BALLYMONEY
BOROUGH COUNCIL

Stage 2/3

Air Quality Review and Assessment Report

June 2004

34. Air Quality Review and Assessment Report – Final Stage 2/3

1.0 INTRODUCTION

Ballymoney Borough Council completed its Stage 1 Air Quality Review and Assessment in August 2000. (HES Committee minute 246.2.5.6 29th August 2000, and by Council minute CM 662.7.2 refers). The findings of this exercise resulted in the following recommendations:-

(1) There was need to progress to a Second Stage Review for nitrogen dioxide and PM_{10} emissions from road traffic (from road junctions, and six roads).

(2) There was a need to progress to a Second Stage Review from SO_2 emissions from one industrial combustion system.

(3) There was a need to progress to a Second Stage Review for SO_2 and PM_{10} emissions from an area of domestic coal burning.

2.0 ROAD TRAFFIC NO_2 and PM_{10} EMISSIONS AND INDUSTRIAL EMISSIONS OF SO_2 FROM 1 NO. COMBUSTION PLANT

The second stage review and assessment of these sources was completed by consultants NETCEN, AEA Technology who reported in February 2002.

The conclusions of this report were that air quality objectives for pollutants nitrogen dioxide, PM_{10} and sulphur dioxide are likely to be met and a third stage review is not required for emissions from vehicular and industrial sources.

3.0 DOMESTIC SOURCES – SO_2 AND PM_{10} EMISSIONS – 2ND STAGE REVIEW

3.1 Sulphur Dioxide

Sulphur dioxide (SO_2) is formed during the combustion of fuels containing sulphur. The most significant source of this pollutant is fossil fuelled power generation, although diesel engines and a number of chemical processes also produce SO_2. In Northern Ireland, domestic solid fuel and oil burning is a major source of SO_2.

The first stage report identified that a 1km2 area, Glebeside Estate, contained a total of 850 houses of which 45% burned coal. To progress the second stage review and assessment process, an 8-port smoke and SO_2 apparatus was located on the periphery of the area.

3.2 Data Capture: 8 Port Continuous Sulphur Dioxide and Smoke Monitor

This monitoring equipment has been installed within a secure location at the Robinson Memorial Hospital, Newal Road, Ballymoney. Prior to its siting, (see photographs 1, 2 and 3 below) an application was made to participate in the UK SO_2 and smoke monitoring network.

A suitable site to place the monitoring apparatus was sought which would be within the most dense coal burning area being both secure and complying with the requirements of chapter 3 of document 20747054/001 AEA Technology "Smoke and Sulphur dioxide monitoring using the 8 port sampler".
No suitable secure location that provided easy access for maintenance and a power supply could be identified within the public sector housing estate. The Hospital site was identified as the best alternative it being on the periphery of the Glebeside estate, and adjacent to residential properties.
Three other alternative sites were considered:-

(1) Charles Street,
(2) Trinity Drive and
(3) The Joey Dunlop Leisure Centre, Garryduff Road, Ballymoney.

The former suffered from a lack of occupied residential properties nearby whilst the latter lies on the outside of the town boundary, effectively surrounded on 3 sides by open country. The Trinity Drive site on the SW boundary of the Glebeside estate was located at a Joiners workshop and storage yard adjacent to a library, day care centre and residential home. This site was rejected for the following reasons:-

Vehicle emissions from vans using the yard, a large drain opening in the middle of the yard and the handling of building materials and concrete slabs in the yard.

Approval for the site at the Robinson Hospital, Newal Road, Ballymoney was subsequently granted, the site being named Ballymoney 4 with identification number 161504. As with all similar sites, the equipment is maintained on a weekly basis with the results of the daily titrations and smoke forwarded to AEA Technology plc on a monthly basis for input to the national database. Training of officers responsible for the equipment has been conducted and accompanied visits to ensure weekly maintenance and validation checks together with auditing of chemical preparation and analysis is carried out as part of internal quality assurance procedures.

Photo 1 Sampler Inlet

Photo 2 Sample Inlet West Elevation

3.3 Data Capture: Diffusion Tube Monitoring

In addition, eight diffusions tubes located within the town area indicate the relative spatial distribution of SO_2 concentrations at various locations within the boundary of Ballymoney town. It was hoped that these results would indicate that the 8 port apparatus location was sited in an area which was representative of the highest levels of smoke and SO_2 emissions. The results of this monitoring are shown in the table below.

Table 1 **SO_2 Diffusion tube results in µg/m^3 for the year 2002.**

Month	Location							
	Parkview	Alexandra Avenue	Kirk Road	Knocklayde Park	Carnany Gardens	Carnany Drive	Stuart Park	Raceview Road
January	-	-	-	-	-	-	-	-
February	12.5	28.5	22.9	15.2	22.0	7.0	3.0	3.7
March	5.0	8.5	8.0	2.7	6.2	5.0	3.2	2.1
April	4.8	5.6	1.6	2.1	2.1	1.0	0.5	-
May	3.2	6.7	3.0	2.4	6.7	-	2.1	-
June	2.1	1.8	-	1.8	4.3	3.7	1.5	1.2
July	0.8	2.1	0.5	0.5	0.25	1.0	1.3	0.3
August	8.0	7.0	5.0	4.8	9.3	7.2	4.0	1.9
September	4.0	2.7	4.0	4.3	3.2	6.1	2.4	2.7
October	6.4	8.0	2.7	5.6	5.6	4.8	4.8	4.3
November	6.1	8.2	4.0	3.7	4.2	3.2	2.9	-
December	8.5	8.5	0.8	2.9	4.0	4.0	7.4	1.6
Average	**5.6**	**8.0**	**5.3**	**4.2**	**6.2**	**4.3**	**3.0**	**2.2**

These indicate that the tube results for the 8 port site location (Knocklayde Park) are consistently less than the diffusion tube located in the middle of the Glebeside estate (Alexandra Avenue). The results are a factor of **2.2** higher, see table 2, within the estate and this factor has been applied to the 8 port apparatus results for both smoke and SO_2 to predict a worst case scenario at the location of greatest concern.

NB Kirk Road would be considered a kerbside site which may account for the elevated levels. The Carnany Gardens site is the closest location to the combustion plant considered by the NETCEN report February 2002.

Photo 3 Diffusion Tube Location Knocklayde Park

The diffusion tube is located on the lamppost to the left of the photograph approximately 30m from the 8 port sampler inlet.

Table 2 **Ratio – SO_2 Diffusion Tube Results 2002**

Month	**Location**							
	Parkview	Alexandra Avenue	Kirk Road	Knocklayde Park	Carnany Gardens	Carnany Drive	Stuart Park	Raceview Road
January	-	-	-	-	-	-	-	-
February	0.8	1.9	1.5	1.0	1.5	0.5	0.2	0.2
March	1.8	3.1	3.0	1.0	2.3	1.9	1.2	0.8
April	2.3	2.7	0.8	1.0	1.0	0.5	0.2	-
May	1.3	2.8	1.3	1.0	2.8	-	0.9	-
June	1.2	1.0	-	1.0	2.4	2.0	0.8	0.7
July	1.6	4.2	1.0	1.0	0.5	2.0	2.6	0.6
August	1.7	1.5	1.0	1.0	1.9	1.5	0.8	0.4
September	0.9	0.6	0.9	1.0	0.7	1.4	0.6	0.6
October	1.1	1.4	0.5	1.0	1.0	0.9	0.9	0.8
November	1.6	2.2	1.1	1.0	1.0	1.1	0.9	0.8
December	2.9	2.9	0.3	1.0	1.4	1.4	2.6	0.6
Average	**1.6**	**2.2**	**1.3**	**1.0**	**1.6**	**1.3**	**1.0**	**0.6**

3.4 Air Quality Objective - Sulphur Dioxide

The Government and the devolved administrations have adopted three objective standards for Sulphur dioxide.

(1) A 15-minute mean of **266 µg/m^3** (100 ppb) as an air quality standard for sulphur dioxide (SO_2), with the objective for the standard not to be exceeded more than 35 times in a year (approximately equivalent to the 99.9th percentile) by the end of 2005.

(2) A new 1-hour mean objective of **350 µg/m^3** (132 ppb), to be exceeded no more than 24 times per year (approximately equivalent to the 99.7th percentile, and

(3) A new 24-hour mean objective of **125 µg/m^3** (47 ppb), to be exceeded no more than 3 times per year (approximately equivalent to the 99.9th percentile), been to be achieved by the end of 2004.

Data Capture

The Second Stage review and assessment for domestic sources relies upon a review of monitoring data within the local area, and consists of the use of an 8 Port apparatus and diffusion tube monitoring described previously.

8 port apparatus 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 8 port apparatus technique is used to measure daily average sulphur dioxide concentrations which can be directly compared against the 24-hour mean objective. Where existing concentrations exceed the 24 hour mean objective a third stage review and assessment will need to be carried out unless there is confidence that source emissions will reduce substantially by 2004 (para 7-29 TG4(00)).

If net acidity titration measurements from 8 port apparatus are considered, the measured maximum daily mean concentration should be multiplied by 1.25 to take account of a general tendency for the 8 port apparatus to under-read at high concentrations. This correction factor is open to uncertainty, and will tend to overestimate the concentrations in most cases, but this is consistent with the precautionary approach for the Second Stage review and assessment.

The relationship between daily average maximum sulphur dioxide concentrations and the 99.7th percentile of 1-hour mean concentrations and the 99.9th percentile of 15-minute mean concentrations is uncertain and is dependent upon the occurrence of unusual meteorological conditions and the impact of individual point sources. The relationships can be expressed by the following functions:-

(A) 99.9th percentile (15-min means) = 1.8962 x maximum daily mean.
(B) 99.7th percentile (1-hour means) = 1.3691 x Maximum daily mean.

Function (A) can be used to estimate the 99.9th percentile of 15-minute means from the annual maximum daily mean. To take account of the uncertainty in the relationship, it can be assumed that the 15-minute mean air quality objective is unlikely to be exceeded if the maximum daily mean concentration is less than **80µg/m^3** (30.1 ppb).

Function (B) can be used to estimate the 99.7th percentile of 1-hour means from the annual maximum daily mean. To take account of the uncertainty in the relationship, it can be assumed that the 1-hour mean air quality objective is unlikely to be exceeded if the maximum daily mean concentration is less than **200 µg/m^3** (75.2 ppb).

Results

Table 3 indicates the SO_2 maximum daily means using the 8 port apparatus for each month measured from the beginning of January 2001 to end December 2003.

For the year 2001,the highest value over the winter months is **34µg/m^3**. The maximum recorded daily mean occurred on the 7th June and is not likely to have arisen as a result of domestic emissions.

The maximum figure for 2002 occurred on the 14th and 15th July and again is not likely to have arisen as a result of domestic emissions. The highest value over the winter months for 2002 is **20 µg/m^3**.

The maximum figure for 2003 occurred on the 12th June and is not likely to have arisen as a result of domestic emissions. The highest value over the winter months for 2003 is **20 µg/m^3.**

Table 3 **SO_2 Maximum-Daily Means (µg/m^3)**

MONTH	2001	2002	2003
January	20	13	20
February	**34**	14	20
March	20	20	20
April	28	20	20
May	27	19	13
June	40	19	**45**
July	20	26	20
August	20	20	26
September	20	**20**	13
October	20	19	13
November	20	13	13
December	20	13	13

Using a maximum daily mean measured value of **34** in 2001, **20** in 2002 and **20** in 2003 permits the following assessment to be carried out against the most stringent objective. It is acknowledged that there were high episodes of SO_2 during January and February 2001 (Belfast), AQMNI 2000-2001 Netcen chapter 5 AEAT/ENV/R/1260/ISSUE 1. The correction factor (x1.25) and the location factor (x2.2) based on the ratios obtained considering the diffusion tube data has also been applied to take account of the worst case scenario (see table 2).

Table 4 **Comparison of Daily Maximum Mean and 15 Minute and 1 Hour Standards**

PERIOD	MEASURED MAX. DAILY MEAN	X 1.25	LOCATION FACTOR X 2.2	>80 µg/m^3	>200 µg/m^3	3RD STAGE
2001	34	42.5	94	Yes	No	Yes
2002	20	25	55	No	No	No
2003	20	25	55	No	No	No

From the results above it can be seen that in 2001 the 15 minute standard was not achieved. This may be attributed to the high episodes of SO_2 during January and February 2001 as previously reported. However in 2002 and 2003 to date (February) the 15 minute objective was met. There is relative consistency between these two data sets, suggesting that the 2001 data may be atypical.

The 24 hour mean objective of **125 µgm^3** (47ppb) approximately equivalent to 99.9th percentile was not exceeded during 2001 as the maximum daily concentration recorded was **40 µg/m^3**. Applying the correction and location factors this equates to (40x1.25x2.2) **110 µgm^3**. This maximum value was recorded on one occasion only.

The 24 hour mean objective of **125 µgm^3** (47ppb) approximately equivalent to 99.9th percentile was not exceeded during 2002 as the maximum daily concentration recorded was **26 µg/m^3**. Applying the correction and location factors this equates to (40x1.25x2.2) **71.5 µgm^3**. This maximum value was recorded on two occasions only.

The 24 hour mean objective of **125 µgm^3** (47ppb) approximately equivalent to 99.9th percentile was not exceeded during 2003 as the maximum daily concentration recorded was **19 µg/m^3**. Applying the correction and location factors this equates to (40x1.25x2.2) **52 µgm^3**. This maximum value was recorded on one occasion only.

Further data has also been obtained from the Housing authority (Northern Ireland Housing Executive) with respect to fuel usage /number of properties within the Glebeside Estate (see table 5 below).

Table 5 **Fuel Usage/No of Properties – Glebeside, Ballymoney**

YEAR	TOTAL	NIHE	OWNER/ OCCUPIED PRIVATELY RENTED	TYPE OF PRIMARY HEATING				
				OPEN FIRE	ROOM HEATER	ELECTRIC STORAGE HEATER	GAS	OIL
2000	850	-	-	382	-	-	-	-
2003	612	396	216	411	54	77	-	70

It should be noted that the 2003 data focussed on the Glebeside estate only and did not include private dwellings on the periphery eg Newal Road/Kirk Road which had been considered during Stage 1 Review.

It is believed that the status of fuel usage within the estate has not changed significantly since the first stage review and it is not envisaged that there will be any change to the type of primary heating in the public sector dwellings within the next three years (2006).

Further the AQMNI 2000-2001 previously referred to suggests that on average, SO_2 concentrations in Northern Ireland, as measured by the non-automatic Smoke and SO_2 Network, have decreased since 1962 and are still decreasing.

3.5 Conclusion

From the monitoring data above it can be seen that all objectives for SO_2 were met during 2002 and 2003 (to date).

3.6 Recommendation

On the basis that the 2001 measured maximum daily means is atypical and that SO_2 concentrations are continuing to decrease, it is recommended that a third stage review for SO_2 is not required for emissions from domestic sources. However, due to the commitment of the council to ensure that Air Quality standards are maintained, the operation of the 8 port apparatus will continue.

4.0 AIR QUALITY OBJECTIVE - PM_{10}

4.1 There is a wide range of emission sources that contribute to PM_{10} concentrations in the UK. The APEG report has confirmed that these sources can be usefully divided into 3 main categories. Primary particle emissions are derived directly from combustion sources, including road traffic, power generation, industrial processes etc. Secondary particles are formed by chemical reactions in the atmosphere, and comprise principally of sulphates and nitrates. Coarse particles comprise of emissions from a wide range of sources, including resuspended dusts from road traffic, construction works, mineral extraction processes, wind-blown dusts and soils, sea salt and biological particles.

The Government and the devolved administrations have adopted two air quality

objectives for fine particles (PM_{10}), which are equivalent to the EU Stage 1 Limit Values. These objectives are:

(1) 40 µg/m^3 as the annual mean, and

(2) 50 µg/m^3 as the fixed 24-hour mean to be exceeded no more than 35 days per year, to be achieved by the end of 2004. The objectives are based on measurements carried out using the European gravimetric transfer reference sampler or equivalent.

The proposed 24 hour objective is more stringent than the annual mean objective. However, the 24 hour mean objective (expressed as 50 µg/m^3, gravimetric, to be exceeded no more than 35 times per year) is potentially a difficult standard against which to carry out an assessment, due to the day to day variations in PM_{10} concentration and composition.

It is therefore recommended that the initial stages of review and assessment are carried out by calculating the annual mean PM_{10} concentration and then estimating the 90th percentile concentration. The 90th percentile of daily means in a calendar year is approximately equivalent to 35 exceedance days.

PM_{10} 90th percentile means = PM_{10} (annual mean) *1.79.

4.2 Screening Criteria (TG4 (00))

An assessment of the impact of domestic solid fuel use can be carried out from existing black smoke data, based upon the empirical relationship described in Figure 8.8 TG4(00).

Black smoke data has been collected between January 2001 and December 2003 in conjunction with the 8 port apparatus as described previously.

- The annual mean black smoke concentrations have been determined for the 3 years and reported in Table 6 below.

- The 1996 annual mean background secondary PM_{10} concentration for the area, using the Internet maps (www.airquality.co.uk) for Ballymoney has been determined as **7 µgm^3**.

Figure 8.8 TG4(00) indicates that exceedences above an annual mean threshold of 18 µg/m^3 indicates a need to progress to a 3rd stage review.

4.3 Results

The following table indicates the black smoke monthly averages and annual means for 2001, 2002 and 2003.

Table 6 - Black Smoke Monthly Averages (µg/m^3.)

MONTH	BLACK SMOKE '01	BLACK SMOKE '02	BLACK SMOKE '03
January	17	7	13
February	30	7	12
March	22	9	12
April	19	7	8
May	13	4	4
June	6	2	4
July	7	7	4
August	8	6	4
September	13	7	6
October	10	12	10
November	18	11	7
December	49	14	7
ANNUAL MEAN	**17.66**	**8**	**7.5**

Data for 2001 has been excluded due to its invalidity. This was due to incorrect calibration of the 'Sticky Pad Reader' to determine black smoke concentration. Using the annual means for 2002 and 2003 permits the following assessment to be carried out.

Table 7 – Annual mean 40 µgm^3 compared to threshold

PERIOD	BLACK SMOKE CONC. ANNUAL MEAN µ/m^3	LOCATION FACTOR X2.2	THRESHOLD FOR AREA µ/m^3	NEED TO PROGRESS TO 3RD STAGE
2002	8	17.6	18	Yes
2003	7.5	16.5	18	Yes

When the location factor is applied to the annual means for each year, (excepting 2001), the threshold is approached but not exceeded.

4.4 Conclusion

Further investigation with respect to PM_{10} is necessary and it is therefore recommended to proceed to a 3rd stage review and assessment with respect to domestic solid fuel use.

4.5 Recommendations

The 3rd stage review and assessment for PM_{10} will necessitate the following:-

(1) A detailed assessment of solid fuel use in the area to determine emissions characterising the different fuels and combustion methods used in order to more accurately quantify emissions.

(2) The application of dispersion modelling.

(3) Local monitoring to confirm existing conditions. A continuous monitoring programme (gravimetric or TEOM) to be implemented in order to more accurately define current PM_{10} concentrations in the area of concern for a minimum period of 12 months.

5.0 3RD STAGE REVIEW AND ASSESSMENT FOR PM_{10} AND SO_2

Following the award of grant aid from the Department of Environment (NI) Environment and Heritage Service, Air and Environmental Quality Unit, the Borough Council commissioned the following:-

5.1 A detailed fuel-use survey within the boundaries of the Glebeside Estate, Ballymoney carried out by Millward Brown Ulster (Appendix 1). The results of the survey showed that oil was the most popular main fuel for heating, it being used by 54% of respondents. Coal/solid fuel (35%) was the second most popular primary fuel. 64% of respondents stated they did not use a secondary source of fuel for heating, with a further 21% using electricity and 10% using coal/solid fuel.

5.2 NETCEN an operating division of AEA Technology plc, Air Quality consultants were engaged again with the assistance of grant aid to complete dispersion modeling exercise for both PM_{10} and SO_2 using the information obtained from the fuel-use survey and corrected for bias using monitoring data from Carrickfergus (Appendix 2). Detailed modeling was carried out using ADMS version 3.1.

In respect of PM_{10}, the modeling suggests that there will not be an exceedence of the 90.4 percentile daily mean PM_{10} objective in 2004, the most stringent objective. If this objective is met, then it is likely that the annual mean objective in 2004 will also be met.

The Report recommended that no further assessment is required and therefore an Air Quality Management Area need not be considered.

For SO_2, the modeling suggests that there will not be an exceedence of the 15 minute mean SO_2 objective. This being the most stringent objective, it is likely that the hourly and daily SO_2 objectives will also be met.

The Report recommended that no further assessment is required and therefore an Air Quality Management Area need not be considered.

5.3 The purchase and installation of a continuous PM_{10} monitor together with quality assurance/quality control to validate the data captured. This will provide local data to verify the model predictions. Monitoring commenced in early December. A number of ‘high’ daily results were recorded during December and January. Unfortunately the equipment failed in February due to a manufacturing fault. The

validity of the early monitoring data remains under question. The equipment has since been repaired and replaced. Satisfactory Winter and Summer data requires to be collected in order to verify the model results, and it is therefore essential that monitoring be continued to accurately define current PM_{10} concentrations within Glebeside Estate for a minimum period of 12 months to ensure valid data capture.

5.4 **Conclusion**

From the modeling work commissioned, it is recommended that no further assessment is required for either PM_{10} (Particulates) or SO_2 (sulphur dioxide) and therefore an AQMA (Air Quality Management Area) in relation to the Glebeside Estate, Ballymoney need not be declared.

6.0 RECOMMENDATIONS

It is not necessary to declare an Air Quality Management Area (AQMA) with respect to either PM_{10} Particulates or SO_2 Sulphur Dioxide.

PM_{10} data capture should continue, for a further 12 month period, so that sufficient valid data is acquired to verify the model results. The model results require to be verified using locally collected data.

The Council will continue to operate an 8 port apparatus to gather SO_2 and black smoke data.

The Council will continue to participate in the UK Nitrogen Dioxide (NO_2) diffusion Tube Network, operating six (6) sites, four (4) of which provide UK Network data.

An annual review of air quality will be carried out.