average of the maximum daily mean concentration is less than 80 $\mu g/m^3$. The NETCEN website details a 2000 average of maximum daily means of 34$\mu g/m^3$ for this site. Therefore the sulphur dioxide objective is unlikely to be exceeded.

5.4 IMPACT OF INDUSTRY ON CONCENTRATIONS OF SULPHUR DIOXIDE

The Stage 1 Review and Assessment Report prepared by Ballymoney Borough Council stated that the following industry had the potential to emit significant quantities of sulphur dioxide.

- Ballymoney Foods Ltd.

This industry was considered in the Stage 1 review and assessment and the nomogram supplied in the Pollutant Specific Guidance was used to determine whether a Stage 2 would be required. It was recommended that a stage 2 was carried out for Ballymoney Foods Ltd. Therefore in this assessment, nomograms in GSS (Guidance for estimating impacts from Stationary Sources) have been used.

5.4.1 Ballymoney Foods

Table 5.4.1 Specifications of combustion processes at Ballymoney Food Ltd.

	Ballymoney Foods
Temperature of emissions (^{0}C)	170
Stack height (m)	28
Stack diameter (m)	0.88
SO_2 tonnes per annum (based on 1% sulphur fuel)	166.3
Discharge velocity (m/s)	12.75

A background SO_2 concentration of 3 $\mu g/m^3$ (4*0.75) has used this assessment. Applying the above information to GSS, the following results are obtained:

99.9^{th} percentile of the 15 minute mean objective 111.9$\mu g/m^3$
(the objective is 266 $\mu g/m^3$).

GSS predicts that the 15 minute mean objective will not be exceeded and this is the most stringent of the objectives. Therefore it is recommended that a stage 3 review and assessment is not necessary for this source.

5.5 CONCLUSIONS FOR SULPHUR DIOXIDE CONCENTRATIONS IN THE BALLYMONEY AREA

It is recommended that Ballymoney Foods is not assessed further.

6 Conclusions and recommendations for each pollutant

6.1 NITROGEN DIOXIDE

Emissions from road transport are not predicted to lead to an exceedence of the air quality objectives for this pollutant.

6.2 PARTICULATE MATTER (PM_{10})

Emissions from traffic are not predicted to lead to an exceedence of the PM_{10} objectives in 2004.

6.3 SULPHUR DIOXIDE

It is recommended that a stage 3 review and assessment is not necessary for this pollutant.

7 References

1. DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Department of the Environment, Transport and the Regions. Cm 4548, SE 2000/3, NIA 7.

2. Review and Assessment : Pollutant Specific Guidance LAQM TG4(00) ISBN 1 85112 387 3DETR May 2000

3. The Air Quality (England) Regulations 2000 DETR April 2000

4. EA (1998b) Guidance for estimating the air quality impact of stationary sources. Guidance Note 24.

5. APEG (1997) Source apportionment of airborne particulate matter in the United Kingdom. Report of the Airborne Particles Expert Group.

6. Abbott, J. and Vincent, K. (1999) Dispersion modelling of SO_2 concentrations in the United Kingdom for comparison with the National Air Quality Strategy. A report produced for the Department of the Environment, Transport and the Regions. AEAT-5120 Issue 1. AEA Technology Environment, Culham, Abingdon, Oxon., OX14 3ED.

7. Loader (2002). Summary results from the UK NO_2 network field inter comparison exercise 2001. A report produced for the Department of the Environment, Transport and the Regions, the Welsh office, the Scottish office and the Department of the Environment for Northern Ireland. AEA Technology Plc.

8. Stedman, JR, Bush, TJ, Murrells, TP and King K (2001). Baseline PM10 and NOx projections for PM10 objective analysis. AEA Technology, National Environmental Technology Centre. Report AEAT/ENV/R/0728

Appendices

CONTENTS

Appendix 1

Local air quality monitoring data available

HEALTH & ENVIRONMENTAL SERVICES DEPARTMENT

AIR QUALITY DIFFUSION TUBE MONITORING NOX **ugm3** **YEAR** **2001**

LOCATION	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL AVE
19 Linenhall Street 1N	A	12	10	20	8		21	23	22	34	18			18.67
14/16 Ozone Avenue 2N	B	25	21	13	11		15	18	13	10	5			14.56
Opp 16 Armour Avenue 3N	C	22	21	11	10		24	36	10	10	14			17.56
2/4 Semicock Avenue 4N	C	20	16	12	9		13	23	8	10	11			13.56
6 Church Street 5N	A		2	18	14		14	16	11	22	5			12.75
31 Charles Street 6N	A	19	17	11	25		17		20	21	23			19.13
Opp 51 Queen Street 7N	A	9	32	38	13		16	23	14	24	22			21.22

Key
A = Kerbside1-5m from busy Road
B = Intermediate 20-30m from busy Road
C = Urban Background >50m from busy Road
D = Rural Background site
E = Special site adj industrial site

Appendix 2

Traffic data

Traffic flows in Ballymoney

Description of Link	distance to receptor (to centre of road) (m)	distance to receptor (to kerbside) (m)	annual average vehicle flow 2005 (veh/hr)	Description of Link
Main St	6.25	2.5	284.2	
Victoria St	7.5	2.5	560.3	
Linenhall St	6.25	2.5	461.2	
High St	11.25	3.8	181.1	
Charles St	8.75	2.5	441.7	
Queen's St	7.5	2.5	485.0	
A26	36.25	30.0	622.9	Portruch Rdbt
B62	45	38.8	275.4	
Queen St	13.75	8.8	485.0	Rodeing Foot rdbt
Meetinghouse St	40	35.0	465.6	
Charles St	7.5	2.5	441.7	Crossroads
Linenhall St	8.75	5.0	461.2	
Coleraine Rd	9.375	5.6	441.7	Technical college rdbt
North Rd	9.375	4.4	416.7	

A traffic growth rate of 2.8% per annum has been used to predict the traffic flows in 2005.
This figure is documented in the Ballymoney Annual traffic Census report, 1997.