

Community Air Pollution Monitoring

2007

Measuring Nitrogen Dioxide Using Diffusion Tubes

**Report by Andrew Elleker Environmental Strategy, Sheffield City
Council and Neil Parry and Barbara Rimmington East End Quality of Life
Initiative**

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1.0 Introduction

Diffusion tubes are a low cost method for the measurement of air pollution. The gas measured is nitrogen dioxide, which is often used as an indicator of general air pollution. The tube itself is left to be exposed for a month, usually attached to road-signs, lamp-posts or buildings and is then sent to a laboratory for chemical analysis.

Community air pollution monitoring for nitrogen dioxide has been taking place in Tinsley by the local community forum for nine years (since 1998), using diffusion tubes in the back gardens of residents.

The rationale being that community organisations are best placed to know the locations in their neighbourhood where residents are concerned about air pollution. This brings the issue of air pollution down to local level. People are able to use these results to highlight the effects that traffic in their community could be having on their health and well-being.

In November 2003 Environmental Strategy (ES) formerly The Environmental Protection Service (EPS) successfully applied to The Department of the Environment, Food and Rural Affairs (DEFRA) for funding.

EPS were then able to;

- i. Partly fund the role of Project Co-ordinator (Neil Parry).
- ii. Fund the supply and analysis of tubes.
- iii. Co-ordinate the collection and storage of monitoring results.
- iv. Report on results.

This DEFRA funding enabled the project to be expanded to include more community groups. In 2007 the following community groups were involved; Heeley Development Trust, Foxhill Forum, Green City Action in Firvale and Burngreave, Broomhall Forum, Nether Edge Forum, Brinsworth and Catcliffe, Handsworth Forum in Handsworth and Darnall, individuals in Greenhill, Kelham Island, Burngreave/Melrose and more recently in Crookes and students in King Ecgbert and Abbeydale Grange Schools. During 2008, a group of individuals have become involved through British Lung Foundation's Breathe Easy Group in Sheffield.

The co-ordinating role of the East End Quality of Life Initiative not only supports community groups in the month-by-month monitoring of nitrogen dioxide, but also provides them (and other interested individuals in their area) with detailed feedback in the form of regularly updated graphs which they can use to raise concerns about health and quality of life in their local communities. East End Quality of Life Initiative has also put together community booklets showing health trends, air quality and some of the health effects of air pollution. Reports and graphs showing community air quality monitoring results have been published on the East End Quality of Life Initiative's website <http://sheffieldeastend.org.uk> to allow immediate access

for anyone interested in Sheffield's air quality. Participating schools also receive the full data files for use in their school's curriculum.

The East End Quality of Life Initiative also undertook the literature review "Air pollution and noise - their effects on human health and social inclusion: a review of recent literature, revised January 2006" (Executive Summary and Full Report can be downloaded from <http://sheffieldeastend.org.uk/reports.htm>) .

Recently a summary of community diffusion tube data has been included on a website at <http://sheffieldairmap.org>. The site contains information on the location of each diffusion tube and the annual mean nitrogen dioxide level for each year. The intention is to develop further this website.

2.0 Method

The method used to measure nitrogen dioxide levels by diffusion tube was as described in DEFRA guidance (Part iv of the Environment Act 1995 Local Air Quality Management-Technical Guidance- LAQM.TG(03)). This guidance was closely followed to ensure the quality assurance of the results.

In the diffusion tube monitoring method, open ended (bottom) tubes are left in the open air for a period of about a month, during this time nitrogen dioxide is absorbed onto a chemical supported on a metal grid in the tube. The times and dates of exposure are recorded and reported to the analysing laboratory. The tubes are then sealed and sent for analysis.

In these particular tubes the absorbing chemical is triethanolamine (50% TEA in acetone). Nitrogen dioxide, absorbed as nitrite by triethanolamine, is determined spectrophotometrically (u/v visible at 540 nanometres). Nitrite reacts with the added reagent to form a reddish purple azo dye. The optical density of this complex is then measured by spectrophotometer.

Concentration in air is then calculated from a precalibrated response factor and exposure times. The values are blank corrected using laboratory blank values. A bias adjustment factor is determined (as described in the guidance) by co-locating tubes with automatic nitrogen dioxide analysers. In 2005 this figure was taken as a mean of several national studies (including studies done in South Yorkshire). Diffusion tube results can be compared with audited values from automatic nitrogen dioxide results. The bias adjustment factor can then be applied to all the laboratory reported nitrogen dioxide concentrations. The monthly (bias adjusted) concentration results are averaged over a year period to produce an annual mean value. This value can be then compared to the DEFRA nitrogen dioxide annual mean objective (for 2005) of $40 \mu\text{g}/\text{m}^3$.

3.0 Results and Discussion

Table 1 in the appendix shows the quality assured (bias adjusted) annual mean nitrogen dioxide levels for 2004, 2005, 2006 and 2007 together with the tube locations.

The bias adjustment factors used were 0.9 for 2004, 0.96 for 2005, 1.03 for 2006 and 1.08 for 2007.

It can be seen that the objective of $40 \mu\text{g}/\text{m}^3$ as an annual mean is often breached. Thirteen tubes in 2004, nine in 2005, fourteen in 2006 and twenty in 2007 either equal or breach the objective.

The highest value in 2004 of $53 \mu\text{g}/\text{m}^3$ was recorded at Town Street, Tinsley adjacent to Bawtry Road and the M1 and at London Road, Heeley. London Road was also the site with the highest recorded level in 2005, at $50 \mu\text{g}/\text{m}^3$.

The highest level in 2006 was $82 \mu\text{g}/\text{m}^3$ at Lady's bridge, which is a new site. This was also the location of the highest level in 2007 with $77 \mu\text{g}/\text{m}^3$.

As these tubes are largely in gardens or next to houses, it is apparent that large numbers of people are living in areas of Sheffield, which are subject to unhealthy levels of nitrogen dioxide.

4.0 Conclusion

- i. A community based monitoring programme for nitrogen dioxide has been carried out for the past four years, coordinated by the East End Quality of Life Initiative.
- ii. The community based monitoring programme has been recognised as a model of good practice in a study by University of the West of England.
- iii. Very useful data has been produced for nitrogen dioxide levels in areas of the city where ES generally has no monitoring.
- iv. This data is very useful in the continuing Review and Assessment of air quality, which all Local Authorities are bound to carry out.
- v. The raised levels (many of the tubes are in locations which breach Government objectives) indicate that many people are living in polluted areas.
- vi. Experience shows that raised levels of nitrogen dioxide are usually associated with high traffic levels.
- vii. It has empowered local communities to better articulate their concerns about poor air quality
- viii. A website has been established which will be used to make public the community diffusion tube results.
- ix. Although there are only four years of data in this study it is apparent that there is no noticeable improving trend in levels of nitrogen dioxide.

5.0 Future Work

- i. The diffusion tube project will be continued at least for another year and may be expanded into more areas.
- ii. Annual reports for future years will be done.
- iii. An annual meeting of community groups will be organised.
- iv. The website <http://sheffieldairmap.org> will be developed further.
- v. It is hoped to involve more schools in the project, which could form part of the 21st century science curriculum.

Appendix

Table 1 Community Diffusion Tube Results (highlighted figures are those which breach the annual mean objective)

Site	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2004	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2005	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2006	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2007
Brinsworth and Catcliffe				
Pringle Road Brinsworth	32	27	28	
Broadway Brinsworth	36	27	28	
Grange Farm Close	42	39	39	
Catcliffe Junior School	37	26	24	
Highfield View Catcliffe	32	27	28	
Main Street Catcliffe	34	31	27	
Sheffield Lane	30	29	26	
Brinsworth Road	40	35	38	
Derwent Crescent		47	52	
St. David's Drive		27	26	
Handsworth and Darnall				
Highfields Highfield Lane	35	35	31	35
St Mary's Church	38	38	35	40
Fitzallan Road Handsworth	29	30	28	28
Angler's Rest Richmond Park Road	29	28	25	30
Handsworth Road	42	40	38	42
Handsworth Road	40	39	38	43
Shop Front Parkway R/A	43	45	41	44
Greenwood Crescent	31	28	30	n/a
Prince of Wales Road	27	27	25	28
Greenland Junior School	29	29	28	31
Greenland Junior School	30	31	28	29
Greenland Court	25	24	23	26
Darnall Medical Centre	34	35	30	33
Nursery Handsworth Road	33	32	31	34
Finchwell Road	33	31	28	32
Handsworth Nursery		29	25	27
126 Retford Road		30	35	39
62 Rotherham Road		32	38	38

Site	Annual Mean NO2 µg/m3 2004	Annual Mean NO2 µg/m3 2005	Annual Mean NO2 µg/m3 2006	Annual Mean NO2 µg/m3 2007
Heeley				
Ann's Grove School	25	23		
Chesterfield Road	50	43	52	
Heeley Green	33	29		
Myrtle Road	24	20	22	26
Heeley Bank Road	39	33	41	42
London Road	53	50	52	53
Daresbury Road				28
East Bank Road				30
Foxhill Forum				
Wolfe Road	21	20	18	20
Keats Road	18	16	18	18
Foxhill Medical Centre	23	22	23	23
Birley Carr Church	19	19	18	20
Chaucer School	20	20	23	23
Nether Edge				
25/27 Junction Road				31
13 Osbourne Road				32
35 Montgomery Road				29
Zeds Nether Edge Road				26
Clifford School Psalter Lane				27
Greenhill				
Westwick Crescent	17	16	18	18
Key Homecare	24	21	22	24
St Peter's Church	19	18	19	21
Greenhill Library	20	19	21	23
Bocking Lane	25	24	23	28

Site	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2004	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2005	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2006	Annual Mean NO2 $\mu\text{g}/\text{m}^3$ 2007
Burngreave				
Abbeyfield Park House	25	25	24	25
Burngreave Road	34	34	34	41
Scott Road	29	28	28	30
Firshill School, Barnsley Road	29	28	32	31
Barnsley Road	34	35	36	39
Tinsley				
Town Street	53	43	51	53
Seimens Close	46	43	48	47
Greasebro Road	40	42	41	44
Ferrars Road	37	38	33	37
Ingfield Avenue	44	39	40	37
Sheffield Road			38	38
Ferrars Road			31	33
Ferrars Road			32	32
Kelham Island				
Wicker			43	41
Ladys Bridge			82	77
Gibraltar Street			37	41
Penistone Road			46	55
King Ecgbert School				
Back of School			13	14
Car park			15	18
Top of drive			16	17
Tesco Express Abbeydale Rd			29	31
Ashfurlong Road			14	15

Site	Annual Mean NO2 µg/m3 2004	Annual Mean NO2 µg/m3 2005	Annual Mean NO2 µg/m3 2006	Annual Mean NO2 µg/m3 2007
Firvale				
Earl Marshall Youth Centre	26	27	37	28
Firth Park Road	35		28	
Owler Lane 1	41	42	41	43
Owler Lane 2	34	34	39	38
Barnsley Road	41	41	39	42
Broomhall				
Ruth Square		21	21	24
Broomhall Road		21	27	26
Hanover Methodist church		26	28	30
Springfield Street		22	25	25
56 Exeter Drive		26	29	27
126 Exeter Drive		36	36	30
103 Exeter Drive		26	25	n/a
Burngreave/Melrose				
120 Burngreave Road			34	40
104 Burngreave Road			35	40
86 Burngreave Road			35	41
Burngreave street junction			33	33
73 Burngreave Road			43	53
Crookes				
Wesleyan Chapel				24
14 Arran Road				17
132 Cross Lane				19