Community Air Pollution Monitoring

2006

Measuring Nitrogen Dioxide Using

Diffusion Tubes

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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 2006 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 School and Brinsworth Comprehensive School.

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. Graphs showing community air quality monitoring results have been published on the East End Quality of Life Initiative's website http://sheffieldeastend.org.uk/new.htm 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/new/view_map.html . The site contains information on the location each diffusion tube and the annual mean nitrogen dioxide level for each year. The website is still in the prototype stage and will be developed further.

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 $\mu g/m^3$.

3.0 Results and Discussion

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

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

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

The highest value in 2004 of 53 $\mu g/m^3$ 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 μg/m^3. The highest level in 2006 was 82 μg/m^3 at Lady's bridge, which is a new site.

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 three years, coordinated by the East End Quality of Life Initiative.

ii. Very useful data has been produced for nitrogen dioxide levels in areas of the city where ES generally has no monitoring.

iii. This data is very useful in the continuing Review and Assessment of air quality, which all Local Authorities are bound to carry out.

iv. The raised levels (many of the tubes are in locations which breach Government objectives) indicate that many people are living in polluted areas.

v. Experience shows that raised levels of nitrogen dioxide are usually associated with high traffic levels.

vi. It has empowered local communities to better articulate their concerns about poor air quality

vii. A prototype website has been established which will be used to make public the community diffusion tube results.

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/new/view_map.html 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.

6.0 Acknowledgement

The success of this monitoring programme has been reliant on the participating communities and individuals, and on the coordinating roles of Neil Parry and Barbara Rimmington of the East End Quality of Life Initiative.

Site	Annual Mean NO2 µg/m3 2004	Annual Mean NO2 µg/m3 2005	Annual Mean NO2 µg/m3 2006
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	n/a	47	52
St. David's Drive	n/a	27	26
Handsworth and Darnall			
Highfields Highfield Lane	35	35	28
St Mary's Church	38	36	32
Fitzallan Road Handsworth	29	30	25
Rosy's Richmond Park Road	29	28	23
Handsworth Road	42	39	35
Handsworth Road	40	38	35
Shop Front Parkway R/A	43	43	38
Greenwood Crescent	31	27	25
Prince of Wales Road	27	27	23
Greenland Junior School	29	29	26
Greenland Junior School	30	30	26
Greenland Court	25	30	21
Darnall Medical Centre	34	34	27
Nursery Handsworth Road	33	32	28
Norfolk Arms	33	31	26
Athelstone School	n/a	29	23
Ballifield School	n/a	30	32
62 Rotherham Road	n/a	32	35

Site	Annual Mean NO2 µg/m3 2004	Annual Mean NO2 µg/m3 2005	Annual Mean NO2 µg/m3 2006
Heeley			
Ann's Grove School	25	23	
Chesterfield Road	50	43	52
Heeley Green	33	29	
Myrtle Road	24	20	22
Heeley Bank Road	39	33	36
London Road	53	50	52
Foxhill Forum			
Wolfe Road	17	20	18
Keats Road	18	16	18
Foxhill Medical Centre	19	22	23
Birley Carr Church	19	19	18
Chaucer School	19	19	23
Neepsend			
Gardener's Rest	27	30	
Brooklyn Works	31	27	
Kelham Island Tavern	25	31	
Rutland Road	40	39	
Borough Mews	28	19	
Greenhill			
Westwick Crescent	17	16	18
Key Homecare	24	21	22
St Peter's Church	19	18	17
Greenhill Library	20	19	21
Bocking Lane	25	24	23

Site	Annual Mean NO2 µg/m3 2004	Annual Mean NO2 µg/m3 2005	Annual Mean NO2 µg/m3 2006
Burngreave			
Abbeyfield Park House	25	25	24
Burngreave Road	34	34	30
Scott Road	29	28	28
Firshill School, Barnsley Road	29	28	30
Barnsley Road	34	35	33
Tinsley			
Town Street	53	43	51
Seimens Close	46	43	48
Greasebro Road	40	42	41
Ferrars Road	37	38	33
Ingfield Avenue	44	39	40
Sheffield Road			38
Ferrars Road			31
Ferrars Road			32
Kelham Island			
Wicker			43
Ladys Bridge			82
Gibraltar Street			37
Penistone Road			46
King Ecgbert School			
Back of School			13
Car park			15
Top of drive			16
Tesco Express Abbeydale Rd			29
Ashfurlong Road			14

Site	Annual Mean NO2 µg/m3 2004	Annual Mean NO2 µg/m3 2005	Annual Mean NO2 µg/m3 2006
Firvale			
Earl Marshall Youth Centre	26	27	32
Firth Park Road	35	n/a	28
Owler Lane 1	40	42	38
Owler Lane 2	34	34	36
Barnsley Road	42	41	36
Broomhall			
Ruth Square	n/a	21	21
Broomhall Road	n/a	21	27
Hanover Methodist church	n/a	26	28
Springfield Street	n/a	22	25
56 Exeter Drive	n/a	26	29
126 Exeter Drive	n/a	36	36
103 Exeter Drive	n/a	26	25
Burngreave/Melrose			
120 Burngreave Road			34
104 Burngreave Road			35
86 Burngreave Road			35
Burngreave street junction			33
73 Burngreave Road			43