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Air Quality Review and Assessment - Stage 2

A report produced for Larne Borough Council

February 2002

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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. Larne 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:

Nitrogen dioxide
It is recommended that Larne Borough Council proceed to a Stage 3 Review and Assessment for this pollutant at two locations:

- Larne Harbour Roundabout
- Antiville Rd/A8 Junction

Particulate matter (PM_{10})
There are likely to be significant emissions of PM_{10} associated with the shipping movements in Larne harbour. It is therefore recommended that these are quantified with detailed modelling and assessment within a Stage 3 Review and Assessment.

Sulphur dioxide
There are likely to be significant emissions of sulphur dioxide from shipping movements in Larne harbour. It is therefore receommended that these are quantified with detailed dispersion modelling and assessment within a Stage 3 Review and Assessment.

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
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 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 Larne 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 Larne Borough Council area
- Identifies any actions that are likely to be required by Larne Borough Council under Part IV of the GB Environment Act, 1995.
- Recommends actions, if necessary, to control the subsequent air quality within the Larne 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 Larne Borough Council area.
2. Model expected present and potential future levels of pollutant concentrations in the Larne 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 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).

1.3 STRUCTURE OF THIS REPORT

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.

1.4 INFORMATION PROVIDED BY LARNE BOROUGH COUNCIL TO SUPPORT THIS ASSESSMENT

The following information from information from Larne Borough Council 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
- Port and shipping details

1.4.1 Larne Borough and its environs

Larne Borough Council is situated on the East Coast of Northern Ireland and is often described as "The Gateway to Ulster" due to the operation of cross channel ferries from the port of Larne. The Borough covers an area of approximately 131km^2, stretching over 36 miles along the Antrim coastline from Islandmagee and Ballycarry in the south to Glenarm and Carnlough in the north. Two of the Glens of Antrim and the Antrim plateau make Larne borough very scenic with two thirds designated as an area of outstanding natural beauty.

The population of the council area is just over 30,000 of which Larne town alone makes up approximately 2/3 of the total population. Larne is a busy seaport and market town situated 20 miles north of Belfast. It is within easy reach of Northern Ireland's two main airports being 21 miles from Belfast International Airport and 24 miles from Belfast City Airport. The area is supported both by major roads and a continuous rail link to Belfast – Dublin route.
The manufacturing, tourism and agriculture industries provide the main economic base of the borough.

~~1.1.1.1~~1.4.1.1 Industrial and Transport Development in Larne Borough Council

Some developments may have an important impact on air quality in the future. Therefore they need to be included in the Stage 2 Review and Assessment. The construction of a CCGT power generation plant is planned for Ballylumford, Islandmagee. This was noted in the Stage 1 as requiring further investigation.

1.4.2 Local air quality monitoring data

1.4.2.1 Extent of data available

Larne Borough Council have carried out monitoring of nitrogen dioxide at five sites in the area using passive diffusion tube samplers. Appendix 1 gives more information about the local air quality monitoring.

~~1.1.1.2~~1.4.2.2 Quality Assurance/Quality control of data

The diffusion tubes were analysed by analysed by the Ruddock and Sherratt Analyst laboratory which participate in the laboratory intercomparison exercises for the UK National NO_2 Diffusion Tube Network. The results would usually be corrected for analyst bias, as advised in the Pollutant Specific Guidance, for the year the data was collected. However in 1997 there was no intercomparison and therefore the lab bias will be based upon the laboratory's performance in other years. It is possible to do this as Ruddock and Sherratt have a consistent pattern of under-reading over many years.

~~1.1.4~~1.4.3 Traffic data

Appendix 2 summarises the traffic information used in the assessment, mostly 2002 traffic counts, the remaining routes were counts from varying dates.

~~1.1.1.1~~1.4.3.1 Flow and speed

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

~~1.1.1.2~~1.4.3.2 Traffic growth

The national air quality objectives are targets for 2004 or 2005. The predicted increase in traffic flows for the years 2004 and 2005 relative to the date of traffic counts have been supplied by Larne Borough Council.

~~1.1.1.3~~1.4.3.3 Fraction of HGVs

The model requires estimates of the fraction of HGVs on the roads to predict the pollutant concentrations. These data was available from Larne Borough Council.

~~1.1.1.4~~1.4.3.4 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 Larne Borough Council in the form of maps (scale 1:1250) on which the required distances could be measured.

~~1.1.6~~1.4.4 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. Larne Borough Council provided a list of Part A and B processes that needed further assessment in a Stage 2. The list included:

- One Part A process in Carrickfergus Borough Council; Kilroot Power Station
- One Part A process in Larne Borough Council area; Ballylumford Power Station.

1.5 SHIPPING IN LARNE

Larne is a significant port town and therefore the effects of the port on local air quality will be considered in this report. There is potential for significant emissions from the ships themselves but also the traffic associated with the port.

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

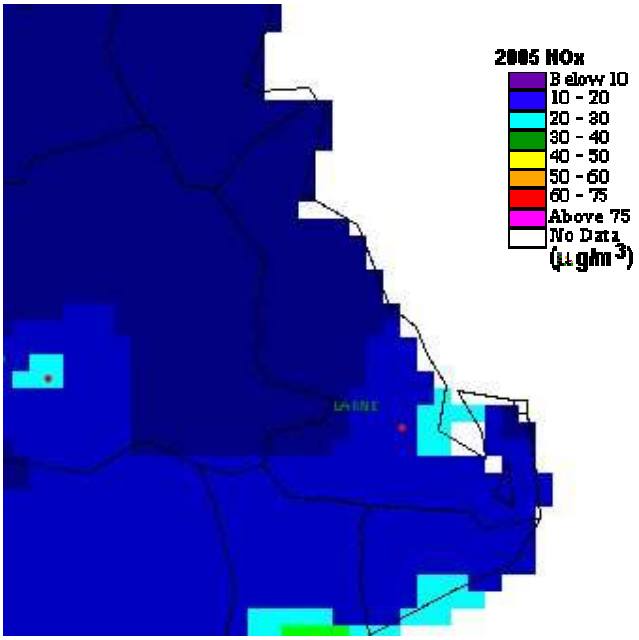
All combustion processes produce some NO_x, but only NO_2 is associated with adverse effects on human health. The main sources of NO_x in the United Kingdom are road transport, which, in 1997 accounted for about half of the emissions, power generation (20%), and domestic sources (4%). In urban areas, 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~~3.2BACKGROUND CONCENTRATIONS OF NITROGEN DIOXIDE

Background concentrations were obtained for the Larne area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html (see figure 3.1).

Figure 3.1 Background NO_x concentrations 2005



An estimated NO_x background concentration has been taken from the map by taking the highest background value in the dataset for a conservative estimate. A background NO_x estimate of 15.6µg/m^3 has been estimated for 2005 in the Larne Borough Council region.

~~1.3~~3.3MONITORING OF NITROGEN DIOXIDE

3.3.1 Diffusion tube data

Larne Borough Council have monitored monthly average concentrations of with passive diffusion tube samplers at five sites in Larne. The Results for 1997 are summarised in Table 3.1 and the data are presented in full in Appendix 1. The monitoring period is representative of a full year and therefore the period average concentrations can be compared with the annual mean objective. The Ruddock and Sherratt Analyst laboratory carried out analysis of the tubes but here was no NO_2 field intercomparison in 1997 or 1996.
However, mean bias achieved by Ruddock and Sherratt in subsequent years' intercomparisons, was as follows:

1998: -23.8% with respect to chemiluminescent analyser, -18.2% relative to mean of all diffusion tubes.
1999: -23.7% with respect to chemiluminescent analyser

2000: -13.7% with respect to chemiluminescent analyser, -27.0% relative to mean of all diffusion tubes.
2001: -46.5% with respect to chemiluminescent analyser

In addition to the field intercomparison, participating laboratories also have to take part in a monthly performance test involving analysis of "doped" diffusion tubes. In 1997, Ruddock and Sherratt's results in the doped tube analysis underestimated by 15% on average.

It is clear that this laboratory's NO_2 tube results typically under-read relative to the reference method and this has been a consistent pattern for some years. For 1997 it has been assumed that the laboratory bias for the Ruddock and Sherratt laboratory in 1997 had a negative bias of 20%.

Table 3.1. Annual average concentrations measured at locations in the Larne area.

		97 annual average ppb	annual average mg/m3	corrected for bias mg/m3	projection for 2005 mg/m3
1	Glenarm Rd	11.0	21.0	25.2	20.5
2	Main Street	13.5	25.8	30.9	25.2
3	Circular Rd	13.9	26.6	31.9	26.0
4	Cross St	12.1	23.1	27.8	22.6
5	Upper Main St	13.7	26.2	31.4	25.6

All kerbside, i.e. 1-5m from a busy road

The diffusion tubes placed at the roadside locations did not exceed the annual mean objective for nitrogen dioxide of 40 $\mu g/m^3$ and are predicted to remain within the objectives in 2005. It is therefore likely that the NO_2 annual mean objective will not be met at these locations in 2005.

3.4 IMPACT OF ROAD TRAFFIC ON CONCENTRATIONS OF OXIDES OF NITROGEN

The Stage one Review and Assessment for Larne Borough Council identified several areas in Larne as needing further study in a Stage two assessment. The concentrations at these roadside locations were estimated using the Design Manual for Roads and Bridges (DMRB) using the traffic flow data provided by Larne Borough Council. 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.

Concentrations have been assessed at the traffic speeds relevant to each road as supplied by Larne Borough Council. 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. This information was obtained from maps supplied by Larne Borough Council.

Table 3.2 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 Larne 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 exceed the 40 $\mu g\ m^{-3}$ objective at two sites, the Antiville Rd/ A8 Junction and the Larne Harbour

roundabout. This is as a result of the exceptionally high HGV% of 26%.which is as a result of the goods traffic to and from the harbour on that road. At all other locations the air quality objectives are predicted to be met.

Table 3.2 Nitrogen dioxide concentrations at roadside locations in the Larne District

Description of Link	NO2 Annual mean ($\mu g/m^3$) 2005	NO2 99.8th percentile of hourly averages ($\mu g/m^3$) 2005
Antiville Rd/A8 Junction	53.6	187.5
Antiville Rd/Mill Brae/Linn Rd Junction	25.2	88.2
Antiville Rd/Lower Cairncastle Rd/Upper Cairncastle Rd Junction	22.9	80.2
The Roddens	25.6	89.5
StationRd/Circular Rd Junction	24.7	86.5
Bank Rd/Gylnn Rd Junction	26.4	92.5
Victoria Rd/Old Glenarm Rd/Agnew St junction	30.7	107.3
Circular Road/Curran Rd/Glenarm Rd/Main St Junction	28.9	101.2
Thorndale Av/Pound St	19.2	67.4
Main St	16.1	56.4
Pound Street	14.7	58.8
Larne Harbour Roundabout	55.6	194.5

The nitrogen dioxide objectives are predicted to be exceeded at 2 sites in Larne and it is therefore necessary to proceed to a stage 3 review and assessment for the two sites:

- Larne Harbour Roundabout
- Antiville Rd/A8 Junction

3.5 IMPACT OF INDUSTRY ON CONCENTRATIONS OF NITROGEN OXIDES

The Stage 1 Review and Assessment for Larne Borough Council concluded that one Part A authorised processes needed further investigation to determine whether it was necessary to proceed to a Stage 3 Review and Assessment. The industry identified was the Ballylumford power generation plant.

3.5.1 Ballylumford Power Generation Plant

An Environmental Impact Assessment has been carried out by Hyder for the proposed Ballylumford power generation plant which showed that there is not likely to be an NO_2 objective exceedance after the proposed developments are in place. This assessment involved modelling of pollutant dispersion using ADMS. The model produced isopleth plots that indicted the geographical areas where the highest ground level concentrations are predicted to occur which are in the vicinity of Island Magee and offshore in the Irish Sea (Hyder, 1999). These locations are within a few hundred metres of the existing and proposed power station sites. The worst case scenarios for operating conditions were modelled and despite this the results of predictive modelling indicate that the air quality objectives will not be exceeded at any receptor location (Hyder, 1999). There is therefore no need to progress further with review and assessment of Nitrogen Dioxide from this source.

3.5.2 Kilroot power station, Carrickfergus.

According to the Larne Stage one review and assessment only the Part A process, Kilroot power station, in the Carrickfergus area, needs consideration for NO_2 emissions. However the Carrickfergus Borough Council Stage 1 review and assessment has referenced the details of the plant to a nomogram as advised in the GB Government Guidance and determined a 2nd stage review necessary. In the 2nd stage review and assessment undertaken by Carrickfergus Borough Council it was predicted that maximum concentrations as a result of emissions from Kilroot would not cause an exceedence of the objective for NO_2 (Carrickfergus Borough Council, 2002). Consequently Larne Borough Council does not need to further consider the effects of Kilroot power station on concentrations within the Larne area.

3.6 CONCLUSIONS FOR NITROGEN DIOXIDE CONCENTRATIONS IN THE LARNE BOROUGH COUNCIL AREA

Emissions from industrial sources are not predicted to lead to an exceedence of the nitrogen dioxide objectives in 2005. In addition, diffusion tube concentrations and predictions show that the objectives are likely to be met at their locations.
However, emissions arising from road transport at two locations in Larne, where HGV percentage is high and receptors are in the close vicinity, are predicted to cause exceedances of the annual average objective. It is therefore recommended that Larne Borough Council deploy diffusion tubes for the measurement of nitrogen dioxide at these locations and consider proceeding to a Stage 3 Review and Assessment for this pollutant at two locations:

- Larne Harbour Roundabout
- Antiville Rd/A8 Junction

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 μg m^{-3} (gravimetric);
- A maximum 24-hourly mean concentration of 50 μg m^{-3} (gravimetric) not to be exceeded more than 35 times a year.

4.1.2 The National Perspective

National UK emissions of primary PM_{10} have been estimated as totalling 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.

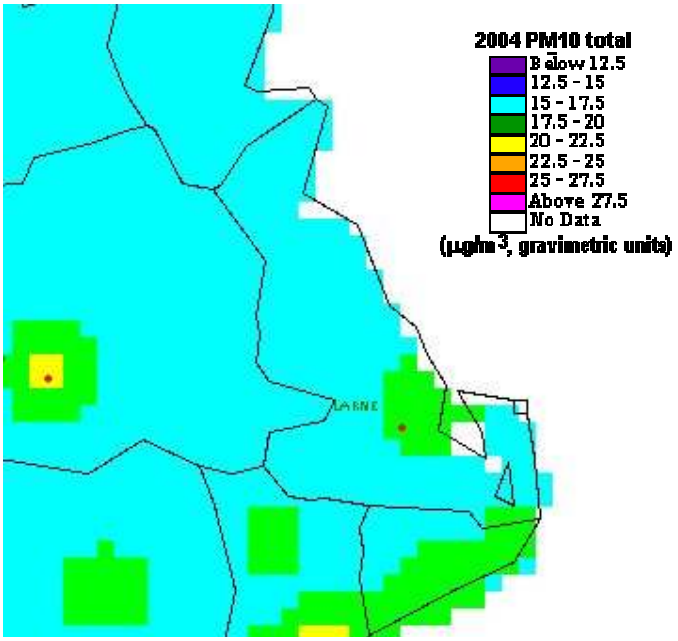
~~1.2~~4.2 MONITORING OF PM_{10}

There is no PM_{10} monitoring data available for Larne Borough Council.

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

Estimates of background concentrations of PM_{10} were obtained for the Larne 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 4.1 shows that the estimated annual average background concentration for 2004 in Larne was 20 μg/m^3 or lower.

Figure 4.1. Background PM_{10} concentrations 2004



4.4 IMPACT OF ROAD TRAFFIC ON PM_{10}

4.4.1 Prediction for 2004

As recommended in GB 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 18.8μg m^{-3} for Larne has been used to provide total predicted PM_{10} concentrations. Estimated traffic flows were provided for 2005 which will provide a conservative estimate of concentrations for the objective year of 2004.

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 4.1 shows the 2004 predictions that may be compared against the objectives. For 2004, the method predicts annual average concentrations of PM_{10} less than 28μg m^{-3} at all of the locations modelled. Therefore the objectives are not likely to be exceeded.

Table 4.1. Predicted PM_{10} concentrations at roadside locations in the Larne Borough Council region.

Description of Link	PM10 Annual mean (μg/m^3) 2004
Antiville Rd/A8 Junction	22.0
Antiville Rd/Mill Brae/Linn Rd Junction	19.9
Antiville Rd/Lower Cairncastle Rd/Upper Cairncastle Rd Junction	19.7
The Roddens	20.0
StationRd/Circular Rd Junction	19.8
Bank Rd/Gylnn Rd Junction	20.0
Victoria Rd/Old Glenarm Rd/Agnew St junction	20.3
Circular Road/Curran Rd/Glenarm Rd/Main St Junction	20.2
Thorndale Av/Pound St	19.4
Main St	19.1
Pound Street	19.0
Larne Harbour Roundabout	23.1

Note: High St traffic data was not available so assumed to be the same as Pound St.

4.5 IMPACT OF INDUSTRY ON CONCENTRATIONS OF PM_{10}

4.5.1 Part A Processes

Larne Borough Council suggest that only the Part A process of Kilroot power station requires further consideration at the stage 2 review and assessment. Kilroot Power station is a oil fired power station situated in Carrickfergus.

Table 4.2 Specifications of combustion processes at Kilroot Power station

	Kilroot Power Station
Temperature of emissions (^{0}C)	120
Stack height (m)	200
Stack diameter (m)	8
PM_{10} tonnes per annum	226

The height of the tallest building within 5 stack heights is 57 metres. The nomogram provided in Figure 8.5 in the PSG provides the annual PM_{10} emission which will give rise to a 90th percentile of the 24 hour ground level concentration of 1 $\mu g/m^3$. Using this nomogram, the permitted PM_{10} emission rate with an industry of the above dimensions is 1,800 tonnes per annum. This is well above the actual emission of 226 tonnes per annum and therefore there is no need to proceed to a Stage 3 Review and Assessment for this source.

4.6 LARNE PORT

Significant emissions of PM_{10} can arise from shipping and the handling of dusty cargoes. There were 5591 vessels that used Larne port in 1999 (source NAEI 1999) the majority of which are roll on-roll off vessels. The nearest residential housing is within 500 metres of the berthing area. Pollutant specific guidance states that "shipping movements can give rise to PM_{10} emissions but there is only the potential for significant impact where there are a large number of ships, e.g. major ports with properties within close proximity". However it also states that "due to the uncertainties in emissions for uncontrolled or fugitive dust release there is no suitable screening approach which can be confidently applied to the 2nd stage review and assessment. In the absence of local monitoring data it is recommended that it would be prudent to assess this source further. Therefore, it is recommended that a modelling and monitoring study is completed as a part of a third stage review and assessment.

4.7 CONCLUSIONS FOR PM_{10} CONCENTRATIONS IN THE LARNE BOROUGH COUNCIL AREA

Emissions from traffic and industrial sources are not predicted to lead to an exceedence of the PM_{10} objectives in 2004. However there is the possibility that there could be significant emissions of PM_{10} associated with the shipping movements in Larne harbour. It is therefore recommended that Larne Borough Council proceed to a Stage 3 Review and Assessment for shipping movement sourced PM_{10} emissions.

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

The 15 minute mean objective is the most stringent; the other two objectives 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%.

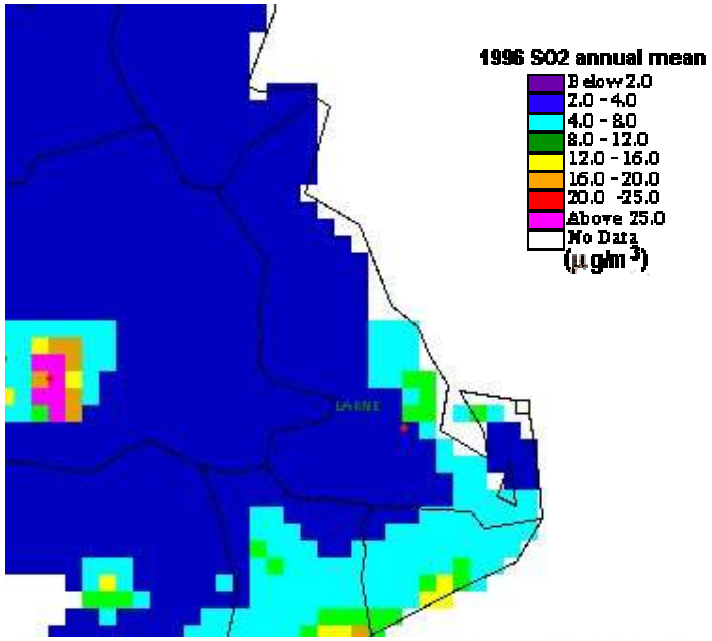
Exceedences of the 15-minute air quality standard currently occur near industrial processes for which the stack heights were designed to meet previous air quality standards and downwind of large combustion plant such as power stations. Exceedences are also possible in areas where significant quantities 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 of lead were obtained for the Larne Borough area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. Figure 5.1 shows the most recent estimates available, for 1996. The estimated annual average concentration for 1996 in the Larne Borough Council area was below 16 μg m^{-3}(6 ppb). Guidance TG4(00) assumes that the annual mean at the end of 2004 and 2005 will be half the 1996 annual mean, however because of the high coal burning nature of the region it has been decided to assume the annual mean at the end of 2004 and 2005 will be ¾ the 1996 annual mean.. Thus the estimated annual mean background concentration in the Larne Borough Council area in 2004 will be 12 μg m^{-3}.

Figure 5.1. Background SO_2 concentrations 1996



~~1.2~~5.3MONITORING OF SULPHUR DIOXIDE

Larne Borough Council have carried out sulphur dioxide monitoring at one site in Larne using an 8 port bubbler monitoring system. The bubbler is located at the junction of Pound Street and Thorndale Avenue. The recent results are summarised in Table 5.1 as average daily concentrations on a monthly basis. The results can therefore be compared against the 24 hour mean objective for sulphur dioxide. The objective states that by the end of 2004 the limit of 125μg/m^3 must be met with not

more than 3 exceedances per year. The results show that at the particular location of the bubbler it is extremely unlikely that the objective will be exceeded.

Table 5.1. Port Bubbler Sulphur dioxide monitoring results (µg/m^3)

1999	Smoke	SO_2	2000	Smoke	SO_2	2001	Smoke	SO_2
Jan	14	14	Jan	18	20	Jan	16	17
Feb	7	14	Feb	18	20	Feb	9	15
Mar	5	13	Mar	11	19	Mar	9	16
Apr	5	21	Apr	8	16	Apr	5	15
May	5	24	May	7	16	May		
Jun	8	15	Jun	4	18	Jun		
Jul	4	14	Jul			Jul		
Aug	8	18	Aug	3	14	Aug	8	15
Sep	4	16	Sep	5	16	Sep	10	17
Oct	11	17	Oct	6	20	Oct	11	19
Nov	17	18	Nov	10	21	Nov	16	19
Dec	12	16	Dec			Dec	14	19
Average	**8**	**17**	**Average**	**9**	**18**	**Average**	**11**	**17**

5.4 IMPACT OF INDUSTRY ON CONCENTRATIONS OF SULPHUR DIOXIDE

The Stage 1 Review and Assessment Report prepared by Larne Borough Council stated that there are 2 processes needing further assessment:

- Ballylumford CCGT Power Generation Plant,
- Kilroot Power Station, Carrickfergus.

5.4.1 Ballylumford CCGT Power Generation Plant

An Environmental Impact Assessment has been carried out by Hyder for the proposed Ballylumford power generation plant. And the report clearly shows that there is not likely to be an SO_2 exceedance with Ballylumford after the proposed developments are in place. However, a worst case scenario was modelled where the plant was operating full time on distillate and low sulphur oil which is only designed as a back up in case of gas supply interruption. This does indicate exceedances. However, this is a worst case scenario and a more realistic scenario of operation on standby fuel is unlikely to exceed 55days and that dilution of the modelled full time use of standby fuel with natural gas will bring the concentrations down below the objective level. The ADMS modelling undertaken by Hyder assume a 1% Sulphur content which is the maximum allowed, they state that it is likely the Sulphur content will in practice be lower than this. As the Local Air Quality Review and Assessment process should be followed with realistic scenario predictions it is concluded that Ballylumford power station is not likely to result in an exceedance on an air quality objective and therefore a stage 3 review and assessment is not needed for this plant.

5.4.2 Kilroot power station, Carrickfergus.

According to the Larne Stage one review and assessment only the Part A process, Kilroot power station, in the Carrickfergus area, needs consideration for SO_2 emissions. Carrickfergus Borough Council Stage 1 review and assessment has referenced the details of the plant to a nomogram as advised in the GB Government Guidance and determined a 2nd stage review necessary. In the 2nd stage review and assessment undertaken by Carrickfergus Borough Council it was predicted that maximum concentrations as a result of emissions from Kilroot would not cause an exceedence of the objective for SO_2 (Carrickfergus Borough Council, 2002). Consequently Larne Borough Council does not need to further consider the effects of Kilroot power station on concentrations within the Larne area.

5.5 LARNE HARBOUR

Government Pollutant Specific Guidance advises that shipping movements can give rise to SO_2 emissions. There is only the potential for a significant impact where there are a large number of ships and there is potential for public exposure within close proximity.

Other Councils with ports in the UK have assessed the effect of emissions from ships. For example monitoring has been undertaken in the Southampton harbour area. Sulphur dioxide was continuously monitored at 3 sites including the harbour area. Southampton docks is a less busy port than Larne (4244 vessels compared to Larne's 4667 per year) and so it can be expected that the effect of shipping would be higher in Larne that Southampton. The Southampton Borough Council Stage 3 Review and Assessment (http://www.southampton.gov.uk/government/environment/environhlth/aqcontents3.htm) found that shipping did cause short lived peaks of SO_2 in areas quite close to the docks but that these were relatively infrequent and very dependant on wind direction. The plumes of SO_2 were very localised and rarely had an impact beyond 1km. Southampton concluded that the sulphur dioxide objective would be met in 2005 as residential housing were not in the close vicinity of the docks.

Larne is a busy port and there is residential housing within 500m of the docking area. It is recommended that Larne Borough Council consider monitoring in this area and proceeding to a Stage 3 review and assessment.

5.6 CONCLUSIONS FOR SULPHUR DIOXIDE CONCENTRATIONS IN THE LARNE BOROUGH COUNCIL AREA

There is uncertainty over the effect that shipping may have on SO_2 concentrations in the direct harbour area, where there is housing within 500m of the docking area. Therefore it is recommended that Larne Borough Council undertake some monitoring. It is therefore concluded that there is a need to further investigate this source of SO_2 in a stage 3 review and assessment.

6 Conclusions and recommendations for each pollutant

6.1 NITROGEN DIOXIDE

Emissions from industrial sources are not predicted to lead to an exceedance of the nitrogen dioxide objectives in 2005. In addition, measurements of nitrogen dioxide with diffusion tubes show that the objectives are likely to be met at these locations. However, emissions arising from road transport at two locations in Larne, where HGV percentage is high and there are receptors in close vicinity, are predicted to cause an exceedances of the annual mean objective. It is therefore recommended that Larne Borough Council proceed to a Stage 3 Review and Assessment for this pollutant at two locations:

- Larne Harbour Roundabout
- Antiville Rd/A8 Junction

6.2 PARTICULATE MATTER (PM_{10})

Emissions from traffic and industrial sources are not predicted to lead to an exceedance of the PM_{10} objectives in 2004. However there is the possibility that there could be significant emissions of PM_{10} associated with the shipping movements in Larne harbour. It is therefore recommended that Larne Borough Council proceed to a Stage 3 Review and Assessment for shipping movement sourced PM_{10} emissions.

6.3 SULPHUR DIOXIDE

There is uncertainty over the effect that shipping may have on SO_2 concentrations in the direct harbour area, where there is housing within 500m of the docking area. Therefore it is recommended that Larne Borough Council undertake monitoring of sulphur dioxide. It is concluded that there is a need to further investigate this source of SO_2 in a stage 3 review assessment.

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Appendices

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Appendix 1

Diffusion Tube Data

Larne Diffusion Tube NO_2 Data:

		ppb	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98
1	1	Glenarm Rd	9.5	15.9	10.0	9.2	11.0	10.8	10.1	10.3	9.5	10.1	11.2	13.6	10.0	6.7	9.8
2	2	Main Street	9.2	15.3	12.7	13.1	13.4	13.4	9.7	13.9	14.3	14.7		15.2	12.7	16.9	15.3
3	3	Circular Rd	11.4	17.2	11.4	11.8	14.3	14.4	14.1	13.6	12.6	14.5	14.3	16.0	12.7	12.5	15.3
4	4	Cross St	16.5	17.7	8.3	12.2	7.8	10.4	7.9	13.9	12.2	14.8	14.1	16.0	10.1	14.3	11.7
5	5	Upper Main St	13.0	14.7		14.4	14.3	12.4	10.3	14.9	10.5	14.1	15.8	16.3	13.0	10.7	16.9

	ppb	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97
3	Higginnsons Lane, Islandmagee	3.9		3.6	3.5	2.8	
2	The Beacon, Glynn	6.2		4.1	4.2	1.9	4.1
1	The Roddens, Larne	9.8		5.5	8.3	7.8	9.3

As there was only a full years data for the first table of sites this was used to calculate the annual average NO_2 projection for 2005

		1997 annual average ppb	1997 annual average μg/m3	corrected for bias μg/m3	projection for 2005 μg/m3
1	Glenarm Rd	11.0	21.0	30.7	25.0
2	Main Street	13.5	25.8	37.7	30.7
3	Circular Rd	13.9	26.6	38.9	31.7
4	Cross St	12.1	23.1	33.9	27.6
5	Upper Main St	13.7	26.2	38.3	31.2

Appendix 2

Traffic Data

New Traffic Counts

Road	Date of traffic count	Volume of traffic v.p.d.	Predicted Volume in 2004 v.p.d.	Predicted volume in 2005 v.p.d.	Difference from data supplied in 1st stage report
Antiville Rd	February 2002	9153	9458	9615	Higher by approx. 800 v.p.d.
Mill Brae	February 2002	3168	3274	3328	Lower by approx. 1000 v.p.d.
Thorndale Av	February 2002	4791	4951	5033	Nearly half that predicted in stage 1 report
Curran Rd	February 2002	5733	5924	6022	Lower by approx. 2000 v.p.d.
Circular Rd	February 2002	7132	7370	7492	Lower by approx. 2000 v.p.d.
Upper Cairncastle Rd	February 2002	6927	7158	7277	Lower by approx. 1000 v.p.d.

The following are the original counts used in the stage 1 review and assessment and also here in this stage 2 where there were no counts from February 2002 available.

Road Name	**Location**	**Date of Traffic Count**	**Average Speed Of road**	**Volume of Traffic v.p.d.**	**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**
Bank Road		December 2000	30 mph	5,304	5,664	5,758
Glynn Road		March 2001	30 mph	4,075	4,280	4,351
Circular Road		June 1992	30 mph	7,347	9,105	9,256
Junction	**Type of Junction**		**Average Speed of junction**		**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**
Bank Road/Glynn Road Junction	T-Junction		30 mph		9,944	10,109

Total traffic at junction obtained by adding the volume of both the Bank Road and Glynn Road
% H.G.V. (assumed) 10%

Road Name	**Location**	**Date of Traffic Count**	**Average Speed Of road**	**Volume of Traffic v.p.d.**	**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**
Station Road		March 2001	30 mph	3,365	3,534	3,593
Circular Road		March 2001	30 mph	5,158	5,418	5,507
Junction	**Type of Junction**		**Average Speed of junction**		**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**
Station Road with Circular Road	T-Junction		30 mph		8,952	9,100

% H.G.V (assumed) 10%

Road Name	Location	Date of Traffic Count	Average Speed of road	Volume of Traffic v.p.d.	Predicted Volume In 2004 v.p.d.	Predicted Volume In 2005 v.p.d.
Victoria Road		January 2001	30 mph	8,346	8,766	8,912
Old Glenarm Road		September 2001	30 mph	7,510	7,888	8,019
Agnew Street		January 2001	30 mph	7,624	8,008	8,140
Junction	**Type of Junction**		**Average Speed of junction**		**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**
Victoria Road/Old Glenarm Road/Agnew Street	Crossroads		15 mph		16,774	17,052

Total at junction obtained by adding the two roads with the highest volume of traffic i.e. Victoria Road and Agnew Street.
% HGV (assumed) 10%

Road Name	Location	Date of Traffic Count	Average Speed of road	Volume of Traffic v.p.d.	Predicted Volume In 2004 v.p.d.	Predicted Volume In 2005 v.p.d.
Thorndale Avenue		October 1980	30 mph	4,611	9,108	9,259
Pound Street	Slip road off dual carriageway	January 1992	30 mph	2,552	3,163	3,215
Junction	**Type of Junction**		**Average Speeed at junction**		**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**
Thorndale Avenue with Pound Street	T-Junction		20 mph		12,271	12,474

Total at junction obtained by adding the volume of traffic of both roads.
% HGV (assumed) 8%

Road Name	**Location**	**Average speed of road**	**Date of Traffic Count**	**Volume of Traffic v.p.d.**	**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**
Circular Road	Outside Builders Yard	30 mph	June 1992	7,347	9,105	9,256
Curran Road	East of traffic lights	30 mph	January 1993	6,115	7,426	7,549
Glenarm Road	North of Hawkinge Avenue	30 mph	September 1999	3,172	3,447	3,504
Main Street		30 mph	January 2001	3,713	3,900	3,965
Junction	**Type of Junction**	**Average Speed of junction**	**Predicted Volume In 2004 v.p.d.**	**Predicted Volume In 2005 v.p.d.**		
Circular Road/Curran Road/Glenarm Road/ Main Street	Cross roads	20 mph	16,531	16,805		

Total at junction obtained by combining the two roads with the greatest volume of traffic.
% HGV (assumed) Main Street 8%
Other roads 10 % HGV assumed

Road Name	Location	Date of Count	Average speed Of traffic	Volume of traffic v.p.d	Predicted volume Of traffic in 2004 v.p.d.	Predicted volume Of traffic in 2005 v.p.d
Antiville Road	Junction with A8	May 1976	30 mph	7,200	8,387	8,527
A8 Dual Carriageway	N/E A36 Junction	October 1998	70 mph	16,623	18,377	18,681

Junction	Type of Junction	Average speed of Junction	Predicted Volume In 2004	Predicted Volume In 2005
Antiville with A8	T-Junction	30 mph	26,764	27,208

Total at junction obtained by adding volume of both roads
% HGV (Assumed) on A8 dual carriageway 26% - due to harbour traffic

Road Name	Location	Date of Count	Average speed Of traffic	Volume of traffic v.p.d	Predicted volume Of traffic in 2004 v.p.d.	Predicted volume Of traffic in 2005 v.p.d
Pound Street	Slip road off Dual Carriageway	January 1992	30 mph	2,552	3,163	3,215
High Street		January 2001	30 mph	8,208	8,621	8,764

Junction	Type of Junction	Average speed at Junction	Predicted Volume In 2004	Predicted Volume In 2005
Pound Street/ High Street	T-Junction	20 mph	11,784	11,979

Total at junction obtained by adding the volume of traffic of both roads.

% HGV (assumed) at junction 8%

Road Name	Location of Traffic counter	Date of Count	Average speed Of traffic	Volume of traffic v.p.d	Predicted volume Of traffic in 2004 v.p.d.	Predicted volume Of traffic in 2005 v.p.d
Antiville Road	Junction with A8	May 1976	30 mph	7,200	8,387	8,527
Mill Brae	At junction With Lower Cairncastle Rd	August 1984	30 mph	2,387	4,153	4,221
Linn Road	At Antiville Junction	March 1996	30 mph	6,250	7,158	7,276

Junction	Type of Junction	Average speed of Junction	Predicted Volume In 2004	Predicted Volume In 2005
Antiville Road/ Mill Brae/ Linn Rd	Crossroads	20 mph	15,545	15,803

Total traffic volume at junction obtained by adding the two roads with the greatest volume.
% HGV (assumed) 8%

Road Name	Location of Traffic counter	Date of Count	Average speed Of traffic	Volume of traffic v.p.d	Predicted volume Of traffic in 2004 v.p.d.	Predicted volume Of traffic in 2005 v.p.d
Antiville Road	Junction with A8	May 1976	30 mph	7,200	8,387	8,527
Lower Cairncastle Rd	Outside High School	October 1993	30 mph	2,955	3,588	3,648
Upper Cairncastle Rd	At Antiville Junction	March 1996	30 mph	7,007	8,025	8,158

Junction	Type of Junction	Average speed at Junction	Predicted Volume In 2004	Predicted Volume In 2005
Antiville Road/ Lower Cairncastle Road/Upper Cairncastle Road	Crossroads	20 mph	16,412	16,685

Total traffic volume at junction obtained by adding the two roads with greatest volumes
% HGV (assumed) 8%

Road Name	Location of Traffic counter	Date of Count	Average speed Of traffic	Volume of traffic v.p.d	Predicted volume Of traffic in 2004 v.p.d.	Predicted volume Of traffic in 2005 v.p.d
The Roddens	At Greenland Road junction	August 1976	30 mph	5,894	13,155	13,373

% HGV (assumed) 8%