AEAT/Env/R/1019

# Air Quality Review and Assessment - Stage 2

**A report produced for Derry City Council**

February 2002

AEAT/Env/R/1019

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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. 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. The Environment Act 1995 requires Local Authorities in England, Scotland and Wales to undertake an air quality review. The Act does not require authorities in Northern Ireland to undertake such a review but many councils such as Derry City Council are undertaking these voluntarily. 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.

The first step in this process is to undertake a review of current and potential future air quality. A minimum of two air quality reviews are recommended in order to assess compliance with air quality objectives, one to assess air quality at the outset of the Air Quality Strategy and a second to be carried out towards the end of the policy timescale (2005). The number of reviews necessary depends on the likelihood of achieving the objectives.

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:

Emissions arising from road transport at six road junctions in the DCC area may cause an exceedence of the AQS for nitrogen dioxide. It is therefore recommended that a stage 3 review and assessment is carried out for this source at the following locations:

Dungiven Road at Irish Street lights
Dungiven Road at Dales Corner
Glenshane Road at Altnagelvin hospital
Strand Road (junction with Barry Street, Philip Street & Meadow Bank Avenue)
Culmore / Buncrana
Buncrana Road at junction with Racecourse Road.

Emissions arising from the Coolkeeragh Power Station and DuPont site are not expected to lead to an exceedence of the objective.

DMRB predicts that emissions from traffic could lead to an exceedence of the $PM_{10}$ objectives in 2004. Therefore it is recommended that a stage 3 review and assessment should be carried out for this source.

No exceedences of the SO2 objective were predicted and therefore there is no need to proceed to a stage 3 review and assessment for this source.

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## Appendices

## 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 |
| DCC | Derry City Council |
| 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 |
| HGV | heavy goods 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

This chapter introduces the important elements of the government's air quality strategy. Chapters 2 onwards present the results of the air quality review and assessment.

## 1.1 THE NEED FOR A NATIONAL AIR QUALITY STRATEGY

During the early 1990s, the Department of Environment, Transport and the Regions' (DETR) investigated the need for a new framework for air quality control. This was fuelled by episodes of poor air quality in many of the UK's major urban areas and increasing concerns expressed by both the public and the scientific community. The need to reconcile rising demands in living standards with the maintenance of environmental quality has already been recognised in Agenda 21 and is now taken further with the development of the Air Quality Strategy (AQS)[1].

On the whole, air quality in the UK today is much improved compared to that of fifty years ago when the occurrence of high $SO_2$ and smoke concentrations as 'smog' in towns and cities resulted in acute health effects on the resident population. However, there is now some evidence of an association between ambient air quality and chronic health effects and discomfort for sensitive individuals. For example, health effects have been linked to particulate emissions from sources such as road transportation. A new approach to the control of air quality was sought to tackle these issues and to provide a further basis for the achievement of wider objectives in relation to sustainable development in the UK.

Part IV of the Environment Act 1995, the main elements of which are shown in Table 1.1, requires the formulation of a national strategy and provides for the further development of local air quality assessment and management. This Act and the subsequent AQS are the culmination of work surrounding a number of consultation documents issued by the Government, the most important of which was 'Air Quality: Meeting the Challenge' in 1995. The Strategy was also developed within the context of information provided by an ongoing programme of research conducted by Government Panels and Review Groups. A draft Strategy was produced in August 1996 and the first National Air Quality Strategy was adopted in April 1997 (DoE, 1997). In December 1997, Air Quality Regulations set out the process of air quality review and assessment.

The 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 1.1 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. |

## 1.2 OVERVIEW OF THE PRINCIPLES AND MAIN ELEMENTS OF THE NATIONAL 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 AQS will provide a framework for the improvement of air quality that is both clear and workable. In order to achieve this, the Strategy is based on several principles which include:

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

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

### 1.2.1 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 1.2. 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 1.2 Air Quality Objectives in the Air Quality Regulations (2000) for the purpose of Local Air Quality Management

| Pollutant | Concentration limits ($\mu g\ m^{-3}$) | (ppb) | **Averaging period** | **Objective** [number of permitted exceedences a year and equivalent percentile] (**$\mu g\ m^{-3}$**) | 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** | by 31.12.2005 [maximum of 18 exceedences a year or equivalent to the 99.8th percentile] |
| | 40 | 21 | **annual** mean | **40** | by 31.12.2005 |
| **$PM_{10}$** (**gravimetric**) (see note) | 50 | – | **24-hour** mean | **50** | by 31.12.2004 [maximum of 35 exceedences a year or ~ equivalent to the 90th percentile] |
| | 40 | – | **annual** mean | **40** | by 31.12.2004 |
| **$SO_2$** | 266 | 100 | **15 minute** mean | **266** | by 31.12.2005 [maximum of 35 exceedences a year or equivalent to the 99.9th percentile] |
| | 350 | 132 | **1 hour** mean | **350** | by 31.12.2004 [maximum of 24 exceedences a year or equivalent to the 99.7th percentile] |
| | 125 | 47 | **24 hour** mean | **125** | by 31.12.2004 [maximum of 3 exceedences a year or equivalent to the 99th percentile] |

**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.

This Stage 2 review and assessment compares the air quality in the Derry City Council area with those standards in the Air Quality Regulations (2000). On September 17th 2001 new guidelines were issued, however these are yet to come official.

### Policies in place to allow these objectives to be achieved

The policy framework to allow these objectives to be achieved is one that that takes a local air quality management approach. This is superimposed upon existing national and international regulations in order to effectively tackle local air quality issues as well as issues relating to wider spatial scales. National and EC policies which already exist provide a good basis for progress towards the air quality objectives set for 2003 to 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.

### 1.2.2 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 1.2. 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.

## 1.3 AIR QUALITY REVIEWS

A range of Technical Guidance has been issued to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This includes the Technical Guidance LAQM.TG4(00) May 2000, on 'Review and Assessment: Pollutant Specific Guidance[2]. This review and assessment has considered the procedures set out in the Guidance.

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 below.

***Stage 1*** A Stage 1 review is expected to have considered all sources of pollutants which could have a significant impact in the authority's locality, either due to the emission of significant quantities of the pollutant(s) of concern, or for which there is potential for exposure of the general public to poor air quality. The review should include details of any significant existing or planned transportation, industrial or other sources in and around the District. If no sources are identified, or the size of the emissions are small, the local authority can conclude that the risk of failing to meet set air quality objectives is negligible and it is it therefore not necessary to conduct a second stage review. Alternatively, if the local authority can identify a significant source for one or more pollutants, it is necessary to proceed to a second stage air quality review.

***Stage 2*** The second stage air quality review provides a further screening of pollutant concentrations in local authority areas. This involves estimating, through the use of monitored or modelled data, the highest likely concentrations of air pollutants within its area and the localities where this may occur in order to assess whether there is a significant risk of an air quality objective not being met. If, as a result of estimations of ground level concentrations at roadside, industrial and background sites, 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.

***Stage 3*** A third stage review is an accurate and detailed review and assessment of current and future air quality in a particular district. The approaches requires more sophisticated modelling and monitoring techniques than those applied at Stage 2. This enables a local authority to predict the likelihood of meeting the objective and so determine the location of any necessary Air Quality Management Areas (AQMAs). 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. Once an AQMA has been identified, there is further set of requirements to be considered. Firstly, 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 in England, Wales and Scotland are expected to have completed a review and assessment of air quality by June 2000. A further review is also needed to be completed for the purposes of the Act before the target date of 2003. However, as this process is voluntary for authorities in Northern Ireland there is no date by which the reviews must be completed.

### 1.3.1 Which locations should the review and assessment 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. Therefore for objectives with short averaging periods (the 15-minute and 1-hour objective for sulphur dioxide and the 1-hour objective for nitrogen dioxide) the review and assessment should focus on any non-occupational, near ground level outdoor location where members of the public might reasonably be expected to be present over the relevant averaging time. For $NO_2$, examples might include a pavement of a busy shopping street, a path running close to a busy road, playing fields close to a busy road. For $SO_2$, examples would be locations downwind of a point source.

For objectives with longer averaging periods (benzene, 1,3-butadiene, carbon monoxide, lead, $PM_{10}$, the 24-hour objective for sulphur dioxide and the annual mean for nitrogen dioxide) the review and assessment should focus on the following near ground level outdoor locations:

- background locations
- roadside locations (sites close to the façade of a building) where there is housing
- other areas where members of the public might reasonably be expected to be regularly exposed to outdoor air for a substantial part of the day (for example near housing, schools or hospitals)

It is unnecessary to consider exceedences of the objectives at any location where public exposure over the relevant averaging period would be unrealistic.

**Key Points**

- The 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.

# 2 Introduction to the air quality review

Part IV of the Environment Act, 1995, establishes a national framework for air quality management, and requires all local authorities in Wales, and Scotland and London borough, district and unitary councils in England to conduct local air quality reviews. Where the reviews indicate that objectives set out in the Air Quality Regulations, 2000[3], will not be met by the prescribed dates, the relevant authority is required to designate an Air Quality Management Area. Further work is then required to investigate ways to ensure compliance of the area by the prescribed dates.

## 2.1 PURPOSE OF THE STUDY

NETCEN was commissioned by Derry City Council (DCC) to complete a Second Stage Air Quality Review (SSAQR) within their area. The review:

- Investigates present and potential future air quality in the DCC area
- Recommends actions, if necessary, to control the subsequent air quality within the DCC area

## 2.2 APPROACH TAKEN

The approach taken in this study was to:

1. Identify the principal sources of pollutant emissions affecting air quality in the DCC area.
2. Model expected present and potential future levels of pollutant concentrations in the DCC 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 City is likely to comply with the requirements of the Air Quality Strategy.
4. Identify areas for further investigation.

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

## 2.3 STRUCTURE OF THIS REPORT

Chapter 1 considers details of the Air Quality Strategy (AQS).

This chapter, Chapter 2, considers proposed developments in DCC which might affect air quality by 2005, the extent of local air quality measurements made by DCC, traffic speed and flow data available, Part A and B processes in the DCC region and sources outside the region which might affect air quality. Chapters 3 to 6 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 7 summarises all the findings and recommendations of the work.

## 2.4 INFORMATION PROVIDED BY DCC TO SUPPORT THIS ASSESSMENT

NETCEN requested a range of information from DCC that was needed to complete this SSAQR. This information included details about:

- Local air quality monitoring data
- Proposed developments
- Part A and B processes under the Environmental Protection Act (EPA)
- Traffic flow and speed data
- Transport strategy
- Large combustion sources

The pollutants and their sources that have been studied in this Stage 2 Report for Derry City Council (DCC) are:

- Nitrogen dioxide

An assessment of traffic emissions on the busiest roads in the borough has been undertaken using DMRB. In addition, Coolkeeragh Power station and Dupont UK ltd have been assessed in terms of their $NO_2$ emissions.

- $PM_{10}$

An assessment of traffic emissions on the busiest roads in the borough has been undertaken using DMRB.

- Sulphur dioxide

Sulphur dioxide emissions from Coolkeeragh Power station and Dupont UK ltd have been assessed. In addition, $SO_2$ emissions from the following 3 combustion plants greater than 5 MW have been evaluated:

- Altnagelvin hospital
- Foyle meats
- Seagate

### 2.4.1 Local air quality monitoring data

#### 2.4.1.1 Extent of data available

The following local air quality monitoring data for DCC is available:

- nitrogen dioxide diffusion tube data for ten sites
- sulphur dioxide 3 bubbler sites

- Black smoke        3 bubbler sites

Where appropriate, data from these surveys have been used. Appendix 1 gives more information about the local air quality monitoring.

#### ~~1.1.1.2~~2.4.1.2 Quality Assurance/Quality control of data

The diffusion tubes were analysed by Harwell Scientifics, who participate in the laboratory intercomparison exercises for the National $NO_2$ Diffusion Tube Network. The results presented in this report have been corrected for bias.

### ~~1.1.4~~2.4.2 Traffic data

Appendix 2 summarises the traffic information used in the assessment. The Derry Area Plan 2011 produced in 1996 outlined the following roads that required widening: Buncrana Road between Pennyburn roundabout and Racecourse Road, Creggan Road, Glendermott Road and the A2 Clooney Road amongst others.  No information was available on these developments and therefore it was presumed that traffic flows would be unaffected.

#### ~~1.1.1.1~~2.4.2.1 Flow and speed

DCC provided traffic flow measurements at a range of locations within the area. A conservative speed of 32 kph has been used on all roads in the borough.

#### ~~1.1.1.2~~2.4.2.2 Traffic growth

DCC provided estimates of the expected vehicle flows in 2005.

#### ~~1.1.1.3~~2.4.2.3 Fraction of HDVs

The % of HDV was provided for the majority of road links. Where no data was available, a figure of 6.8% has been applied which was the highest % HDV figure obtained on road surveys in the council area.

#### ~~1.1.1.4~~2.4.2.4 Assumed distance from the centre of the road to the kerbside

At all locations distances to the nearest receptors have been approximated from maps provided by DCC.

### ~~1.1.6~~2.4.3 Part A and B process and >5 MW (thermal) combustion plants

Combustion processes can contribute a range of pollutants to ambient air. DCC provided a list of processes that needed further assessment in a Stage 2.  These were:

- Altnagelvin hospital
- Foyle meats
- Seagate

In addition, Coolkeeragh Power station and Dupont UK Ltd in neighbouring authorities have been assessed.

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

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

### 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.

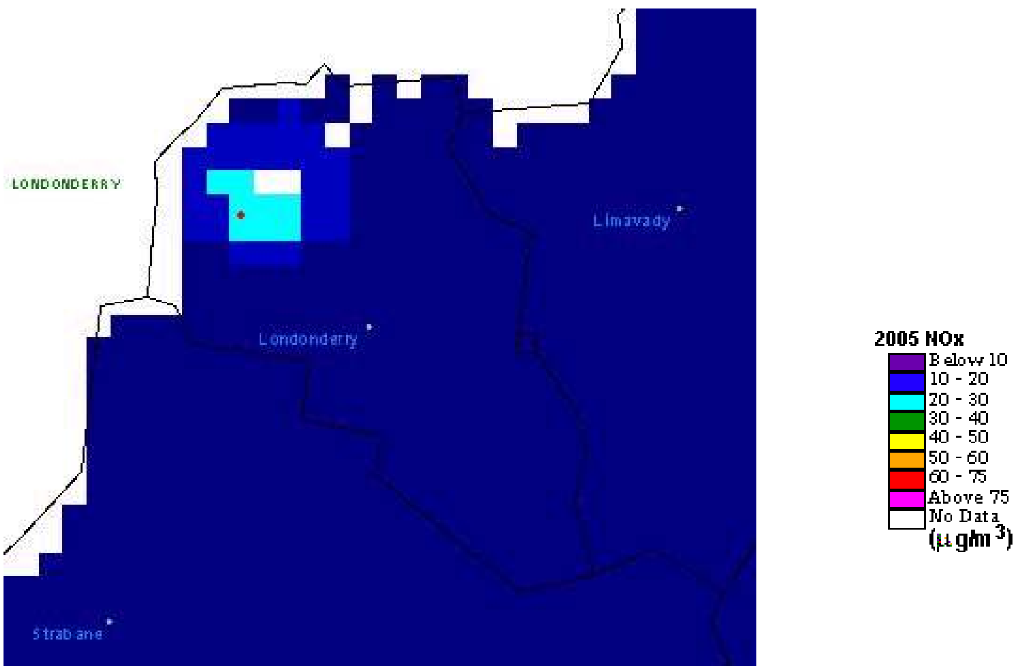
The results of the analysis set out in the National Air Quality Strategy suggest that for $NO_2$ a reduction in $NO_x$ emissions over and above that achievable by national measures will be required to ensure that air quality objectives are achieved everywhere by the end of 2005. Local authorities with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

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

Figures 3.2 shows estimates of $NO_x$ background concentrations for 2005.

**Figure 2.3 Background $NO_x$ concentrations 2005**




A maximum background NOx estimate of 30 µg/m$^3$ has been estimated for 2005 in the DCC region.

## ~~1.3~~3.3 MONITORING OF NITROGEN DIOXIDE

### 3.3.1 Continuous monitoring

There has been a continuous monitor recording $NO_2$ levels in Brooke Park in Derry since 1997. This site is part of the DEFRA automatic monitoring network. The monitor is located in an urban background location approximately 1 kilometre from the city centre in a park. For a detailed breakdown of the concentrations measured see the air quality archive web site at http://www.aeat.co.uk/netcen/airqual/
The annual average concentrations recorded at the site between 1999 and 2001 are shown in Table 3.3.1 below:

Table 3.3.1 Annual average $NO_2$ concentrations recorded at Brooke Park

| Year | Concentration ($\mu g/m^3$) |
|---|---|
| 1999 | 15.3 |
| 2000 | 15.3 |
| 2001 | 15.3 |

### 3.3.2 Diffusion tube data

Monthly average concentrations of $NO_2$ have been measured with diffusion tubes at ten sites in Derry City during 2001. The data are summarised in Table 3.3.2a and 3.3.2b and monthly average data are presented in Appendix 1. Annual average concentrations are only shown where more than 6 months of monitoring has taken place.

The data have been corrected for bias in two ways. Diffusion tubes can under or over-read and if possible should be referred to continuous results. This may be done in two ways: either by using results from a tube co-located with a continuous analyser or by using the results of the UK National Diffusion Tube Survey Field Intercomparison. It should be taken into account that diffusion tubes are spot measurements and may be very sensitive to distance from the road as concentrations change rapidly with distance from the road when comparing them with modelled results. The true value for the diffusion tubes may be considered to lie within the ranges suggested by the adjusted values in Tables 3.3.2a and 3.3.2b.

***Analyst Bias***

The diffusion tubes were analysed by Harwell Scientifics. In 2001 the laboratory was found to have a positive bias of 50.2% relative to an automatic analyser. (UK National Diffusion Tube Survey Field Intercomparison Exercise 2001). Therefore the data has been corrected for bias using the above factor.

**Table 3.3.2a Annual average concentrations measured in 2001 at locations in the Derry City area corrected for analyst bias and predictions for 2005.**

| Site Name | Site Type | Average $NO_2$ $\mu gm^{-3}$ uncorrected for bias | Average $NO_2$ $\mu gm^{-3}$ corrected for analyst bias | Predicted concentration in 2005 $\mu gm^{-3}$ |
|---|---|---|---|---|
| 1 - 3 Creggan Rd | K | 62.1 | 29.8 | 27.0 |
| 2 - 7 Harberton Park | K | 23.9 | 11.5 | 10.4 |
| 3 - 3 Glendermott Rd | K | 47.4 | 22.8 | 20.7 |
| 4 - 3 Simpson's Brae | K | 31.1 | 14.9 | 13.5 |
| 5 - 139c Strand Rd | K | 47.1 | 22.6 | 20.5 |
| 6 - 2 Farren Park | K | 26.7 | 12.8 | 11.7 |
| 7 - 19 St. Patrick's Terrace | K | 42.5 | 20.4 | 18.5 |
| 8 - 34 Northland Terrace | K | 31.0 | 14.9 | 13.5 |
| 9 - Temple Rd | K | 19.3 | 9.3 | 8.4 |
| 10 - AUN site, Brook Park | B | 22.4 | 10.7 | 9.5 |

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

When the diffusion tubes are corrected for analyst bias all the sites are predicted to meet the AQS objective in 2005.

***Co-located bias***

Diffusion tubes exposed at site 10 are located next to an automatic analyser. In 2001, the average concentration recorded by the diffusion tubes was 22.4 μg/m$^3$ uncorrected for bias. The automatic monitor gave an annual concentration of 8 ppb (15.3 μg/m$^3$). This reading was 31% less than that recorded by the diffusion tubes. The results shown in Table 3.3.2b below have been corrected for co-located bias.

**Table 3.3.2b Annual average concentrations measured in 2001 at locations in the Derry City area corrected for co-located bias.**

| Site Name | Site Type | Average $NO_2$ μgm$^{-3}$ uncorrected for bias | Average $NO_2$ μgm$^{-3}$ corrected for co-located bias | Predicted concentration in 2005 μgm$^{-3}$ |
|---|---|---|---|---|
| 1 - 3 Creggan Rd | K | 62.1 | 42.3 | 38.4 |
| 2 - 7 Harberton Park | K | 23.9 | 16.3 | 14.8 |
| 3 - 3 Glendermott Rd | K | 47.4 | 32.3 | 29.4 |
| 4 - 3 Simpson's Brae | K | 31.1 | 21.2 | 19.2 |
| 5 - 139c Strand Rd | K | 47.1 | 32.1 | 29.2 |
| 6 - 2 Farren Park | K | 26.7 | 18.2 | 16.6 |
| 7 - 19 St. Patrick's Terrace | K | 42.5 | 29.0 | 26.3 |
| 8 - 34 Northland Terrace | K | 31.0 | 21.1 | 19.2 |
| 9 - Temple Rd | K | 19.3 | 13.2 | 12.0 |
| 10 - AUN site, Brook Park | B | 22.4 | 15.3 | 13.9 |

When the co-located bias is applied, the diffusion tubes placed on Creggan Road exceeded the annual mean AQS for nitrogen dioxide of 40 μg/m$^3$ in 2001. However, in 2005 this site is predicted to have an annual concentration of 38.4 μg/m$^3$ which is below the AQS.

## 3.4 IMPACT OF ROAD TRAFFIC ON CONCENTRATIONS OF OXIDES OF NITROGEN

The Stage one Review and Assessment for Derry City Council identified various 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 DCC. The effect of junctions has been taken into account in DMRB where traffic data have been provided. Traffic flow details are given in Appendix 2. The model has been used to predict nitrogen dioxide concentrations for 2005. A background NOx concentration of 30 μg m$^{-3}$ has been used. This is a conservative estimate.

Concentrations have been assessed at traffic speeds (32 kph in the urban areas) which may be lower than those considered representative. The speed of 32 kph is representative of traffic congestion in a 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 DCC. For the majority of roads, the % of HDV on the roads was provided. For roads where % HDV data was available a figure of 6.8% has been used as this was the highest figure obtained on any of the roads that have been studied in the borough.

Table 3.4 lists the annual average and $99.8^{th}$ percentile of maximum hourly average kerbside concentrations (equivalent to 18 exceedences per year) of nitrogen dioxide predicted for 2005 in the DCC area. Following advice given in 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 over 40 $\mu g\ m^{-3}$ at six of the road links. At all the road links the hourly objective was predicted to be met.

**Table 2.4 Nitrogen dioxide concentrations at roadside locations in DCC**

| Description of Link | Distance to nearest receptor from kerbside (m) | $NO_2$ Annual mean ($\mu g\ m^{-3}$) 2005 | $NO_2$ 99.8th percentile of hourly averages ($\mu g\ m^{-3}$) 2005 |
|---|---|---|---|
| Northland Rd at Junc. with Asylum Rd | 3.75 | 36.2 | 126.8 |
| Dungiven Rd at Irish St lights | 2.5 | **42.2** | 147.7 |
| Dungiven Rd, at Dales Corner | 5 | **49.6** | 173.5 |
| Northland Rd opp. Magee College | 7.5 | 37.5 | 131.3 |
| Clooney Rd | 13.8 | 29.3 | 102.5 |
| Glenshane Rd at Altnagelvin hospital | 8.8 | **41.0** | 143.5 |
| Strand Rd (junc, with Barry St, Philip St & Meadowbank Av.) | 5 | **44.7** | 156.6 |
| Culmore Rd / Buncrana Rd | 8.8 | **49.9** | 174.6 |
| Buncrana Rd at junc. with Racecourse Rd | 2.5 | **44.2** | 154.9 |
| Simpsons Brae | 1.9 | 24.2 | 84.8 |
| Creggan Street, opp. Don Bar | 3.8 | 26.6 | 93.1 |

At road junctions, the distance from the kerb to the nearest receptor has been given as the closest receptor to any of the road links.
There is a good correspondence between the diffusion tube results corrected for analyst bias and the results of DMRB for Creggan Road.

## 3.5 IMPACT OF COMBUSTION PROCESSES ON $NO_2$ CONCENTRATIONS IN THE DCC AREA.

Two large combustion plants (Coolkeeragh Power station and Dupont) were identified in the Stage one review and assessment as requiring further assessment in a stage 2.

### 3.5.1 Coolkeeragh Power Station

The existing power station burns heavy fuel oil. However this plant is to be decommissioned by 31st December 2005 at the latest and replaced with a combined cycle gas turbine plant. For sulphur dioxide the 1 hour and 24 hour mean objectives are to be achieved by 31st December 2004. The 15 minute objective is to be achieved by 31st December 2005. Therefore the existing power station may still be in operation when the 1 hour and 24 hour objectives should apply. As a result both the existing fuel oiled power station and the proposed CCGT plant have been considered.

***Existing power station running on heavy fuel oil***

The existing power station consists of 5 heavy fuel oil boilers capable of generating 300 MW. There is also a gas turbine generator which is normally used for emergency generation and has been used for a very limited number of hours in recent years. The data shown in Table 3.5.1a below relates only to the main heavy fuel oil boilers.

Table 3.5.1a Specifications of combustion processes at Coolkeragh Power Station

| | **Coolkeragh Power Station** |
|---|---|
| Temperature of emissions ($^0$C) | 160 (max) |
| Stack height (m) | 2* 81 |
| Stack diameter (m) | 3.8 & 4.4 |
| $NO_x$ emissions (tonnes/year) | 781 |
| Gas exit velocity (m/s) | 7.9, 5.8 |

Whilst the main boilers have the ability to generate 300 MW it is rare for this to be the case. Two scenarios were modelled for the assessment that accompanied the application for authorisation by Cordah Environmental Management Consultants (Harrop, 1998).

Scenario 1 - Absolute worst case - 5 generating units producing 60 MW each
Scenario 2 - Typical maximum generating mode - 2 generators producing 48 MW.

Cordah used the dispersion model ADMS 2.2 to evaluate the impact of the plant on nearby $NO_2$ concentrations. The results are conservative estimates as they assume that all $NO_x$ is present as $NO_2$ and the results are worst case scenarios as single maximum ground level mean annual concentration values are compared to AQS and these maxima occur in very restricted areas. The report concluded that predictions for 2001 - 2004 showed that $NO_2$ air quality criteria were unlikely to be exceeded under typical operations.

Table 3.5.1b - Predicted $NO_2$ concentrations $\mu g/m^3$ (Harrop, 1998).

| | **Scenario 1 (worst case)** | **Scenario 2 (typical worst case)** |
|---|---|---|
| Annual mean (1 hr) | 6.9 | 13.2 |
| 98th percentile (1 hr) | 137.2 | 177.5 |

***Proposed CCGT power station***

The project proposal is to construct a new electricity generating plant at Coolkeeragh Power Station. Th new plant design will be a combined cycle gas turbine using natural gas as its main fuel. Low sulphur fuel oil will be used as a stand by fuel in the event of an interruption to the gas supply. The plant may be operated in a combined cycle mode where the hot exhaust gases pass through a heat recovery boiler and are emitted through the main stack or in open cycle mode where the hot gases pass directly to the atmosphere through a by-pass stack without raising steam in the heat recovery boiler.

The Environmental Statement produced for the CCGT development by ESB International assessed the impact of the proposed plant on local air quality. The study included air quality dispersion modelling using ADMS 3.3 to evaluate the impact of atmospheric emissions from the proposed plant on local air quality.

Table 3.5.1c Specifications of combustion processes for the main stack at the proposed Coolkeeragh CCGT Station

| | **Coolkeeragh CCGT** |
|---|---|
| Temperature of emissions ($^0$C) | 95 |
| Stack height (m) | 65 |
| Stack diameter (m) | 7 |
| $NO_x$ emissions (g/s) | 27.2 |
| Gas exit velocity (m/s) | 19 |

The results of the modelling carried out by ESB International showed that with the CCGT operating on natural gas and discharging gases through the main stack, the highest 99.8$^{th}$ percentile of hourly average $NO_2$ concentrations was predicted to be 70 μg/m$^3$. In addition the maximum concentrations were predicted over water. Over most of the area, the maximum 99.8$^{th}$ percentile of hourly concentrations is less than 30μg/m$^3$. The maximum predicted annual average $NO_2$ concentration based on the CCGT operating on a continuous base load for the whole year is 1.6 μg/m$^3$. This concentration is predicted to occur over open water to the north of the site. Predicted levels over land beyond the power station boundary were generally predicted to be less than 0.75 μg/m$^3$. These emissions are lower than the AQS objectives.

In the event that the CCGT operates for a limited number of hours per year using fuel oil, the mass emission rate of NOx will be about 2.5 times greater than when natural gas is burnt. Based on the modelled results the maximum 99.8$^{th}$ percentile hourly concentration is predicted to be 129 μg/m$^3$, which is about 65% of the AQS objective hourly value of 200 μg/m$^3$.

With the CCGT operating in open cycle mode the exhaust gases will be released to the atmosphere via the bypass stack. The higher plume buoyancy due to the higher exit velocity and exhaust temperature results in significantly lower $NO_2$ ground level concentrations.

### 3.5.2 DuPont COGEN Plant

The environmental statement supporting the application for authorisation for this process was produced by Dames & Moore. The software package used to model releases from the COGEN Plant was ADMS 2.2. The dispersion modelling exercise was run assuming the worst case for boilers 6 & 7, that is running at 100% load for a full year and assuming the emissions of the prescribed substances were at their maximum during this period. Table 3.5.2 below shows the results that were obtained:

Table 3.5.2: Maximum average concentrations obtained (μg/m$^3$).

| Pollutant | Annual Average | 99.9 percentile of hourly average |
|---|---|---|
| $NO_2$ | 4.9 | 66 |

The predicted maximum values all occur within the DuPont site boundary. The AQ review and assessment process focuses on relevant locations where people are exposed over the relevant averaging period. Therefore, nearby schools, hospitals and residential housing are where the objective will apply and not within the site boundary. Outside the site the concentrations will be lower. The concentrations obtained are well within the AQS objectives for nitrogen dioxide.

### 3.5.3 Combining the impacts of the Coolkeeragh Power Station and the DuPont Cogen Plant.

The concentrations obtained above do not include background concentrations nor those arising from other major release sources such as Coolkeeragh Power Station. The modelling for the proposed CCGT Coolkeeragh Power station predicts that the maximum annual average ground level $NO_2$ concentration over land will be 0.75 μg/m$^3$. Combining this to that predicted from the DuPont plant (4.9 μg/m$^3$) a total concentration of 5.7 μg/m$^3$ is obtained. Therefore it is very unlikely that the combined impacts of the two plants will exceed the $NO_2$ annual average AQ objective. The hourly average figures cannot be added together as this would not be a true representation of what will actually occur as it is very unlikely that the peaks in hourly concentrations will occur at the same time or in the same location.

## 3.6 CONCLUSIONS FOR NITROGEN DIOXIDE CONCENTRATIONS IN THE DCC AREA

Emissions arising from road transport at six road junctions in the DCC area may cause an exceedence of the AQS. It is therefore recommended that a stage 3 review and assessment is carried out for this source. Emissions arising from the Coolkeeragh Power Station and DuPont site are not expected to lead to an exceedence of the objective.

# 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 $\mu g\ m^{-3}$ associated with poor dispersion. However, it is clear that many of the sources of $PM_{10}$ are outside the control of individual local authorities and the estimation of future concentrations of $PM_{10}$ are in part dependent on predictions of the secondary particle component.

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

There has been monitoring of $PM_{10}$ concentrations at an urban background location in Brooke Park in Derry. For a detailed breakdown of the concentrations measured see the air quality archive web site at http://www.aeat.co.uk/netcen/airqual/
The annual average concentrations recorded at the site between 1999 and 2001 are shown in Table 4.2 below:

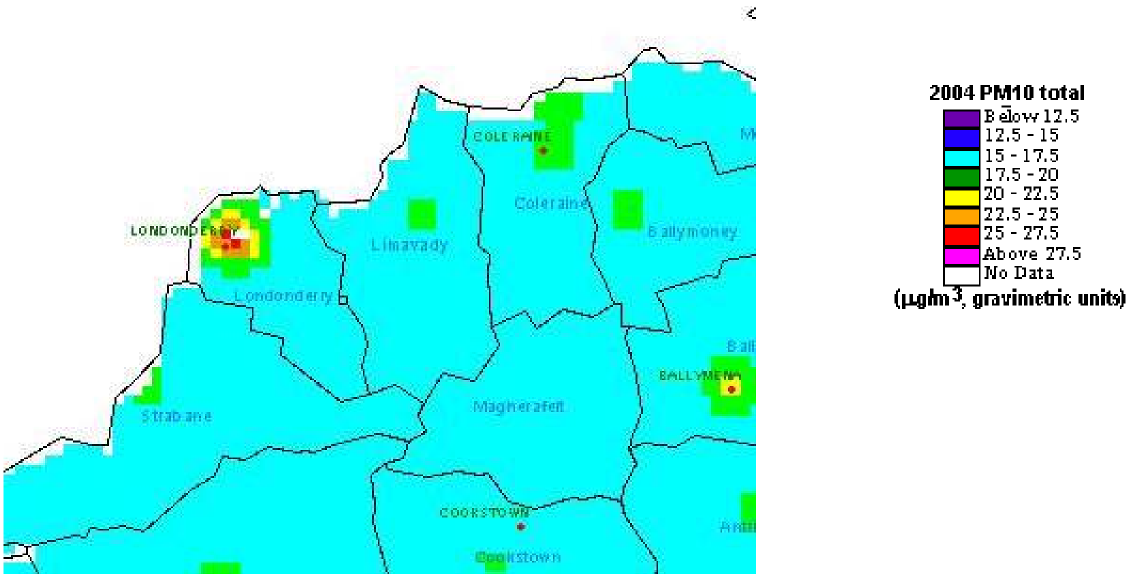
Table 4.2 Annual average $PM_{10}$ concentrations recorded at Brooke Park

| Year | Concentration ($\mu g/m^3$) |
|---|---|
| 1999 | 20 |
| 2000 | 15 |
| 2001 | 18 |

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

Estimates of background concentrations of $PM_{10}$ were obtained for the DCC area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. Figure 4.3 shows that the estimated annual average background concentration for 2004 in the DCC area was 27.3 $\mu g/m^3$ or lower.

**Figure 4.3.1 Background total $PM_{10}$ concentrations 2004 ($\mu g\ m^{-3}$)**




## 4.4 IMPACT OF ROAD TRAFFIC ON $PM_{10}$

As recommended in TG4 (00) DMRB has been used to predict $PM_{10}$ concentrations for 2004 from road traffic but the background concentrations given within the model have been ignored. The estimated maximum background concentration for 2004 of 27.3 $\mu g\ m^{-3}$ for the DCC area has then been added to provide total predicted $PM_{10}$ concentrations. Estimated traffic flows for 2005 (as expected traffic flows in 2004 were not available) as supplied by DCC were used in these calculations.

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

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

**Table 4.4 Predicted $PM_{10}$ concentrations at roadside locations in the DCC region.**

| Description of Link | $PM_{10}$ Annual mean ($\mu g\ m^{-3}$) 2004 |
|---|---|
| Northland Rd at Junc. with asylum Rd | **29.3** |
| Dungiven Rd at Irish St lights | **30.3** |
| Dungiven Rd, at Dales Corner | **31.7** |
| Northland Rd opp. Magee Colege | **29.2** |
| Clooney Rd | **28.2** |
| Glenshane Rd at Altnagelvin hospital | **29.7** |
| Strand Rd (junc, with Barry St, Philip St & Meadowbank Av.) | **30.7** |
| Culmore Rd | **30.8** |
| Buncrana Rd at junc. with racecourse Rd | **30.6** |
| Simpsons Brae | **28.0** |
| Creggan Street, opp. Don Bar | **28.2** |

## 4.5 CONCLUSIONS FOR $PM_{10}$ CONCENTRATIONS IN THE DCC AREA

DMRB predicts that emissions from traffic could lead to an exceedence of the $PM_{10}$ objectives in 2004. Therefore it is recommended that a stage 3 review and assessment should be carried out for this source.

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

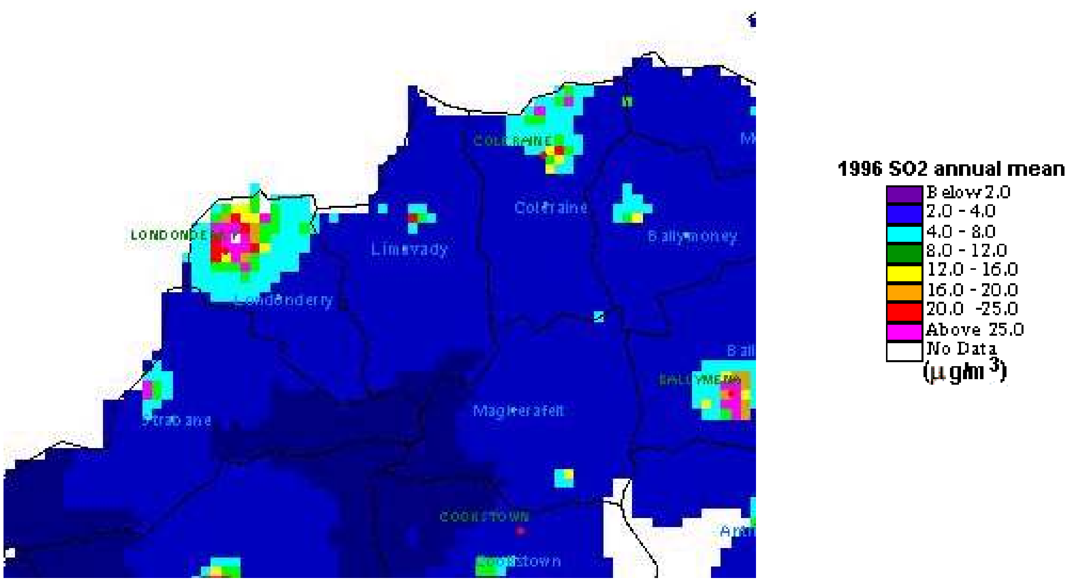
Sulphur dioxide is emitted in the combustion of coal and oil. Emissions today are dominated by fossil-fuelled power stations which in 1997 accounted for 62% of the national total emission. Emissions from road transport are a very small fraction of the national total: 2%.

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 DCC 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 estimated background annual average concentration for 1996 in the DCC area was 66.5 $\mu g\ m^{-3}$ and the average was 7.4 $\mu g\ m^{-3}$. Guidance TG4(00) assumes that the annual mean at the end of 2004 and 2005 will be half the 1996 annual mean. However, in Northern Ireland due to the high levels of domestic coal burning it is unlikely that the background concentrations will be reduced this much. Therefore 0.75 times the 1996 background has been used. This provides a maximum background concentration of 50 $\mu g\ m^{-3}$ and an average for the borough of 5.6 $\mu g\ m^{-3}$.

**Figure 5.2 Background $SO_2$ concentrations 1996**




## ~~1.2~~5.3 MONITORING OF SULPHUR DIOXIDE

### 5.3.1 Continuous monitoring

There has been monitoring of $SO_2$ concentrations at an urban background location in Brooke Park in Derry. For a detailed breakdown of the concentrations measured see the air quality archive web site at http://www.aeat.co.uk/netcen/airqual/
The annual average concentrations recorded at the site between 1999 and 2001 are shown in Table 5.3.1 below:

Table 5.3.1 Annual average $SO_2$ concentrations recorded at Brooke Park

| **Year** | **Concentration (μg/m³)** |
|---|---|
| 1999 | 10.6 |
| 2000 | 10.6 |
| 2001 | 10.6 |

### 5.3.2 Non-automatic monitoring

There has been monitoring of sulphur dioxide in DCC by three bubblers since the early 1970s. These sites are part of the UK smoke and sulphur dioxide network. The results for 2000/2001 for the two sites that were in operation are shown in Table 5.3.2 below.

**Table 5.3.2 Average $SO_2$ concentrations recorded in the Derry City council area between April 2000 and April 2001 (μg/m³).**

| **Site code** | **$SO_2$** |
|---|---|
| Londonderry 12 (Shantallow) | 38.12 (58) |
| Londonderry 14 (St Columb's Park) | 38.82 (120) |

(The number shown in brackets is the maximum daily mean recorded at each site)

The data are presented here for completeness, but sulphur dioxide diffusion tube measurements have limited application in the review and assessment process because the Strategy objectives are for short-term exposure. However, the following conversion figures are provided in the PSG:

$99.9^{th}$ percentile (15 minute means) = 1.8962 x maximum daily mean
$99.7^{th}$ percentile (1 hour mean) = 1.3691 x maximum daily mean

The maximum daily mean recorded in the Derry City area at Columb's Park was 120 μg/m³. Using the above figures this provides a $99.9^{th}$ percentile of the 15 minute mean of 228 μg/m³ and a $99.7^{th}$ percentile of the 1 hour mean of 164 μg/m³. These figures are below the objectives for $SO_2$ (266 μg/m³ as a 15 minute mean not to be exceeded more than 35 times a year and 350 μg/m³ as a 1 hour mean not to be exceeded more than 24 times a year).

## 5.4 IMPACT OF COMBUSTION PROCESSES IN DCC ON $SO_2$ CONCENTRATIONS.

Two large combustion plants (Coolkeeragh Power station and Dupont) were identified in the Stage one review and assessment as requiring further assessment in a stage 2. In addition, four combustion plants greater than 5 MW were identified as needing further analysis. These are discussed in the following sections.

### 5.4.1 Coolkeeragh Power Station

The existing power station consists of 5 heavy fuel oil boilers capable of generating 300 MW. However this plant is to be decommissioned by 31st December 2005 at the latest and replaced with a combined cycle gas turbine plant. For sulphur dioxide the 1 hour and 24 hour mean objectives are to be achieved by 31st December 2004. The 15 minute objective is to be achieved by 31st December 2005. Therefore the existing power station may still be in operation when the 1 hour and 24 hour objectives should apply. As a result both the existing fuel oiled power station and the proposed CCGT plant have been considered.

***Existing power station running on heavy fuel oil***

In the year 2000, the plant emitted 5,308 tonnes of $SO_2$. For further information on the power station, please see Section 3.5

Cordah used the dispersion model ADMS 2.2 to evaluate the impact of the plant on nearby $SO_2$ concentrations. The results are worst case scenarios as single maximum ground level mean annual concentration values are compared to AQS and these maxima occur in very restricted areas. The report concluded that predictions for 2001 - 2004 showed that $SO_2$ air quality criteria were unlikely to be exceeded under typical operations except for occasional elevated short term concentrations in relation to the 15 minute mean standard. The results of the modelling carried out by Cordah are shown in Table 4.5.1 below:

Table 4.5.1 - Predicted $SO_2$ concentrations (2001-2004) $\mu g/m^3$ (Harrop, 1998).

| | **Scenario 1 (worst case)** | **Scenario 2 (typical worst case)** |
|---|---|---|
| Annual mean (1 hr) | 18.4 | 35.2 |
| 99.9th percentile (15 minute) | 782 | 609 |
| 99th percentile (24 hour)⋆ | 184 | 352 |

⋆ Factors supplied in the PSG have been used to convert the annual mean to the 99th percentile of 24 hour means so that a comparison can be made with the $SO_2$ objectives.

Since this modelling was carried out the power station have now switched to 1% sulphur fuel. Prior to April 2001, the sulphur content used was 3%. Therefore it is likely that the $SO_2$ concentrations are now much lower than that predicted above.

***Proposed CCGT power station***

For an introduction to the proposed CCGT power station, please see Section 3.5.1 above. Emissions of $SO_2$ arising from the main stack when the plant is running on natural gas are negligible.

Dispersion modelling using ADMS was carried out by ESB International Environmental Services for the Environmental Statement for the unlikely scenario of the plant running on fuel oil with gases being emitted from the main stack. The results of the modelling showed that the highest predicted 99.9th percentile of 15 minute mean $SO_2$ concentrations was 260 $\mu g/m^3$ which occurred near the south east of the station, 0.6 kilometres from the site. This maximum short term concentration is about 98% of the AQS objective.
The predicted maximum 99.7th percentile of hourly $SO_2$ concentrations over land was 224 $\mu g/m^3$ near the site boundary. No exceedence of the 350 $\mu g/m^3$ AQS objective is predicted. The maximum

predicted 99.2 percentile of daily $SO_2$ concentrations was 97μg/m$^3$, although this area was over open water. The AQS objective for this averaging period is 125 μg/m$^3$.

ESB also carried out modelling to assess $SO_2$ concentrations based on the scenario of the CCGT plant burning fuel oil with the exhaust gases exiting from the by-pass stack. The results showed that the resulting 99.9$^{th}$ percentile of the 15 minute mean, 99.7$^{th}$ percentile of the hourly mean and 99.2 percentile of the daily average concentrations would be lower than when the gases exit through the main stack and would comply with the AQS objectives for these averaging periods.

To summarise, emissions of $SO_2$ arising from the CCGT plant when running on natural gas are negligible. The scenarios of the plant running on fuel oil emitting gases from the main stack or the plant burning fuel oil with exhaust gases exiting from the by-pass stack are unlikely. Presuming that the current power station is replaced with CCGT, it is recommended that there is no need to do a stage 3 review and assessment for this source.

### 5.4.2 DuPont COGEN Plant

For an introduction to this section, please see Section 3.5.2. Modelling of this plant was carried out by the Dames and Moore Group. The dispersion modelling exercise was run assuming the "worst case" for Boiler 6 & 7, that is running at 100% load for a full year and assuming that the emissions of prescribed substances were at their maximum during this period.

The model showed that the area of maximum concentration for the long term $SO_2$ average is within the DuPont site boundary. The maximum predicted value is 11.8 μg/m$^3$ and the concentration falls rapidly to a level of less than 4 μg/m$^3$ at any potential sensitive location. The one exception to this was an area to the south-east of the source where the maximum is predicted to be 6.4 μg/m$^3$.

For short term $SO_2$ average concentrations, the 99.9 percentile of one hour averages is maximum within the site boundary. Within approximately 1.5 km of the source the predicted 99.8 percentile concentration falls to below 80 μg/m$^3$ (less than 23% of the hourly standard).

The maximum 99.9 percentile for $SO_2$ 15 minute averages occurs within the site boundary, approximately 500 metres due east of the source. Within approximately 1.5 km of the source the predicted 99.9 percentile concentration falls to below 100μg/m$^3$ compared to a target value of 266 μg/m$^3$.

The above predictions are all within the AQS objectives for $SO_2$. The modelling carried out by Dames & Moore did not take in to account other nearby sources such as the Coolkeeragh Power Station. However this is now expected to be converted to a CCGT plant (by the end of 2005 at the latest) with negligible $SO_2$ emissions.

### 5.4.3 Altnagelvin Hospital

Altnagelvin Hospital is situated on Glenshane Road in Derry. This industry was identified in the Stage 1 review and assessment as requiring further assessment. Figure 7.1 provided in the PSG has been used to decide whether it is necessary to proceed to a stage 3 for this source. The nonogram in Figure 7.1 estimates the emissions rate in tonnes per annum which would produce a 99.9$^{th}$ percentile of 15 minute mean ground level concentration of 53.2 μg/m$^3$ (20 ppb), which is equivalent to 20% of the more stringent 15 minute mean objective.

Table 5.4.3 Specifications of combustion processes at Altnagelvin Hospital.

| | **Altnagelvin Hospital** |
|---|---|
| Temperature of emissions ($^0$C) | 197 - 210 |
| Stack height (m) | 27 |
| Stack diameter (m) | 0.8 |
| $SO_2$ tonnes per annum | 55.4 |
| Discharge velocity (m/s) | - |

The height of the tallest building within 5 stack heights of the chimney is 12 metres. The nonogram in PSG uses the effective stack height. This is equal to the actual stack height unless the height of the release is greater than 3 metres above the building on which it sits, but less than 2.5 times the height of the tallest adjacent building. In this case the effective stack height can be calculated from the following formula:

$U_{eff} = 1.66 * (U_{act} - H)$

Where H is the height of the tallest adjacent building in metres within 5 actual stack heights distance;
$U_{eff}$ is the effective stack height; and
$U_{act}$ is the actual (physical) stack height.

Applying this to the chimney at Altnagelvin hospital gives an effective stack height of 24.9 metres (1.66*(27-12)).

Using the nonogram provided in the PSG a permitted $SO_2$ emission of approximately 80 tonnes is obtained. This is above the actual emission of 55.4 tonnes and therefore there is no need to proceed to a stage 3 review and assessment for this source.

### 5.4.4 Seagate Technology

Seagate Technology is situated on Buncrana Road in Derry. There are three stacks at the site. Where there are multiple stacks at the same site the PSG recommends that a precautionary approach is taken and that the total emissions from all the stacks are taken to be released from the smallest stack.

Table 5.4.4 Specifications of combustion processes at Seagate Technology.

| | **Seagate Technology** |
|---|---|
| Temperature of emissions ($^0$C) | 150 - 180 |
| Stack height (m) | 27, 25, 25 |
| Stack diameter (m) | 0.4 *3, 0.55*3, 0.3*2 |
| $SO_2$ tonnes per annum | 15.5 |
| Discharge velocity (m/s) | - |

The height of the tallest building within 5 stack heights of the chimney is 12.7 metres. The nonogram in PSG uses the effective stack height. This is equal to the actual stack height unless the height of the release is greater than 3 metres above the building on which it sits, but less than 2.5 times the height of the tallest adjacent building. In this case the effective stack height can be calculated from the following formula:

$U_{eff} = 1.66 * (U_{act} - H)$

Where H is the height of the tallest adjacent building in metres within 5 actual stack heights distance;
$U_{eff}$ is the effective stack height; and
$U_{act}$ is the actual (physical) stack height.

Applying this to the chimneys at Seagate Technolgy gives an effective stack height of 20.4 metres (1.66*(25-12.7)).

The nonogram in the PSG requires the diameter. As there are multiple stacks at this site the effective stack diameter has been calculated. This is estimated to be 1.3 metres. Using the nonogram provided in the PSG a permitted $SO_2$ emission of approximately 120 tonnes is obtained. This is above the actual emission of 15.5 tonnes and therefore there is no need to proceed to a stage 3 review and assessment for this source.

### 5.4.5 Foyle Meats

Foyle meats is situated on Temple Road in Derry and burns tallow oil.

Table 5.4.5 Specifications of combustion processes at Foyle Meats.

| | **Foyle Meats** |
|---|---|
| Temperature of emissions ($^0$C) | 220 |
| Stack height (m) | 25.5 |
| Stack diameter (m) | 1.2 |
| $SO_2$ tonnes per annum | 62.5 |
| Discharge velocity (m/s) | - |

Using the nonogram provided in the PSG a permitted $SO_2$ emission of approximately 150 tonnes is obtained. This is above the actual emission of 62.5 tonnes and therefore there is no need to proceed to a stage 3 review and assessment for this source.

## 5.5 CONCLUSIONS FOR SULPHUR DIOXIDE CONCENTRATIONS IN THE DCC AREA

There were no predicted exceedences of the Strategy objectives in the DCC region and it is concluded that the National Strategy targets for sulphur dioxide will be achieved by the due dates in 2004 and 2005. There is no need to proceed to a Stage 3 Review and Assessment for this pollutant.

# 6 Conclusions and recommendations for each pollutant

## 6.1 NITROGEN DIOXIDE

Emissions arising from road transport at six road junctions in the DCC area may cause an exceedence of the AQS for nitrogen dioxide. It is therefore recommended that a stage 3 review and assessment is carried out for this source at the following locations:

Dungiven Road at Irish Street lights
Dungiven Road at Dales Corner
Glenshane Road at Altnagelvin hospital
Strand Road (junction with Barry Street, Philip Street & Meadow Bank Avenue)
Culmore / Buncrana
Buncrana Road at junction with Racecourse Road.

Emissions arising from the Coolkeeragh Power Station and DuPont site are not expected to lead to an exceedence of the objective.

## 6.2 PARTICULATE MATTER ($PM_{10}$)

Results from DMRB show that emissions from traffic are predicted to lead to an exceedence of the $PM_{10}$ objectives in 2004.

## 6.3 SULPHUR DIOXIDE

It is concluded that the Strategy objectives for sulphur dioxide are likely to be achieved by 2004. There is no need to progress to a more detailed Stage 3 review and assessment for this pollutant.

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# Appendices

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## Diffusion tube monitoring data

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# Appendix 2
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