ENVIRONMENTAL HEALTH SECTION

Environment (N.I.) Order 2002

Air Quality Review and Assessment

Progress Report 2004

April 2005

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Air Quality Review And Assessment

Stages 2 and 3

A Report of the Review and Assessment of Air Quality
As required under Part III of the Environment (N.I.) Order 2002,
Representing Stage 2 and Stage 3.

April 2004

Antrim Borough Council

Environmental Health Section

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APPENDICES

Executive Summary

This report covers the Second and Third Stages of review and assessment of air quality within the Borough of Antrim.

Antrim Borough Council is required under Part III of the Environment (NI) Order 2002 to undertake the Local Air Quality Management (LAQM) process, through the review and assessment of air quality.

This process is to enable district councils to appraise current and future air quality for their geographical area, against the current Air Quality Strategy (AQS) objectives for future years. These objectives are set out in the Air Quality Regulations (NI) 2002. If the results of the assessment are such that one or more of the objectives are unlikely to be met by the relevant year, the Council is then required to designate an Air Quality Management Area (AQMA) and prepare a written action plan.

The Council has previously undertaken the First Stage review and assessment which was completed in March 2001. The conclusions from the Stage 1 report were that Stage 2 review and assessments were required for three pollutants, nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulates (PM_{10}).

The Second Stage review and assessment provides a further screening of pollutant concentrations in district council areas. This involves estimating, through the use of monitored or modelled data, the highest likely concentrations of air pollutants within the district council area and the localities where they may occur, in order to assess whether there is a significant risk of an air quality objective not being met.

The National Environmental Technology Centre (NETCEN) was appointed to carry out the Second Stage review and assessment for road vehicular and industrial sources of the pollutants of interest. This consisted of an examination of the locations and sizes of principal emission sources, emissions modelling exercises and reference to monitored air quality data. The review and assessment for domestic sources of SO_2 was based primarily on an evaluation of results of local air quality monitoring.

The conclusions for the Second Stage review and assessment are as follows;

The air quality objective for the following pollutants are likely to be met and a Third Stage review and assessment is not required for the following pollutants:

- Particulates (PM_{10})
- Nitrogen dioxide

The risk of the air quality objectives for sulphur dioxide being exceeded as the result of domestic solid fuel burning cannot be ruled out and there is a need to proceed to a Third Stage review and assessment for this pollutant.

The Third Stage review is a detailed review and assessment of current and future air quality in a particular district using more sophisticated modelling and monitoring techniques. This enables a district council to predict whether or not an objective will be met by the appropriate date and so determine the location of any necessary AQMAs.

NETCEN was appointed to carry out the Third Stage review and assessment on behalf of the Council. This involved the investigation of sulphur dioxide levels through an examination of the locations and sizes of domestic sources, emissions modelling exercises and by reference to monitored air quality data.

As part of the review NETCEN carried out detailed modelling, using an atmospheric dispersion model, for a 2.5 x 2.5 Km^2 grid, within Antrim town, which includes 5 residential areas with high levels of domestic solid fuel burning. These areas were modelled together because of their close proximity. The areas are;

- Parkhall Estate
- Stiles Estate
- Ballycraigy Estate
- Newpark Estate
- Greystone Estate

Input data for the modelling was obtained from a fuel use survey conducted in the estates. As there is no continuous monitoring of sulphur dioxide in the Antrim Borough the model results have been bias corrected using data from a continuous monitor in Carrickfergus.

The conclusions from the Third Stage review and assessment are that in the Parkhall, Newpark, and Stiles Estates the sulphur dioxide objectives are unlikely to be exceeded. The modelling predicts that there will be exceedences of the 15 minute mean objective within the Ballycraigy and Greystone Estates, assuming that the current emission and meterological conditions remain.

As a result of review and assessment the Council will be declaring an Air Quality Management Area which will cover the Ballycraigy and Greystone Estates.

The Council will now seek to consult with the relevant statutory authorities and other interested parties. Following the period of consultation the Council will designate by Order an Air Quality Management Area and then proceed to the next stage of the LAQM process and seek to continue working to improve air quality within the Borough.

Acronyms and definitions

AQS	Air Quality Strategy
AADTF	annual average daily traffic flow
ADMS	an atmospheric dispersion model
APEG	Airborne Particles Expert Group
AQDD	Common Position on Air Quality Daughter Directives
AQMA	Air Quality Management Area
AUN	Automatic Urban Network
BATNEEC	Best available techniques not entailing excessive costs
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
EHS	Environment and Heritage Service
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
GIS	Geospatial Information System
HA	Highways Agency
HFO	heavy fuel oil
HGV	heavy goods vehicle
IPPC	Integrated Pollution Prevention and Control
M	mega ($1x10^6$)
Mg/m^3, $Mg\ m^{-3}$	Micrograms per cubic metre
NAEI	National Atmospheric Emission Inventory
NAQS	National Air Quality Strategy
NETCEN	National Environmental Technology Centre
NIHE	Northern Ireland Housing Executive
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
SSF	Solid smokeless fuel
TEOM	tapered element oscillating microbalance
VOC	volatile organic compound

1 AN INTRODUCTION TO ANTRIM BOROUGH COUNCIL

Situated north west of Belfast City and bordering the north and east shores of Lough Neagh, the Borough of Antrim includes the towns of Antrim, Toomebridge, Crumlin, Randalstown, Parkgate and Templepatrick. Covering an area of 220 square miles – approximately 4.1% of the total area of Northern Ireland – the Borough stretches from Toome in the west to Clady in the east and from Tardree in the north to Crumlin in the south.

The Province's economic engines of growth have long been associated with the Historic Borough of Antrim. Its industrial history is based around a large and prosperous textile and agricultural base, whilst today's economic drivers revolve around construction, distribution, transport and hospitality. The area's principal strength literally revolves around a superbly developed transport infrastructure that provides easy access to all the main external gateways for Northern Ireland, as well as easy access to all parts of the Province. Antrim town lies on two of the main transport corridors, the Belfast – Derry corridor and the Southern corridor. Belfast International Airport is located within the Borough, only 4 miles from the historic town of Antrim. The importance and benefit of the Borough's central geographical location is emphasised by the strong interest shown by potential investors. Due to its location, businesses are able to access skilled labour from both inside and outside the Borough.

Originally a rural community, new industry, with associated expansion and development, has made the Borough much more urban with the town of Antrim now the main populated centre. The Borough has a strong and diverse industrial base, employment levels are among the best in the Province and the infrastructure already in place will complement economic development throughout the 21st century.

Population

According to the 2001 Census the population of Antrim Borough was 48,366. Over half of the Borough's population live in the town of Antrim. The Borough has a youthful face with one in three of the population (31.6%) within the 25-44 age group.

Economic Activity

Antrim has a high proportion of its population economically active (68.04%) which is higher than the NI average. Both male and female economic activity is in line with the NI average. According to the D.E.T.I. research department there are 1,610 VAT registered enterprises with the Borough of Antrim.

Labour Market

The Borough of Antrim has a flexible and adaptable labour force with the skills to serve a variety of industries. Unemployment rates within Antrim are lower than NI average.

Economic Structure

The service sector continues to be a substantial benefactor of Antrim Borough's economy, providing employment to the largest number of people (43.94%). In particular there is a high relative concentration in transport and communication (International Airport). The manufacturing base, which contributes towards 13.94% of employment, is evenly spread between small and large firms. Most importantly, there is a committed and highly skilled workforce on hand to help make your business prosper.

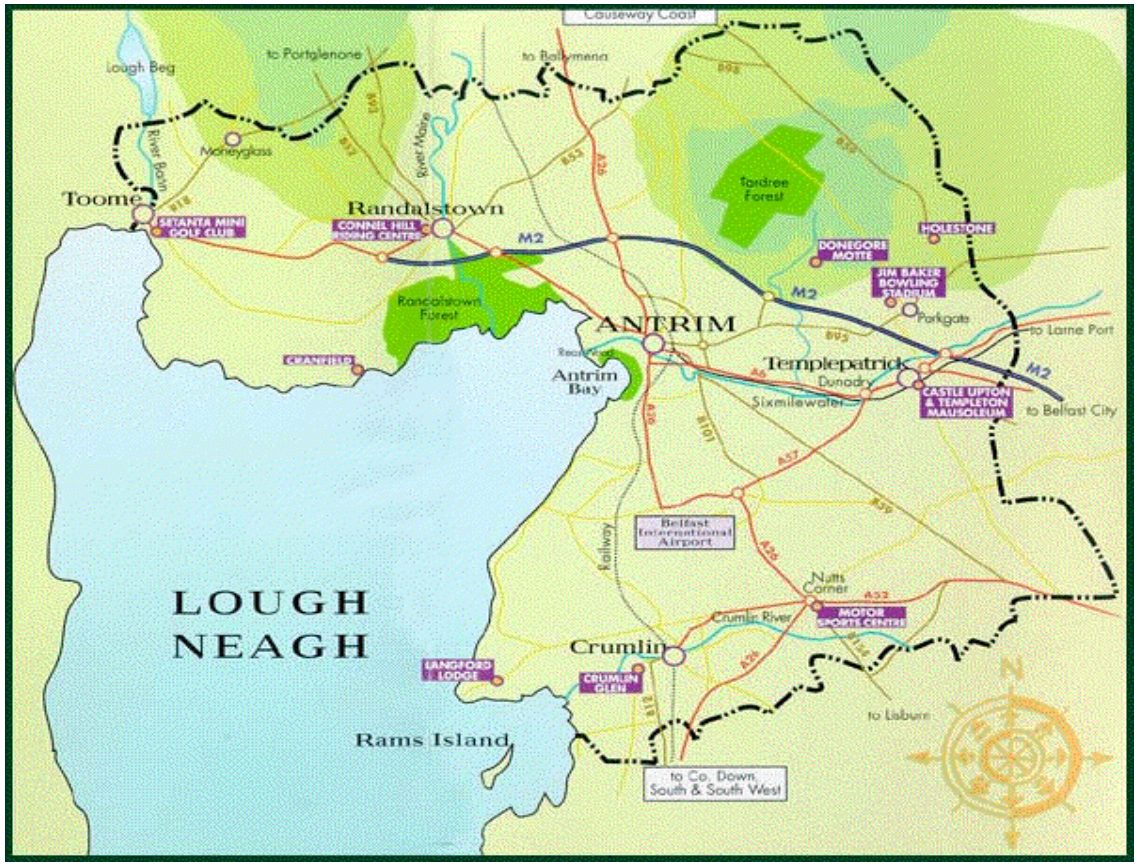
Antrim Borough has been successful in attracting a number of significant new inward investments to Northern Ireland, e.g. Daewoo, Daewha and Schrader Electronics. These companies have contributed considerably to the Antrim area, both in terms of employment and wealth generation.

Tourism

The historic Borough retains much of its natural beauty and boasts a wealth of natural attractions. Lough Neagh and its tributary rivers provide opportunities for water-sports, scenic walks and some of Northern Ireland's best kept angling secrets. Antrim Castle Gardens, Clothworthy Arts Centre, Pogue's Entry, the Round Tower, Cranfield Holy Well and the Holestone, provide an array of cultural, heritage and historical experiences. Recreational facilities include Antrim Form Leisure Complex, the Nutts Corner Motor Sports Centre, and three excellent 18-hole golf courses. Centrally located within Northern Ireland, the Borough of Antrim is within 15 minutes of Belfast City Centre, 20 minutes from Larne Harbour and within easy access to all the main scenic and tourist attractions throughout the Province.

The Borough is home to the International Airport, one of the busiest regional airports in Europe, and is also regarded as one of the strongest tourist accommodation destinations in Ireland. There are over 700 hotel beds of which over 60% are in 4 star accommodation. An extensive selection of superb Guesthouses and Bed and Breakfast accommodation is also available, several of which have won industry awards. Antrim continues to perform well in the number of trips to the Borough, attracting in excess of 100,000 visitors annually who make use of the vast range of facilities and natural attractions in the Borough. The establishment of the Lough Neagh Cycle Way bordering Antrim, Randalstown and Toome, will encourage increased visitors to the area.

Figure 1.1 Map of Antrim Borough.



2 THE UPDATED AIR QUALITY STRATEGY

2.1 THE NEED FOR AN AIR QUALITY STRATEGY

After agreement of a Common Position on the Air Quality Daughter Directives (AQDD), in June 1998 at the European Union Environment Council, the government published its proposals for review of the National Air Quality Strategy (NAQS) in 1999. Subsequently the Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in January 2000.

The Environment (NI) Order 2002 came into operation in January 2003 and implements both the European Air Framework Directive 96/62EC and the UK Air Quality Strategy.

The 2002 Order provides the framework for district councils to review and assess air quality and, if necessary the implementation of an Air Quality Management Area (AQMA). Local Air Quality Management Policy Guidance LAQM PG NI(03) was issued by the Department of the Environment in Northern Ireland under Article 16 of the Environment (NI) Order 2002. Under article 16 of the Order, district councils and other relevant authorities are required to have regard to this guidance when carrying out any of their duties under, or by virtue of Part III of the Order. The document provides guidance for district councils and other relevant authorities such as NIHE as outlined in Table 2.1 below.

Table 2.1: NI Environment Order 2002 key Guidance:

▪ The statutory background and the legislative framework within which relevant authorities have to work
▪ The new principles behind reviews and assessments of air quality up to 2010 and the recommended steps that relevant authorities should take
▪ The timetable for reviews and assessments up to 2010
▪ How district councils should handle the designation of AQMAs
▪ How relevant authorities should handle the drawing up and implementation of action plans
▪ Recommendations and suggestions on taking forward the development of local and regional air quality strategies
▪ Suggestions of how relevant authorities should consult and liase with others
▪ Local transport measures which the Roads Service might wish to consider
▪ The general principles behind air quality and land use planning; and
▪ How enforcing authorities should use powers of entry under Article 19 of the Order

2.3 OVERVIEW OF THE PRINCIPLES AND MAIN ELEMENTS OF THE NAQS

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 target dates of 2003, 2004, 2005, 2008 and 2010 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.

2.2.1 National Air Quality Standards And Objectives

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 2010 are shown in Table 2.2. The table shows the standards in $\mu g\ m^{-3}$ with the number of exceedences that are permitted (where applicable).

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. Proposed Objectives included in the Air Quality Regulations (NI) 2003 for the purpose of Local Air Quality Management.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 µg m^{-3} 3.25 µg m^{-3}	Running annual mean Running annual mean	31.12.2003 31.12.2010
1,3 Butadiene	2.25 µg m^{-3}	Running annual mean	31.12.2003
Carbon Monoxide	10.0 µg m^{-3}	Maximum daily running 8-hour mean	31.12.2003
Lead	0.5 µg m^{-3} 0.25 µg m^{-3}	Annual mean Annual mean	31.12.2004 31.12.2008
Nitrogen Dioxide[1]	200 µg m^{-3} not to be exceeded more than 18 times a year 40 µg m^{-3}	1 hour mean annual mean	31.12.2005 31.12.2005
Particles (PM_{10})[2] **Gravimetric**[3]	50 µg m^{-3} not to be exceeded more than 35 times a year 40 µg m^{-3}	24 hour mean annual mean	31.12.2004 31.12.2004
Sulphur Dioxide	350 µg m^{-3} not to be exceeded more than 24 times per year 125 µg m^{-3} not to be exceeded more than 3 times per year 266 µg m^{-3} not to be exceeded more than 35 times per year	1 hour mean 24 hour mean 15 minute mean	31.12.2004 31.12.2004 31.12.2005

Notes

1	The objectives for nitrogen dioxide are provisional.
2	There are likely to be new particles objectives for 2010, not in regulation at present, expected after the review of the EU's first Air Quality Daughter Directive (2004).
3	Measured using the European gravimetric transfer standard or equivalent.

2.2.2 Relationship between the UK National Air Quality Standards and EU Air Quality Limit Values

As a member state of the EU, the UK must comply with European Union Directives.

There are three EU ambient air quality directives that the UK has transposed in to UK law. These are:

- **96/62/EC** Council Directive of 27 September 1996 on ambient air quality assessment and management. (The Ambient Air Framework Directive)

- **1999/30/EC** Council Directive of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide, oxides of nitrogen, particulate matter and lead in ambient air. (The First Daughter Directive)

- **2000/69/EC** Directive of the European Parliament and the Council of 16 Nov 2000 relating to limit values for benzene and carbon monoxide in ambient air. (The Second Daughter Directive)

The first and second daughter directives contain air quality Limit Values for the pollutants that are listed in the framework directive. The United Kingdom (i.e. Great Britain and Northern Ireland) must comply with these Limit Values. The UK air quality strategy should allow the UK to comply with the EU Air Quality Daughter Directives, but the UK air quality strategy also includes some stricter national objectives for some pollutants, for example, sulphur dioxide.

The Government is ultimately responsibility for achieving the EU limit values. However, it is important that Local Air Quality Management is used as a tool to ensure that the necessary action is taken at local level to work towards achieving the EU limit values by the dates specified in those EU Directives.

2.2.3 Policies in place to allow these objectives to be achieved

The policy framework to allow these objectives to be achieved is one 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 2010. For example, the Industrial Pollution Control (NI) Order 1997 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. 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. Northern Ireland now has in place the Air Quality Limit Value regulation (NI) 2002, the Air Quality (Amended) Limit Value Regulations (NI) 2002 and the Air Quality (Ozone) Regulations (NI) 2003. The Government has recognised the problems associated with achieving the standard for ozone, 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.

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 Borough. 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.

2.2.4 Timescales to achieve the objectives

In most local authorities, 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.

2.3 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.TG(03), and the previous 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 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.

At present Northern Ireland district councils are engaged in the 3 staged approach of review and assessment. A Stage 1 review is expected to have considered all sources of pollutants which could have significant impact on its locality, either due to the emission of significant quantities of the pollutant of concern, or for which there is potential for exposure to 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 Borough. If no sources are identified the district council can conclude that the risk of failing to meet set air quality objectives is negligible and it is therefore not necessary to conduct a second stage review. If, on the other hand, a district council can identify a significant source of one or more pollutants, it is necessary to proceed to a Second Stage air quality review.

The Second Stage air quality review provides a further screening of pollutant concentrations in district council areas. This involves estimating, through the use of monitored or modelled data, the highest likely concentrations of air pollutants within its area and the locations where these

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 district council judges that there is no significant risk of not achieving an air quality objective, it can be confident that an AQMA will not be required. However, where there is doubt that an air quality objective will be achieved; a Third Stage review should be conducted.

A Third Stage review is an accurate and detailed review and assessment of current and future air quality in a particular district using more sophisticated modelling and monitoring techniques. This enables a district council to predict whether or not an objective will be met by the appropriate date and so determine the location of any necessary 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.

The latest technical guidance LAQM.TG(03) is based on a revised '2 step' approach. The steps are briefly described in Table 2.3.

The EHS recommends that district councils, where feasible, should use the latest technical guidance LAQM.TG(03) to complete their first rounds of review and assessment. Where district councils have commenced using the old technical guidance (LAQM.TG4 (00) they may continue using the old guidance. However the methodology should be cross-referenced with the new guidance.

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

Level of Assessment	Objective	Approach
Updating and Screening Assessment (USA)	• To identify those matters that have changed since the last review and assessment, which might lead to a risk of an air quality objective being exceeded.	• Use a checklist to identify significant changes that require further consideration. • Where such changers are identified, then apply simple screening tools to decide whether there is sufficient risk of an exceedence of an objective to justify a detailed assessment.
Detailed Assessment	• To provide an accurate assessment of the likelihood of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation or amendment of any necessary AQMAs.	• Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.

2.4 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 facade), 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 facade), 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 Environment (Northern Ireland) Order 2002 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 2010.
- 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 AN INTRODUCTION TO AIR QUALITY MANAGEMENT IN ANTRIM.

This report combines a Stage 2 and 3 review and assessment of air quality in the Borough of Antrim in compliance with the Environment (NI) Order 2002.

3.1 SUMMARY OF STAGE ONE

Antrim Borough Council completed its Stage 1 review and assessment of air quality in March 2001. This comprised of an initial screening process to identify if any of the objectives for seven key pollutants specified in the National Air Quality Strategy would be breached by 2005.

3.2 POLLUTANTS IDENTIFIED AS REQUIRING NO FURTHER ACTION

Carbon Monoxide (CO).

There are no significant sources of carbon monoxide in the Antrim area or close to it, and there are no proposals for developments likely to produce this pollutant. There are no parts of the road network with traffic flows that are high enough to represent a significant source of carbon monoxide.

Benzene.

Within the Antrim Borough Council area all potential sources of benzene relate to car use and are subject to ongoing national controls. It is considered that the risk exceeding the air quality objective for benzene is negligible.

1,3-Butadine.

There are no industrial sources of 1,3-butadine in the Borough or in surrounding areas. Emissions from road traffic are considered to be insignificant and, as such, the risk of the objective being exceeded in the Antrim area is negligible.

Lead.

There are no significant sources of this pollutant in or near the Borough and consequently the objective for lead is likely to be achieved at all locations within the Antrim Borough Council area.

3.3 POLLUTANTS IDENTIFIED AS REQUIRING FURTHER ACTION

Nitrogen Dioxide (NO_2).

The First Stage report highlighted the need for further investigation into traffic related generation of this pollutant.

Particulates (PM_{10})

Having regard to the D.E.T.R. Pollutant Specific Guidance in place at that time it was concluded that the PM10 objective was unlikely to be exceeded as a result of domestic coal burning and that there are no significant industrial sources of this pollutant. It was found however, that there was a need for further investigation into particulates generated by road traffic.

Sulphur Dioxide SO_2

Having regard to the D.E.T.R. Pollutant Specific Guidance in place at that time it was concluded that there was significant generation of this pollutant from domestic solid fuel burning and that further assessment of this source was required. The report also identified two small combustion systems greater than 5MW thermal rating using solid fuel or fuel oil that needed further assessment.

4 AN INTRODUCTION TO THE SECOND STAGE REVIEW AND ASSESSMENT

4.1 PURPOSE

The purpose of a Second Stage Air Quality Review (SSAQR) is to provide further screening, within the Antrim Borough Council area, for pollutants identified by the First Stage review as requiring further consideration, namely domestic and industrial sources of SO_2, road vehicular sources of NO_2 and road vehicular and industrial sources of PM_{10}. The review:

- Investigates present and potential future air quality in the Antrim Borough Council area
- Identifies any actions that are likely to be required by Antrim Borough Council under Part III of the Environment (Northern Ireland) Order 2002
- Recommends actions, if necessary, to control the subsequent air quality within the Antrim Borough Council area

The Second Stage review and assessment has been carried out in accordance with guidance prescribed in the DETR Review and Assessment: Pollutant Specific Guidance LAQM.TG4 (00). Technical Guidance LAQM.TG(03) was published before the completion of the review and assessment and the guidance in this document has been used in preference to LAQM.TG4 (00) where possible. Where LAQM.TG(03) has been used reference to this use is included in the text.

It should be noted that the Second Stage review and assessment aims only to provide additional screening of pollution concentrations in the Authority's area using simple screening models and monitoring techniques. It is not intended to provide an accurate prediction of current and future air quality across the whole of the Authority's area.

If the Second Stage indicates that there is a risk that an air quality objective may not be met by the relevant future year, then the Authority will need to undertake a more detailed and accurate Third Stage review and assessment.

4.2 APPROACH TAKEN

The Council commissioned the National Environmental Technology Centre (NETCEN) to carry out the Second Stage review and assessment for road vehicular and industrial sources of air pollution. NETCEN is the UK's leading centre of expertise in the field of air quality. Its work spans emissions and ambient quality measurement and management, air quality mapping and forecasting and compilation of the national air emissions inventory. The Council chose NETCEN because it has considerable expertise both in the requirements of the NAQS and its implementation within local authorities. NETCEN works closely with DETR and EHS in the provision of air quality information in support of the NAQS and, in particular has assisted in the preparation of guidance for local authorities, a review of the work of the first phase authorities, support on the review of the NAQS and training for local authorities. NETCEN has undertaken reviews and assessments for numerous local authorities, including district councils in Northern Ireland.

The approach taken in this study was to:

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

The following main screening methods were used (in accordance with the guidance):

- for road transport sources, the revised Highway Agency's Design Manual for Roads and Bridges (DMRB) model.

- for industrial sources, the Environment Agency's Guidance for estimating the Air Quality Impact of Stationary Sources

The review and assessment for sulphur dioxide from domestic sources was carried out by Antrim Borough Council staff and was based primarily on a review of the results of local monitoring.

4.3 INFORMATION PROVIDED BY ANTRIM BOROUGH COUNCIL TO NETCEN TO SUPPORT ASSESSMENT

The following information was provide by Antrim Borough Council to facilitate the review and assessment process:

- 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

4.3.1 Industrial and Transport Developments in Antrim Borough Council

Some developments may have an important impact on air quality in the future and are therefore considered in the Stage 2 review and assessment. The proposed A6 Toome by-pass due to open in 2004 may have an effect on the vehicle movements which has been taken into consideration in this review and assessment.

4.3.2 Local Air Quality Monitoring Data

Antrim Borough Council has been monitoring nitrogen dioxide at a number of kerbside sites with passive diffusion tube samplers. Monitoring has been ongoing since May 2000. Details of nitrogen dioxide diffusion tube monitoring are included in the body of this report and in Appendix 1.

4.3.3 Traffic data

Appendix 2 summarises the traffic information used in the assessment.

4.3.3.1 Flow and speed

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

4.3.3.2 Traffic growth

The national air quality objectives are targets for 2004 or 2005. Traffic growth forecasts were provided by the NI Roads Service Division.

4.3.3.3 Fraction of HGVs

The model requires estimates of the fraction of HGVs on the roads to predict the pollutant concentrations. This information was available from Antrim Borough Council.

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

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

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

Part A and B processes can contribute a range of pollutants to ambient air. Antrim Borough Council had no Part A and B processes that needed further assessment in a Stage 2. There were however two combustion plants with a thermal rating of greater than 5 MW that needed assessment at this level:

- Holywell Hospital
- Antrim Hospital

5 SECOND STAGE REVIEW AND ASSESSMENT OF NITROGEN DIOXIDE

5.1 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.

5.1.1 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.

5.1.2 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.

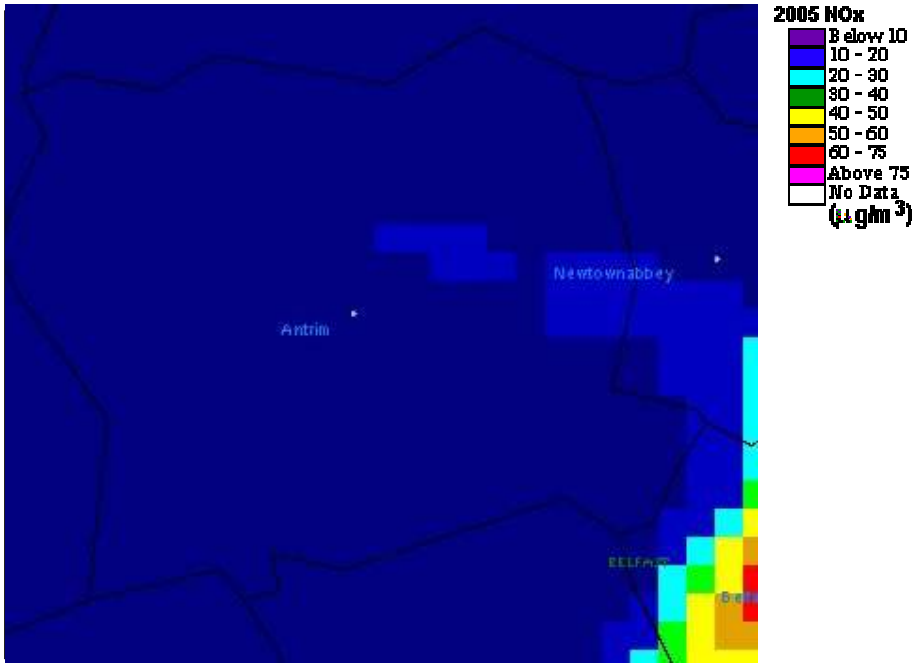
The results of the analysis set out in the National Air Quality Strategy suggest that for NO_2 a reduction in NO_x emissions over and above that achievable by national measures will be required to ensure that air quality objectives are achieved everywhere by the end of 2005. Local authorities with major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

5.2 BACKGROUND CONCENTRATIONS OF NITROGEN DIOXIDE

Background concentrations were obtained for the Antrim area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. The background concentration for NO_x in 2005 is predicted to be 11.8 $\mu g/m^3$ or lower (Figure 5.1).

Figure 5.1. NO_x background concentrations for 2005($\mu g/m^3$)



5.3 IMPACT OF ROAD TRAFFIC ON CONCENTRATIONS OF OXIDES OF NITROGEN

The Stage one review and assessment for Antrim Borough Council identified several areas in Antrim as needing further study in a Stage two assessment. The concentrations at these roadside locations were estimated by NETCEN using the Design Manual for Roads and Bridges (DMRB) using the traffic flow data provided by Antrim 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 1. The model has been used to predict nitrogen dioxide concentrations for 2005.

Pollutant concentrations have been assessed at the traffic speeds relevant to each road as supplied by Antrim Borough Council. The distances 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 either directly from Antrim Borough Council or from maps supplied by Antrim Borough Council.

Table 5.1 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 Antrim Borough Council area. Following advice given in the 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, the annual average concentration of nitrogen dioxide is predicted to exceed the 40µg m^{-3} objective at one location, the A26 Lisnevenagh Road, north of the Dunsilly Roundabout. At all other locations the air quality objectives are predicted to be met.

Table5.1 Nitrogen dioxide concentrations at roadside locations in the Antrim District

Description of Link	NO2 Annual mean (µg/m^3) 2005	NO2 99.8th percentile of hourly averages (µg/m^3) 2005
Fountain St/Fountain Hill	19.5	68.3
A6 Belfast Rd/Belmont Rd	23.4	81.7
Randalstown Rd/A26 Ballymena Rd	21.9	76.5
A26 Ballymena Rd/B518 Stiles Way	25.6	89.7
A26 Oldstone Rd/A57 Airport to Templepatrick Rd	38.5	134.7
A57 Ballyclare Rd/A6 Belfast Rd	35.1	122.8
Fountain St/B518 Stiles Way	18.7	65.3
A26 Oldstone Rd/A6 Belfast Rd	27.0	94.4
A26 Oldstone Rd/B37 Sevenmile Straight	21.8	76.2
B518 Stiles Way/Greystone Rd roundabout	39.1	136.7
M2 Rathbeg - Templepatrick	30.9	108.3
Fountain St	35.4	124.0
Randalstown Main St	32.2	112.5
M2 Rathbeg - Dunsilly	29.1	102.0
A26 north of Dunsilly	44.3	154.9

A proposed development to construct a retail park near the junction of Ballymena Road and Stiles Way has been submitted for Planning Permission. An Environmental Impact Assessment has been prepared by GM Design Associates, who have undertaken a traffic impact assessment of the proposed retail development. The maximum percentage traffic increase on the Ballymena Road as a result of the proposed development is 9.1%. However, without the proposed development the predicted annual mean concentration of nitrogen dioxide at the nearest sensitive receptors is 26 µg/m^3 (Table 5.1). This is well below the objective of 40 µg/m^3 and therefore the increase in traffic as a result of the proposed development is very unlikely to cause an exceedence of the objective.

5.3.1 NETCEN CONCLUSIONS FOR NITROGEN DIOXIDE CONCENTRATIONS IN THE ANTRIM BOROUGH COUNCIL AREA

DMRB modelling carried out by NETCEN indicated that emissions arising from road transport at one road in the Antrim Borough Council area, the A26 Lisnevenagh Road, north of the Dunsilly Roundabout, might cause an exceedence of the nitrogen dioxide objective. NETCEN recommended that diffusion tube monitoring be undertaken at the identified receptor and then consideration be given to proceeding to a Stage 3 review and assessment.

5.4 MONITORING OF NITROGEN DIOXIDE

5.4.1 Passive diffusion tubes

Antrim Borough Council has been monitoring for nitrogen dioxide using passive diffusion tubes at a number of locations since May 2000.

Diffusion tubes provide an integrated average concentration for the pollutant being monitored over a particular exposure period and are useful in providing an assessment against annual mean objectives.

Nitrogen dioxide diffusion tubes possess absorbent gauze coated in triethanolamine, which is an effective absorber of NO_2. Each tube remains at a particular location for a four week exposure time, then taken down, and when analysed in a laboratory, an average monthly concentration can be calculated.

5.4.2 Locating the NO2 tubes for Stage 2

It is known that measurements from sites close to busy roads and road junctions will only be representative over a very small area as NO_2 concentrations close to sources vary considerably, even over short distances. Diffusion tubes were therefore located where possible at relevant locations close to the nearest receptor to roads and road junctions identified during First Stage review as being at risk of exceeding the objective. In all cases tubes were located as close or closer to the road or road junction as the nearest receptor.

NO_2 diffusion tubes were positioned to meet the criteria contained in LAQM.TG4 (00) as closely as possible. The location of each site was as open as possible in relation to surrounding buildings and trees. Diffusion tubes were placed at approximately 3m above ground level, within the ideal range for sampling of between 1.4 and 4m. Tubes were attached to lampposts, telegraph poles or road signs.

It is important that air can circulate freely around the open end of the tube. Certain surfaces may act as absorbents for atmospheric pollution leading to thin layer of reduced pollutant immediately adjacent to surfaces. To counteract this, wooden blocks were used to stand the tubes at least 5cm from the surface of any supporting structure.

All sampling sites were kerbside (Up to 1m from roadway) or roadside (1 to 5m from roadway) sites. The locations and descriptions of diffusion tube monitoring sites as used in this assessment are shown in Tables 5.2, 5.3 and 5.4.

5.4.4 QA/QC of NO_2 passive diffusion tubes

The nitrogen dioxide diffusion tubes used in this study were supplied and analysed by Casella CRE Air.

Casella CRE Air has a defined quality system, which forms part of the UKAS accreditation that the laboratory holds. All accredited methods are fully documented. UKAS assessors visit on an annual basis and review all aspects of the analysis, from sample handling to analysis and reporting. As a condition of accreditation, the laboratory is required to participate in any

suitable proficiency schemes in operation. Casella CRE Air participates in the WASP scheme organised by the Health and Safety Laboratory.

Any result from such a scheme that falls outside the relevant limits is immediately investigated and steps taken to rectify the situation. All external proficiency schemes results are also assessed by the Quality Manager at Casella. The Quality Manager also carries out internal audits.

Quality Control at Casella CRE Air

A series of ten quality control check solutions are analysed before any samples in order to check system stability and performance.

A quality control check is run after every ten samples and is assessed against warning and action limits defined in the method. Quality control solutions are prepared from standards supplied by a different vendor to that of the calibration standards.

An external quality control check solution prepared by NETCEN is analysed once per month in order to check internal QC. Results of this check are reported back to NETCEN.

Tube preparation and analysis

The NO_2 tubes are prepared and analysed in a separate, designated part of the laboratory. Ambient nitrogen dioxide concentrations within the laboratory are monitored routinely. Blanks from each batch of tubes prepared in the laboratory are retained for verification.

Incoming samples are stored in a fridge used solely for this purpose. Calibration standards, QC solutions and other reagents are stored in a separate fridge.

The analyst checks data as it is generated and QC data is plotted immediately after it is obtained. All raw data and data transfer is checked by the supervisor, data entry into the Laboratory Information Management System is also checked and the final reports are checked before signing.

Antrim Borough Council QA/QC.

Our QA/QC procedure is to ensure that when a tube batch is received they are stored in a refrigerator. On the day of sampling they are removed from the fridge and installed. Laboratory blanks are retained in the fridge and are taken out only when the exposed tubes are being returned to the laboratory.

When tubes are collected from sampling sites they are immediately packaged and sent to the laboratory for analysis.

5.4.4 Correction for laboratory bias

The performance of diffusion tubes is variable, and concentrations reported by different laboratories may under or over-read by 30% or more. LAQM.TG(03) advises that where data is obtained from diffusion tube monitoring a correction for laboratory bias should be applied.

Bias is the over-read or under-read of the diffusion tubes relative to the reference method, expressed as a percentage. Bias (B) is calculated as follows:

$$B = 100 \times (D - C) / C$$

Where –

- D = average NO_2 concentration as measured by the diffusion tubes, and
- C = average NO_2 concentration as measured by a chemiluminescent analyser.

LAQM.TG(03) makes provision for calculation of a bias correction factor for diffusion tube results, from co-location studies where diffusion tubes are collated with an automatic chemiluminescent analyser.

The bias adjustment factor "A" is the ratio of the automatic analyser result to the collated diffusion tube result and is calculated as follows:

$$A = C/D$$

Where –

- D = annual mean NO_2 concentration as measured by the diffusion tubes, and
- C = annual mean NO_2 concentration as measured by the analyser (the mean measured continuously over the entire period, rather than the average of individual months)

Annual mean diffusion tube results from other sites, prepared by the same method, analysed by the same laboratory and exposed for the same period, can then be corrected for bias by multiplying them by this factor.

Antrim Borough Council has not carried out a co-location study, however, such studies have been undertaken by other local authorities and Casella CRE Air diffusion tubes have been included in studies of this type.

A collation study of co-location studies for NO_2 diffusion tubes was carried out by Air Quality Consultants Ltd on behalf of the Welsh Assembly, Scottish Executive, DEFRA and DOENI and has produced bias factors for various diffusion tube suppliers for years 2001, 2002 and 2003.

The collation study has produced the following bias correction factor for Casella 10% Tea in water diffusion tubes:

For year 2001:- 1.03
For year 2002:- 0.91
For year 2003:- 1.00
The bias adjusted annual average concentration is obtained using the following formula:

Bias adjusted annual average = measured annual average concentration x correction factor.

5.4.5 Projection to 2005

To make a direct comparison with the national objective, it is necessary to make a prediction as to the concentration in 2005. LAQM TG (03) provides a method, which can be used to produce a correction factor, which will allow measured concentrations to be adjusted for the relevant future year.
The formula to project for a future year has been obtained from Box 6.6 and is as follows:

$$\text{Relevant year concentration} = \text{measured concentration} \times \frac{\text{Correction factor for 2005}}{\text{Correction factor for measured year}}$$

e.g. for results obtained in 2002 this would be 2002 concentration x 0.892/0.969.

5.4.6 Diffusion tube data

A summary of results for 2001, 2002 and 2003 are shown in Tables 5.2, 5.3 and 5.4 below. The monitoring periods are representative of full calendar years for most sites and therefore the period average concentrations can be compared with the annual mean objective for these sites.

Table 5.2. Annual average concentrations for 2001 measured by diffusion tube at kerbside locations in the Antrim area (µg m^{-3})

Location	Site	OS Grid Reference	K/R	2001 Annual Average	2001 corrected for analyst bias	2005 annual average prediction
A 6 Moneynick Rd	1	3049 3897	R	18.6	19.2	17.1
A6 Belfast Rd in Templepatrick	2	3233 3858	K	30.5	31.4	28.0
Fountain St Antrim	3	3154 3865	K	23.8	24.5	21.9

kerbside = within 1 metre of the road
Roadside = within 1- 5 metres of the road

Table 5.3 Annual average concentrations for 2002 measured by diffusion tube at Kerbside/Roadside locations in the Antrim area (µgm^{-3})

Location	Site	OS Grid Reference	K/R	2002 Annual Average	2002 corrected for analyst bias	2005 annual average prediction
A6 Moneynick Road	1	3049 3897	R	23.8	21.7	19.9
Templepatrick	2	3233 3858	K	31.4	28.6	26.3
Fountain St	3	3153 3865	K	23.2	21.1	19.5
A 26 Lisnevenagh Road	4	3135 3905	R	27.1	27.7	22.8
Randalstown Main St	5	3082 3904	K	37.2	33.9	31.2
M2 at Donegore	6	3208 3874	R	18.3	16.7	15.2

Table 5.4 Annual average concentrations for 2003 measured by diffusion tube at Kerbside/Roadside locations in the Antrim area (µg/m^{-3})

Location	Site	OS Irish Grid Reference	K/R	2003 Annual Average	2003 corrected for analyst bias	2005 annual average prediction
Templepatrick	2	3233 3858	K	31.8	31.8	30.1
Fountain St	3	3153 3865	K	22.6	22.6	21.4
A26 Lisnevenagh Road	4	3135 3905	R	30.6	30.6	29.0
Randalstown Main St	5	3082 3904	K	34.4	34.4	32.6
M2 at Donegore	6	3208 3874	R	22.0	22.0	20.9

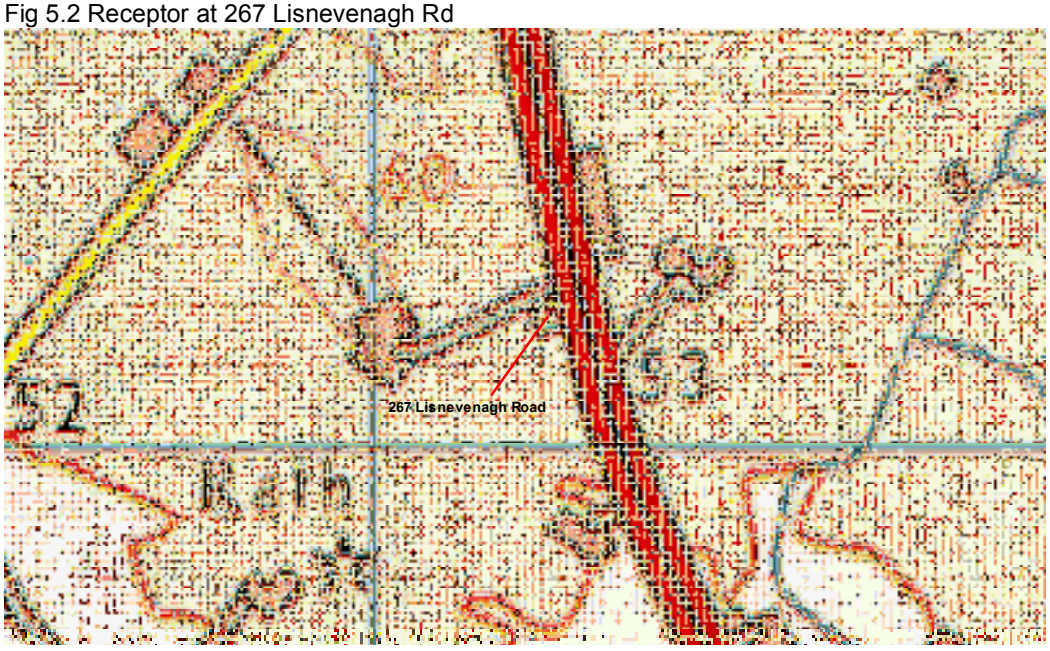
The NO_2 concentrations recorded with these diffusion tubes do not exceed the annual mean objective of 40 µgm^{-3} at any of the sites. The Government Guidance suggests that it is therefore likely that the NO_2 annual mean objective will be met by the end of 2005.

5.4.7 MONITORING AT NEAREST RECEPTOR TO A26, LISNEVENAGH ROAD

In response to recommendations made by NETCEN, diffusion tube monitoring was carried out at the nearest receptor to this road. The A26 Lisnevenagh Road is a dual carriageway and is the main arterial route between the towns of Antrim and Ballymena. The nearest receptor on the Antrim stretch of this road is 267 Lisnevenagh Road, which is located approximately 7.3m from the northbound carriageway. This property was the location for which the DMRB assessment predicted an exceedence the annual mean objective.

The location of this receptor is shown in Figure 5.2.

Fig 5.2 Receptor at 267 Lisnevenagh Rd



The diffusion tube was affixed to a telegraph pole located almost directly in front of the receptor at a distance of 3m from the roadside.

Two years monitoring results from this site are available and are shown in table 5.5

Table 5.5 Results from monitoring at nearest receptor to A26, Lisnevenagh Road (µg m^{-3})

Year	Measured Annual Average	Annual Average Corrected For Lab Bias	2005 Annual Average Prediction
2002	27.1	24.7	22.8
2003	30.6	30.6	29.0

Ballymena Borough Council has also been monitoring for nitrogen dioxide using diffusion tubes at a kerbside site on this road. The diffusion tubes used by Ballymena Borough Council are analysed by Lambeth Scientific Services and the monitoring results from this site for 2002 are shown in table 5.6

Table 5.6 Results of monitoring by Ballymena Borough Council at Lisnevenagh Road (µg m^{-3})

Year	Measured Annual Average	Annual Average Corrected for Lab Bias (x 1.20)	2005Annual Average Prediction
2002	18.1	21.7	19.4

5.5 IMPACT OF INDUSTRY ON CONCENTRATIONS OF NITROGEN OXIDES

The Stage 1 review and assessment for Antrim Borough Council concluded that there were no processes needing further investigation.

5.6 CONCLUSIONS AND FUTURE ACTIONS FOR NITROGEN DIOXIDE

The DMRB assessment carried out by NETCEN predicted that emissions arising from road transport may cause an exceedence of the air quality objective at one road within the Borough, the A26 Lisnevenagh Road, North of the Dunsilly roundabout.

Passive diffusion tubes monitoring at the relevant location where the DMRB assessment was carried out shows, that at the roadside location relevant to public exposure, exceedences of the annual mean standard are unlikely to occur. These results are corroborated by results of monitoring of the same road in the Ballymena Borough Council area.

LAQM.TG4 (00) advises that if diffusion tube monitoring data is available and the measurements are representative of roadside or kerbside locations relevant to public exposure, then that data can be used in preference to or in conjunction with modelling predictions.

It can be concluded from the Second stage modelling and monitoring that there is no risk of an exceedence of the air quality objective. Antrim Borough Council will not therefore need to undertake a Third Stage review and assessment for nitrogen dioxide.

Diffusion tube monitoring at the nearest receptor to the A26 Lisnevenagh Road will continue. Monitoring will also continue to be carried out at various other locations within the Borough. The data obtained will be used in the next phase of reviews and assessments.

6 Review and Assessment of PM_{10}

6.1 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.

6.2 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.

6.3 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.

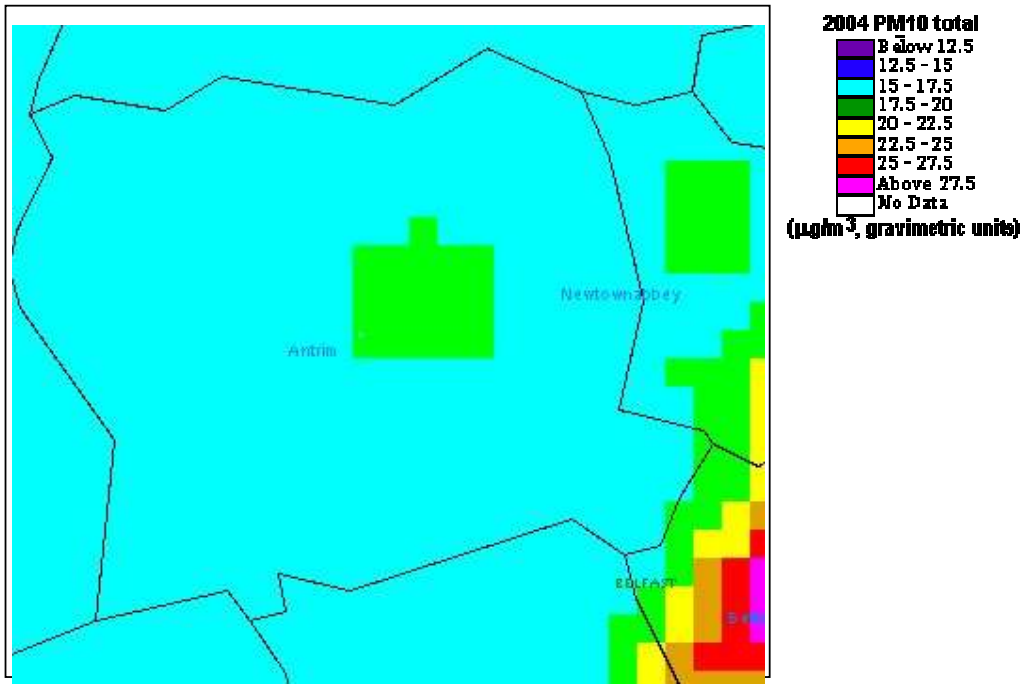
The Government established the Airborne Particles Expert Group (APEG) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999). APEG concluded that a significant proportion of the current annual average PM_{10} 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.

6.4 BACKGROUND CONCENTRATIONS OF PM_{10}

Estimates of background concentrations of PM_{10} were obtained for the Antrim 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 6.1 shows that the estimated annual average background concentration for 2004 in Antrim was 18.7 μg/m^3 or lower.

Figure 6.1. Background PM_{10} concentrations 2004 ($\mu g\ m^{-3}$)



6.5 IMPACT OF ROAD TRAFFIC ON PM_{10}

6.5.1 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 18.7 μg m^{-3} for Antrim has been used to provide total predicted PM_{10} concentrations. Estimated traffic flows for 2005 were used which will provide a conservative estimate for the objective year of 2004.

GB 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 6.1 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 no exceedences of the PM_{10} objective are predicted.

Table 6.1 Predicted PM_{10} concentrations at roadside receptor locations in the Antrim Borough Council region.

Description of Link	PM10 Annual mean ($\mu g/m^3$) 2004
Fountain St/Fountain Hill	19.5
A6 Belfast Rd/Belmont Rd	19.7
Randalstown Rd/A26 Ballymena Rd	19.6
A26 Ballymena Rd/B518 Stiles Way	19.8
A26 Oldstone Rd/A57 Airport to Templepatrick Rd	20.7
A57 Ballyclare Rd/A6 Belfast Rd	20.5
Fountain St/B518 Stiles Way	19.3
A26 Oldstone Rd/A6 Belfast Rd	19.9
A26 Oldstone Rd/B37 Sevenmile Straight	19.5
B518 Stiles Way/Greystone Rd roundabout	20.8
M2 Rathbeg - Templepatrick	20.2
Fountain St	21.1
Randalstown Main St	20.8
M2 Rathbeg - Dunsilly	20.1
A26 north of Dunsilly	21.5

6.6 CONCLUSIONS FOR PM_{10} IN THE ANTRIM AREA

The emissions from traffic sources are considered unlikely to cause an exceedence of the PM_{10} objectives in 2004. It is therefore recommended that there is no need for any further assessment of PM_{10} in the Antrim Borough Council area.

7 SECOND STAGE REVIEW AND ASSESSMENT OF SULPHUR DIOXIDE

7.1 INTRODUCTION

Sulphur dioxide is a corrosive acid gas, which combines with water vapour in the atmosphere to produce acid rain. Both wet and dry depositions 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.

7.2 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.

7.3 THE NATIONAL PERSPECTIVE

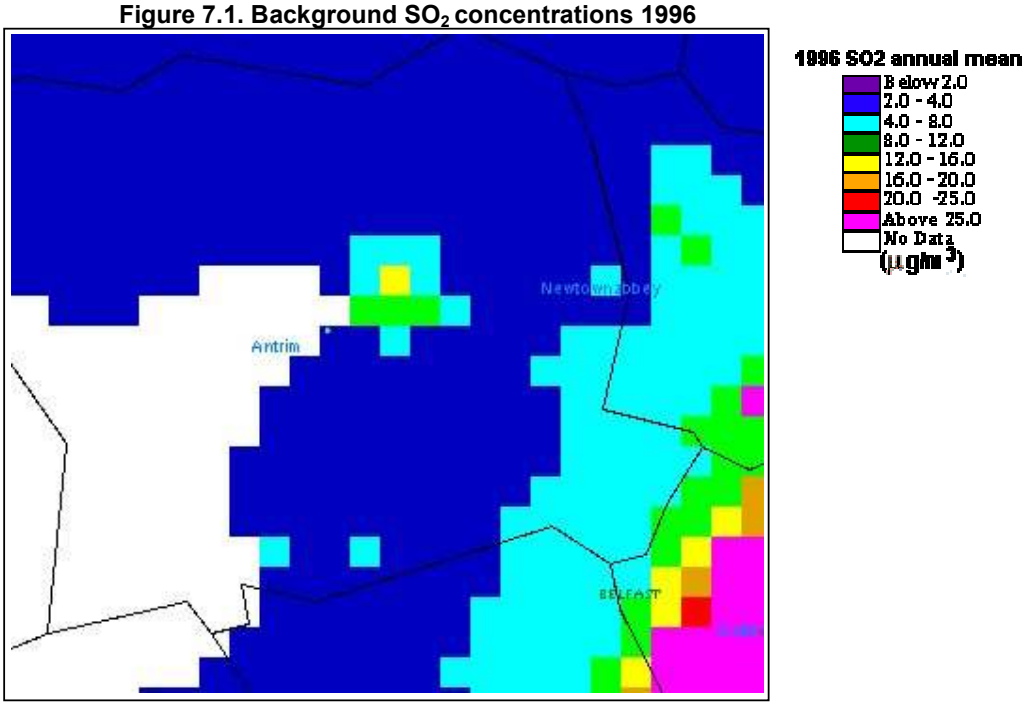
Sulphur dioxide is emitted in the combustion of coal and oil. Emissions today are dominated by fossil-fuelled power stations which in 1997 accounted for 62% of the national total emission. Emissions from road transport are a very small fraction of the national total: 2%.

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 Industrial Pollution Control (NI) Order 1997, and will come under the provisions of the IPPC. The government considers that bearing in mind the envisaged change in fuel use, exceedences of the 15-minute objective by 2005 from these sources are not expected. Sulphur dioxide concentrations are elevated at the kerbside but not sufficiently to exceed the air quality standard in the absence of other sources.

7.4 BACKGROUND CONCENTRATIONS OF SULPHUR DIOXIDE

Estimates of background concentrations of sulphur dioxide were obtained for the Antrim District area using the maps on the UK National Air Quality Information Archive web site http://www.aeat.co.uk/netcen/airqual/home.html. Figure 7.1 shows the most recent estimates available, for 1996. The maximum estimated annual average concentration for 1996 in the Antrim Borough Council area was 16 μg m^{-3} and more generally 2-4 μg 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 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 Antrim Borough Council area in 2004 will be no more than 12 μg m^{-3} and more generally 1.5-3 μg m^{-3}.

Figure 7.1. Background SO_2 concentrations 1996



7.5 IMPACT OF INDUSTRY ON CONCENTRATIONS OF SULPHUR DIOXIDE

The Stage 1 review and assessment report prepared by Antrim Borough Council stated that there were no Part A and Part B processes in the area needing further assessment. There were however two small combustion systems greater than a 5MW thermal rating using solid fuels or fuel oil:

- Holywell Hospital
- Antrim Hospital

These are a potential significant source of SO_2 and are likely to be in existence in 2005. NETCEN were commissioned to carry out an assessment of these sources using GSS (Guidance for Estimating the Air Quality Impact of Stationary Sources) as advised by the Government Pollutant Specific Guidance. To proceed with the use of this model the sources must have:

- Stacks between 20metres and 200metres tall
- Stack exit velocities between 10m/s and 25 m/s
- Releasing buoyant plumes, i.e. temperature slightly above or greater than ambient.

As the two hospital sources both fitted these criteria they could be confidently assessed using the GSS model.

The 15 minute objective is the most stringent of the sulphur dioxide objectives and so if this objective is predicted to be met it can be assumed that the other objectives, the hourly and the 24 hourly, will be met. GSS predicts15-minute and hourly objective relationships based on conservative assumptions and will tend to over-predict concentrations.

7.5.1 Antrim Hospital

Table 7.2. Specifications of combustion processes at Antrim Hospital

	Antrim Hospital
Temperature of emissions (^{0}C)	187
Stack height (m)	30.13
Stack radius (m) or equivalent	0.433
SO_2 emissions (g/s)	2.7
Gas exit velocity (m/s)	12.2

GSS gives you the option of choosing a stack height. The stack is 30.13 metres so a stack height of 30 metres has been used in GSS. Using GSS, the following maximum ground level SO_2 concentrations are obtained:

53.2μg/m^3 as the 99.9th percentile of hourly means.

In order for these results to be compared against the objectives, PSG states the following conversion factor:

99.9th percentile of 15 minute means = 1.34 x 99.9th percentile of 1 hour means

This relationship is based upon a conservative estimate and will tend to over-predict concentrations in most cases. Adding the background concentrations to those emitted from the boiler gives the following result:

99.9th percentile of the 15 minute mean is 95.3μg/m^3
(the 15 minute objective for SO_2 is 266 μg/m^3 as a 99.9th percentile);

The above results show that the maximum ground level concentrations are well within the objectives for SO_2.

7.5.2 Holywell Hospital

Table 7.3. Specifications of combustion processes at Holywell Hospital

	Holywell Hospital
Temperature of emissions (^{0}C)	250
Stack height (m)	32
Stack radius (m) or equivalent	0.318
SO_2 emissions (g/s)	5.7
Gas exit velocity (m/s)	10.7

GSS gives you the option of choosing a stack height. The stack is 32 metres so a stack height of 30 metres has been used in GSS. Using GSS, the following maximum ground level SO_2 concentrations are obtained:

141.3μg/m^3 as the 99.9th percentile of hourly means.

In order for these results to be compared against the objectives, PSG states the following conversion factor:

99.9th percentile of 15 minute means = 1.34 x 99.9th percentile of 1 hour means

This relationship is based upon a conservative estimate and will tend to over-predict concentrations in most cases. Adding the background concentrations to those emitted from the boiler gives the following result:

99.9th percentile of the 15 minute mean is 213.3μg/m^3
(the 15 minute objective for SO_2 is 266 μg/m^3 as a 99.9th percentile);

The above results show that the maximum ground level concentrations are within the objectives for SO_2.

It is concluded then that the two >5 MW combustion systems do not need to be investigated further.

7.5.3 Conclusions for industrial sources of sulphur dioxide

It is concluded that industrial sources of sulphur dioxide in the Antrim Borough Council are likely to meet the air quality objective and therefore no further review and assessment of these is required at this time.

7.6 IMPACT OF DOMESTIC SOLID FUEL BURNING ON SULPHUR DIOXIDE CONCENTRATIONS

7.6.1 Introduction

The First Stage Review and Assessment identified four 1Km^2 areas in Antrim town and a single 1Km^2 area in Crumlin village where there were likely to be in excess of 300 houses burning solid fuel and that there was a need to proceed to a Stage 2 review and assessment for this source.

7.6.2 Approach taken

LAQM.TG4 (00) states that a Second Stage review and assessment for sulphur dioxide from domestic sources is likely to rely upon a review of monitoring data within the local area. The Second Stage review for Antrim Borough Council is based on a review of data obtained over a twelve-month period from an 8-port smoke and sulphur dioxide sampler.

7.6.3 The 8-port sampler

The 8-port sampler has been used extensively throughout the UK in order to determine sulphur dioxide concentrations, and whilst their use has declined in recent years, the data can still be of use in review and assessment.

The sampler draws in ambient air at a controlled and metered rate, first through a filter paper on which suspended particulates are collected, then through a solution in which SO_2 is absorbed.

Sampled air is drawn through one of eight bubblers (Dreschel bottles), containing a solution of dilute, acidified hydrogen peroxide. The outlet of each bubbler is connected to one of the 8 outer ports of an 8-port valve, a device which automatically switches the air flow once every 24-hour period to pass through a fresh filter and bubbler. Each filter and bubbler is 'active' for one day only.

The sampler can operate unattended for up to eight consecutive 24-hour periods; in practice it is normally set to change over at midnight and visited weekly, when the exposed filters and solutions are replaced.

7.6.4 Determining sulphur dioxide concentrations from an 8-port sampler

The concentration of SO_2 is estimated by passing a measured sample of air filtered through a known volume of a dilute, acidified solution of hydrogen peroxide. This solution is acidified to pH 4.5 so that strongly acidic compounds will be absorbed in preference to weakly acidic compounds such as carbon dioxide.

The amount of acid in the exposed sample is determined by titration with a standard alkaline solution, and the amount of titre required to return the solution to pH 4.5 can be used to calculate a daily mean concentration of sulphur dioxide in air.

Other strong acids and alkalis in the air will effect the result, so technically this method measures total gaseous acidity rather than sulphur dioxide, however, in normal circumstances the concentrations of such substances is very much less than sulphur dioxide and therefore the result obtained is usually a good approximate to the concentration of SO_2.

7.6.5 Location of 8-port sampler

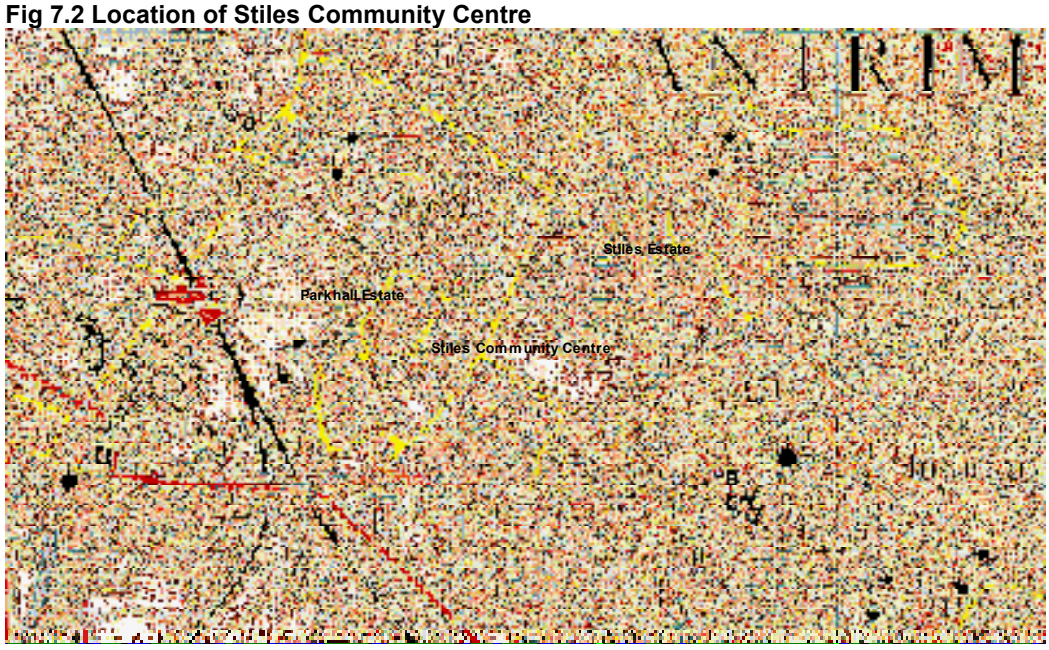
The 8-port sampler is located within the Council owned Stiles Community Centre, Fountain Hill, Antrim. The monitoring site lies between the Stiles and Parkhall housing estates, which are estates with high levels of solid fuel burning, and is within one of the $1Km^2$ areas identified during the First Stage as requiring further consideration. The location of Stiles Community Centre is shown in Figure 7.2.

Two other alternative sites were considered :-

1. Muckamore Community Centre, Ballycraigy Road, Antrim.
2. Parkhall Community Centre, Seacash Drive, Antrim.

These sites were rejected because they were located towards the edges, rather than the centres of solid fuel burning areas.

Fig 7.2 Location of Stiles Community Centre



It is recognised that the requirement to locate the 8-port apparatus within Council property limited the sites available. The chosen site lies between two known solid fuel burning areas, the Parkhall and Stiles housing estates and was the best site available. The site does not lie within the area of highest housing density and whilst it is hoped that results obtained at the site will be representative of the general area, it is recognised that areas of higher concentrations of pollutant may exist elsewhere within the areas under investigation.

7.6.6 Passive diffusion tube monitoring

In addition to the 8-port sampler, nine sulphur dioxide passive diffusion tubes were located at various locations in order to indicate the relative spatial distribution of SO_2 concentrations across solid fuel burning areas. Whilst it is recognised that results of diffusion tube monitoring cannot be compared to air quality objectives for SO_2, it was hoped that results would indicate that the 8-port apparatus was sited in an area which was representative of the highest levels of sulphur dioxide emissions.

The locations of diffusion tube monitoring sites are set out in table 7.5.

7.6.7 Monitoring QA/QC

<u>8-port sampler</u>

Before the 8-port sampler was installed Antrim Borough Council applied to NETCEN to have the site accepted for inclusion in the UK Smoke and Sulphur Dioxide Monitoring Network. NETCEN approval of the site was subsequently granted and the site was accepted onto the network and given the site designation Antrim 1, and site identification code 0068851.

The equipment was installed, operated and maintained in accordance with the procedures set out in the UK Smoke and Sulphur Dioxide Network instruction manual. The equipment

was visited at the same time each week and titrations were carried out under laboratory conditions on the day received.

Weekly, two-monthly and six-monthly checks quality control were carried out in accordance with the instruction manual and the officers who had responsibility for the monitoring were trained by and worked under the supervision of a senior officer. Validation checks and auditing of chemical preparation and analysis were carried out as part of internal quality assurance procedures.

Diffusion Tubes

The sulphur dioxide diffusion tubes were supplied by Enviro Technology Services plc. The analysis of exposed samples was carried out using Ion Chromatography, the loaded absorbent being extracted with hydrogen peroxide solution and run with sulphate calibration standards. The concentration of the pollutant on the tube was measured as µg sulphur and this concentration was then calculated into µg m^{-3} sulphur dioxide using the exposure data and constants derived from coefficients of diffusion and uptake rates. The values were then blank corrected using blank tubes returned with the sample batch.

Each batch of sample tubes was run with a traceable calibration standard. The analysis was carried out in accordance with Enviro Technology Services internal Laboratory Quality Procedure GLM 1.

The Laboratory Methods and Procedures used for this analysis form part of the Quality Management System which has been written to comply with the requirements of ISO/IEC 17025.

Antrim Borough Council's QA/QC procedure was to ensure that when a tube batch was received they were stored in a refrigerator. On the day of sampling they were removed from the fridge and installed. Laboratory blanks were retained in the fridge and are taken out only when the exposed tubes were being returned to the laboratory.

7.6.8 Monitoring results

Twelve months monitoring results are available for the 8-port sampler from the beginning of September 2002 to the end of August 2003.

Table 7.4 shows the maximum daily mean concentrations for SO_2 obtained for each of the twelve months over which monitoring took place. Daily data for the complete period is shown in Appendix 3.

Table 7.4 Measured and Corrected Monthly Maximum Daily Mean Concentrations of Sulphur Dioxide Obtained from 8-Port Sampler (µg m^{-3}).

Month & Year	Max Daily Mean Concentration	Corrected Max Daily Mean
September 02	36	45
October 02	37	46.25
November 02	43	53.75
December 02	67	83.75
January 03	79	98.75
February 03	55	68.75
March 03	37	46.25
April 03	37	46.25
May 03	36	45
June 03	30	37.50
July 03	36	45
August 03	54	67.50

LAQM.TG4 (00) states that if net acidity titration measurements from 8-port samplers are considered, the measured maximum daily mean concentrations should be multiplied by 1.25 to take account of a general tendency for bubblers to under-read at high concentrations. This correction factor is open to uncertainty and in most cases will tend to overstate the concentrations, but this is consistent with the precautionary approach for Second Stage review and assessment.

The results of diffusion tube monitoring for the same months are shown in table 7.6 below

Table 7.5 Names and Locations of Diffusion Tube Sites

Site Name	Location	OS Grid Ref
S1	Greystone / Ballycraigy	3172 3868
S2	Crumlin	3154 3762
S3	Randalstown	3082 3907
S4	Station Road	3153 0868
S5	Stiles Community centre	3162 3870
S6	Stiles / Rathenraw	3173 3869
S7	Cunningham way	3151 3860
S8	Moylena Road	3158 3860
S9	Springfarm	3148 3888

Table 7.6 SO_2 Diffusion tube results in µg m^{-3}.

	Site Name								
	S1	S2	S3	S4	S5	S6	S7	S8	S9
September 02	5.41	-	3.80	3.54	6.20	5.38	2.54	1.58	-
October 03	5.22	0.44	-	-	10.12	1.45	1.88	1.59	-
November 02	6.72	1.49	1.16	-	8.98	0.75	1.64	2.83	3.13
December 02	-	0.71	3.28	3.75	18.86	6.77	6.22	7.63	4.66
January 03	9.81	1.40	4.09	10.30	7.53	2.79	2.45	1.92	4.90
February 03	4.32	2.31	1.57	3.85	4.79	4.94	-	2.47	4.50
March 03	9.61	4.71	4.07	5.53	14.57	12.76	-	5.26	5.05
April 03	4.43	2.78	5.25	8.58	12.16	7.02	4.44	3.28	2.96
May 03	4.32	1.09	-	-	4.17	6.21	5.39	1.99	1.31
June 03	1.59	15.21	5.23	3.17	-	4.91	-	4.90	5.87
July 03	5.73	4.46	7.3	4.13	13.02	-	-	9.68	8.71
August 03	4.68	3.50	-	8.84	7.20	-	-	2.69	3.17
Average	**5.23**	**3.46**	**4.03**	**5.74**	**9.78**	**5.30**	**3.51**	**3.82**	**4.43**

The diffusion tube at Site S5 was located on a lamppost at Stiles Community Centre and was approximately 30m from the inlet for the 8-port sampler. Sites S1 (Greystone / Ballycraigy), and S2 (Crumlin), S4 (Station Road), S6 (Stiles / Rathenraw) and S9, (Springfarm) were also within the areas of concern identified in the First Stage report. Table 7.6 shows that the results for Site S5 are consistently higher than those for the diffusion tubes located elsewhere. The results provide a measure of confidence that the 8 port apparatus results for SO_2 represent the location of greatest concern although it is recognised that hot spots may exist elsewhere.

It can also be seen that results obtained from sampling sites within the 4 areas identified as areas of concern in the Stage 1 review and assessment are higher than for those outside these areas. This provides a measure of confidence that the areas of concern have been correctly identified.

7.6.9 Sulphur dioxide screening methodology.

LAQM.TG4 (00) provides a methodology by which daily average SO_2 concentrations measured by an 8-port sampler can be used to estimate exceedences of the objectives. The sampler is used to measure daily average concentrations and these can be directly compared against the 24-hour mean objective
Although the relationship between the daily maximum sulphur dioxide concentration and the 99.7th percentile of 1-hour mean concentration and the 99.9th percentile of 15-minute mean concentrations is uncertain and is dependant upon the occurrence of unusual meteorological conditions and the impact of individual point sources, LAQM TG4 (00) allows the following assumptions to be made

■ The 15-minute mean air quality objective is unlikely to be exceeded if the maximum daily concentration is less than **80µg/m^3.**

■ The 1-hour mean air quality objective is unlikely to be exceeded if the maximum daily mean concentration is less than **200µg/m^3.**

A comparison of the corrected maximum measured daily mean concentrations against the screening criteria set out in LAQM.TG4 (00) is shown in table 7.7.

Table 7.7 Comparison of sampler results with SO_2 objectives

Month	Corrected Maximum Daily Mean (µg/m^3)	Exceedence of Sceening Value for 24_hour Objective	Exceedence of Screening Value For 1-hour Objective	Exceedence of Screening Value For 15- minute Objective
		(>124µg/m^3)	(>200µg/m^3)	(>80µg/m^3)
September 02	45	NO	NO	NO
October 02	46.25	NO	NO	NO
November 02	53.75	NO	NO	NO
December 02	83.75	NO	NO	**YES**
January 03	98.75	NO	NO	**YES**
February 03	68.75	NO	NO	NO
March 03	46.25	NO	NO	NO
April 03	46.25	NO	NO	NO
May 03	45	NO	NO	NO
June 03	37.50	NO	NO	NO
July 03	45	NO	NO	NO
August 03	67.50	NO	NO	NO

Using the screening technique it can be seen that the highest corrected daily concentration of 98.75 $\mu g/m^3$ would indicate that there is a significant risk of the 15-minute mean objective being exceeded. The results indicate that exceedences of the daily mean and 1-hour mean objectives are unlikely.

The diffusion tube data would indicate that the highest concentrations of sulphur dioxide are being experienced in the area of Antrim town which was identified in the First Stage report as requiring further assessment.

Further data has also been obtained from the Housing authority, The Northern Ireland Housing Executive (NIHE) with respect to fuel usage within this area (see table7.8 below). These update the figures used in the First Stage review and which are shown in brackets.

Table 7.8 Solid fuel burning in NIHE houses.

Estate Name	Total Houses in Housing Executive Ownership	Number of HE Houses Burning Solid Fuels
Ballycraigy/Glenburn	299 (350)	224 (303)
Greystone	287 (314)	160 (212)
Newpark	110 (148)	74 (132)
Parkhall	663 (760)	263 (423)
Springfarm	323 (398)	176 (233)
Stiles	236 (320)	104 (162)
Townparks North	129 (152)	38 (65)
Randalstown	233 (274)	110 (247)
Crumlin	122 (166)	34 (79)
Firfields/Dublin Road	173 (202)	68 (156)
Menin Rd/Springfarm Rd	20 (30)	16 (24)
Moylena Grove	23 (31)	7 (16)
Rathenraw	172 (204)	55 (74)
Toome	96 (115)	47 (48)
Townparks South	68 (75)	0 (45)

The Ballycraigy/ Glenburn, Newpark, Parkhall, Stiles and Greystone Estates are all contained within a 2.5 x 2.5 Km^2 area. This area contains three of the four 1 Km^2 areas of the town identified for further investigation in Stage 1, and, as can be seen from the above table, is the major solid fuel burning area within the town. This area also contains the 8 port sampler site which is situated in an area between the Parkhall and Stiles Estates.

The estates within this area also contain a number of houses which are in private ownership and for which no fuel use information is presently available. Outside these estates the dwellings within the area are under private ownership and the vast majority of these use oil for heating purposes.

The data provided by NIHE shows that, although decreasing, high levels of solid fuel burning persist within the areas identified in the First Stage review and assessment.

The Housing Executive has embarked upon a long-term strategy of replacing solid fuel appliances in their properties with oil or gas central heating. It is known that the Springfarm estate, which dominates the fourth area of concern identified in Stage 1, will be converted to oil or gas before 2005. This conversion programme will be rolled out across the other estates

over the next few years, although this is unlikely to impact upon the area of greatest concern by the target date for the air quality objectives.

Crumlin Village.

The diffusion tube results indicate that the concentrations detected at the site in Crumlin village (Site S2) are consistently lower than those detected in the solid fuel burning areas of Antrim town.

The screening assessment carried out in 2001 for the first stage review and assessment, based on LAQM TG4 (00) guidance failed to rule out a risk of exceedences of the objectives, as the result of solid fuel burning, in the village.

In view of the low concentrations detected by the diffusion tube monitoring, and because the 2001 review and assessment was based on a 10% sample survey of domestic to gauge the extent of solid fuel burning, it was decided to carry out a repeat survey, using the revised guidance in LAQM TG (03).

This survey focused on the 500 by 500m area which known to contain the area of highest density housing within the village and a high proportion of the remaining solid fuel burning properties.

The area was found to contain 375 houses of which a 50% sample was surveyed. The survey results are shown in table 7.9 below.

Table 7.9 Results of domestic heating survey for Crumlin Village.

Houses	Oil Only	Solid Fuel Only	Solid Fuel As Secondary Source > 10 Days/year	Solid Fuel as Secondary Source < 10 Days/year
%	91.5	8.5	10.1	2.4
Number	343	32	38	9

If all the houses likely to be burning solid fuel at any time are aggregated the total comes to a total of 79. This total is less than the screening total of 100 properties burning solid fuel specified in LAQM TG (03) and on the basis of this new survey it can be assumed that domestic fuel burning is unlikely to cause exceedences of the objectives for sulphur dioxide in Crumlin Village, and that Crumlin can be excluded from further review and assessment.

7.6.10 Conclusions for domestic sources of sulphur dioxide

The guidance in LAQM TG4 (00) for Second Stage review and assessment for sulphur dioxide arising from domestic sources states that if monitoring shows that existing concentrations the air quality objective a Third Stage review and assessment should be undertaken.

An analysis of results of monitoring carried over a 12-month period and a review of information on solid fuel burning within Housing Executive properties has shown that the risk of the 15-minute mean objective for sulphur dioxide being exceeded, as the result of domestic solid fuel burning by the end of 2005 is not negligible.

The Parkhall, Stiles, Greystone, Ballycraigy and Newpark housing estates all lie within a 2.5Km x2.5 Km grid square and contain significant areas of solid fuel burning. The risk of exceedences of the air quality objective within these estates cannot be ruled out.

The Springfarm Estate, which was identified in the First Stage review as requiring further investigation, will largely be converted from solid fuel to oil before the air quality objective target date and consequently this area can be excluded from further assessment.

Crumlin village can also be excluded from further review and assessment.

7.7 SECOND STAGE REVIEW AND ASSESSMENT RECOMMENDATIONS FOR SULPHUR DIOXIDE

It is recommended that aThird Stage review and assessment for sulphur dioxide is carried out at the following locations :-

Parkhall Estate;
Stiles Estate;
Ballycraigy Estate;
Greystone Estate;
Newpark Estate.

8 THIRD STAGE REVIEW AND ASSESSMENT OF SULPHUR DIOXIDE

8.1 INTRODUCTION

The Second Stage review and assessment identified the need for a further investigation into SO_2 for an area of domestic fuel burning in Antrim town. This area contains the Parkhall, Stiles, Greystone, Ballycraigy and Newpark housing estates. These estates are areas of high housing density and are known to have high levels of solid fuel usage for domestic heating purposes.

The Council commissioned NETCEN, who had previously undertaken the Council's second stage review and assessment for road vehicular and industrial sources of air pollution, to carry out the Third Stage review and assessment.

8.2 VERSION OF THE POLLUTANT SPECIFIC GUIDANCE USED IN THIS ASSESSMENT

In the previous stages of review and assessment areas of potential exceedence of the air quality objectives for SO_2 and PM_{10} were identified following LAQM.TG4 (00). The latest guidance, LAQM.TG (03) requires the assessment to be carried out in greater detail by considering 500x500m areas. The detailed modelling carried out in this Stage 3 uses the 1x1km areas, but this takes account of all areas of significant domestic solid fuel burning. In practice, the high resolution modelling and the method of source definition used in this report means that defining a 1x1km area makes no difference to the output when compared with a smaller total area. This is because treatment of the sources with the present model is at a resolution of 10 – 20m, hence the model output for a given location is the same whether the area modelled is a 1x1km area or a 0.5x0.5km area or less.

8.3 GENERAL APPROACH TAKEN

The approach taken in this study was to:

- Collect fuel use survey data for the grids identified as requiring future assessment;
- Compile emission inventory for each area;
- Use monitoring data to assess the ambient concentrations produced by domestic fuel combustion and to verify the output of modelling studies;
- Model the concentrations of SO_2 in each selected grid square including local background concentration using ADMS 3.1;
- Present the concentrations as contour plots, directly comparable to the relevant objectives, overlaid onto a map of local housing;
- Comment on the uncertainty in the predicted concentrations.

8.4 Fuel use survey

Antrim Borough Council commissioned PSC Management Consultants to carry out a domestic fuel use survey in five areas identified in the Stage 2 review and assessment as requiring modelling.

The survey aimed to determine the following:

- The types and quantities of fuels used in the domestic sector
- Seasonal use of heating fuels
- The types of heating appliances used
- Any proposed change in fuel usage
- The total number of houses that burn coal in each of the survey areas.

The survey areas identified as requiring modelling were:

- Parkhall Estate
- Greystone Estate
- Newpark Estate
- Ballycraigy Estate
- Stiles Estate

The survey sampled 25.5% of households within these areas. The survey form is reproduced in Appendix 7, and the survey results are shown in Appendix 8.

Table 8.1 Estimated number of houses in each survey area and number of survey returns

Grid Area	No. houses	No. of returns
Parkhall Estate	1396	359
Greystone Estate	510	130
Newpark Estate	605	157
Ballycraigy Estate	757	203
Stiles Estate	653	149

The results of the survey showed that, for all areas, oil was the most popular main fuel for heating purposes with 56.3% of respondents using it across the five survey areas. Coal/solid fuel was the second most popular with 22.3% of respondents using it for their main source of heating across the 5 survey areas.
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8.4.1 Grid 1 – Parkhall Estate

In Grid square 1, there were estimated to be 1396 households. The following two tables summarise the results of the survey in this grid. Appendix 8 provides further details.

Table 8.2A % of households burning different fuel types in the Parkhall Estate area.

Use	Oil	Mains gas	Bottled gas	Electricity	coal/SF	Other	None
Main fuel	60.7	1.7	3.9	16.2	17.3	0	0.3
Secondary fuel	0.8	0	2.2	24.2	8.1	0.3	64.3

SF = solid fuel

Table 8.2B The type of coal and / or solid smokeless fuel used as main fuel for heating in the Parkhall Estate survey area (%).

Type	Non-smokeless coal	Smokeless coal	Logs/sticks
% who use	17	82	1

In the Parkhall Estate survey area, it was found that the majority (60.7%) of households burned oil as their primary fuel. A smaller proportion (17.3%) burnt coal or solid fuel.

The emission factors shown in Table 8.7 below have been applied to the results of the fuel survey for grid square 1 to calculate an average SO_2 emission arising from each block of housing in the area.

8.4.2 Grid 2 – Greystone Estate

There were estimated to be 510 households in Grid square 2. The following two tables summarise the results of the survey in this grid. Appendix 8 provides further details.

Table 8.3A % of households burning different fuel types in the Greystone Estate area.

Use	Oil	Mains gas	Bottled gas	Electricity	coal/SF	Other	None
Main fuel	37.7	0	1.5	30.0	30.8	0	0
Secondary fuel	0.8	0	0	16.2	0.8	0	82.3

SF = solid fuel

Table 8.3B The type of coal and / or solid smokeless fuel used as main fuel for heating in the Greystone Estate survey area (%).

Type	Non-smokeless coal	Smokeless coal	Logs/sticks
% who use	2	98	0

In the Greystone Estate survey area, it was found that the largest proportion (37.7%) of households burned oil as their primary fuel. The next most popular primary fuel for heating was coal/solid fuel (30.8% of respondents).

The emission factors shown in Table 8.7 below have been applied to the results of the fuel survey for grid square 2 to calculate an average SO_2 emission arising from each block of housing in the area.

8.4.3 Grid 3 – Newpark Estate

In Grid square 3, there were estimated to be 605 households. The following two tables summarise the results of the survey in this grid. Appendix 8 provides further details.

Table 8.4A % of households burning different fuel types in the Newpark Estate area.

Use	Oil	Mains gas	Bottled gas	Electricity	coal/SF	Other	None
Main fuel	73.9	0	0.6	8.3	16.6	0	0.6
Secondary fuel	1.3	0	0	32.5	1.3	0	65

SF = solid fuel

Table 8.4B The type of coal and / or solid smokeless fuel used as main fuel for heating in the Newpark Estate survey area (%).

Type	Non-smokeless coal	Smokeless coal	Logs/sticks
% who use	0	100	0

In the Newpark Estate survey area, it was found that the majority (73.9%) of households burned oil as their primary fuel. A smaller proportion (16.6%) burnt coal or solid fuel.

The emission factors shown in Table 8.7 below have been applied to the results of the fuel survey for grid square 3 to calculate an average SO_2 emission arising from each block of housing in the area.

8.4.4 Grid 4 – Ballycraigy Estate

In Grid square 4, there were estimated to be 757 households. The following two tables summarise the results of the survey in this grid. Appendix 8 provides further details.

Table 8.5A % of households burning different fuel types in the Ballycraigy Estate area.

Use	Oil	Mains gas	Bottled gas	Electricity	coal/SF	Other	None
Main fuel	50.7	0	0	22.7	26.6	0	0
Secondary fuel	0	0	0.5	25.1	2	0	72.4

SF = solid fuel

Table 8.5B The type of coal and / or solid smokeless fuel used as main fuel for heating in the Ballycraigy Estate survey area (%).

Type	Non-smokeless coal	Smokeless coal	Logs/sticks
% who use	3	95	2

In the Ballycraigy Estate survey area, it was found that the majority (50.7%) of households burned oil as their primary fuel. The next largest proportion (26.6%) burnt coal or solid fuel.

The emission factors shown in Table 8.7 below have been applied to the results of the fuel survey for grid square 4 to calculate an average SO_2 emission arising from each block of housing in the area.

8.4.5 Grid 5 – Stiles Estate

In Grid square 5, there were estimated to be 653 households. The following two tables summarise the results of the survey in this grid. Appendix 8 provides further details.

Table 8.6A % of households burning different fuel types in the Stiles Estate area.

Use	Oil	Mains gas	Bottled gas	Electricity	coal/SF	Other	None
Main fuel	51	0.7	0.7	20.1	27.5	0	0
Secondary fuel	0	0	0	25.5	3.4	0	71.1

SF = solid fuel

Table 8.6B The type of coal and / or solid smokeless fuel used as main fuel for heating in the Stiles Estate survey area (%).

Type	Non-smokeless coal	Smokeless coal	Logs/sticks
% who use	16	84	0

In the Stiles Estate survey area, it was found that the majority (51%) of households burned oil as their primary fuel. The next most popular main fuel for heating was coal or solid fuel (27.5%).

The emission factors shown in table 8.7 below have been applies to the results of the fuel survey for grid square 5 to calculate an average SO_2 emission arising from each block of housing in the area.

8.5 DISPERSION MODELLING

NETCEN was commissioned to complete the domestic fuel combustion investigation for Antrim Borough Council.

8.5.1 Information Used By NETCEN To Support The Assessment.

This section presents the information used by the consultants to support the emissions modelling.

8.5.1.1 Maps

Antrim Borough Council provided a detailed map covering a 2.5x2.5km^2 grid which included the five areas of concern. The areas include areas of significant coal burning in the Borough.

8.5.1.2 Meterological data used in the dispersion modelling

Hourly sequential data was obtained for 2002 and 2003 for the Aldergrove site for input into the ADMS dispersion model. 2002 data was used for the modelling and a combination between 2002 and 2003 was used to bias correct the modelling work as this covers the same period of monitoring data available for PM_{10} and SO_2 (July 2002 – June 2003).

8.5.1.3 Ambient monitoring

Antrim had no local continuous real-time monitoring data available. Carrickfergus Borough Council has carried out monitoring of SO_2 since July 2002 with a continuous monitor in Carrickfergus Town (341130, 387999). The instrumentation employed uses UV fluorescence for the measurement of SO_2 and this method are appropriate for detailed assessment under LAQM (LAQM TG(03)). Appendix 6 provides more details about this local air quality monitoring programme.

NETCEN has not undertaken any scaling or ratification of the dataset provided by Carrickfergus BC. However, NETCEN has undertaken a review of the data comparing the trends of the pollutants to other nearby National Network monitoring stations. The Carrickfergus dataset follows the same temporal variation as seen at the AURN station at Belfast Centre, providing a degree of confidence in the dataset.

A fuel use survey for the areas to be modelled, described in Section 8.4, has also been used to support the assessment.

8.5.2 Overview Of The Modelling Approach

The dispersion model ADMS 3.1 has been used to predict the SO_2 levels in Carrickfergus BC. ADMS is a PC-based model that includes an up-to-date representation of the atmospheric processes that contribute to pollutant dispersion and has been deemed suitable for use in the review and assessment process.

The emissions arising from each survey area have been modelled as volume sources 10m high with each emission point set at 5m high. Emissions have been weighted with both seasonal and diurnal emission patterns. The seasonal pattern was calculated on a degree day basis to weight emissions to the colder periods of the year following the BREDEM model (BREDEM, BRE, 1985). Temperature data for each hour was taken from the 2002 Aldergrove meteorological data.

The modelled concentrations have then been added to estimated background concentrations (taken from the NETCEN NAEI web site www.naei.org.uk).

8.5.3 Model Bias

The monitoring site at Carrickfergus Town (Rosebrook Avenue) has been used as a reference site to bias correct the model results in accordance with section 4.41 of LAQM. TG(03). The monitoring data was reviewed by NETCEN as explained above.
The purpose of this adjustment was to ensure that the modelled concentrations equalled the measured values at the monitoring locations. The same modelling methodology has been used at other Local Authorities to maintain consistency in the modelling approach and thus minimise the uncertainty of applying a generic bias correction.

More details of the bias correction are given in Appendix 6.

8.5.4 Model Uncertainties

The calculations have not taken account of:

- Uncertainties in the fuel use survey;
- Uncertainties in how the burning of domestic fuel might change in future years;
- Uncertainty resulting from year to year variations in atmospheric conditions;
- Uncertainty in emission factors;
- Uncertainty in monitoring data.

The above uncertainties are dealt with as fully as possible but it is important to remember that the modelling depends highly on the accuracy of the fuel use survey, which is a sample survey. It is assumed that the fuel use survey is representative and will remain representative of the fuel use at the time of the objectives. As we are assuming the fuel use profile will remain the same there is no need to correct the fuel use survey to the year of the objective. Predicted future background concentrations have been applied.

The dispersion modelling is based upon the meteorology and emissions for 2002, clearly meteorological conditions will vary from year to year but overall would be expected to be broadly representative of local conditions for the year of the objectives.

The monitoring data was provided by Carrickfergus Borough Council for July 03 to June 04.

8.5.5 Emission Factors Used In The Modelling

The SO_2 emissions arising from domestic fuel combustion were taken from the UK emission factor database (www.naei.org.uk). This web site is managed by NETCEN on behalf of defra. The exception to this is the emission factor for sulphur dioxide from household coal, which has been taken from a CRE study carried out for Belfast City Council. This locally derived emission factor is more representative of fuel burnt in Northern Ireland.

Table 8.7 Emissions arising from domestic fuel combustion

Fuel type	SO_2	Units
Anthracite	13	kt/mt fuel burnt
Burning Oil	0.42	kt/mt fuel burnt
Coal	10*	kt/mt fuel burnt
SSF	16	kt/mt fuel burnt

Source: UK emission factor database (www.naei.org.uk)
SSF = solid smokeless fuel
* - emission factor taken from CRE, 1997.

The emission factors provided in the above table have been used to derive SO_2 emissions for the survey areas.

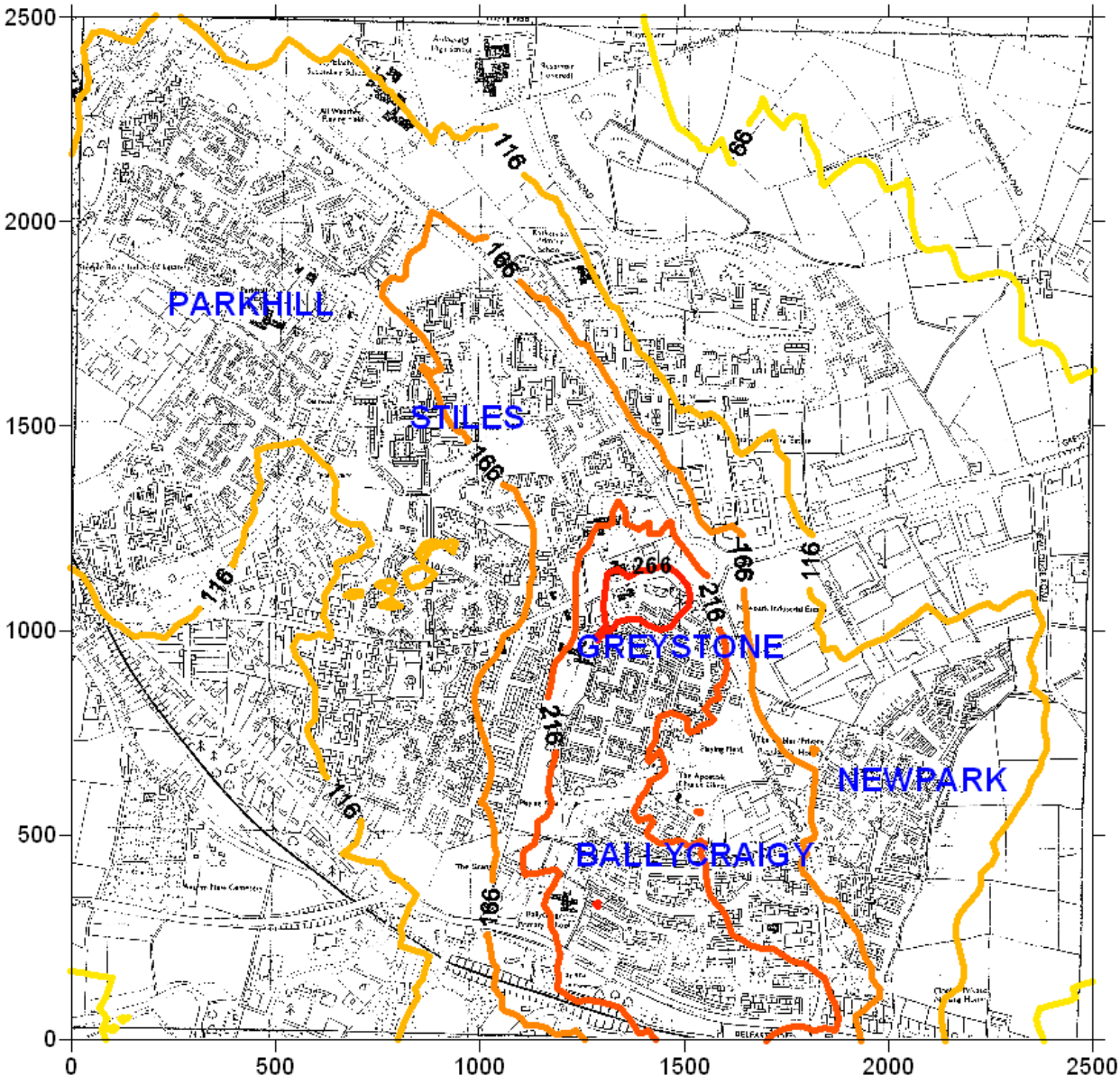
Emissions Factors are average emission factors and do not take into account, for example natural variation in coal and its sulphur content variability.

8.6 DETAILED MODELLING

The five areas of interest have been modelled together on a 2.5x2.5km^2 grid. This is because of their close proximity to one another, which means that emissions from one area may have an effect on SO_2 and PM_{10} levels of the other areas.

Figure 8.1 shows predicted SO_2 concentrations in the 2.5x2.5km^2 area. The model predicts that the 99.9 percentile of the 15 minute mean SO_2 concentration will be exceeded in the Greystone and Ballycraigy Estates but not in the Parkhall, Newpark and Stiles Estates. It has been assumed that domestic fuel burning in the area will not change between when the survey was carried out and 2004/5.

Figure 8.1 – 99.9 percentile 15 minute mean SO_2 concentrations for the five survey areas (model results corrected for bias using monitoring data from Carrickfergus)



8.7 CONCLUSIONS AND RECOMMENDATIONS

Detailed modelling using ADMS version 3.1 has been undertaken at five locations where large amounts of domestic solid fuel burning is common. The modelling predicted that in the Parkhall, Newpark and Stiles Estates the SO_2 objectives are unlikely to be exceeded. The model predicted that in the Greystone and Ballycraigy Estates air quality objectives are likely to be exceeded.

8.7.1 Magnitude of predicted exceedences and improvement needed

The maximum modelled 99.9 percentile of the 15 minute mean SO_2 concentration was 293µg m^{-3}. This compares to the air quality objective of 266 µg m^{-3} to give a modelled exceedence of 27 µg m^{-3}.

8.7.2 Relevant exposure

The Council having identified the likelihood that an AQS objective will be exceeded is required to confirm that public exposure is likely over the averaging period for the objective. For the 15 minute mean SO_2 objective it is necessary to consider locations where members of the public might reasonably be exposed for a period of 15 minutes or longer. As Greystone and Ballycraigy are residential areas the possibility of relevant exposure can be confirmed.

8.7.3 Source apportionment

Domestic fuel combustion is believed to be the only significant source in the area and therefore for source apportionment it is reasonable to conclude that domestic fuel combustion is the cause of the exceedence.

The SO_2 exceedence here is likely to be the result of a high housing density coinciding with a relatively high usage of Solid Smokeless Fuel (SSF), which has a higher SO_2 emission factor than the other fuels used for heating in the area.

It has been assumed that domestic fuel burning in the area will not change between when the survey was carried out in October 2003 and 2004/5.

8.7.4 Identification of the AQMA

Having identified that an AQS objective will be exceeded and that relevant exposure is likely, the Council is required to designate an Air Quality Management Area (AQMA). The Council is therefore required to identify the geographical extent of the possible exposure to enable it to designate an AQMA.

The modelling predicted exceedences to occur within the Ballycraigy and Greystone Estates. As pointed out in section 8.4.1.6 the modelling results are subject to several uncertainties which may lead to under or over prediction of concentrations. It is also recognised that the 15 minute AQS objective poses many challenges to air pollution modelling, as it is the most uncertain of the objectives to predict. Any local topographical and meteorological effects that might arise can add further complications.

Despite these major difficulties the modelling highlighted areas where the 99.9th percentile (i.e. equivalent to the AQS objective) would exceed 266µg m^{-3}. The map in figure 8.1 shows the extent of the area inside the 266µg m^{-3}, however to allow for any potential under prediction and to take a precautionary approach the Council would propose to designate the AQMA based on the 216µg m^{-3} contour. This contour takes in the whole of the Greystone Estate and almost all of the Ballycraigy Estate. It is therefore proposed that the AQMA would encompass the Ballycraigy and Greystone Estates in their totality.

8.7.5 Recommendations

The modelling shows exceedences of the SO_2 objective are likely. Article 12(1) of the Environment Order states that where the air quality objectives are not being achieved or are unlikely to be met on time, An Air Quality Management Area (AQMA) must be declared officially by means of an "Order".

It is recommended that Antrim Borough Council declare an Air Quality Management Area (AQMA) on the basis of the likely exceedence of the 15 minute mean SO_2 objective highlighted in this report

In order to take account of uncertainties inherent in the modelling it is recommended that the proposed AQMA covers the Ballycraigy and Greystone residential estates where the modelling predicted that exceedences will occur

8.7.6 Future actions

The Council will now seek to consult with the relevant authorities and interested parties and following the period of consultation will designate by Order an Air quality Management Area for the area encompassing the Ballycraigy and Greystone Estates.

The Council once the AQMA is designated, will start work on a draft action plan which will set out the measures that we intend to introduce in pursuit of the air quality objectives.

Although the Council will seek to consult on the measures to be included in the action plan, a further assessment will be undertaken at the Ballycraigy and Greystone Estates.

Further modelling of possible fuel use scenarios would provide information on the quantity of emissions reduction that the scenarios could deliver. From this the subsequent change in concentrations could be modelled within the exceedence area. This further modelling could therefore provide the information required to inform what options are available to reduce concentrations for the action planning phase and how effective they would be for working towards the objective.

The Council will seek to install a continuous real-time SO_2 monitor within the area of predicted highest concentration within the proposed AQMA. This will provide data for the verification of future modelling and provide on the spot evaluation of pollutant concentrations to inform decision making in relation to the AQMA.

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Appendices

CONTENTS

Appendix 1

Traffic Data

Description of Link	annual average vehicle flow (veh/hr)	% HDV	average speed (km/hr)
Fountain St	839	10.5	39
Fountain Hill	472	6.8	64
A6 Belfast Rd	460	10.4	61
Belmont Rd	346	13.8	84
Randalstown Rd	623	10.4	64
A26 Ballymena Rd	662	8.7	66
A26 Ballymena Rd	662	8.7	66
B518 Stiles Way	467	24.9	82
A26 Oldstone Rd	462	16.3	84
A57 Airport to Templepatrick Rd	493	17.2	87
A57 Ballyclare Rd	684	14.4	82
A6 Belfast Rd	460	10.4	61
Fountain Hill	472	6.8	64
B518 Stiles Way	467	24.9	82
A26 Oldstone Rd	462	16.3	84
A6 Belfast Rd	460	10.4	61
A26 Oldstone Rd	462	16.3	84
B37 Sevenmile Straight	131	11.4	66
B518 Stiles Way	467	24.9	82
Greystone Rd	388	9.8	71
M2 Rathbeg - Templepatrick	1545	12.92	89
Fountain St	839	10.5	39
Randalstown Main St	806	7.9	40
M2 Rathbeg - Dunsilly	1348	12.92	89
A26 north of Dunsilly	1274	16	90

Appendix 2

Diffusion Tube Data

Nitrogen Dioxide Diffusion Tubes, $\mu g/m^3$.

Location	Site
A6 Moneynick Road	1
A6 Belfast Road in Templepatrick Village	2
Fountain Street, Antrim	3
A26 Lisnevenagh Road North of Dunsilly	4
Main Street, Randalstown	5
M2 Motorway at Donegore	6

YEAR – 2001

Site	Jan/ Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Average
1	27	24	20	15	16	15	15	20	15	13	25	18.6
2	34	38	35	37	23	34	29	32	33	18	32	30.5
3						17	27	30	14		31	23.8

YEAR – 2002

Site	Jan	Feb	Mar	Apr	May	June	July/ Aug	Sept	Oct	Nov	Dec	Annual Average
1	30	5	26	30	20	19	-----	32	16	20	40	23.8
2	31	----	37	33	----	36	24	34	19	24	44	31.4
3	36	----	28	17	20	20	18	19	----	8	43	23.2
4	30	11	20	36	36	23	24	32	16	43	27	27.1
5	53	----	39	28	34	35	31	40	38	32	42	37.2
6	11	----	22	19	28	24	18	17	13	23	15	18.3

YEAR – 2003

Site	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Average
2	28	----	45	36	38	34	30	28	30	27	35	29	31.8
3	14	22	13	----	15	25	25	25	27	39	26	18	22.6
4	12	24	33	57	25	----	26	25	21	50	30	34	30.6
5	17	----	57	40	24	32	29	34	31	46	32	36	34.4
6	29	19	----	23	27	23	17	19	19	44	19	3	22.0

APPENDIX 3

DAILY AVERAGE SO_2 CONCENTRATIONS FROM 8-PORT SAMPLER

Daily Average SO_2 Concentrations (µg m^{-3}).

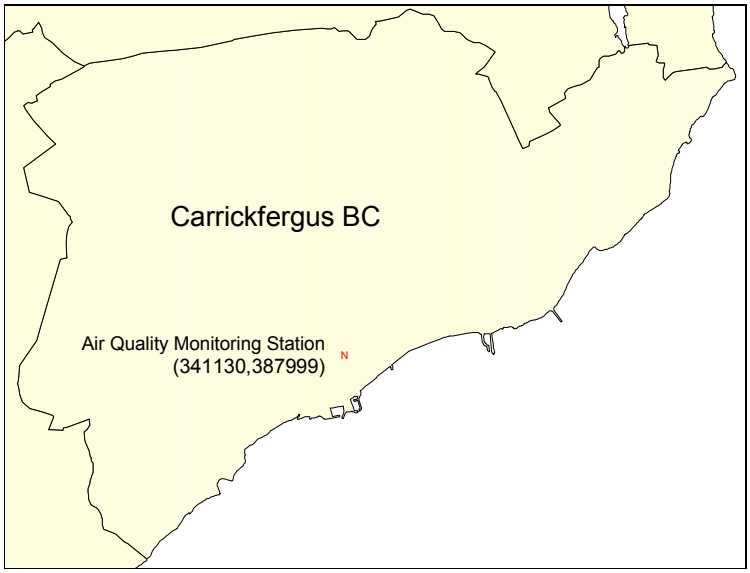
DAY	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG
1		12	18	12	-----	18	24	6	24	24	30	30
2		6	18	6	-----	25	24	18	18	24	30	24
3	18	18	12	18	-----	18	24	18	18	12	30	36
4	-----	18	18	32	73	25	12	18	18	24	24	48
5	12	12	24	44	79	24	12	18	24	24	30	24
6	12	12	18	51	37	18	6	18	18	24	18	24
7	18	18	12	25	37	18	12	24	12	30	24	36
8	18	18	18	32	24	12	18	24	18	30	-----	54
9	24	18	30	25	43	12	12	37	12	18	24	42
10	24	24	18	25	61	12	18	31	18	12	24	36
11	36	18	18	12	24	24	12	24	18	30	18	36
12	12	18	18	30	12	18	30	24	24	18	30	30
13	18	24	18	37	12	18	24	18	12	12	36	18
14	12	24	18	30	18	55	30	31	12	24	36	30
15	12	12	18	24	18	24	30	18	18	30	48	30
16	18	25	18	43	12	18	30	24	24	30	-----	24
17	18	37	24	67	18	12	30	30	18	18	36	30
18	24	31	18	37	18	18	36	30	24	12	30	30
19	24	37	18	24	18	24	37	24	18	12	42	12
20	12	25	18	31	24	24	18	18	12	18	36	18
21	12	12	12	24	37	12	18	12	18	30	36	12
22	24	18	18	24	24	18	12	18	24	30	12	24
23	24	12	24	24	24	12	30	12	18	24	12	30
24	18	18	18	-----	18	18	24	18	24	24	24	36
25	18	12	18	-----	18	18	24	18	24	18	36	36
26	18	18	12	-----	18	24	24	18	24	18	30	30
27	18	24	12	18	12	18	37	24	18	18	30	36
28	18	12	24	18	18	18	31	12	12	24	24	30
29	9	16	12	24	18	-----	18	18	30	30	18	24
30	10	43	18	24	31	-----	24	18	36	24	18	30
31	-----	24	-----	-----	31	-----	18	-----	30	-----	18	-----

Appendix 4

Automatic Monitoring Station Data

CARRICKFERGUS AMBIENT AIR MONITORING PROGRAMME

Carrickfergus Borough Council has undertaken automatic ambient air monitoring of SO_2 and PM_{10} since July 2002. The instrumentation employed uses UV fluorescence for the measurement of SO_2 and the TEOM technique for PM_{10}, these methods are appropriate for Detailed Assessment under LAQM (LAQM TG(03)). The monitoring station is located in Carrickfergus Town in Rosebrook Avenue. The exact location of the monitoring station is provided below. The station is located in the Carrickfergus Town Centre grid which has been modelled for domestic fuel combustion. It is therefore in a relevant location.



Location of Automatic Monitoring Station in Carrickfergus

The data presented here has been provided to **netcen** by Carrickfergus Borough Council as finalised data. Thus no further data scaling or ratification of the data has been undertaken. However, a qualitative review of the data has been completed comparing the trends of the pollutants to nearby AURN monitoring stations. As can be seen in Figures 1 & 2 below, the Carrickfergus dataset broadly follows the same temporal variation as seen at the AURN station at Belfast Centre for PM_{10} and Belfast Centre and Belfast East for SO_2. This provides a degree of confidence in the dataset.

The data supplied by Carrickfergus Borough Council, and used in the verification process of the modelling, was uploaded to the **netcen** database and analysis of the data provided the following data summaries. Table 1 provides descriptive statistics of the Carrickfergus data, whilst Table 2 provides comparison against the Air Quality Objective values set down in the Air Quality Regulations (Northern Ireland) 2003.

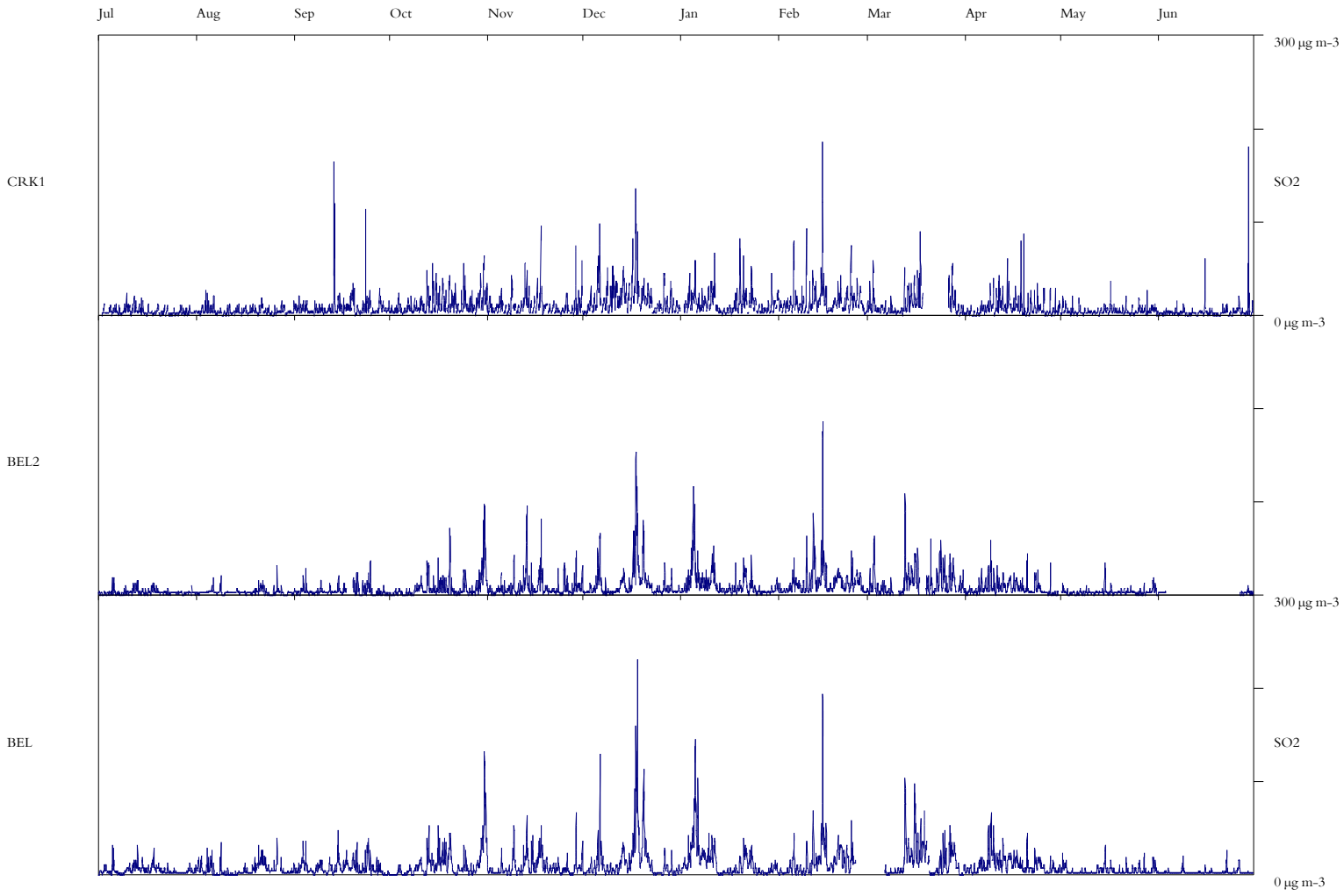
Table 1 Air Quality Summary Statistics, Carrickfergus 01 July 2002 to 30 June 2003

POLLUTANT	SO_2	PM_{10}	GR_{10}
Maximum 15-minute mean	237 µg m^{-3}	574 µg m^{-3}	746 µg m^{-3}
Maximum hourly mean	186 µg m^{-3}	287 µg m^{-3}	373 µg m^{-3}
Maximum running 24-hour mean	57 µg m^{-3}	59 µg m^{-3}	77µg m^{-3}
Maximum daily mean	52 µg m^{-3}	56 µg m^{-3}	72 µg m^{-3}
Average	9 µg m^{-3}	20 µg m^{-3}	25 µg m^{-3}
Data capture	88.6 %	78.2 %	78.2 %

Table 2: Air Quality Exceedence Statistics, Carrickfergus 01 July 2002 to 30 June 2003

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
Sulphur Dioxide	15-minute mean >266 µg m^{-3}	0	0
Sulphur Dioxide	Hourly mean > 350 µg m^{-3}	0	0
Sulphur Dioxide	Daily mean > 125 µg m^{-3}	0	0
PM_{10} Particulate Matter (Grav)	Daily mean > 50 µg m^{-3}	17	17
PM_{10} Particulate Matter (Grav)	Annual mean > 40 µg m^{-3}	0	-

Note: A factor of 1.3 has been used to correct TEOM PM_{10} to gravimetric equivalent PM_{10} (GR_{10} in Table 1)



Sulphur Dioxide July 2002 to June 2003

Appendix 5

Aldergrove Met Station Data

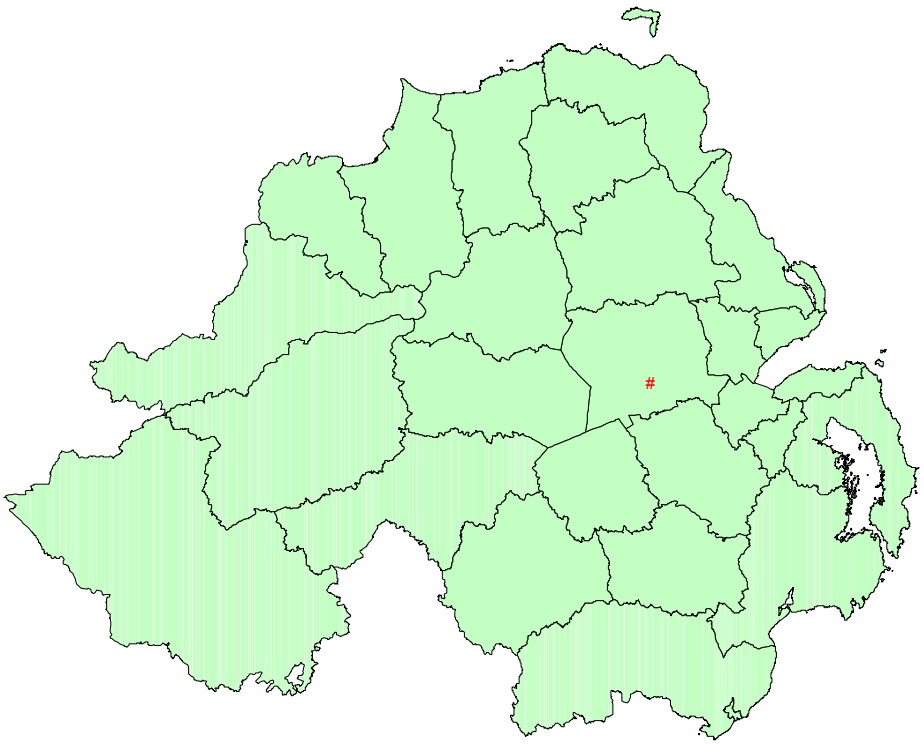
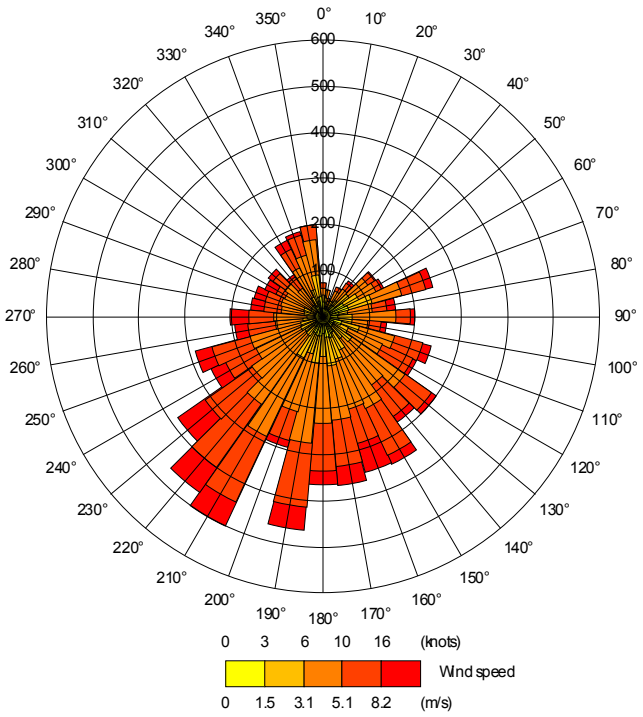


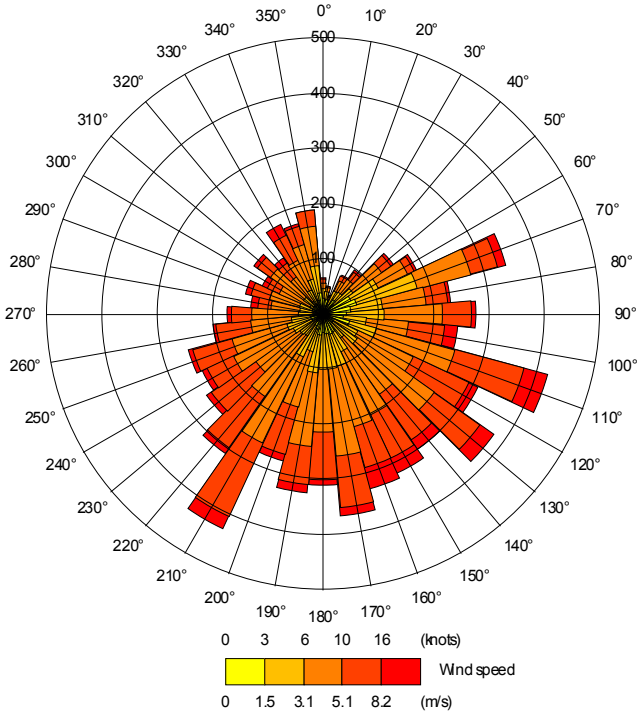
Figure A2- Location of Aldergrove Station

Table A2 - Characteristics of Aldergrove Station

Description – Aldergrove International airport.	
DCNN	9142
Eastings	314700
Northings	379800
Latitude Deg Min	54 39 N
Longtitude Deg Min	06 13 W
Station height AMSL (m)	68
Effective height of anemograph (m)	10



Wind rose for the Aldergrove 2002 met data



Wind rose for the Aldergrove July 2002 – June 2003 met data

Appendix 6

Model Bias correction

Carrickfergus BC Bias Correction and Modelling

Bias correction

PM_{10} and SO_2 ambient concentrations were modelled using met data from Aldergrove between July 2002 and June 2003 (This is the same period from which monitoring data for PM_{10} and SO_2 was available from the monitoring station). This model run included both time varying emissions from domestic fuel burning and the constant emissions from Kilroot Power Station.

The modelled 90%ile of 24h mean for PM_{10} and 99.9%ile of 15 minute mean for SO_2 were then compared to the monitoring results for the same period. Following the formulas below, a bias correction factor was worked for PM_{10} and SO_2:

$$PM_{10\ monitoring\ data} = (background_{PM10} \times 1.68) + (Modelled\ result \times f_{PM10}) \quad [90.41\%\ 24h\ mean]$$

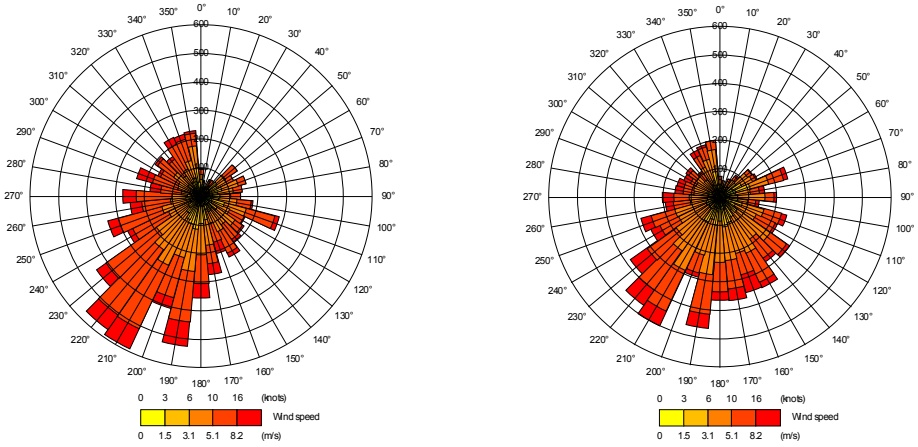
$$SO_{2\ monitoring\ data} = (background_{SO2} \times 2) + (Modelled\ result \times f_{SO2}) \quad [99.9\%\ 15\text{-}min\ mean]$$

Table 3.1 Summary of model bias correction

	Monitoring data (Carrickfergus station)	**Background** (from NAEI)	**Modelled** (ADMS 3.1)	**Bias correction** (factor)
PM_{10} gravimetric	46.8 μg m^{-3}	19 μg m^{-3}	7.0 μg m^{-3}	**2.13**
SO_2	133 μg m^{-3}	10 μg m^{-3}	100.5 μg m^{-3}	**1.12**

Met data variations

Having worked out a bias correction factor for the model run, modelling was carried out again using 1999 and 2002 met data, separately. The results obtained for these two years were very similar. The most recent met data was to be used (2003 was not complete at the time of modelling). As can be seen in figure 1, 1999 and 2002 met data have similar windrose with a predominant southwesterly wind[1].



[1] **Note that there are other factors affecting pollutants dispersions. Wind directions is only an example to show that met data used is different.**

Fig 1. Wind rose for the Aldergrove 1999 (left) and 2002 (right) met data

In order to carry out the modelling assessment, met data for the complete year 2002 was used. However, the bias correction used to correct the model results were from the met data 2002-2003 as this was the only period with monitoring data available. This explains the difference between modelled results presented in the report (Year 2002) and monitoring data measured in Rosebrook Avenue Station since July 2002. On this basis had there been monitoring for the whole of 2002 more PM_{10} exceedences may have been recorded.

As figure 2 shows, the wind patterns between 2002 and 2002/2003 are not similar. Both Southeasterly and Southwesterly winds dominated in 2002/2003 compared to Southwesterly winds in 2002.

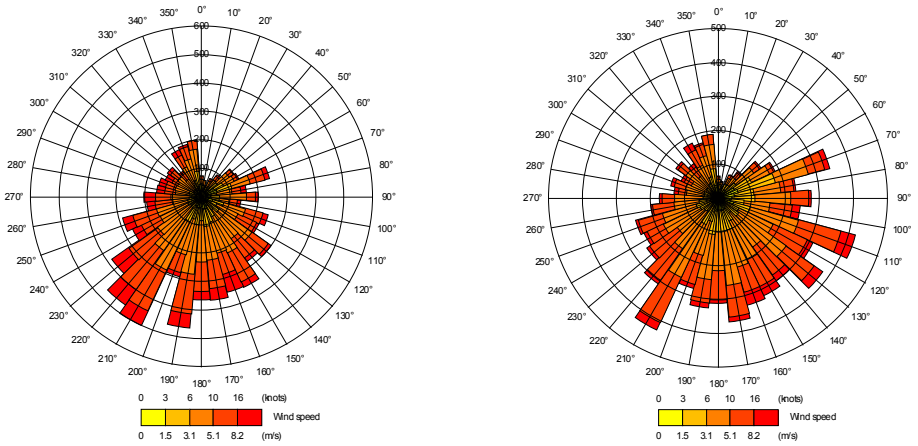
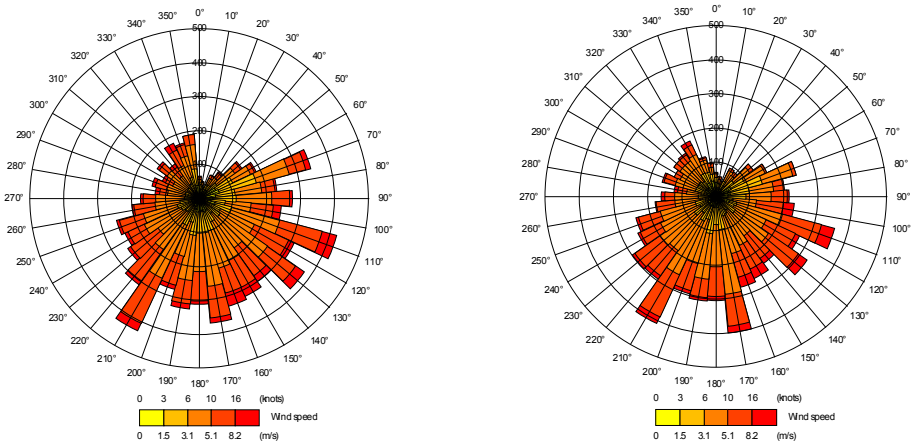


Fig 2. Wind rose for 2002 met data (left) and july 2002 – June 2003 met data (right)

Figure 3 shows that 2002/2003 windroses are similar to 2003 met data alone.



Wind rose for July 2002 – June 2003 met data (left) and 2003 met data (right)

Monitoring period used for Bias correction

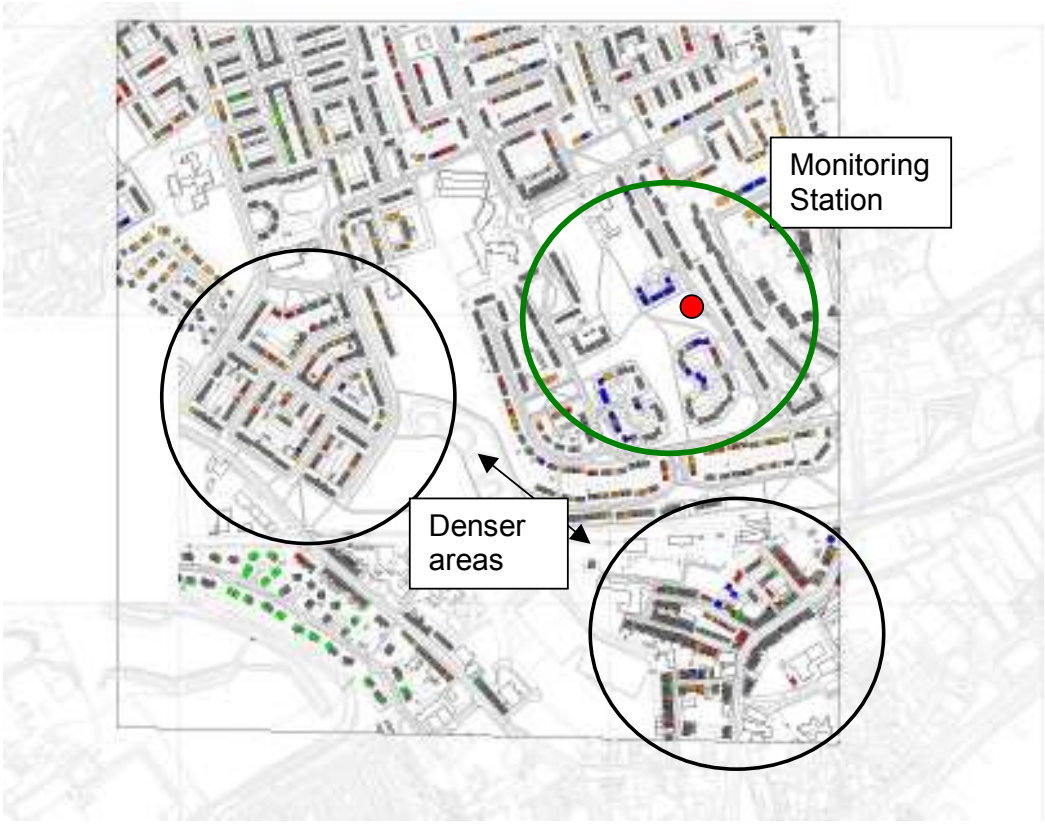
The data set used for model verification runs 01/07/2002 through 30/06/2003. This was the monitoring data provided by Carrickfergus BC. In reviewing the data (Appendix 1), it was noted that the period of interest (Winter 2002/2003) coincided with periods of elevated PM_{10} across the whole of the UK. These periods are well documented (see http://www.airquality.co.uk/archive/reports/list.php - forecasting reports) and were driven by transboundary PM_{10}.

These national PM episodes were considered with respect to the model verification process. It is recognised that the inclusion of many transboundary episodes within a dataset will result in a conservative model bias correction factor. On review, a decision was made to use all available data within the monitoring period for the following reasons:

- The national transboundary episodes were recorded during the winter 2002/2003 period, the same period of interest with respect to domestic fuel combustion. Simply removing the transboundary episodes may remove significant domestic contributions.
- On the basis of the information available, we consider there is no robust method of source apportionment to enable the domestic contribution to be isolated, LAQM.TG (04) does not provide guidance on this.
- Many of national episodes are not present in the Carrickfergus monitoring data set with gaps coinciding with known transboundary episodes.

Location of monitoring station

Apart from the influence of met data to the modelling results, it should also be highlighted that monitoring results from Rosebrook Avenue might not represent the areas with highest pollution. House density nearby is less compared to two areas where possible exceedences have been modelled.


Monitoring Station
Denser areas

Appendix 7

Fuel use survey form

INTERVIEWER _____

ANTRIM BOROUGH COUNCIL
FUEL USE SURVEY

PERSONAL INFORMATION

All the information you give in this part of the survey will be treated as totally confidential. Your responses will be analysed collectively with those of many other people.

ADDRESS _____

_____ **Postcode** __BT_____

1a. Could you please tell me what is the main fuel you use for heating purposes in your home?

- None ☐
- Oil ☐
- Mains gas ☐
- Bottled gas ☐
- Electricity ☐
- Coal/solid fuel ☐
- Other ☐

1b. Which other types of fuel do you use for back-up or occasional heating in your home?

- None ☐
- Oil ☐
- Mains gas ☐
- Bottled gas ☐
- Electricity ☐
- Coal/solid fuel ☐
- Other ☐

2a. If solid fuel is used, what type of heating appliances do you have in your house?

- Open fire ☐
- Glass fronted fire ☐
- Gravity feed boiler ☐
- Stove/range ☐
- Other ☐ Please specify _____

2b. If solid fuel, what is the main type of fuel used?

Non smokeless coal	☐	Please specify: Anthracite	☐
Smokeless coal	☐	Phurnacite	☐
Turf/peat	☐	Burnglo	☐
Logs/sticks	☐	Glovoids	☐
		Home Fire	☐
		Coalite	☐
		Wonderco	☐
		Petcoke	☐
		Blend	☐
		Red Flame	☐

Other ☐ Please specify _____

3. If you have a solid fuel appliance, how often do you light it?

Once daily	☐
2-3 times weekly	☐
Once per week	☐
Less frequently	☐
Not applicable	☐

4. If you use coal (including smokeless coal) in your solid fuel appliance, how many 25 kg or 50 kg bags do you use per week?

In winter _____
In summer _____

Not applicable ☐

5. If you use oil, what is your estimated annual consumption in litres?

_____

Not applicable ☐

6. Have you any plans to change your heating in the next 3 years?

Yes	☐
No	☐

If yes, what would you change to?

Coal	☐
Mains gas	☐
Bottled gas	☐
Oil	☐

Electricity	☐	
Other	☐	Please specify _____

Appendix 8

Fuel use survey results

Fuel Use Survey Results

A total of 998 households were surveyed throughout five distinct housing Estates in Antrim Borough Council area over a two-week period during October 2003. The number of houses for each particular research area is detailed as follows:

Table 1 Households surveyed in each area

Households Surveyed in each Area	
Parkhall Estate	359
Greystone Estate	130
Newpark Estate	157
Ballycraigy Estate	203
Stiles Estate	149
Total	**998**

The surveys were carried out on a three call back basis, in order to ensure maximum response rates.

Methodology Employed

The questionnaire which was used during the research project was provided by Antrim Borough Council. PSc Management Consultants piloted thirty questionnaires in the area in order to identify any instrument ambiguities, before producing the required one thousand copies of the survey instrument. No alterations were made to the questionnaire following the pilot. A copy of the questionnaire is shown in Appendix 7

Two researchers were used in order to carry out the survey. Researchers were given introductory letters from Antrim Borough Council which were shown to informants, along with laminated photographic identification cards. Data collection took place Monday to Saturday, including evenings, over a two-week period from Monday 13th October until Monday 27th October 2003. The fuel survey project was publicised by the council through the local media in order to raise community awareness that researchers would be in their particular area, while community police representatives were informed regarding the researchers' presence in a given location.

Each research team was provided with a master list of house numbers and street names in their survey area. The master sheet detailed five columns as per the example as follows:

Fig 1 Sample master sheet page.

Sample Master Sheet Page						
		am	**pm**	**evening**	**Alt. am**	**Alt. pm**
Donegore Drive	**1**					
	3					
	5					

	9					
	11					
	13					
	15					
	19					
	2					
	4					
	8					
	10					

The five columns above detailed a period of time; am (morning), pm (afternoon), evening, Alt. am (alternative morning) and Alt. pm (alternative afternoon) during which researchers could visit each house on the list. Researchers were required to manually mark each property for which a completed survey had been secured, or enter the date of each call back visit. The master sheet for each researcher was copied and checked by PSc Management Consultants staff on a weekly basis in order to co-ordinate progress of the project.

A total of 998 completed questionnaires were secured from a total of 3,921 households, giving an overall sampling rate of 25.5%. The following numbers of questionnaires were completed for each particular area:

Table 2 Returns for each area.

Households Surveyed in each Area			
	Total Households	**No. of Returns**	**% Return**
Parkhall Estate	1,396	359	25.7
Greystone Estate	510	130	25.5
Newpark Estate	605	157	26.0
Ballycraigy Estate	757	203	26.8
Stiles Estate	653	149	22.8
Total	**3,921**	**998**	**25.5**

Figure 2 below presents the number of returns for each of the five areas as a percentage of the total number of completed questionnaires.

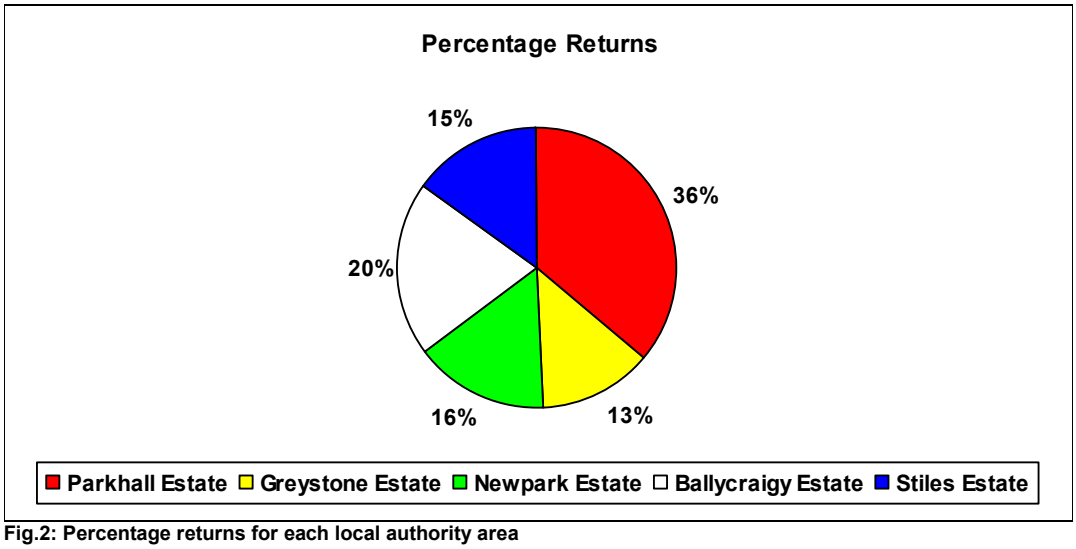


Fig.2: Percentage returns for each local authority area

Survey Results

Respondents were asked to detail the type of fuel which they use as their main source of heating. The most popular fuel source within the project area is oil, which is used by 56.3% of respondents. The second most commonly used fuel in the area is coal/solid fuel at 22.3%, while 18.6% rely primarily on electricity to heat their homes. The frequency of responses for oil and coal/solid fuel was 562 and 223 households respectively.

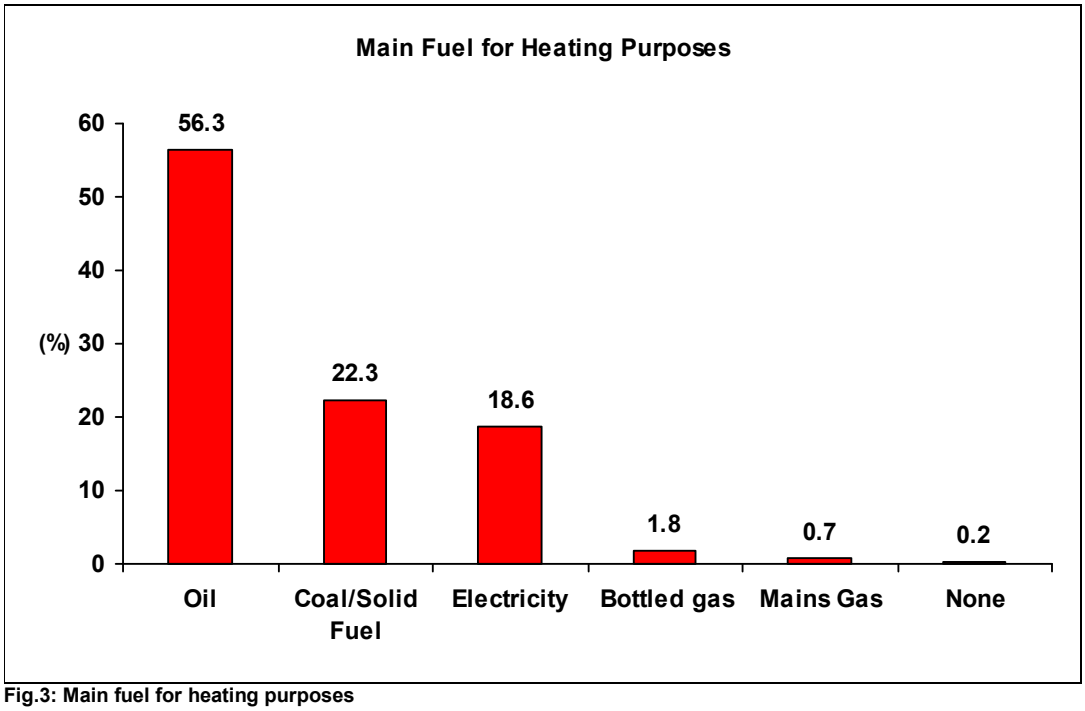


Fig.3: Main fuel for heating purposes

Table 3 below details that the greatest usage of coal/solid fuel is within the Greystone Estate with 30.8% of respondents currently citing this as their main fuel for heating purposes. In addition, almost three quarters of those surveyed within the Newpark Estate currently use oil as their main heating fuel.

Table 3 Main fuel for heating purposes (Broken down by area)

Main fuel for heating purposes								
		None	Oil	Mains Gas	Bottled gas	Electricity	Coal/Solid Fuel	**Total**
Parkhall	Number	1	218	6	14	58	62	**359**
	%	0.3	60.7	1.7	3.9	16.2	17.3	**100%**
Greystone	Number	0	49	0	2	39	40	**130**
	%	0.0	37.7	0.0	1.5	30.0	30.8	**100%**
Newpark	Number	1	116	0	1	13	26	**157**
	%	0.6	73.9	0.0	0.6	8.3	16.6	**100%**
Ballycraigy	Number	0	103	0	0	46	54	**203**
	%	0.0	50.7	0.0	0.0	22.7	26.6	**100%**
Stiles	Number	0	76	1	1	30	41	**149**
	%	0.0	51.0	0.7	0.7	20.1	27.5	**100%**
Total	Number	2	562	7	18	186	223	**998**
	%	0.2	56.3	0.7	1.8	18.6	22.3	**100%**

In terms of the back-up fuel or that which is used occasionally to heat the home, the chart below shows that the vast majority of respondents (69.4%) did not have any form of back-up, while as might be expected, the most frequently cited source of occasional heat was electricity at 24.9%, and the least popular back-up sources were bottled gas at 0.9% and oil at 0.6%.

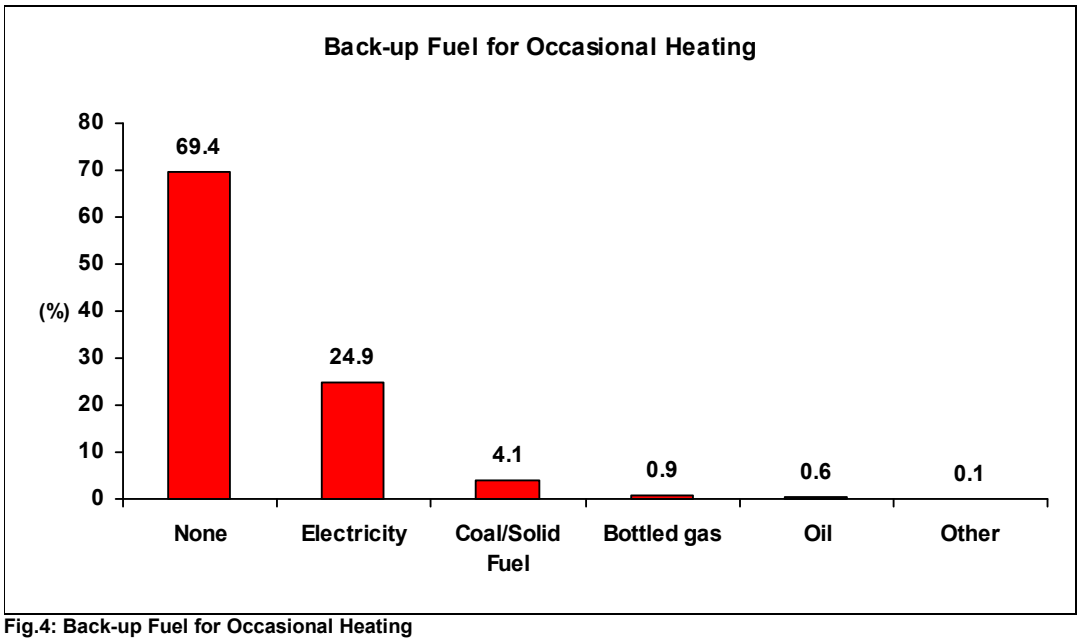


Fig.4: Back-up Fuel for Occasional Heating

The survey indicated that those living within the Greystone Estate were most likely not to have any back-up fuel source, with 82.3% stating that this was the case. The most popular form of back-up fuel in all five areas was electricity, with the Newpark Estate displaying the highest percentage of users (32.5%).

Table 4 Back-up fuel for heating purposed (Broken down by area)

Back-up fuel for heating purposes								
		None	Oil	Bottled gas	Electricity	Coal/Solid Fuel	Other	**Total**

Parkhall	Number	231	3	8	87	29	1	359
	%	64.3	0.8	2.2	24.2	8.1	0.3	100.0
Greystone	Number	107	1	0	21	1	0	130
	%	82.3	0.8	0.0	16.2	0.8	0.0	100.0
Newpark	Number	102	2	0	51	2	0	157
	%	65.0	1.3	0.0	32.5	1.3	0.0	100.0
Ballycraigy	Number	147	0	1	51	4	0	203
	%	72.4	0.0	0.5	25.1	2.0	0.0	100.00
Stiles	Number	106	0	0	38	5	0	149
	%	71.1	0.0	0.0	25.5	3.4	0.0	100.0
Total	Number	693	6	9	248	41	1	998
	%	69.4	0.6	0.9	24.8	4.1	0.1	100.0

Those respondents who stated that they used coal/solid fuel as either their main or back-up fuel, were asked to indicate the type of heating appliances that they have within their homes. Of the 26.5% of respondents who did use coal/solid fuel, the overwhelming majority (87.4%) used a glass fronted fire. 10.7% had an open fire, with only a small percentage using a stove/range (1.5%) and a gravity feed boiler (0.4%).

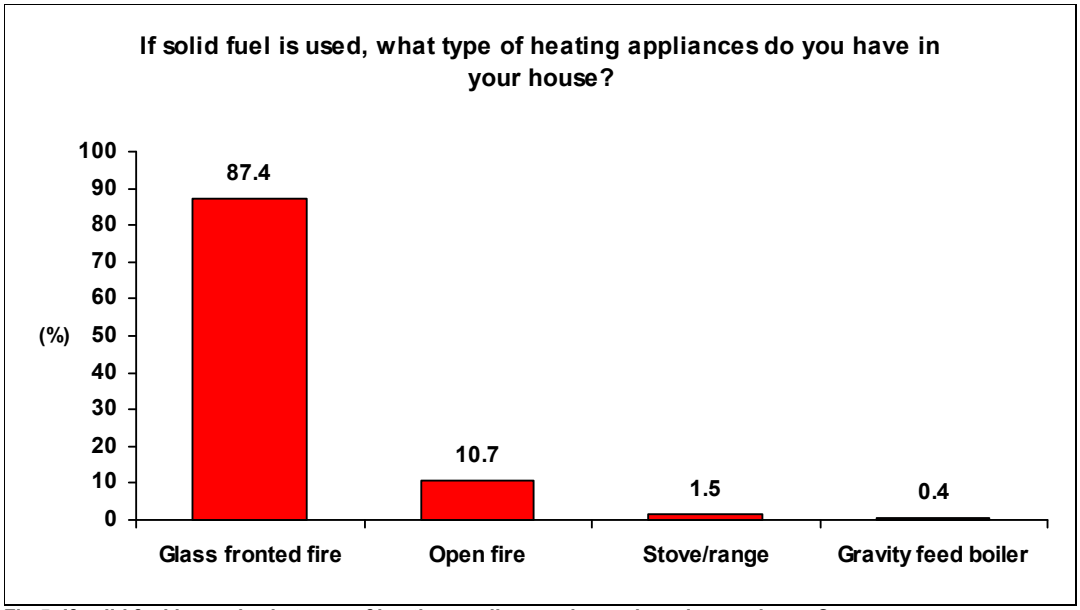


Fig 5: If solid fuel is used, what type of heating appliances do you have in your house?

Figure 6 below indicates that respondents from the Parkhall Estate are more likely to have an open fire, with just over a fifth of respondents currently using this type of appliance.

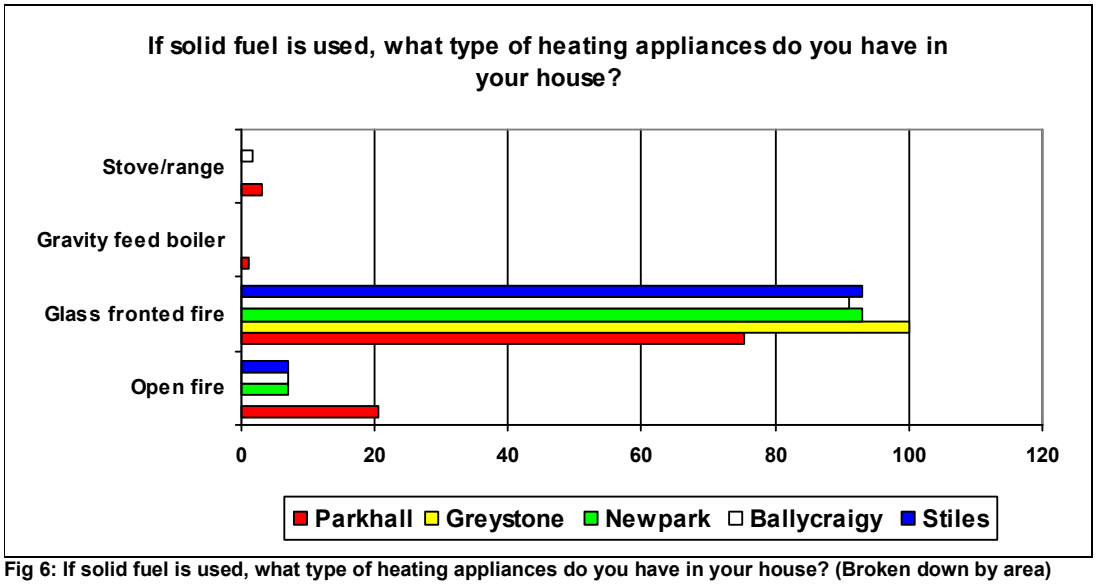


Fig 6: If solid fuel is used, what type of heating appliances do you have in your house? (Broken down by area)

The same respondents were asked to indicate the main type of solid fuel used within their household, either as their main or back-up fuel. The majority of respondents burn smokeless coal, with 90% using this form of solid fuel. 9% of respondents stated that they currently use non-smokeless fuel with the remaining 1% using logs/sticks.

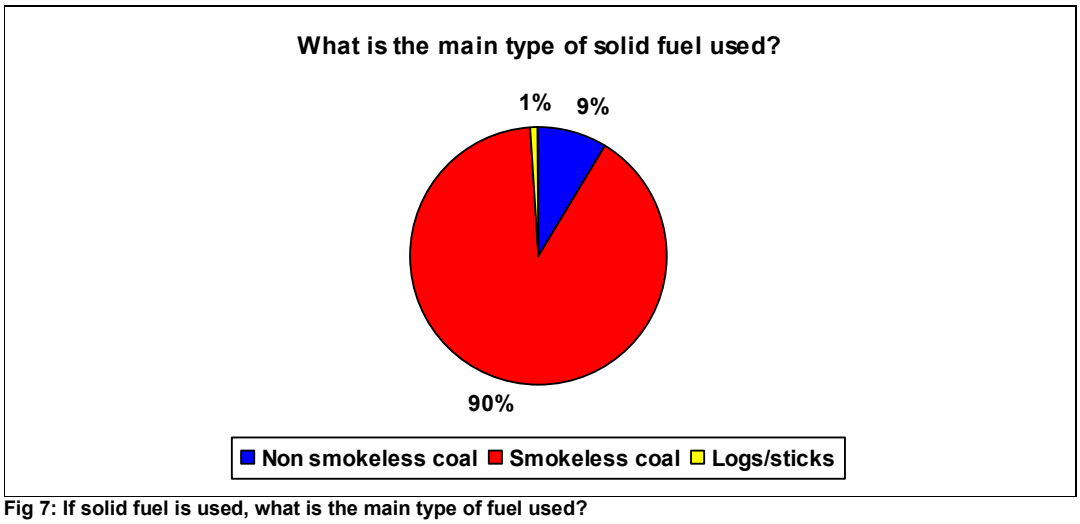


Fig 7: If solid fuel is used, what is the main type of fuel used?

As shown in the chart overleaf, the highest percentage of users of non-smokeless fuel was in the Parkhall Estate, which is indicative of the higher percentage of open fires within this area. The second highest percentage usage of non-smokeless fuel was within the Stiles Estate, with 13.6% currently using this type of fuel. All of the respondents who use solid fuel within the Newpark Estate and 97.5% of respondents from the Greystone Estate, currently use smokeless fuel.

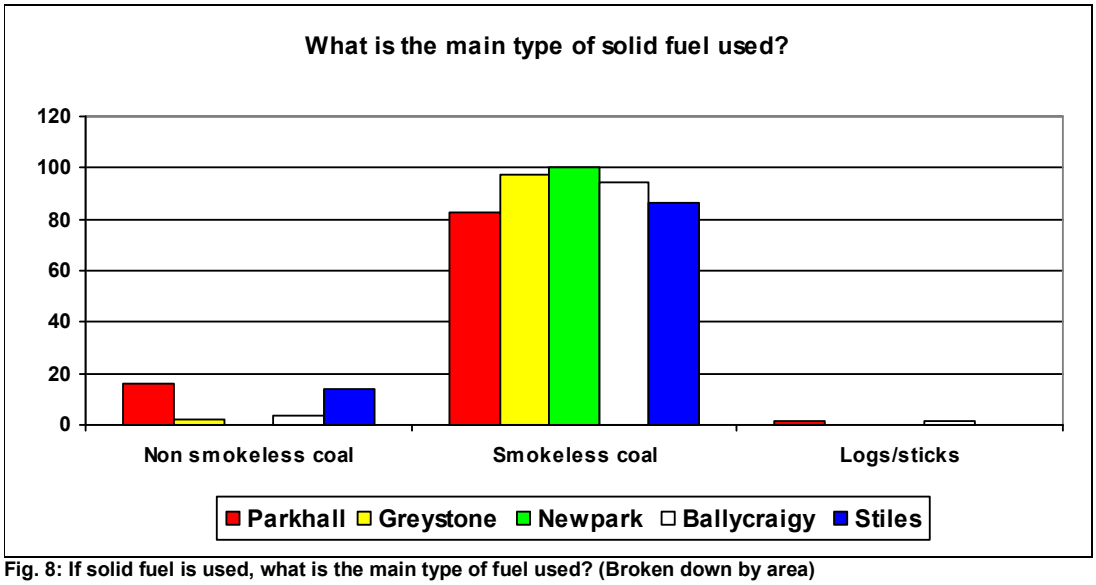


Fig. 8: If solid fuel is used, what is the main type of fuel used? (Broken down by area)

Respondents were asked to indicate the specific type of smokeless coal that they currently use. The most popular smokeless fuels used within the project area are Burnglo (60.2%), Anthracite (17.8%) and Phurnacite (14.9%). Less commonly used smokeless fuels in the area are Blend (1.2%), Coalite (1.8%), Home Fire (0.4%) and Red Flame (0.4%).

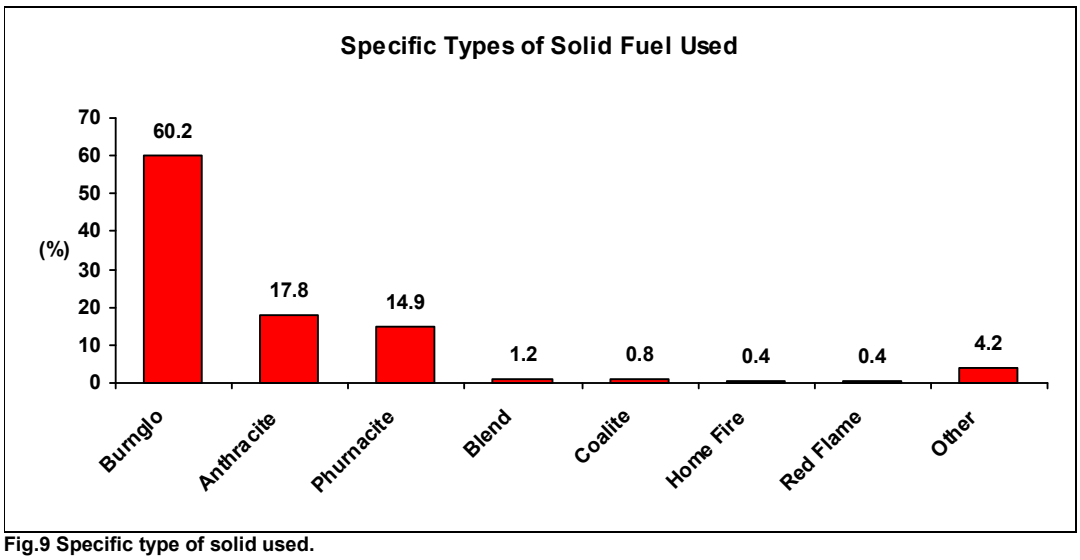


Fig.9 Specific type of solid used.

4.2% (ten people) of respondents cited that they use other forms of smokeless fuel. Seven people named their smokeless fuel as Premium Esse, one person used Fireblend, with the remaining two respondents stating that they were unsure of the name.

Respondents were subsequently asked to estimate how often they lit their solid fuel appliances. The majority of respondents (74.6%) stated that the question was not applicable. 19.3% of respondents stated that they light their fire once daily, 2.5% light their fire two to three times a week, with a further 1% only lighting their fire once per week. 2.6% of respondents state that they light their fire less frequently than once per week.

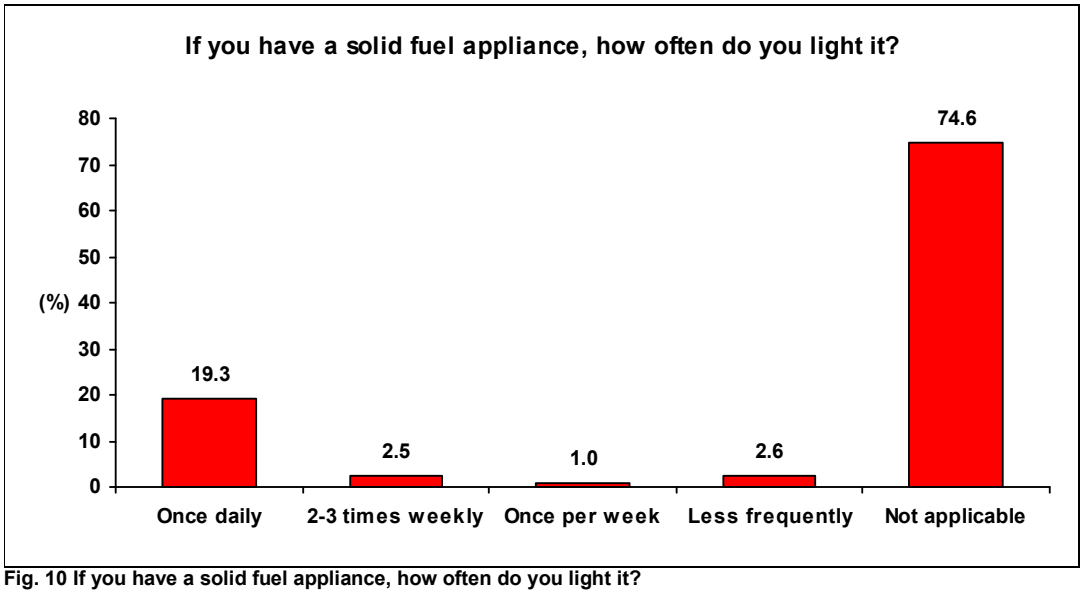


Fig. 10 If you have a solid fuel appliance, how often do you light it?

As shown in Figure 11, residents within the Greystone Estate are most likely to light their fire on a daily basis. This may be relative to the fact that over 82% of respondents from this area do not have a back-up heating source. Similarly, respondents from the Parkhall Estate are more likely to light their fire less frequently than once a week, which again may be a result of only using the appliance as a source of additional heating.

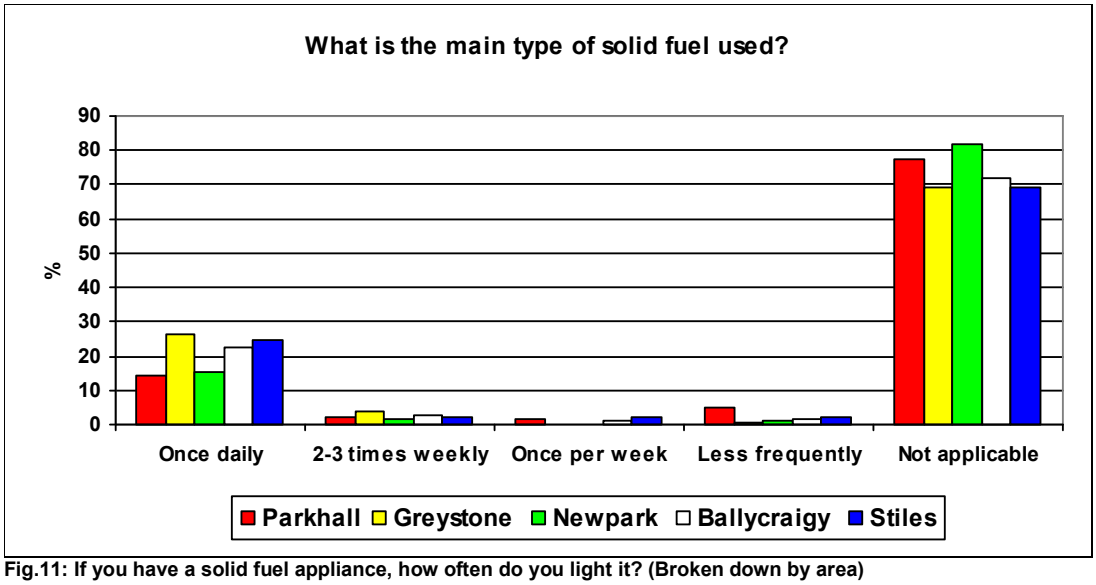


Fig.11: If you have a solid fuel appliance, how often do you light it? (Broken down by area)

The questionnaire instrument asked respondents to estimate how many 25kg or 50kg bags of coal (including smokeless and non-smokeless) they used per week during the winter. For the purposes of the study, the total weight of coal used per household per week has been presented. Approximately one-fifth of those respondents who use solid fuel, burn less than 50kg of coal per week, with the majority of respondents (66.3%) using between 51-100kg per week. A total of 14.8% use in excess of 100kg.

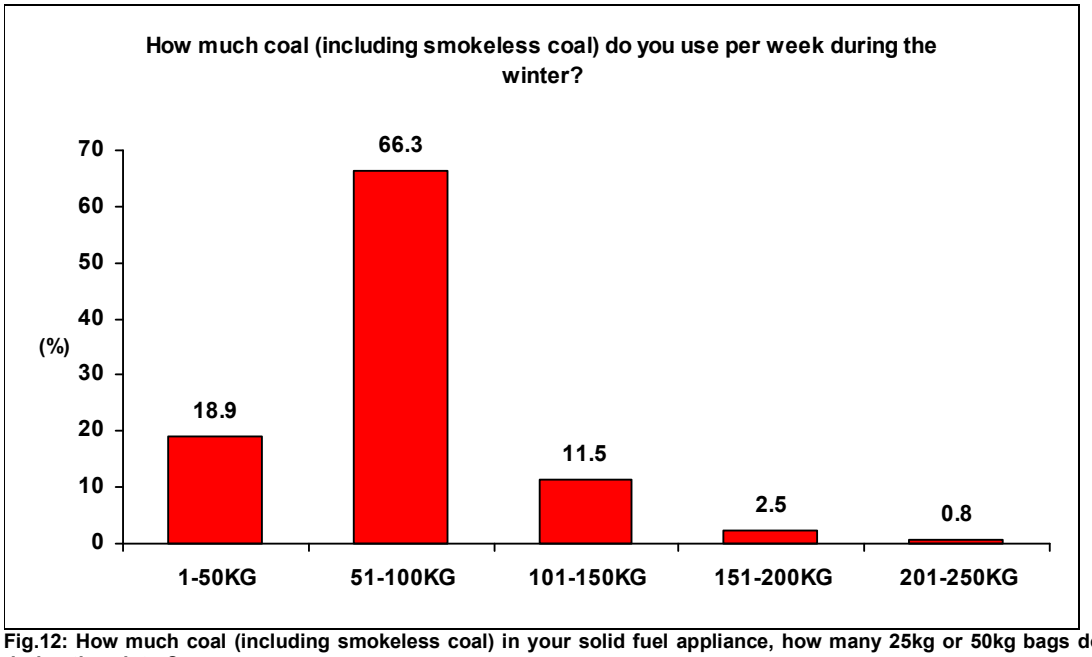


Fig.12: How much coal (including smokeless coal) in your solid fuel appliance, how many 25kg or 50kg bags do you use per week during the winter?

As might be expected, the Parkhall Estate in which households light their fire less frequently, displayed the lowest level of coal usage, with 31% of respondents using less than 50kg of coal per week. The highest consumption of coal was in the Ballycraigy area, with almost 27% of respondents using more than 100kg per week in comparison with 16.8% (Parkhall), 10.7% (Newpark), 9.5% (Stiles) and 2.5% (Greystone).

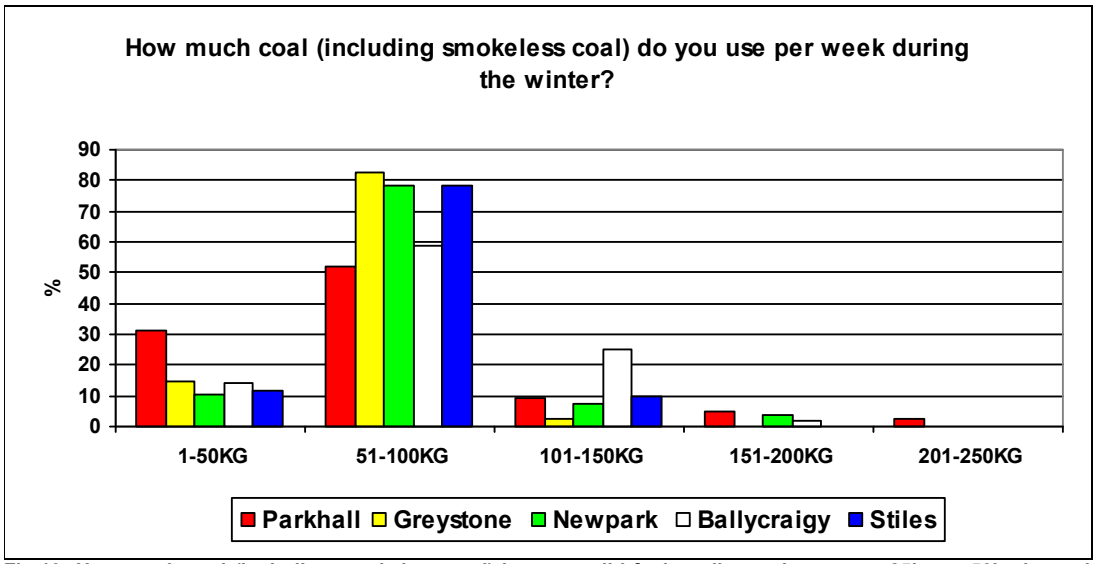


Fig.13: How much coal (including smokeless coal) in your solid fuel appliance, how many 25kg or 50kg bags do you use per week during the winter? (Broken down by area)

Similarly, the questionnaire instrument asked respondents to estimate how many 25kg or 50kg bags of coal they used per week during the summer period. As would be expected, the quantity of coal burned during the summer months is considerably less, with 58% of those respondents who burn solid fuel during the winter months stating that they do not burn solid fuel at all during the summer. A further 39.5% of respondents burn less than 50kg per week. Only 2.5% currently use over 50kg per week during the summer months.

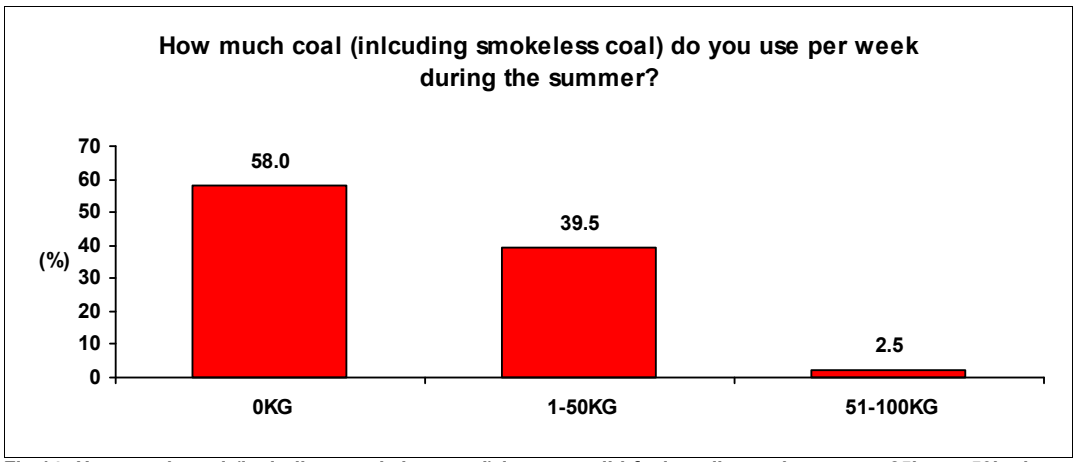
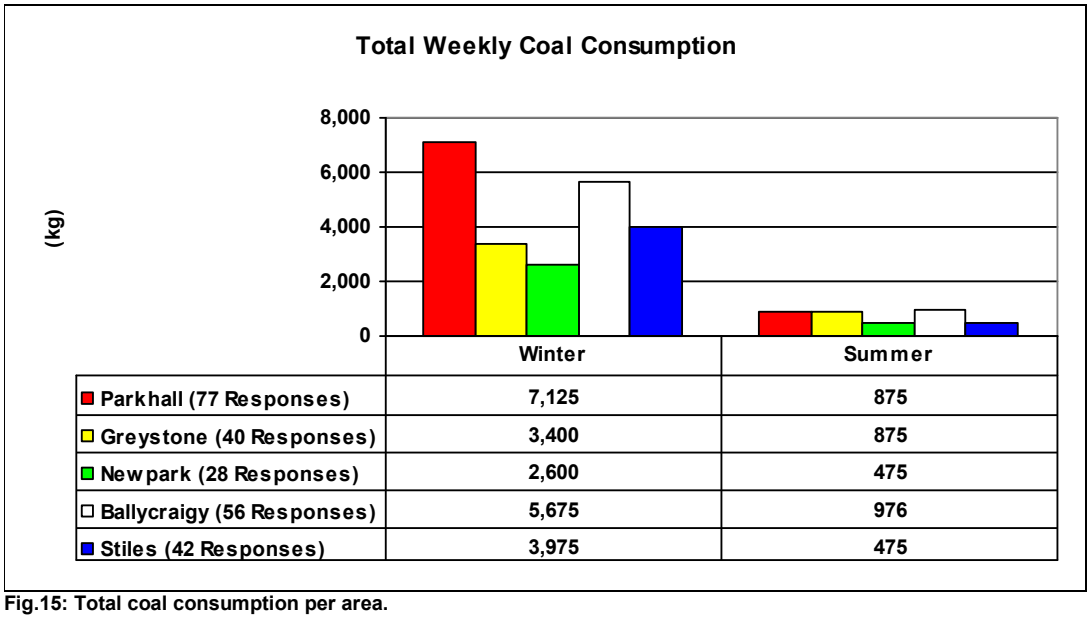


Fig.14: How much coal (including smokeless coal) in your solid fuel appliance, how many 25kg or 50kg bags do you use per week during the summer?

The chart below details the total weekly amount of coal burned in each area during the summer and the winter. As would be expected, considering 36% of total questionnaire respondents are from this area, the highest level of coal consumption is within the Parkhall Estate, with respondents using 7,125kg per week during the winter. The Stiles Estate displays the greatest percentage increase in coal usage during the winter period from the amount used during the summer, with respondents increasing their weekly consumption by 737%. This is followed by the Parkhall Estate which displays a 714% increase, the Ballycraigy Estate which displays a 482% increase and the Newpark Estate which displays an increase of 447%. The lowest percentage increase in fuel usage between the summer and winter period is within the Greystone Estate (289%).



	Winter	Summer
Parkhall (77 Responses)	7,125	875
Greystone (40 Responses)	3,400	875
Newpark (28 Responses)	2,600	475
Ballycraigy (56 Responses)	5,675	976
Stiles (42 Responses)	3,975	475

Fig.15: Total coal consumption per area.

As stated previously, 56.31% of respondents currently use oil as their main fuel for heating purposes. Those respondents who use oil were asked to estimate their annual consumption in litres. For the purposes of the study, the volume of oil consumed per household has been presented in seven bands. The most frequently used amount in the project area is 1,501 – 2,000 litres per annum which is the estimated consumption for approximately 35.4% of households using an oil heating system. Just under

a third of respondents use between 1,001-1,500 litres, with a quarter of respondents using between 501 – 100 litres per annum. A total of 6% of respondents currently use in excess of 2,000 litres per annum.

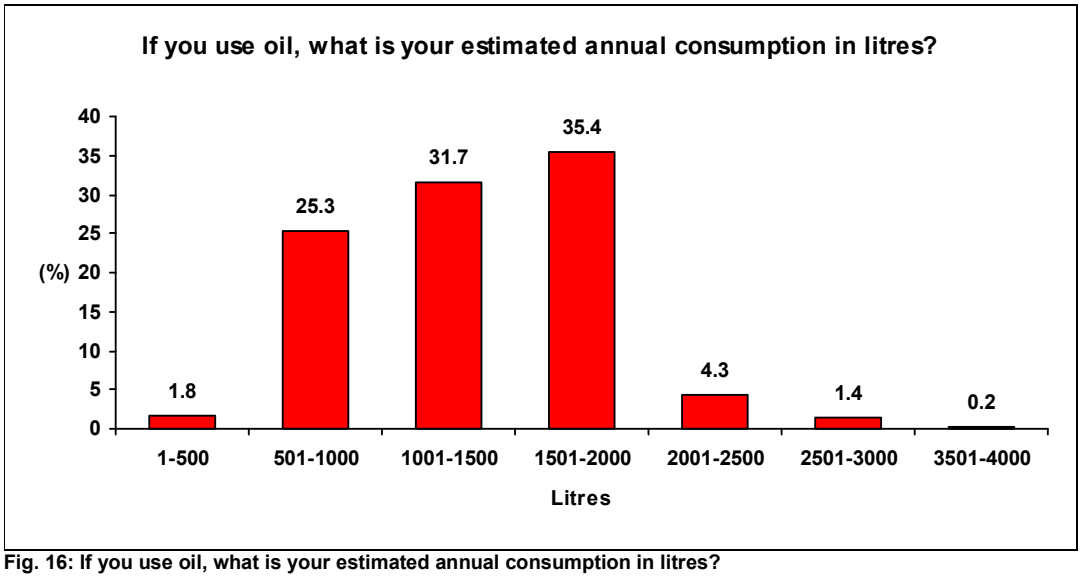


Fig. 16: If you use oil, what is your estimated annual consumption in litres?

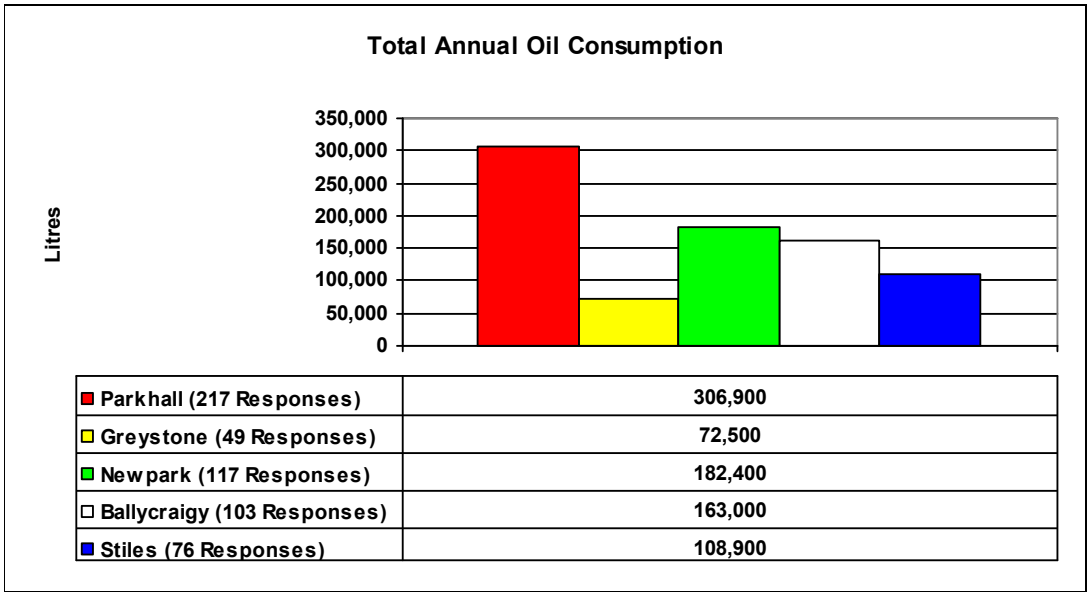
Not surprisingly, the greatest level of oil consumption is within the Newpark area (within which almost three-quarters of respondents use oil as their main fuel source) with 49% of respondents using in excess of 1,500 litres per annum. In addition, 47.6% and 43.4% of respondents in the Ballycraigy and Stiles Estates respectively use a similar amount per annum.

Table 5 If you use oil, what is your annual consumption? (Broken down by area)

	Amount (Litres)						
	1-500	501-1000	1001-1500	1501-2000	2001-2500	2501-3000	3501-4000
Parkhall	1.4	38.7	24.9	29.5	4.1	0.9	0.5
Greystone	2.0	22.4	40.8	28.6	2.0	4.1	0.0
Newpark	0.9	14.5	35.9	41.0	6.8	0.9	0.0
Ballycraigy	3.9	6.8	41.7	39.8	4.9	2.9	0.0
Stiles	1.3	30.3	25.0	42.1	1.3	0.0	0.0

Table 6 below details the total annual consumption of oil broken down by area as follows:

Table 6 Total annual oil consumption



Respondents were then asked if they were considering any other change to their fuel source over the next three years. As shown in the diagram below, the overwhelming majority (90%) of respondents stated that they were not considering any change to their main fuel source.

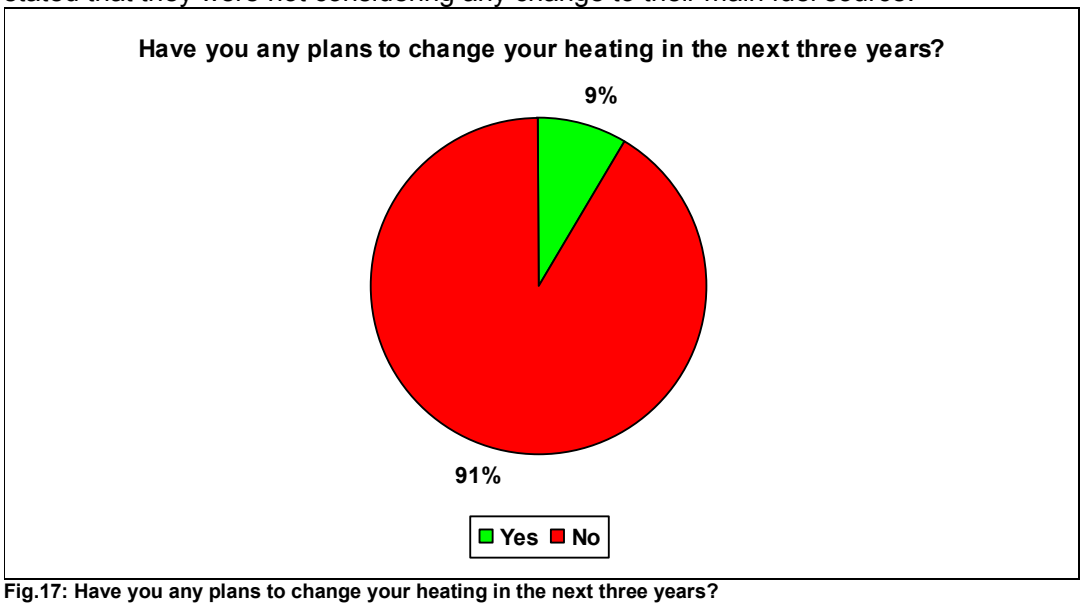


Fig.17: Have you any plans to change your heating in the next three years?

Almost 15% of respondents in the Stiles Estate stated that they are considering changing their heating system within the next three years. As stated previously, this area displayed the second highest percentage of solid fuel users (27.5%). Only 0.6% of respondents within the Newpark Estate plan to change their heating system, which again may be indicative of the lower percentage of respondents (16.6%) with solid fuel heating.

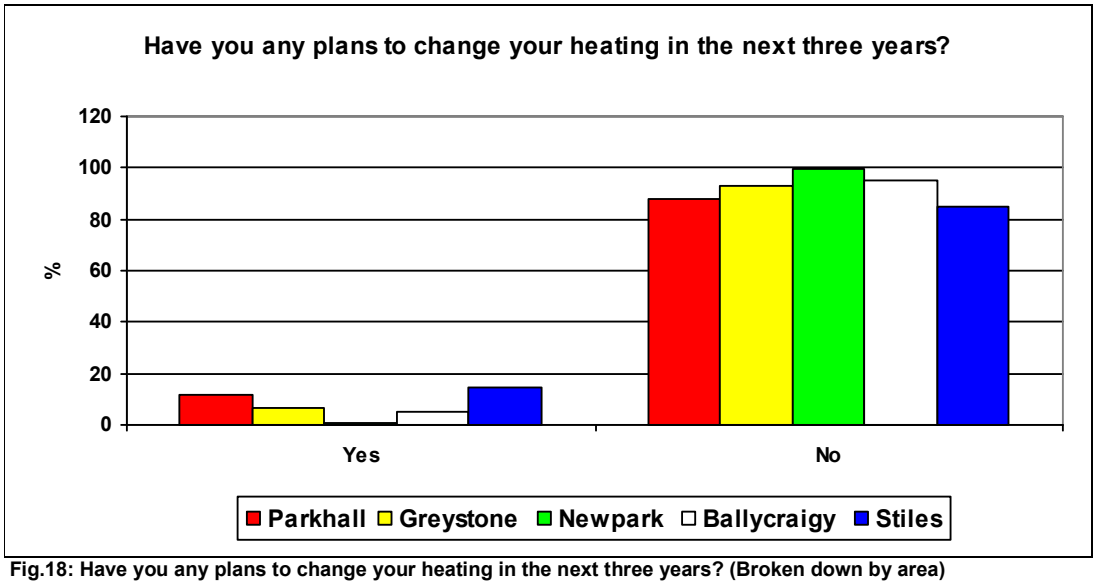


Fig.18: Have you any plans to change your heating in the next three years? (Broken down by area)

The 9% of respondents who stated that they are considering changing their heating source were asked what type of fuel to which they might consider changing. The overwhelming response at 92.8% was oil, with gas at 6.0%, and electricity at 1.2%.

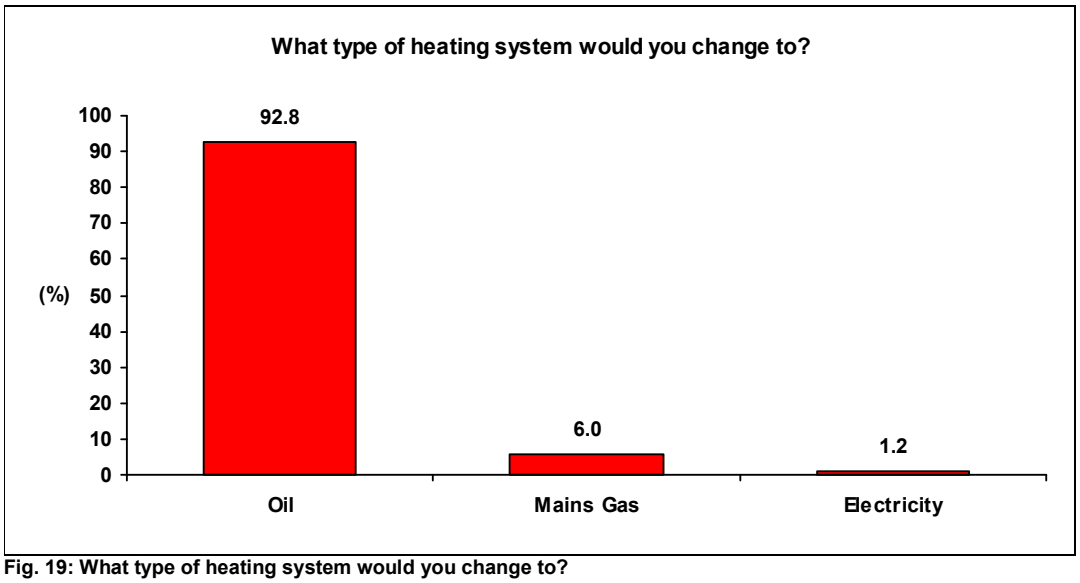


Fig. 19: What type of heating system would you change to?