

Local Air Quality Management:

Airwatch Annual Report for 2009

October 2010



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Introduction

1. This is the sixteenth Airwatch Annual Report produced by the Environmental Health Business Unit. Results are compared to the standards and objectives contained in the United Kingdom Air Quality Strategy and Air Quality (England) Regulations 2000 (as amended).
2. Three continuous monitoring sites listed below are currently operated under the Airwatch programme.

Site	Start date	Pollutants Monitored
Oxford Centre (kerbside)	November 1997	Nitrogen dioxide,
St Ebbe's (urban background)	July 1997	Nitrogen dioxide, PM ₁₀ , Ozone, PM _{2.5} (from 2009)
Oxford High Street (kerbside)	July 2003	Nitrogen dioxide, PM ₁₀

The first two sites listed above are affiliated into the Automated Urban Network of sites where continuous air quality monitoring data is collected on behalf of DEFRA. The St Ebbe's site has been upgraded by DEFRA to monitor for the new particulate standard PM_{2.5}. This data is reported to the European Commission, and used within national reporting statistics on urban air quality in the UK.

3. Data, reports and information about local air quality management and the monitoring programme is available on the Council's Internet site at <http://www.oxford.gov.uk/environment/air-pollution.cfm>

following links to:-

- Air Quality Management pages.
- 'Airwatch' web pages. This includes hourly data continuously updated, monthly and annual reports. This web site is updated daily:

<http://www.oxford-airwatch.aeat.co.uk>

4. There is a scrolling display unit at the Ramsay House office reception providing up to date hourly data from the sites.
5. The Oxford Centre site is included in the Department for Environment, Food and Rural Affairs (DEFRA), Automated Urban Network (AUN), and data is presented daily on:-
 - teletext page 155 & 169,
 - freephone 0800556677
 - Internet site <http://www.airquality.co.uk>
6. The nitrogen dioxide diffusion tube survey involves 65 sites at kerbside, intermediate and background locations. These tubes are changed

monthly, and form an important part of the assessment tools that are used to determine the continuing status of air quality within Oxford.

7. Maps showing the location of continuous monitoring and diffusion tube sites are provided in Appendix 3. Details of data validation procedures are given in Appendix 5 and a Glossary is included in Appendix 6.

Air Quality Management Areas (AQMA)

8. Air Quality Management Areas are designated where monitoring and assessment determines that the air quality objectives are not likely to be met in areas where there is relevant exposure.
9. Oxford had two AQMA's, the central Oxford AQMA (from 2001), and the Green Road Roundabout AQMA (from 2005). Both of these AQMA's have been designated due to the failure to meet the annual mean objective for Nitrogen Dioxide of 40 microgrammes per cubic metre ($\mu\text{g}/\text{m}^3$)
10. The City Council Executive Board in February 2009 agreed a recommendation to declare a city-wide AQMA, following the Detailed Assessment Report in 2008.
11. The Updating and Screening Assessment in 2009 verified the requirement for a City-wide AQMA,
12. An on-line public consultation exercise on the City-wide AQMA was completed in April 2010, providing the basis for formal adoption by the City Executive in September 2010.
13. A new Air Quality Action Plan (AQAP) will be produced in time for integration into the next Local Transport Plan (LTP 2011).

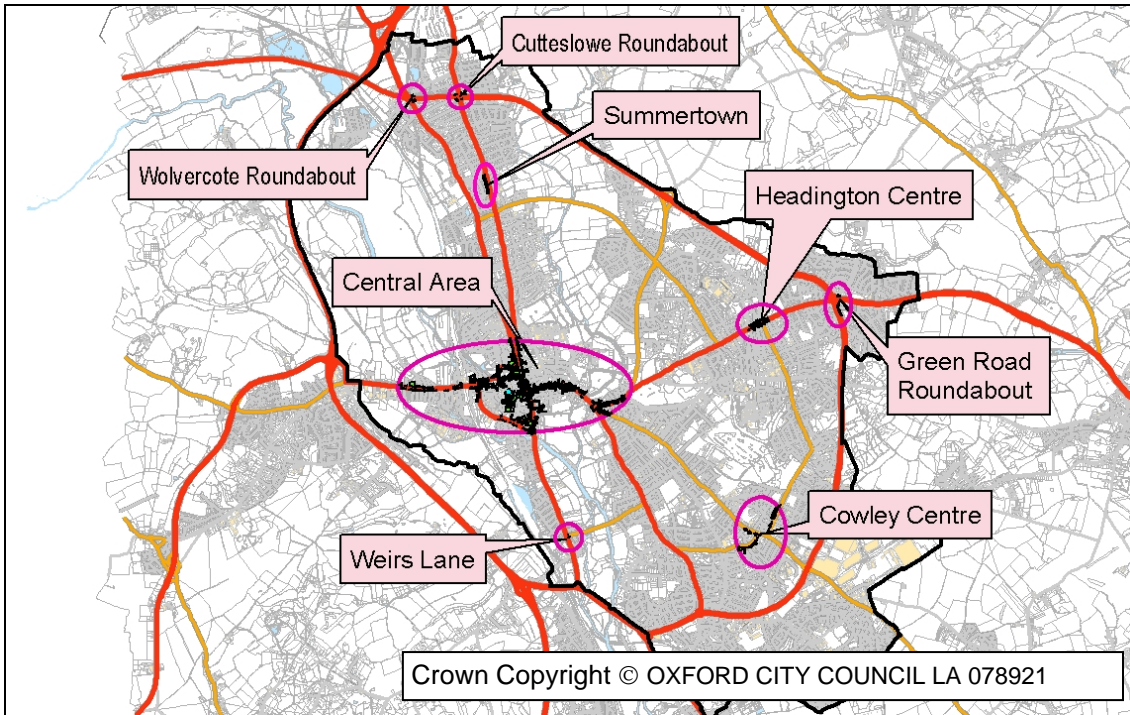


Figure 1 Designation of air quality hot-spots in Oxford

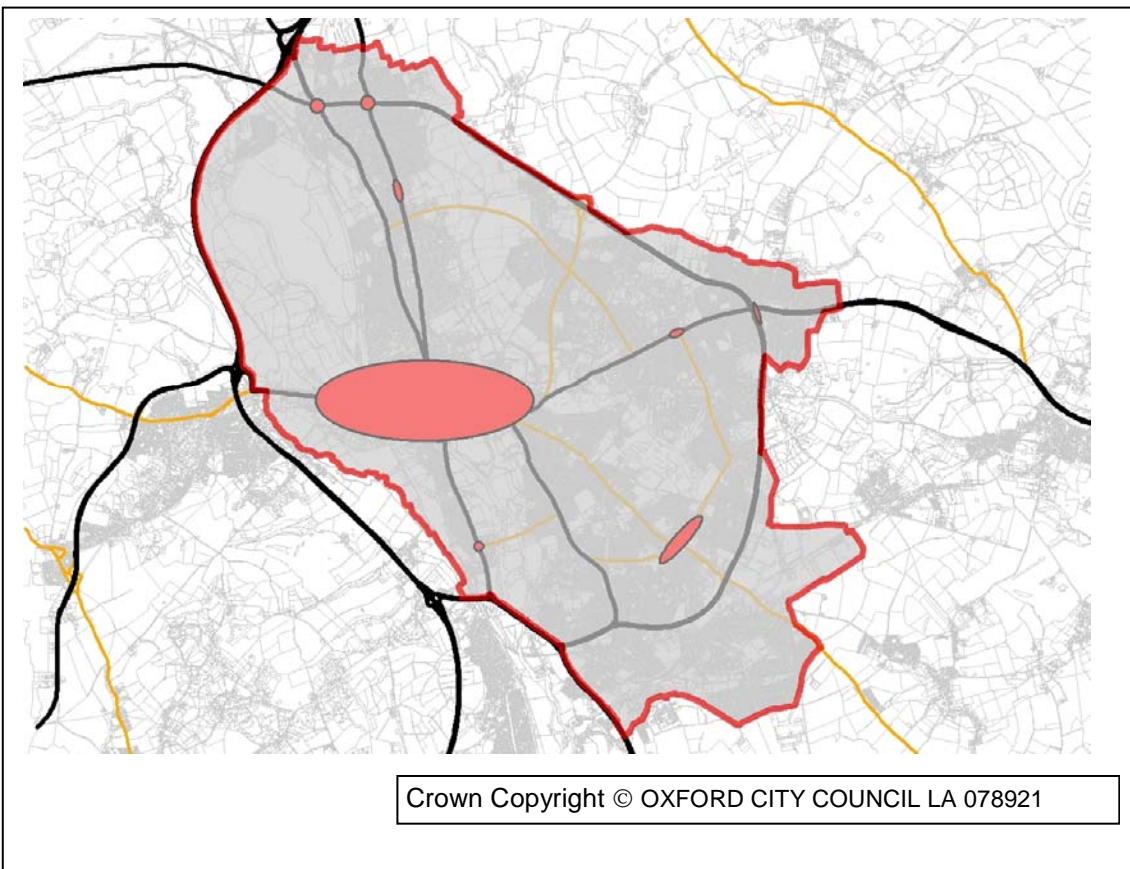


Figure 2 Proposed City-wide AQMA following 2008 Detailed Assessment

Air Quality Standards and Guidelines

14. Data is assessed in accordance with the air quality standards contained in the Air Quality Regulations^{1,2} and the United Kingdom Air Quality Strategy³. The standards are expressed as objective levels to be achieved by dates specified in the regulations. (Carbon monoxide 31 December 2003, Particulate Matter (PM₁₀) and sulphur dioxide 31 December 2004, nitrogen dioxide 31 December 2005).
15. The latest UK Air Quality Strategy (2007), includes a standard for fine particulates (PM_{2.5}), where it is considered that there is no recognised safe level for exposure. The UK air quality objective for PM_{2.5} is based on an annual mean concentration of 25µg/m³ to be achieved by 2020, with a target of 15% reduction to be achieved in concentrations measured at urban background locations
16. The St Ebbe's monitoring station is now affiliated to DEFRA's Automated Urban Network of monitoring stations, the site now includes the facility for monitoring to determine compliance with the proposed reductions in PM_{2.5}.
17. In addition, measurements are compared to the air pollution bands defined by the Department for Environment Food and Rural Affairs (DEFRA). Air pollution levels are categorised as low, moderate, high and very high. This banding is based on advice from the Department of Health and provides guidance as to the effects of air pollutants on health. At low levels of pollution it is unlikely that anyone will experience any adverse effects. These standards, along with a detailed explanation of the new 10 point banding scale can be examined in full on the following Internet site:
http://www.airquality.co.uk/archive/Current_Bulletin.php
18. This site gives details of up to date air quality information in urban areas across the UK, allowing comparison from one area to another.
19. Full details of the air quality objective levels and air pollution bands used for assessing the results in this report are given in Appendix 1.

¹ The Air Quality (England) Regulations 2000 SI 938

² The Air Quality (England) (Amendment) Regulations 2002 SI 3043

³ The United Kingdom Air Quality Strategy for England Wales and Northern Ireland.
Cmd paper No 7169 Issued 17th July 2007

Summary of Results

20. This section comments on the results for individual pollutants. More detailed data is given in Appendix 2. Results are compared to relevant air quality standards and objectives.

Nitrogen Dioxide

21. Two air quality objective levels have been set for nitrogen dioxide, 200 microgrammes per cubic metre ($\mu\text{g}/\text{m}^3$), when expressed as an hourly mean (not to be exceeded more than 18 times a year), and 40 $\mu\text{g}/\text{m}^3$ when expressed as an annual mean. These objectives are to be measured against likely human exposure. Therefore the annual mean is more appropriate for assessing longer-term exposure from background concentrations and the hourly mean for assessing short-term exposure from kerbside concentrations. The Air Quality Regulations 2000 formally prescribe that these objectives should be achieved by 31st December 2005, in line with EC Daughter Directive 1999/30/EC.
22. Hourly measurements made at the three continuous monitoring sites is used to assess against both objective levels. Data from diffusion tube monitoring is compared to the annual mean objective level.

Nitrogen Dioxide Diffusion Tube Survey

23. The diffusion tube survey has now been running for fourteen years. The current programme involves sixty-five sites at a mixture of kerbside, intermediate and background locations including areas representative of residential streets. All diffusion tube results are bias corrected by comparison with more accurate continuous monitoring data. Bias corrected results for 2008 indicate that 22 of the routinely monitored sites reach or exceed the 40 $\mu\text{g}/\text{m}^3$ annual nitrogen dioxide objective. These results are shown in Appendix 2 as nine years of results for each site from 2000 to 2008.

Nitrogen Dioxide Continuous Monitoring (2008 Figures in brackets)

24. Continuous monitoring for nitrogen dioxide was carried out at two roadside locations, Oxford Centre and Oxford High Street, and one background site, St Ebbe's First School. Both roadside sites are on the bus priority route within the AQMA.
25. At Oxford Centre roadside site, the annual mean was 50 $\mu\text{g}/\text{m}^3$ (51); the maximum hourly mean was 160 $\mu\text{g}/\text{m}^3$ (231 $\mu\text{g}/\text{m}^3$ in November).
26. At Oxford High Street, the annual mean was 55 $\mu\text{g}/\text{m}^3$ (54); the maximum hourly mean was 181 $\mu\text{g}/\text{m}^3$ (271 $\mu\text{g}/\text{m}^3$ in February).
27. At St Ebbe's the annual mean concentration was 23 $\mu\text{g}/\text{m}^3$ (19) and the maximum hourly mean was 153 $\mu\text{g}/\text{m}^3$ (96 in February).

28. The annual mean objective was not met at Oxford Centre or at Oxford High Street, both roadside sites within the City-wide Air Quality Management Area (AQMA).
29. The annual mean objective was met at St Ebbe's, a background site.
30. The hourly mean objective of $200\mu\text{g}/\text{m}^3$ (not to be exceeded more than 18 times a year) was met at Oxford Centre, Oxford High Street and St Ebbe's monitoring sites.
31. At Oxford Centre, 0 hours were recorded above this level, compared to 3 hours in 2008 and 11 hours in 2007. This is within the permitted 18 exceedences per year.

Ozone

32. Ozone is a secondary pollutant and is produced by chemical reactions in the atmosphere primarily between nitrogen oxides and hydrocarbons in the presence of sunlight. It is a transboundary pollutant and elevated concentrations are often caused in the summer months by air masses originating in central Europe.
33. The Air Quality Regulations did not set an objective level for ozone. However the UK Air Quality Strategy suggested the objective level of $100\mu\text{g}/\text{m}^3$ daily maximum running 8-hour mean not to be exceeded more than 10 times a year.
34. Ozone was monitored continuously at St Ebbe's. The annual mean concentration was $47 (41)\mu\text{g}/\text{m}^3$. The maximum hour of $188 (140)\mu\text{g}/\text{m}^3$ was recorded in (July) and the maximum 8-hr running mean of $171 (211)\mu\text{g}/\text{m}^3$ was recorded in (May).
35. The air quality objective level was exceeded at St Ebbe's on 18 days (10 in 2008), for 97 hours (49 in 2008) where the objective allows 10 days. Ozone exceedences took place between April and July 2009, (with 23 hours in May and 22 hours in June).
36. The air quality objective for ozone was not met.

PM₁₀ Particulate Matter

37. Two air quality objective levels have been set for PM₁₀. A 24-hour mean of $50\mu\text{g}/\text{m}^3$ not to be exceeded more than 35 times a year, and an annual mean objective of $40\mu\text{g}/\text{m}^3$ to be achieved by 31st December 2004.
38. PM₁₀ was monitored continuously at Oxford High Street (a roadside site) and St Ebbe's (a background site).

39. The annual mean concentration was 25 (25) $\mu\text{g}/\text{m}^3$, measured as Gravimetric concentration, [or 19 (20.5) $\mu\text{g}/\text{m}^3$ as VCM] at the High Street, which meets the objective. The annual mean concentration was 17 (15)* $\mu\text{g}/\text{m}^3$ at St Ebbe's or 11 (12.9)** $\mu\text{g}/\text{m}^3$ as VCM, which meets the objective. (*Gravimetric = measured concentration x 1.3) (** VCM = volatile correction equivalent)
40. The maximum 24-hour mean recorded in January was 68 (94)* $\mu\text{g}/\text{m}^3$ at St Ebbe's, and 64 (93)* $\mu\text{g}/\text{m}^3$ at the High Street. The objective level of 50 $\mu\text{g}/\text{m}^3$ was exceeded on 5 (1) day at St Ebbe's, and 6 (6) days at the High Street. Both results are within the permitted level of 35 exceedences per year, meeting the objective. (*Gravimetric measurement)

Comparison with other sites

41. Data from the Oxford sites is compared to other selected sites in the table below. All of the other sites are part of, or affiliated to the automatic urban network and data was downloaded from the UK National Air Quality Information Archive :<http://www.airquality.co.uk/archive/glossary.php>

MONITORING SITE	YEAR	NO ₂ µg/m ³		PM ₁₀ µg/m ³		SO ₂ µg/m ³		O ₃ µg/m ³		CO mg/m ³	
		1 hour		24-hour		15 mins		running 8-hour		running 8-hour	
		Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Oxford Centre (Roadside)	2009	160	50	-	-	-	-	-	-	-	-
	2008	231	51	-	-	-	-	-	-	-	-
	2007	265	57	-	-	27	2	-	-	1.4	0.10
	2006	244	67	-	-	64	3	-	-	1.9	0.20
Oxford St Ebbes (Urban background)	2009	153	23	68*	17*	-	-	171	47	-	-
	2008	96	19	94*	15* (12.9)	-	-	130	41	-	-
	2007	118	23	84*	17*	-	-	128	40	-	-
	2006	115	24	56*	19*	-	-	197	46	-	-
Oxford High St (Roadside)	2009	181	55	64*	19*	-	-	-	-	-	-
	2008	271	54	93*	25*	-	-	-	-	-	-
	2007	264	58	77*	26*	-	-	-	-	-	-
	2006	239	56	84*	28*	-	-	-	-	-	-
Reading (Urban background - 20 metres from A4)	2009	124	22	95*	16*	-	-	164	43	-	-
	2008	160	22	67*	18*	-	-	143	46	-	-
	2007	214	23	103*	24*	53	6	133	43	1.6	0.2
	2006	88	21	64*	23*	133	5	158	49	1.6	0.3
London, Marylebone Road (Roadside - 1m from main road)	2009	332	107	100*	35*	67	7	94	14	1.9	0.7
	2008	378	115	129*	47*	93	7	113	16	2.5	0.7
	2007	329	102	119*	45*	98	6	111	17	2.7	0.8
	2006	403	111	109*	47*	170	8	84	16	2.8	1.0
Leamington Spa (Urban background - 10m from main road)	2009	130	27	72*	20*	136	2	148	32	-	-
	2008	122	27	82*	21*	37	3	153	41	-	-
	2007	193	25	87*	21*	37	3	130	39	1.5	0.2
	2006	117	20	101*	24*	88	4	205	46	1.7	0.2
Harwell (Rural)	2009	83	10	52*	17*	131	1.7	157	49	-	-
	2008	89	10	105*	19*	202	2	135	50	-	-
	2007	89	12	89*	22*	167	3	132	48	-	-
	2006	86	11	58*	22*	198	3	184	54	-	-
Bath Roadside (Roadside - on A4 London Rd)	2009	218	65	-	-	-	-	-	-	-	-
	2008	288	65	-	-	-	-	-	-	-	-
	2007	220	63	-	-	-	-	-	-	2.2	0.5

Conclusions

In summary for 2009 (2008 figures in brackets):

- There were 17 (26) days when the results of continuous monitoring indicated an air quality objective (for any pollutant) had been exceeded. Of these, 17 (10) days were for ozone, 7(3) days for particulate matter, and 6 (0) days for nitrogen dioxide. There were 6 days when more than one objective was exceeded.
- The annual mean nitrogen dioxide air quality objective was achieved at St Ebbe's. The objective was exceeded at Oxford Centre and at Oxford High Street, both located in the Central Oxford Air Quality Management Area (AQMA).
- The hourly mean nitrogen dioxide air quality objective was exceeded on 3 (11) occasions, over 3 (4) days at the Oxford Centre site. The hourly mean nitrogen dioxide air quality objective was exceeded on 6(3) occasions, over 3 (3) days at the Oxford High Street site. The regulations allow 18 exceedences. The objective was achieved.
- The diffusion tube monitoring data shows that out of 58 sites, 20 (30) exceeded the 2005 annual mean nitrogen dioxide air quality objective.
- The annual mean objective for particulate matter was achieved at the High Street and at St Ebbe's.
- The 24-hour mean air quality objective for particulate matter was exceeded at the High Street on 6 (11) days, and at St Ebbe's on 1(4) day. The regulations allow 35 exceedences; therefore the air quality objective was achieved at both locations indicative of the situation throughout the AQMA.
- The air quality objectives for sulphur dioxide and carbon monoxide were achieved at the Oxford Centre site.
- The air quality objective level for ozone was exceeded at St Ebbe's on 49 (56) occasions on 10 (10) days between April and July. 10 days exceedences are permitted under the UK National Air Quality Strategy therefore the objective was not achieved.
- Between March and July 122 (114) hours of moderate ozone pollution, and 0 (0) hours of high pollution were recorded at St Ebbe's.

Appendix 1 Air Quality Standards and Guidelines

Air Quality Objectives (taken from the Air Quality Regulations 2000 and Air Quality (Amendment) Regulations 2002)

Pollutant	Standard Measured as Concentration	Specific objective to be achieved
Carbon monoxide	10 mg/m ³ Maximum daily running 8 Hour Mean	by 31/12/03
Nitrogen dioxide	200µg/m ³ 1 hour mean	not to be exceeded more than 18 times a year by 31/12/05
	40µg/m ³ annual mean	by 31/12/05
Particles PM ₁₀	50µg/m ³ 24-hour mean	mean not to be exceeded more than 35 times a year by 31/12/04
	40µg/m ³ annual mean	by 31/12/04
Sulphur dioxide	266µg/m ³ 15 minute mean	not to be exceeded more than 35 times a year by 31/12/05
	125µg/m ³ 24-hr mean	not to be exceeded more than 24 times a year by 31/12/04
	350µg/m ³ hourly mean	not to be exceeded more than 3 times a year by 31/12/04
Ozone*	100µg/m ³ daily maximum of running 8-hour mean	not to be exceeded more than 10 times a year by 31/12/05

*Ozone does not have an objective set within the UK Air Quality Regulations, it is considered as a national objective but not included in Regulations for the purposes of Local Air Quality Management. Thus it is treated as a national problem and does not fall within local authority controls.

Appendix 1 (continued) Air Quality Standards and Guidelines

DEFRA Air Pollution Bands (for public information)

Pollutant	DEFRA Air Pollution Bands				Measured as
	Low <i>Index (1-3)</i>	Moderate <i>Index (4-6)</i>	High <i>Index (7-9)</i>	Very High <i>Index (10)</i>	
Nitrogen dioxide	286µg/m ³ or less 1) 0-95 µg/m ³ 2) 96-190 3) 191-286	286-572µg/m ³ 4) 287-381 µg/m ³ 5) 382-476 6) 477-572	573-763µg/m ³ 7) 573-635µg/m ³ 8) 636-700 9) 701-763	equal to or greater than 764µg/m ³ 10) >764 µg/m ³	hourly mean
Ozone	100µg/m ³ or less 1) 0-32 µg/m ³ 2) 33-66 3) 67-99	100-179µg/m ³ 4) 100-126 µg/m ³ 5) 127-152 6) 153-179	180-359µg/m ³ 7) 180-239 µg/m ³ 8) 240-299 9) 300-359	equal to or greater than 360µg/m ³ 10) >360µg/m ³	running 8 hour mean for low, hourly for remainder*
Carbon monoxide	10ppm or less 1) 0- 3.8mg/m ³ 2) 3.9- 7.6 3) 7.7- 11.5	10-14ppm 4) 11.6-13.4 mg/m ³ 5) 13.5-15.4 6) 15.5-17.3	15-19ppm 7) 17.4-19.2 mg/m ³ 8) 19.3-21.2 9) 21.3-23.1	equal to or greater than 20ppm 10) > 23.2 mg/m ³	running 8 hour mean
Sulphur dioxide	266µg/m ³ or less 1) 0 – 88 µg/m ³ 2) 89 – 176 3) 177 - 265	266-531µg/m ³ 4) 266 – 354µg/m ³ 5) 355 - 442 6) 443 - 531	532-1061µg/m ³ 7) 532-708 µg/m ³ 8) 709 – 886 9) 887 - 1063	equal to or greater than 1064µg/m ³ 10) >1064 µg/m ³	15 minute mean
PM ₁₀	50µg/m ³ or less 1) 0 – 16 ug/m ³ 2) 17 – 32 3) 33 – 49	50-74µg/m ³ 4) 50 – 57 ug/m ³ 5) 58- 66 6) 67 – 74	75-99µg/m ³ 7) 75 – 82 ug/m ³ 8) 83 – 91 9) 92 – 99	equal to or greater than 100µg/m ³ 10) >100 ug/m ³	running 24 hour mean

1. When air pollution is LOW (1-3) effects are unlikely to be noticed even by those who are sensitive to air pollution.
2. When air pollution is MODERATE (4-6) sensitive people may notice mild effects but these are unlikely to need action.
3. When air pollution is HIGH (7-9) sensitive people may notice significant effects and may need to take action.
4. When air pollution is VERY HIGH (10) effects on sensitive people, described for HIGH pollution, may worsen.

Appendix 2 Oxford Airwatch Results

Table 1: Oxford Centre Summary

Standard	Nitrogen Dioxide $\mu\text{g}/\text{m}^3$	Carbon Monoxide mg/m^3	Ozone $\mu\text{g}/\text{m}^3$	Sulphur Dioxide $\mu\text{g}/\text{m}^3$	Particulates PM_{10} $\mu\text{g}/\text{m}^3$
Mean	50	-	-	-	-
Max 15 min mean	214	-	-	-	-
Max hour	160	-	-	-	-
Max running 8-hr mean	131	-	-	-	-
Max 24-hour mean	109	-	-	-	-
Data Capture %	96.9	-	-	-	-
DEFRA Band (hrs)					
Low	8492	-	-	-	-
Moderate	0	-	-	-	-
High	0	-	-	-	-
Very High	0	-	-	-	-
Air Quality Regulations / Strategy	*	*	**	*	*
Number of Exceedences					
15 min mean	-	-	-	-	-
Hourly mean	0	-	-	-	-
8 hour mean	-	-	-	-	-
24 hour mean	-	-	-	-	-
Annual Mean	1	-	-	-	-

* Air Quality Regulations.

** The United Kingdom Air Quality Strategy for England Wales and Northern Ireland.

*** Expressed as 15 minute periods.

**** The air quality objective level for sulphur dioxide is $266 \mu\text{g}/\text{m}^3$ when expressed as a 15 minute mean not to be exceeded more than 35 times a year

Appendix 2 (continued)

Table 2: St Ebbe's Summary

Standard	Nitrogen Dioxide $\mu\text{g}/\text{m}^3$	Carbon Monoxide mg/m^3	Ozone $\mu\text{g}/\text{m}^3$	Sulphur Dioxide $\mu\text{g}/\text{m}^3$	Particulates PM_{10} $\mu\text{g}/\text{m}^3$
Mean	23	-	47	-	17 ****
Max hour	153	-	188	-	105
Max running 8-hr mean	-	-	171	-	83
Max 24hr mean	-	-	115	-	68
Data Capture %	83	-	93.9	-	88.9
DEFRA Band (hrs)					
Low	7275	-	8064	-	7730
Moderate	0	-	194	-	17
High	0	-	3	-	0
Very High	0	-	0	-	0
Air Quality Regulations / Strategy	*	*	**	*	*
Number of Exceedences					
Hourly mean	0	-	-	-	-
Running 8-hr mean	-	-	97 hours*** 18 days***	-	-
24 hour mean	-	-	-	-	5****
Annual Mean	0	-	0	-	0

* Air Quality Regulations

** The United Kingdom Air Quality Strategy for England Wales and Northern Ireland

*** The air quality objective level for ozone is $100\mu\text{g}/\text{m}^3$ when expressed as the daily maximum running 8 hour mean not to be exceeded more than 10 times a year. The 97 hours of exceedence of the running 8-hour mean were spread across 18 days during 2009.

**** The 24-hour mean air quality objective level for PM_{10} is $50\mu\text{g}/\text{m}^3$ not to be exceeded more than 35 times a year. The annual mean air quality objective level for PM_{10} is $40\mu\text{g}/\text{m}^3$. Concentrations are reported as TEOM data and exceedences as VCM corrected data.

Appendix 2 (continued)

Table 3: High St Summary

Standard	Nitrogen Dioxide $\mu\text{g}/\text{m}^3$	Carbon Monoxide mg/m^3	Ozone $\mu\text{g}/\text{m}^3$	Sulphur Dioxide $\mu\text{g}/\text{m}^3$	Particulates PM_{10} $\mu\text{g}/\text{m}^3$
Mean	55				25 ()****
Max hour	181				325
Max running 8-hr mean	148				184
Max 24hr mean	108				83
Data Capture %	77.4				89.3
DEFRA Band (hrs)					
Low	6778				7831
Moderate	0				21
High	0				0
Very High	0				0
Air Quality Regulations / Strategy	*	*	**	*	*
Number of Exceedences					
Hourly mean	0	-	-	-	-
Running 8-hr mean	-	-	-	-	-
24 hour mean	-	-	-	-	6 ****
Annual Mean	1	-	-	-	0

* Air Quality Regulations

** The United Kingdom Air Quality Strategy for England Wales and Northern Ireland

**** The 24-hour mean air quality objective level for PM_{10} is $50\mu\text{g}/\text{m}^3$ not to be exceeded more than 35 times a year. The annual mean air quality objective level for PM_{10} is $40\mu\text{g}/\text{m}^3$. Concentrations are reported as TEOM data and exceedences as VCM corrected data.

Appendix 2 (continued)

Table 4: Nitrogen Dioxide Oxford Centre

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean $\mu\text{g}/\text{m}^3$	57	57	54	62	44	57	37	39	44	53	40	57
Max hour $\mu\text{g}/\text{m}^3$	138	126	149	157	132	149	170	92	132	143	130	145
% Data Capture	98.5	99.7	99.6	99.7	95.4	99.7	94.5	95.4	95.3	95.4	95.6	94.8
DETR Band (hrs)												
Low	733	670	741	718	710	718	703	710	686	710	688	705
Moderate	0	0	0	0	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0
Very High	0	0	0	0	0	0	0	0	0	0	0	0
Air Quality Regs												
Number of hours $>200\mu\text{g}/\text{m}^3$	0	0	0	0	0	0	0	0	0	0	0	0

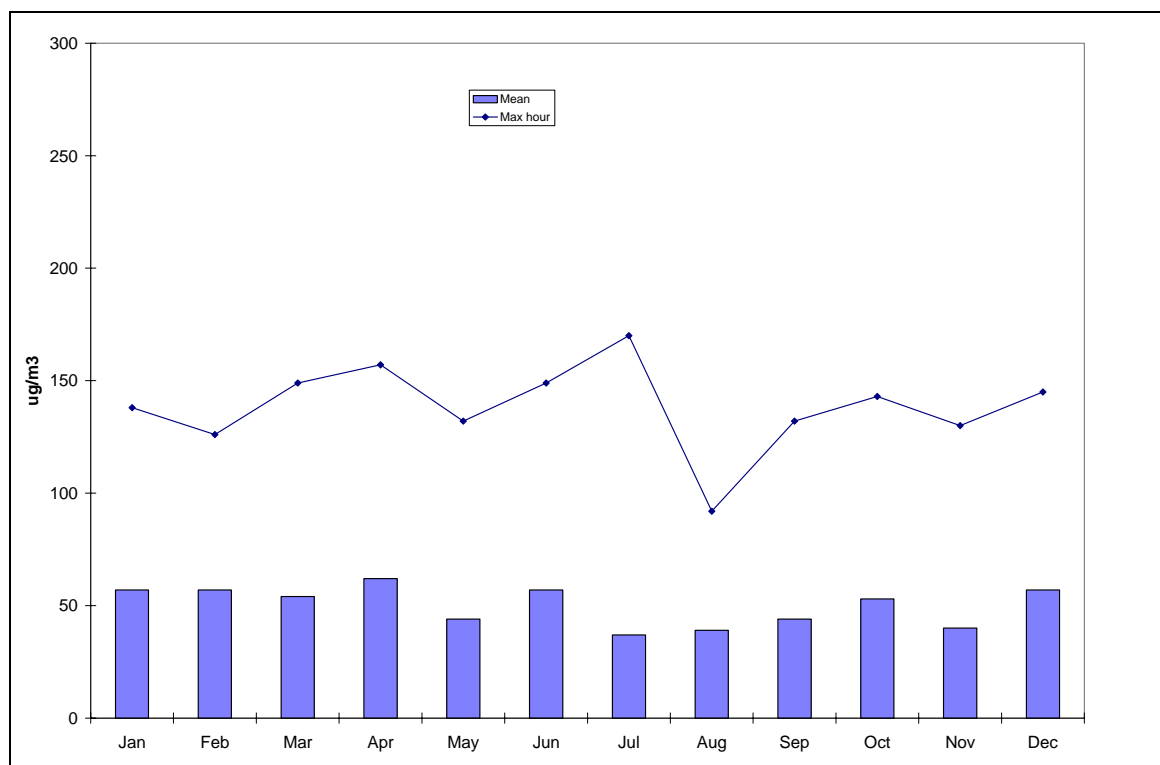


Figure 3: Oxford Centre Monthly Nitrogen Dioxide concentration

Appendix 2 (continued)

Table 5: Nitrogen Dioxide Oxford High Street

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean $\mu\text{g}/\text{m}^3$	50	70	63	55	45	59	47	-	60	61	37	57
Max hour $\mu\text{g}/\text{m}^3$	117	136	143	145	115	157	181	-	149	164	117	168
% Data Capture	59.3	100	99.9	99.6	99.7	99.4	44.9	0	29.7	99.7	99.7	99.3
DETR Band (hrs)												
Low	441	672	743	717	742	716	334	0	214	742	718	739
Moderate	0	0	0	0	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0
Very High	0	0	0	0	0	0	0	0	0	0	0	0
Air Quality Regs												
Number of hours $>200\mu\text{g}/\text{m}^3$	0	0	0	0	0	0	0	0	0	0	0	0

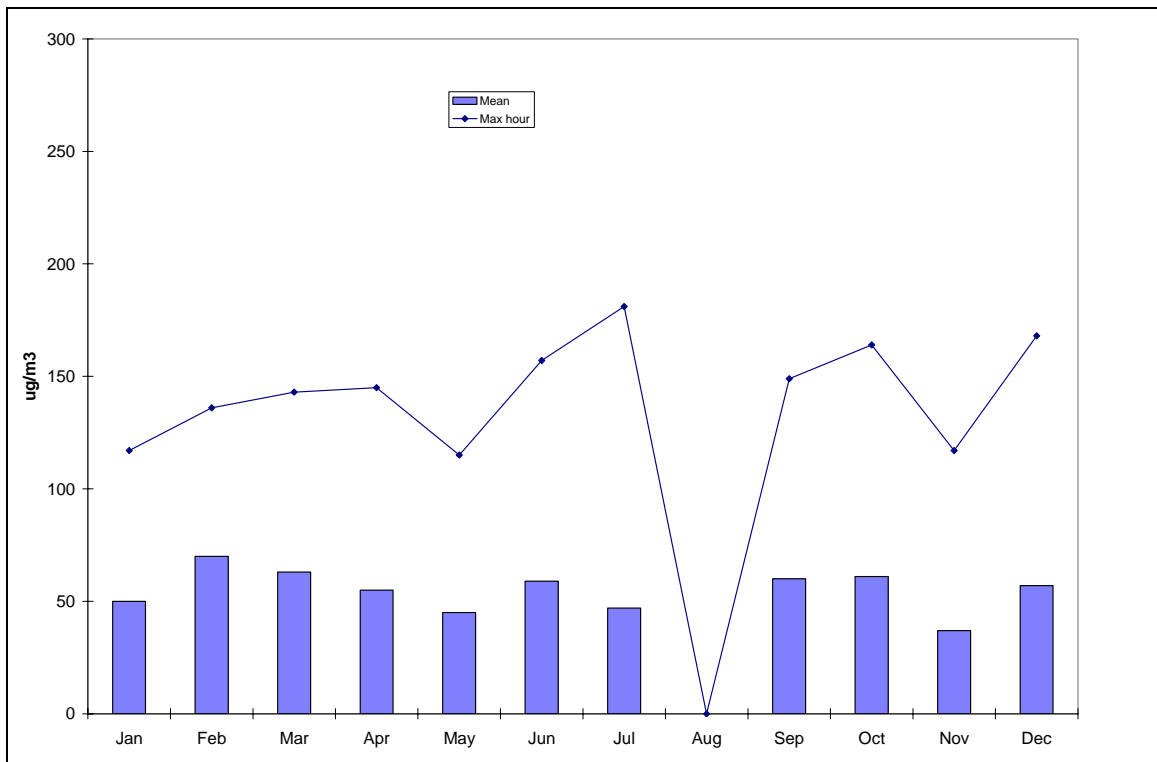


Figure 4: Oxford High Street Nitrogen Dioxide concentration

Appendix 2 (continued)

Table 6: Nitrogen Dioxide St Ebbe's

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean $\mu\text{g}/\text{m}^3$	32	28	20	24	16	18	14	10	24	33	18	33
Max hour $\mu\text{g}/\text{m}^3$	73	73	82	82	73	88	69	50	90	84	76	153
% Data Capture	95.7	99.7	99.3	99.7	99.7	99.4	17.7	38.8	92.5	87.6	91	78.5
DETR Band (hrs)												
Low	712	670	739	718	742	716	132	289	666	719	655	584
Moderate	0	0	0	0	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0
Very High	0	0	0	0	0	0	0	0	0	0	0	0
Air Quality Regs Number of hours > $200\mu\text{g}/\text{m}^3$	0	0	0	0	0	0	0	0	0	0	0	0

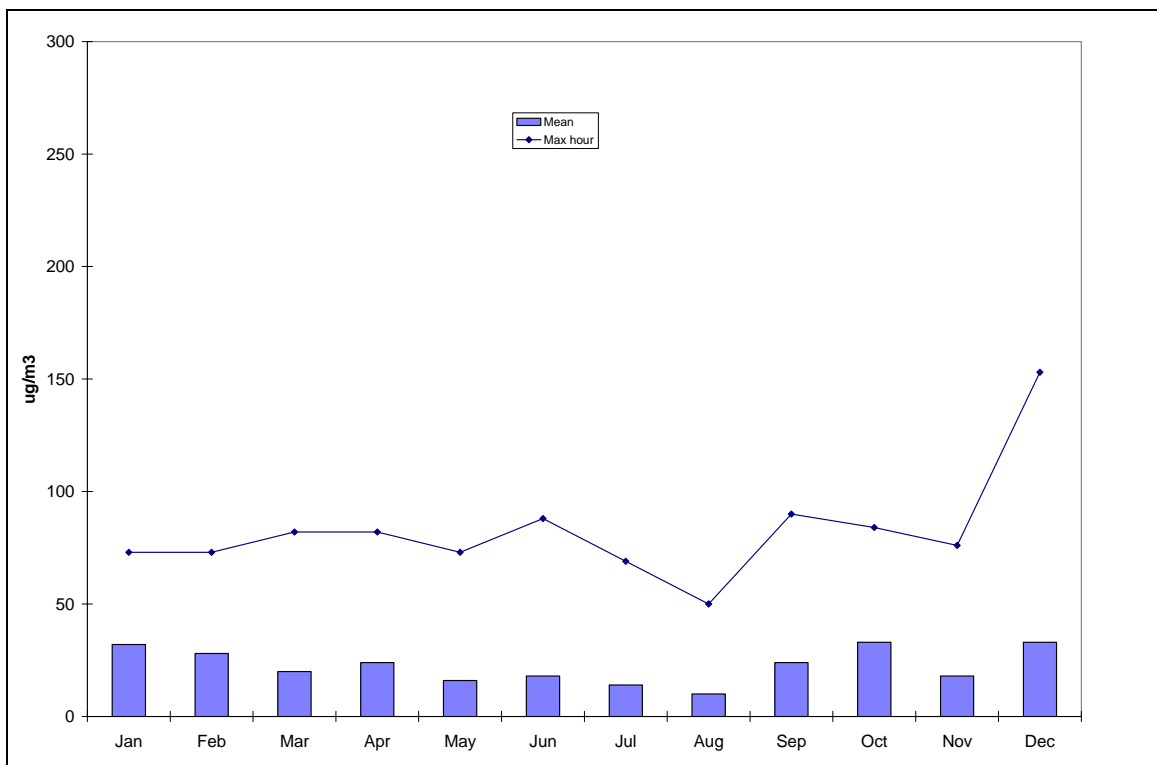


Figure 5: St Ebbe's Nitrogen Dioxide concentration

Appendix 2 (continued)

Table 7: Nitrogen Dioxide Green Road (Lydia Close)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean $\mu\text{g}/\text{m}^3$	47	44	43	38								
Max hour $\mu\text{g}/\text{m}^3$	126	115	139	199								
% Data Capture	100	99.9	100	74.2								
DETR Band (hrs)												
Low	744	671	744	534								
Moderate	0	0	0	0								
High	0	0	0	0								
Very High	0	0	0	0								
Air Quality Regs Number of hours > $200\mu\text{g}/\text{m}^3$	0	0	0	0								

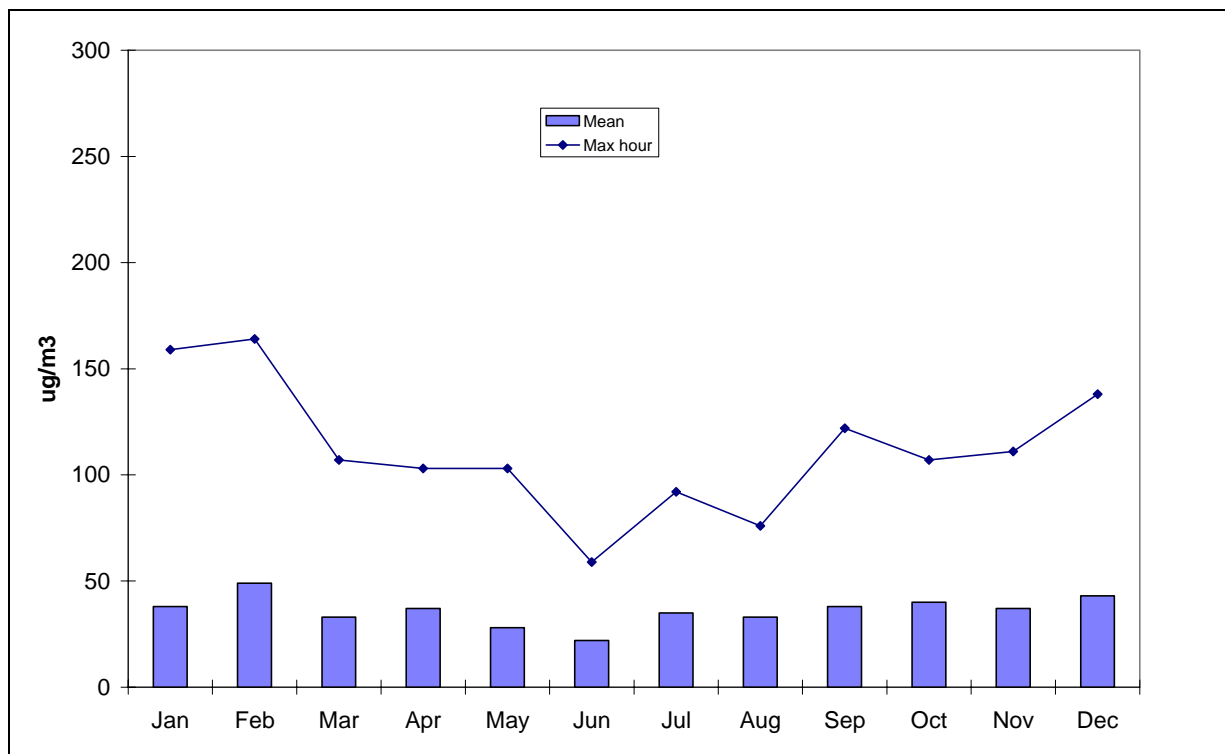


Figure 6: Green Road (Lydia Close) Nitrogen Dioxide concentration

Appendix 2 (continued)

Table 8: Ozone St Ebbe's

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean $\mu\text{g}/\text{m}^3$	32	27	46	50	55	50	41	39	36	29	49	45
Max hour $\mu\text{g}/\text{m}^3$	82	66	82	104	110	116	160	104	94	78	96	80
Max running 8 hr mean $\mu\text{g}/\text{m}^3$	81	61	77	94	100	104	147	95	70	73	90	72
% Data Capture	91.1	99	98.7	99.6	100	99.6	98.7	100	99.9	96.4	99.6	45.3
DETR Band (hrs)												
Low	685	672	740	714	730	699	716	735	720	719	720	339
Moderate	0	0	0	5	14	20	24	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0
Very High	0	0	0	0	0	0	0	0	0	0	0	0
National Air Quality Strategy												
Number of running 8hr means $>100\mu\text{g}/\text{m}^3$	0	0	0	0	0	5	15	0	0	0	0	0
On number of days*	0	0	0	0	0	2	3	0	0	0	0	0

*The air quality objective for ozone is based on the max daily running 8-hour mean. Thus the number of days on which the objective level was exceeded is a better indicator of exceedence.

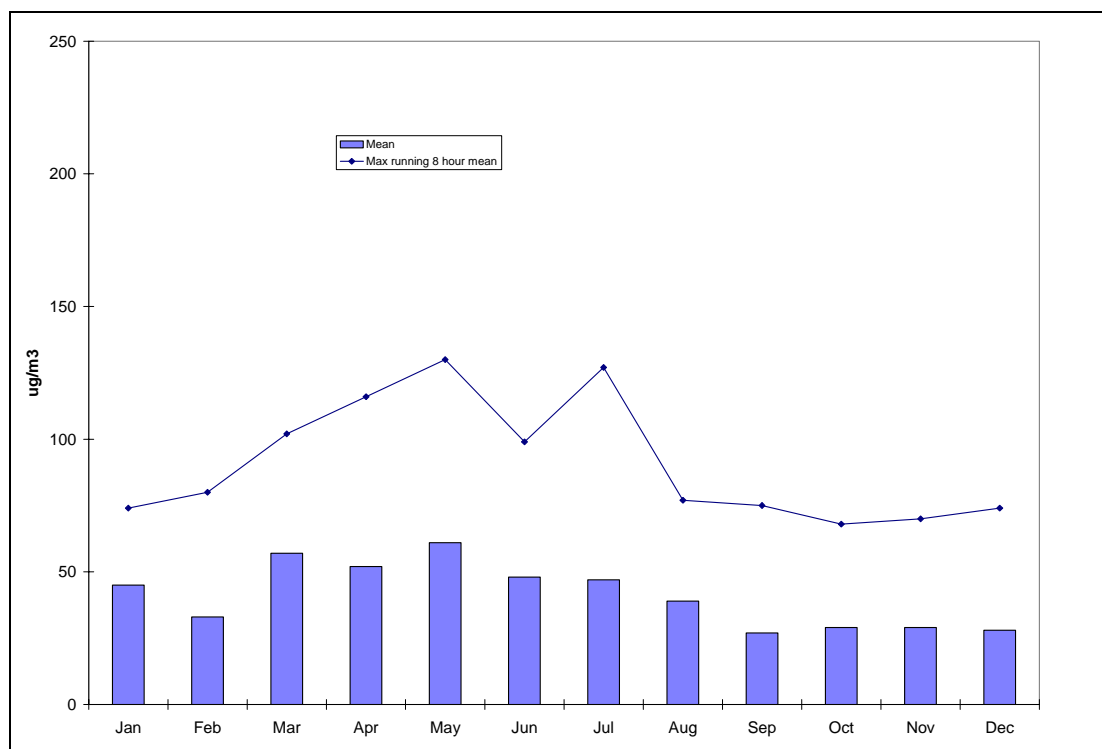


Figure 7: St Ebbe's ozone concentration

Appendix 2 (continued)

Table 9: PM₁₀ Oxford High Street

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean $\mu\text{g}/\text{m}^3$	25	23	31	26	24	28	22	23	29	33	19	19
Max hour $\mu\text{g}/\text{m}^3$	151	92	72	112	56	203	78	104	231	325	87	66
Max 24hr mean $\mu\text{g}/\text{m}^3$	51	47	51	50	42	52	49	37	52	83	44	34
% Data Capture	99.9	37.9	65.6	99.3	99.1	73.2	99.1	96.6	97.9	99.3	99.6	99.6
DETR Band (hrs)												
Low	744	261	472	720	744	516	744	723	720	723	720	744
Moderate	0	0	0	0	0	0	0	0	0	21	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0
Very High	0	0	0	0	0	0	0	0	0	0	0	0
Air Quality Regs												
Number 24-hr means $>50\mu\text{g}/\text{m}^3$	0	0	0	0	0	0	0	0	1	5	0	0

For particles (PM₁₀) compliance with the objective level requires the use of gravimetric equivalent data (TEOM x 1.3). The 24-hour (daily) mean air quality objective level for PM₁₀ is $50\mu\text{g}/\text{m}^3$ (gravimetric) not to be exceeded more than 35 times a year. The annual mean air quality objective level for PM₁₀ is $40\mu\text{g}/\text{m}^3$ (gravimetric). Concentrations are reported as TEOM data and exceedences as gravimetric equivalent data.

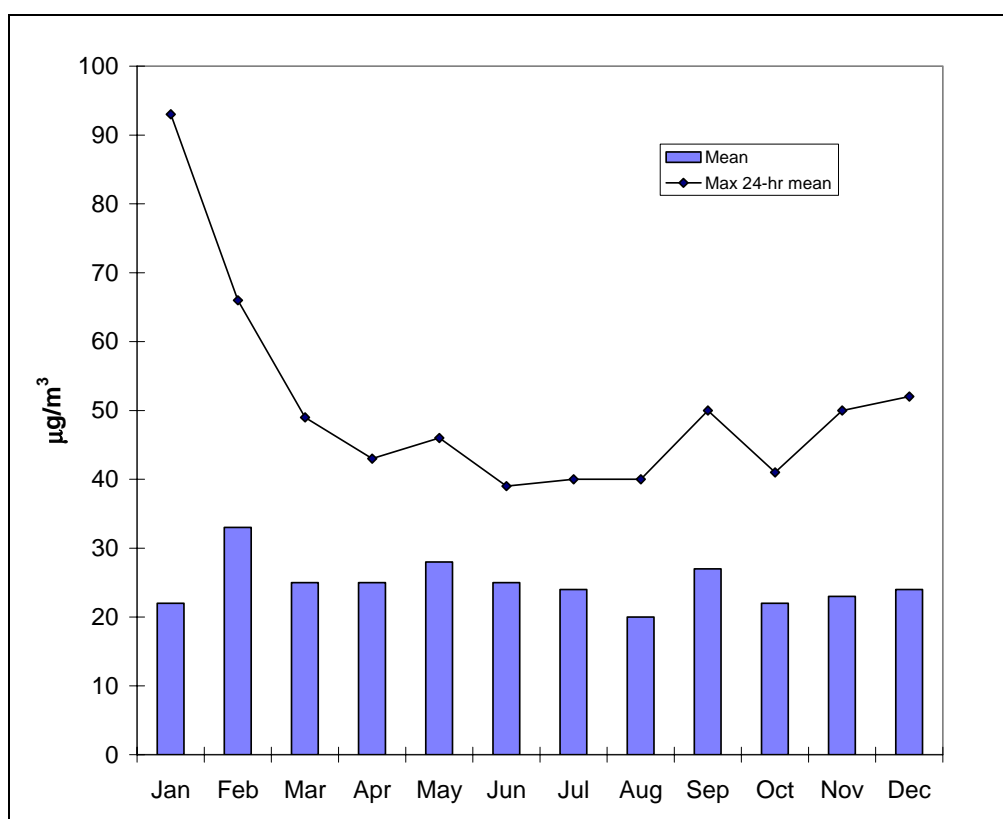


Figure 8: Oxford High St PM10 concentrations

Appendix 2 (continued)

Table 10: PM₁₀ St Ebbe's

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean $\mu\text{g}/\text{m}^3$	31	23	24	26	16	15	12	11	14	17	14	17
Max hour $\mu\text{g}/\text{m}^3$	60	70	95	105	63	49	53	25	61	44	79	53
Max 24hr mean $\mu\text{g}/\text{m}^3$	51	47	63	68	49	30	35	18	37	30	40	45
% Data Capture	11.7	94.3	99.7	99.7	99.9	99.9	99.7	99.9	100	91.7	91.3	81
DETR Band (hours)												
Low	66	623	744	709	744	720	744	744	720	688	641	593
Moderate	0	0	0	11	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0
Very High	0	0	0	0	0	0	0	0	0	0	0	0
Air Quality Regs												
Number 24 hr means $>50\mu\text{g}/\text{m}^3$	0	0	3	2	0	0	0	0	0	0	0	0

For particles (PM₁₀) compliance with the objective level requires the use of gravimetric equivalent data (TEOM x 1.3). The 24-hour (daily) mean air quality objective level for PM₁₀ is $50\mu\text{g}/\text{m}^3$ (gravimetric) not to be exceeded more than 35 times a year. The annual mean air quality objective level for PM₁₀ is $40\mu\text{g}/\text{m}^3$ (gravimetric). Concentrations are reported as TEOM data and exceedences as gravimetric equivalent data.

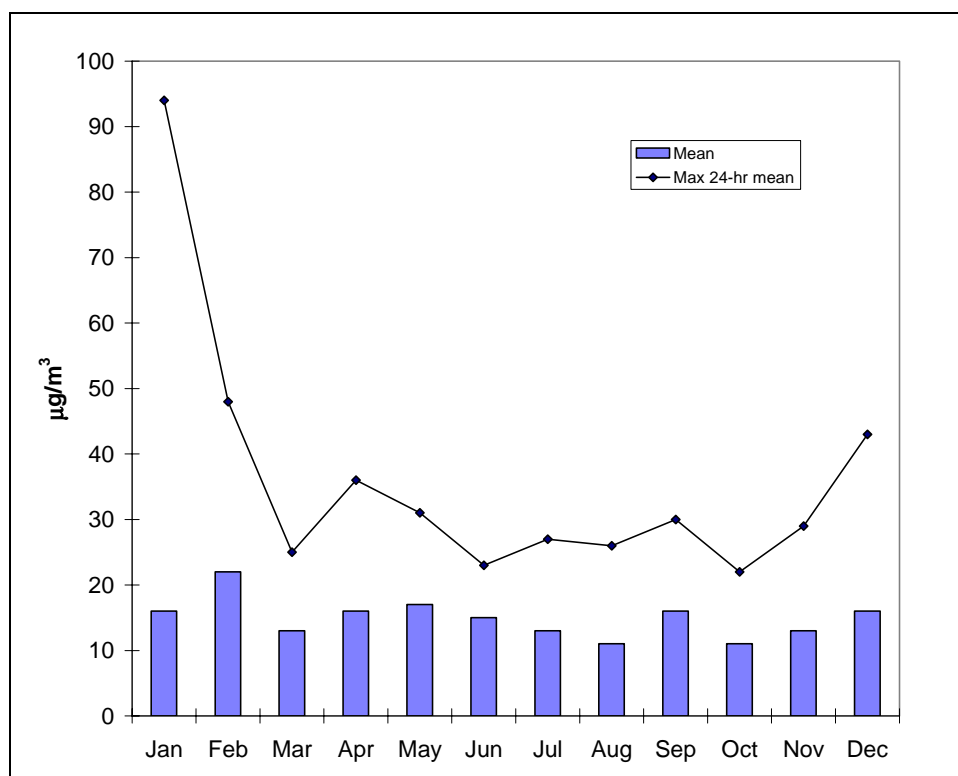


Figure 9: St Ebbe's PM10 concentrations

Appendix 2 (continued)

Table 11: Nitrogen Dioxide Diffusion Tube Data

For ease of comparison to national data, the results have been classified in terms of site type.

Category Kerbside 1-5 metres from a major road, Intermediate 20-30 metres from a major road, urban Background in residential area greater than 50 metres from a major road.

Location	Cat*	2009** Ann mean ug/m ³	Location	Cat*	2009** Ann mean ug/m ³
Abingdon Rd / Weirs Lane	K	40	Iffley Rd/ Boundary Brook Rd	K	38
Beaumont Street	K	44	Keble Road	K	36
Beckett Street	K	32	Lenthall Road	B	15
Between Towns Rd	K	43	London Road / Holyoake Rd	K	39
Bonn Square	K	67	Longwall Street	K	58
Botley Road	K	35	Lydia Close/Bayswater Road	I	38
Botley Road (N)	K	31	Lydia Close / A40	I	36
Botley Road (Abbey Road)	K	31	New Road	K	52
Butterwyke Place	I	35	Norfolk Street	K	28
Cornmarket Street	I	38	Oxpens Road	K	33
Cowley Shopping Precinct	K	31	Oxford Rd, Cowley (L/P 13)	K	38
Floyd's Row	K	46	Park End Street	K	49
Frideswide Square – Path south	K	57	Parks Road (Science Library)	K	39
Frideswide Square (R.Ox.H)	K	45	Pike Terrace	I	37
George Street	K	51	Pusey Street	I	36
George Street / Magdalen Street	K	52	Queen Street	K	63
Green Road (No.29)	I	35	Roundway Precinct	I	35
Green Road (No. 67)	K	39	Speedwell Street	K	42
Headington Precinct	K	34	St Aldate's	K	50
High Street	K	64	St Ebbe's First School	B	20
High Street (Covered Market)	K	43	St Giles	K	45
High Street (No.50)	K	55	Thames Street	K	37
Hollow Way (Bennet Court)	K	30	Trinity Street	I	22
Hollybush Row	K	35	Windmill Rd N (Headington)	K	43
Horsepath Driftway	K	34	Worcester Street	K	51
Hythe Bridge Street	K	43			

** Bias Corrected result

Shaded results are above the 40ug/m³ nitrogen dioxide annual mean objective for 2005



Appendix 2 (continued)

Nitrogen Dioxide Diffusion Tube Charts

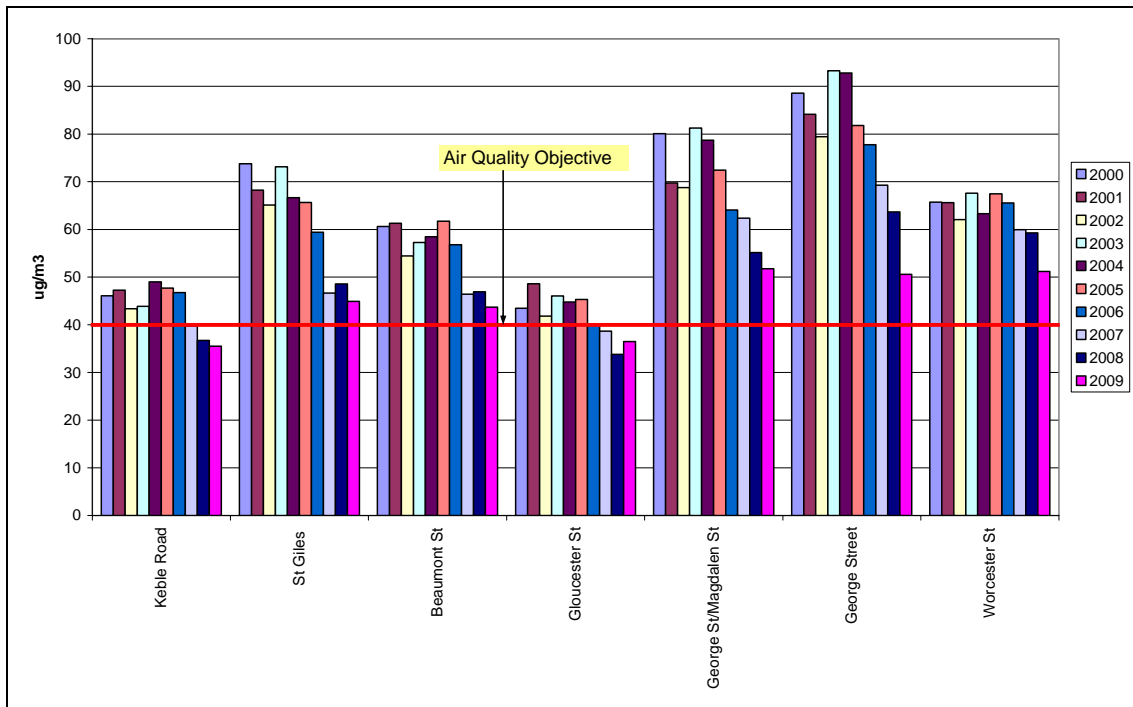


Figure 10: Annual mean nitrogen dioxide 2000-2009

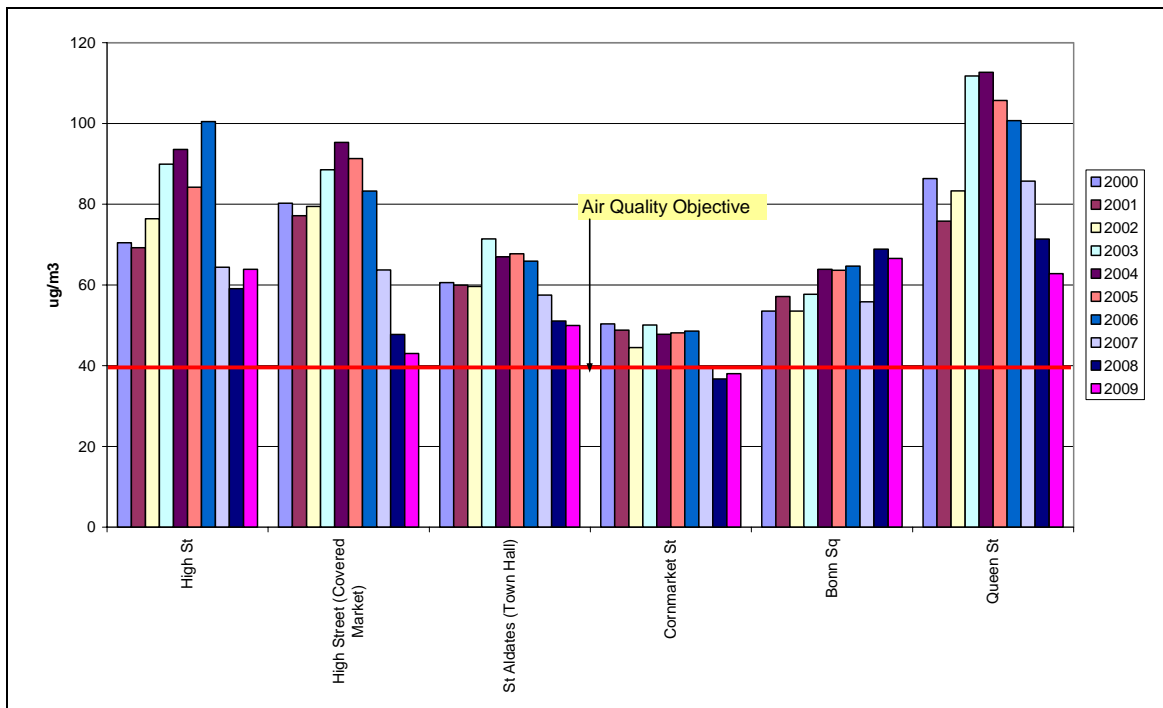


Figure 11: Annual mean nitrogen dioxide 2000-2009

Appendix 2 (continued)

Nitrogen Dioxide Diffusion Tube Charts

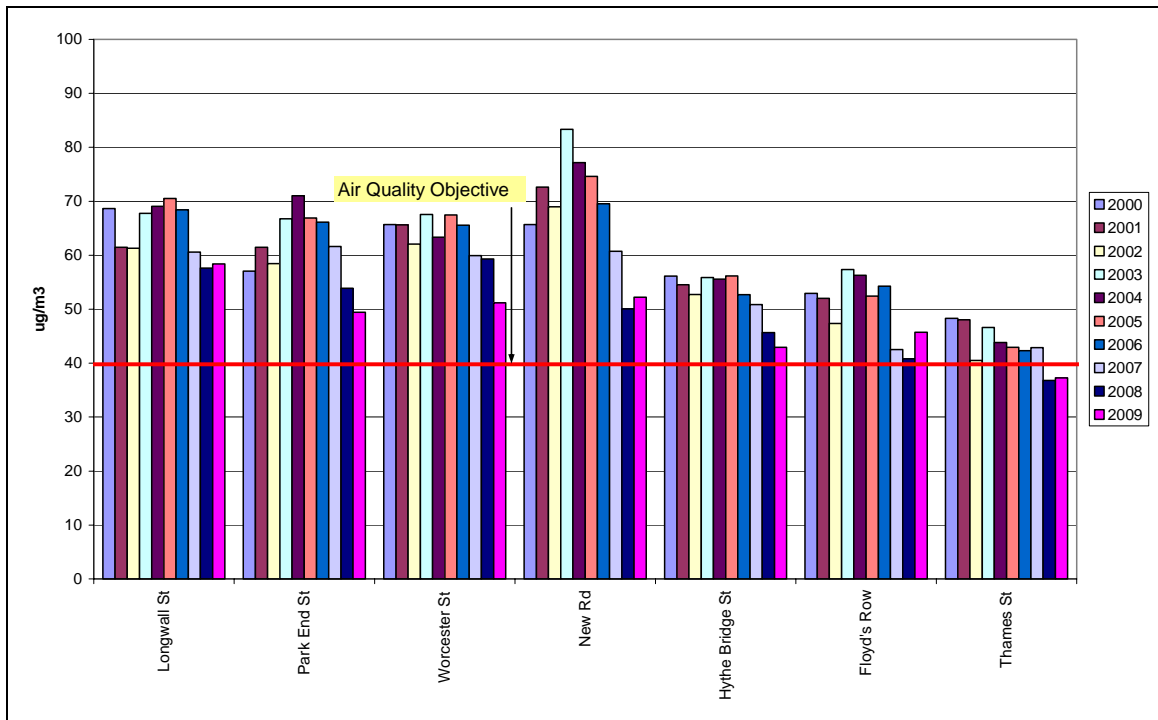


Figure 12: Annual mean nitrogen dioxide 2000-2009

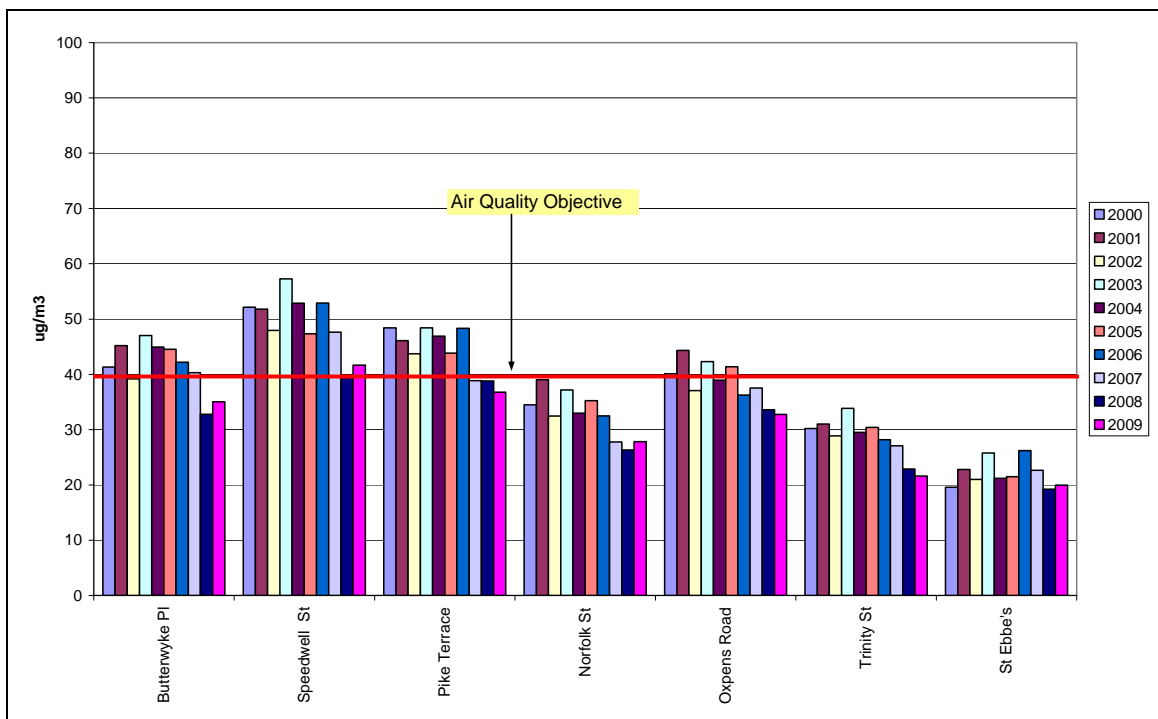


Figure 13: Annual mean nitrogen dioxide 2000-2009

Appendix 2 (continued)

Nitrogen Dioxide Diffusion Tube Charts

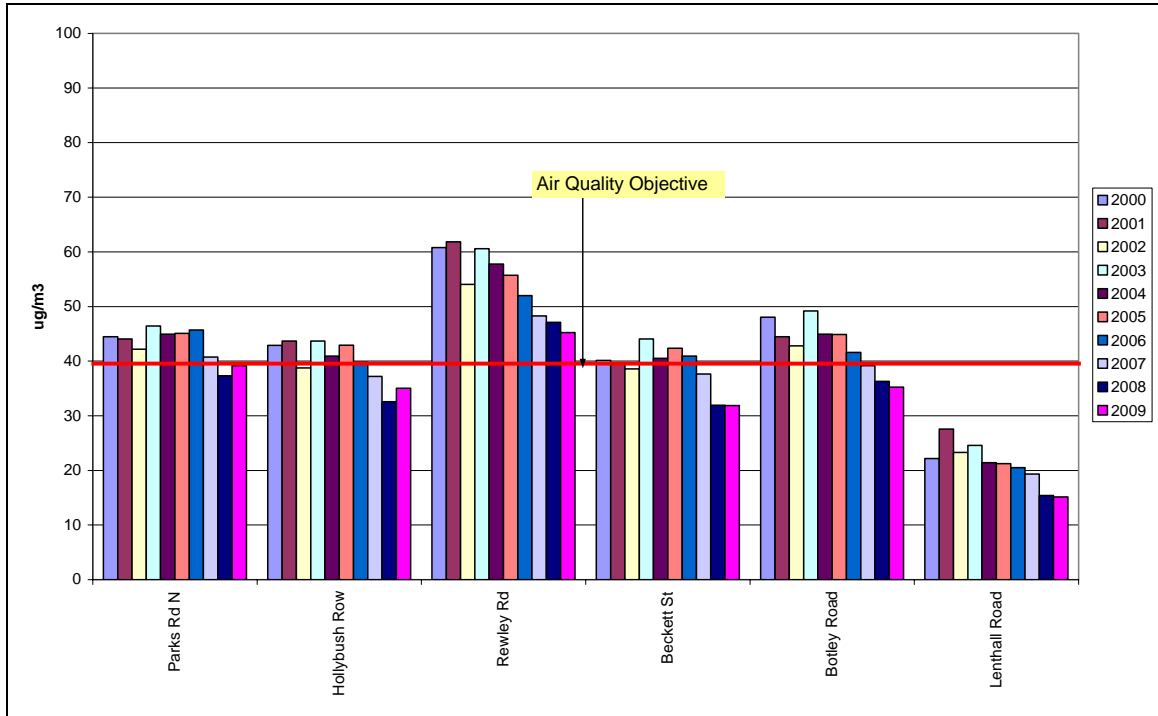


Figure 14: Annual mean nitrogen dioxide 2000-2009

Appendix 3 Maps Showing Monitoring sites

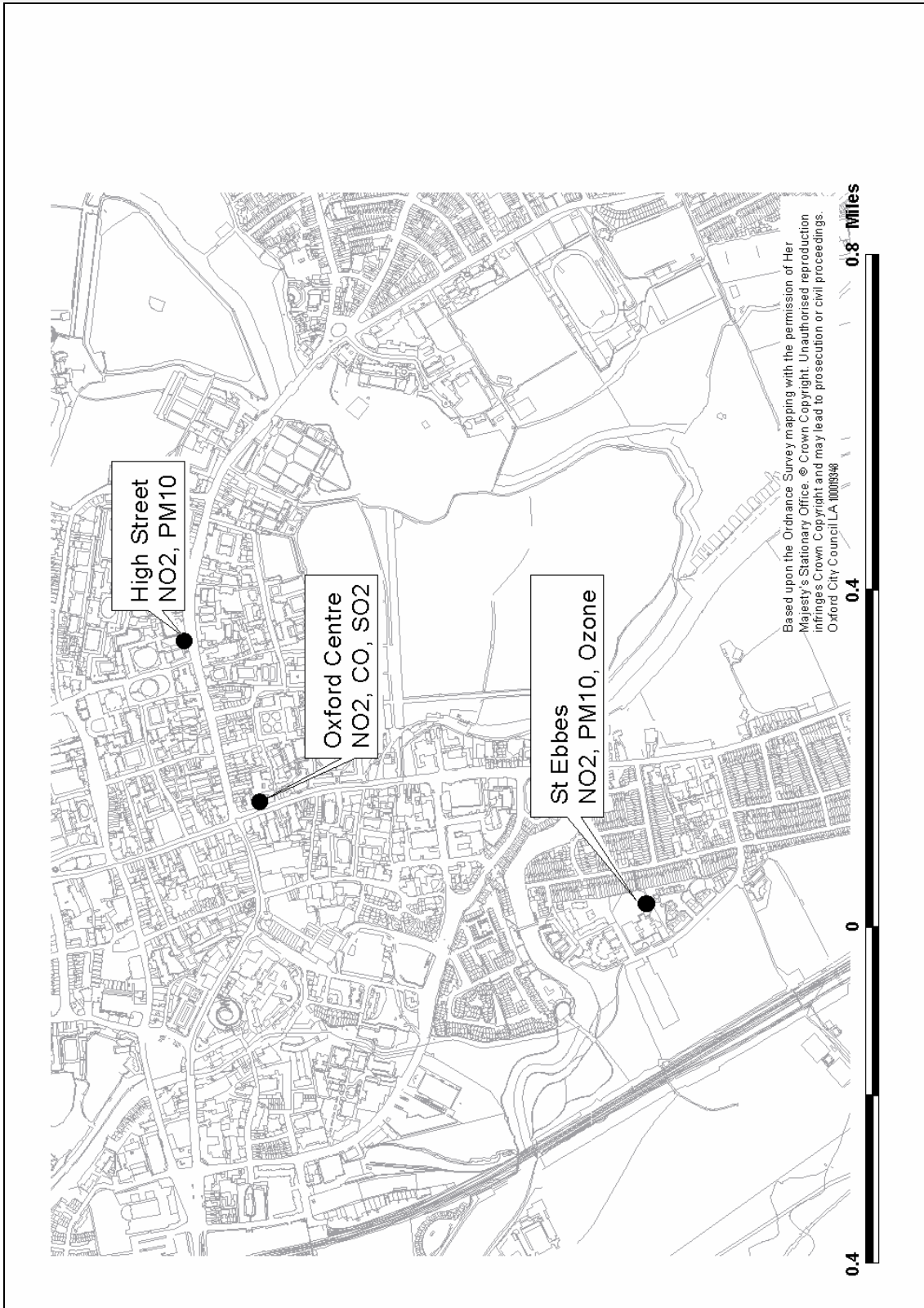


Figure 15 Continuous Monitoring Sites

Appendix 3 (continued)



Figure 16 NO₂ Diffusion Tube Sites

Appendix 4 Data validation

Continuous monitoring sites

1. All routine calibration and maintenance is carried and recorded in accordance with manufacturers' and Automated Urban Monitoring Network site operators' manuals.
2. Instrument drift is routinely checked by: -
 - a daily internal instrument calibration which is carried out automatically using an electronic calibration check,
 - every 2 weeks a manual external instrument calibration is carried out using gas cylinders that can be traced back to reference standards for each pollutant,
 - every 6 months an audit of instrument response is carried out by an external organisation using independent gas calibration standards.
3. The above checks enable data to be examined subsequently for instrument drift, which is expected, or for faulty data which is usually not expected. Instrument drift is routinely adjusted by means of the 2 weekly external gas calibrations. Scaled data is calculated using the gas calibrations for each analyser. Instrument response is also recorded on a chart recorder along with response to calibration gases. These chart records are also used to check the normal response as part of the data validation process.
4. Data from the continuous monitoring sites is collected and independently validated by the National Environmental Technology Centre, AEA Technology Environment.

Diffusion Tube Monitoring

5. Diffusion tubes are supplied and analysed by an accredited laboratory. The laboratory is subject to quality assurance testing as part of their accreditation. This involves an independent comparison to other laboratories. These results of inter-comparisons are available for scrutiny.
6. Diffusion tube monitoring results are based upon single samples that represent a monthly average exposure are not as accurate as continuous monitoring which records data every 15 minutes.
7. A bias correction factor can be applied to diffusion tube results to account for laboratory bias and to correct to continuous monitoring results.

Appendix 5 Glossary

Air quality: usually refers to the concentration in air of one or more pollutants.

Air quality objectives: policy targets of what the Government intends should be achieved in the light of the air quality standards.

Air quality standards: the concentrations of pollutants in the atmosphere, which can broadly be taken to achieve a certain level of environmental quality. Air quality standards are based on the assessment of the effects of each pollutant on health.

Carbon monoxide (CO): a colourless, odourless flammable gas produced by the incomplete combustion of the fuels containing carbon.

Concentration: the amount of substance in a given volume (for gaseous pollutants usually in parts per million or parts per billion)

Dispersion: the way in which pollution spreads from its point of emission and becomes diluted in the atmosphere.

Emission: the process of discharging into the atmosphere.

Episode: an air pollution incident in a given area caused by a combination of circumstances, e.g. meteorological, topographical, accidental escape of pollution from industry.

Exceedence: an air pollution measurement that is above and thus fails to comply with a designated air quality standard or objective.

Monitoring: measuring pollution.

Nitrogen dioxide (NO₂): acid irritant gas.

Ozone (O₃): the reactive molecular form of oxygen, it is very poisonous.

Particulate matter: fine particles found in the air or emissions such as smoke.

PM₁₀: particulate matter less than 10 microns in diameter (10 millionths of a metre).

Parts per billion (ppb) / million (ppm): units of volume of the pollutant for every billion (hundred million) or million units of air. For example, an ozone guideline of 50ppb would recommend a maximum volume of 50 units of ozone for every billion volume units of air.

Running 8-hour mean: a mean which is calculated on an hourly basis, yielding one running 8 hour mean per hour. It is calculated from the hourly mean for that hour and the preceding 7 hours.

Sulphur dioxide (SO₂): colourless, acid irritant gas with a pungent odour.

Microgrammes per cubic metre (µg/m³), a measure of pollutant concentration

Milligrammes per cubic metre (mg/m³), a measure of pollutant concentration
 $1 \text{ mg/m}^3 = 1000 \text{ µg/m}^3$