AIR QUALITY MANAGEMENT

DETAILED ASSESSMENT II

A joint report prepared by Scientific Services (EH)
and Transport Policy (Environmental Studies)

Scientific Services (EH), Millshaw Park Way
Churwell, Leeds LS11 0LS Tel. (0113) 398 4760

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INTRODUCTION AND SUMMARY

Under the provisions of the Environmental Protection Act 1990 and the Air Quality Regulations, local authorities have been required to carry out detailed investigations into air quality within their areas.

The first round of the review and assessment process included four reports (described as Stages 1 to 4) which were published between May 1999 and July 2002. As part of this work, the City Council established that the air quality objectives for 2004/05, in particular relating to nitrogen dioxide and PM_{10} particles, were unlikely to be achieved in some areas of the city. It therefore declared two air quality management orders (AQMOs) in July 2002 and commenced work on an Air Quality Action Plan which, following a period of consultation, was agreed by the City Council in December 2003. This document identified steps to be taken which would address the air quality issues in the areas covered by the AQMOs.

Following completion of the first round of the process, Local Authorities were required to carry out a further review of progress in accordance with guidance published by the Department for Environment, Food and Rural Affairs (DEFRA) [Local Air Quality Management Technical Guidance LAQM.TG03]. Initially, this involved two stages; a relatively brief review of the current situation for each of the seven pollutants covered by the guidance and a more detailed assessment for those pollutants where significant changes from the previous round of assessment has occurred.

The City Council published the first part of this second round in November 2003. The Updating and Screening Assessment (USA) followed the detailed guidance, reviewing the situation in relation to carbon monoxide, benzene, 1,3 butadiene, lead, nitrogen dioxide, sulphur dioxide and PM_{10} particles. The conclusions of this work were that there was little likelihood of five of the pollutants failing to achieve the air quality objectives currently in place. The Detailed Assessment (DA) that followed (in November 2004) reviewed the progress made in respect of the remaining two pollutants (nitrogen dioxide and PM_{10} particles) towards achieving the air quality objectives.

The DA found no significant contribution to ground level concentrations of nitrogen dioxide from sources other than road vehicles and that the hourly objective value of 200 $\mu g.m^{-3}$ was unlikely to be exceeded at any location where the objective could be properly applied. In addition, it was concluded that the vast majority of the Leeds conurbation would comply with the annual mean objective for nitrogen dioxide although it was accepted that there was the potential for properties within a narrow band along busy roads to fail the annual mean objective. These were subsequently described as 'Areas of Concern' and were to be subject to further investigation.

In respect of PM_{10} particles, no significant issues were identified although the revocation of the existing Air Quality Management Order affecting the properties at Garden Village, Micklefield was not proposed at the time as officers were aware of an impending review of the air quality objective for this pollutant.

Following completion of this round of assessments, the Council was required to carry out a further review, following the same process of USA and DA. The second USA

(USA II) was published in September 2006 and reached the same conclusions in relation to the seven pollutants as the original assessment.

This is the second DA (DA II) and has continued the process, bringing monitoring results up to date (to the end of 2007) and analysing those results with the benefit of additional modelling work to assess the current and predicted position in relation to the air quality throughout the Leeds area. It is accompanied by a second document, 'Nitrogen Dioxide Maps and Modelling Runs' that contains the graphical representations of the modelling work.

In summary, nitrogen dioxide continues to occur at levels which could breach the air quality objectives in some previously identified locations. As a result of further monitoring, some of the other previously identified Air Quality Management Areas are no longer thought to be at risk of breaching the objective. However, this monitoring has indicated that there are other sites that are now known to exceed that objective and others, following the modelling work, where exceedences may occur.

In the case of PM_{10} particles, the only area of concern, confirmed by the USA, lay with a small community to the east of Leeds and monitoring at this location has subsequently indicated that the air quality objectives are now being achieved. No other locations have been identified where air quality objectives are likely to be breached and as a result of the publication of the new EU directive and revised Air Quality Strategy, no exceedences are anticipated. It is likely that the majority of the Leeds area will comply with the $PM_{2.5}$ directive as currently measured PM_{10} concentrations are close to the directive value.

Issues surrounding complaints from members of the public in relation to dust from a quarry have been resolved by redesigning the access to the site and although it was proposed to monitor PM_{10} concentrations at and in the vicinity of the complainants properties, such has been the improvement that they no longer see the need for this work to be undertaken.

Future work will include a recommendation to adopt the necessary changes to the Council's Air Quality Management Orders and a review of the Council's Air Quality Action Plan, both to address the specific issues identified and to bring about a general reduction in pollutant levels to the benefit of all the people of Leeds.

In view of the recent publication of a consultation draft of a revised Technical Guidance document, further detailed work is likely to be associated with this when formally published.

NITROGEN DIOXIDE

1.0 INTRODUCTION

There were two specific objectives to be achieved by the end of 2005 for nitrogen dioxide; an annual mean of 40 µg.m^{-3} and that the hourly mean should not exceed 200 µg.m^{-3} more than 18 times a year. In practice, many local authorities found that they were unable to achieve this deadline for the annual average objective and although the UK has retained the objective, the EU directive requires this standard to be achieved by 2010.

Nitrogen dioxide was considered within the Leeds City Council Stage 3 Review published in December 2000. That review concluded that the annual mean specific objective (for 2005) was at risk of being breached at a number of locations along the inner ring road corridor and at the northern end of the M621. Seven discrete air quality management areas (AQMAs) were declared in these areas where there were residential receptors and an Air Quality Action Plan was published indicating how we intended to address the anticipated exceedences.

Two Updating and Screening Assessments (USAs) and an earlier Detailed Assessment (DA) have been carried out. The most recent of these was USA II, that prepared in September 2006 and reported the following conclusions:

> *‘No significant contribution to ground level concentrations of nitrogen dioxide from sources other than road vehicles has been found.*
>
> *‘Monitoring of hourly mean values of nitrogen dioxide at kerbside sites indicates that the hourly objective value of 200 µg.m^{-3} is very unlikely to be exceeded at any location where the objective may properly be applied.*
>
> *‘Monitoring at suburban background and urban centre locations give predicted annual mean nitrogen dioxide concentrations for 2005 well below 40 µg.m^{-3}. This indicates that the vast majority of the Leeds conurbation will comply with the annual mean objective for nitrogen dioxide. However at kerbside (and at one roadside/urban centre location) annual means greater than 40 µg.m^{-3} are still being measured. There is therefore still the potential for properties within a narrow band along busy roads to fail the annual mean objective.*
>
> *‘Previous reviews identified seven locations at risk of exceeding the annual mean value and AQMAs were declared. Monitoring within these AQMAs has indicated that all but two of these AQMAs are now likely to have passed the 2005 annual mean nitrogen dioxide standard. A detailed assessment of the existing AQMAs will therefore be needed to determine whether some should be revoked or reduced in size.*
>
> *‘Busy roads and junctions were reconsidered in this USA in the light of the revised national background nitrogen dioxide concentrations. ‘No*

roads or junctions outside the inner ring road with appropriate receptors were found by the DMRB screening tool to exceed the nitrogen dioxide standard. There has been an increase in the published background for the some of the city centre, which is contrary to the monitoring data. Whether or not the DMRB screening tool identifies failing receptors within the city centre is largely dependent on the background used. Given that a number of sensitive receptors may have been introduced into the city centre due to recent development, it would be prudent to undertake a detailed assessment of the city centre.

'A detailed assessment will be required for a residential property close to a bus stopping area, where monitoring indicates that the annual mean nitrogen dioxide standard is likely to be exceeded.

'Modelling has indicated that some residential property close to the M62/M1 interchange may be more likely to exceed the standard than previously thought. Monitoring is currently being undertaken and will be reported in the detailed assessment.'

The presentation of this DA follows that of the USA II, updating the monitoring data where available and incorporating additional analysis, results of modelling work etc. to support the conclusions reached.

To assist the modelling work associated with the DA, the previously identified shortcomings in the traffic flow database were addressed with a further substantial review and recalibration to reflect the recent past (for model verification purposes) and to predict traffic flows on the developing highway network for modelling runs of future scenarios.

2.0 THE DETAILED ASSESSMENT

The guidance provided in the form of a checklist to aid the earlier Updating and Screening Assessment required the local authority to consider the available monitoring data, busy roads and junctions, roads with a high percentage of HGVs, bus stations, industrial and other sources. The structure of that checklist offers an appropriate methodology to apply to the DA and was adopted for the previous report and is again being used in this. Additional monitoring has been carried out to assist in the assessment of public exposure in specific areas that have been identified and as tool to assist in the calibration and validation of the latest Airviro model runs used to identify potential areas of the city where the air quality objectives might not be achieved.

3.0 MONITORING RESULTS

In previous reports, results have been separated into groups representing monitoring within AQMAs and outside AQMAs. In this report, the results have been merged as monitoring has been undertaken to clarify the conditions that exist within AQMAs and (with the exception of ongoing long term monitoring sites at which trend information is being collected) to identify the situation in 'Areas of Concern' and other busy junctions at which officers thought worthy of investigation.

Although more reliable data is available from the chemiluminescent analysers used to monitor nitrogen dioxide (and these are updated in the tables below and form the majority of the reported results), results collected from diffusion tubes to supplement the data provided in the USA, together with the information on bias correction from co-location tests are reported separately below to assist the analysis.

3.1 CHEMILUMINESCENT MONITORING

There are five 'permanent' chemiluminescent nitrogen dioxide monitoring sites within Leeds that are not in AQMAs. The Leeds Centre AURN urban centre monitoring station has been operated on behalf of DEFRA by the city council since 1993. Monitoring at a suburban background site (Potternewton) was commenced in 1998 but was moved to a new location (Millshaw where it is co-located with the high-volume PAH sampler that is part of the national network) at the end of 2004.

In addition, there are two kerbside monitoring stations that have provided data since 1999. One of these, located on the A660 at Otley Road, Headingley was affiliated into the national network during 2007. The other, described as the 'Corn Exchange' site is located at the Vicar Lane/New Market Street junction in the centre of the city alongside the public transport box (and bus stops).

Finally, the fifth site at the West Street Car Park is described as Urban Centre and has been operating since 2002. Unfortunately due to equipment malfunctions, reliable data collection at this site has been intermittent.

Summaries of the results are shown in Tables 1 to 3 and in Figures 1 to 3.

Following investigations associated with the previous Review and Assessment and Detailed Assessment reports, an Air Quality Management Order was made, identifying seven discrete locations at which is was believed that exceedence of the annual average air quality objective for nitrogen dioxide was likely. In addition, a number of other locations were subsequently identified and described as 'Areas of Concern'. The permanent monitoring locations and 'areas of concern' are shown in Map1 (see 'Nitrogen Dioxide Maps and Modelling Runs' document that accompanies this DA).

Table 1. Monitored background data for nitrogen dioxide at Leeds Centre, Potternewton and Millshaw sites

Year	Leeds Centre AURN site (Queen Square Court)		Potternewton site (Suburban background)		Millshaw site (Suburban background)	
	Annual mean ($\mu g.m^{-3}$)	Number of hours >200 $\mu g.m^{-3}$	Annual mean ($\mu g.m^{-3}$)	Number of hours >200 $\mu g.m^{-3}$	Annual mean ($\mu g.m^{-3}$)	Number of hours >200 $\mu g.m^{-3}$
1993	50	0				
1994	53	7				
1995	50	1				
1996	52	1				
1997	52	2				
1998	46	0	31	0		
1999	44	0	30	0		
2000	37	0	27	0		
2001	36	0	32	0		
2002	39	0	30	0		
2003	40	0	36	0		
2004	31	0	26	0		
2005	31	0			29	0
2006	39	0			30	2
2007	37	0			27	0
2010	33 predicted from 2007				24 predicted from 2007	

Table 2. Monitored data for nitrogen dioxide at the Headingley and Corn Exchange kerbside sites

Year	Headingley kerbside site			Corn Exchange kerbside site		
	Annual mean ($\mu g.m^{-3}$)	Data capture %	Number of hours >200 $\mu g.m^{-3}$	Annual mean ($\mu g.m^{-3}$)	Data capture %	Number of hours >200 $\mu g.m^{-3}$
1999	60	93	1			
2000	54	48	0	70	93	5
2001	51	83	0	70	80	0
2002	49	99	2	70	98	1
2003	52	91	1	75	94	2
2004	49	92	1	67	96	0
2005	44	97	0	68	78	5
2006	51	64	0	72	96	6
2007	47	93	0	71	91	4

Table 3. Monitored data for nitrogen dioxide at the West Street Urban Centre site

Year	Annual mean ($\mu g.m^{-3}$)	Number of hours >200 $\mu g.m^{-3}$
2002	43[1]	0
2003	49	0
2004	---	
2005	41[1]	0
2006	45[1]	0
2007	43	0
2010	39 predicted from 2007	

Note:
[1] This is a projected value calculated from an incomplete year's data

Figure 1 - Leeds Centre AURN nitrogen dioxide results

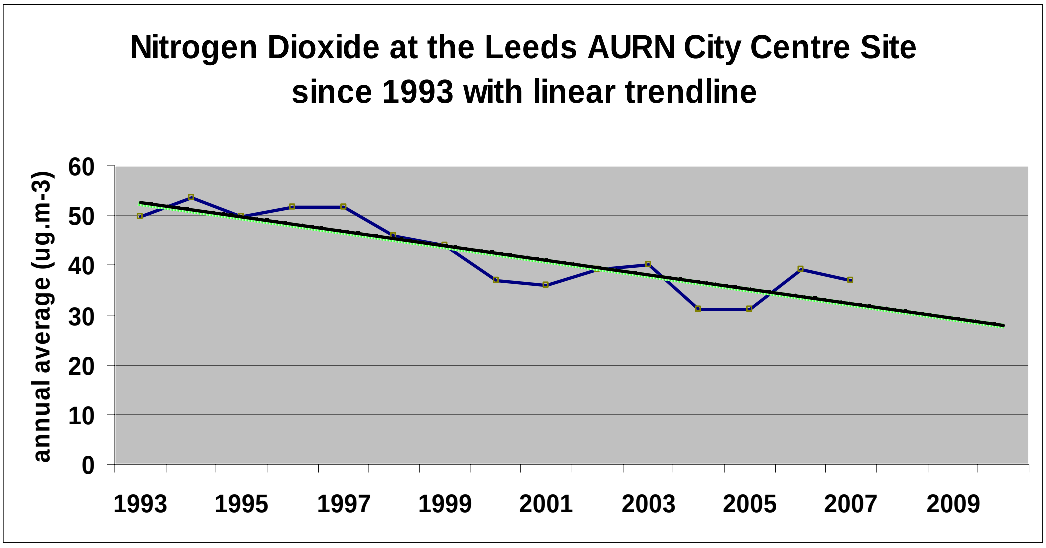


Figure 2 – Suburban background nitrogen dioxide results

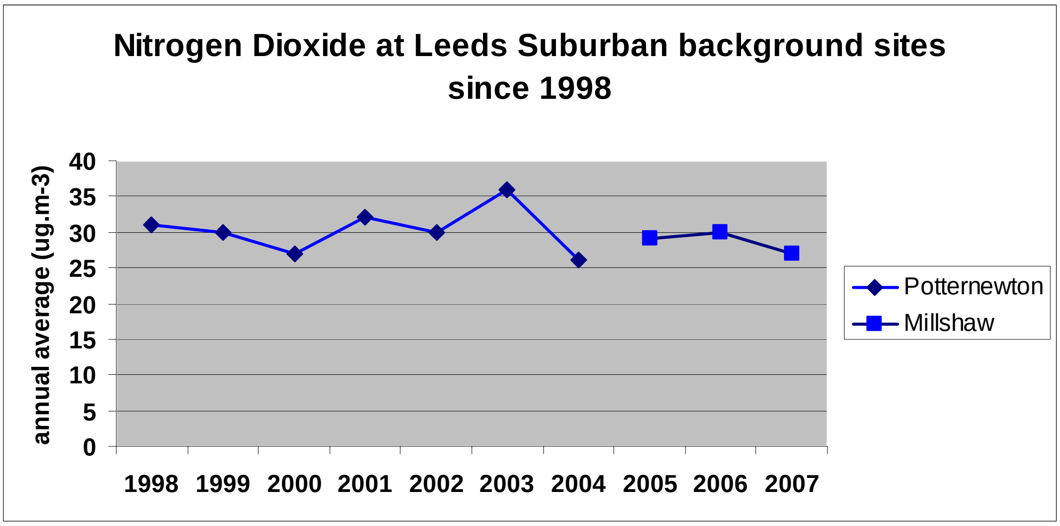
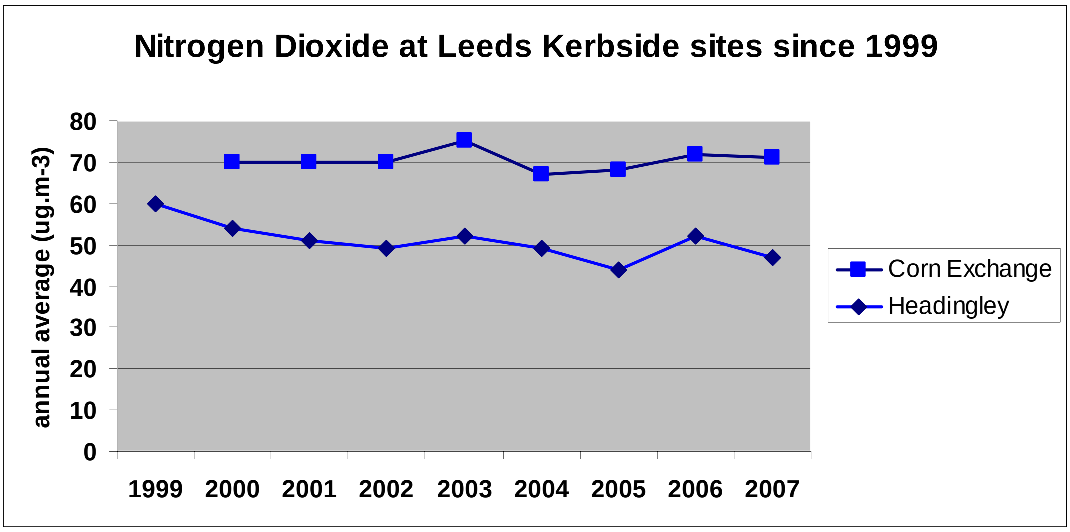


Figure 3 – Kerbside nitrogen dioxide results



Chemiluminescent monitoring has also been undertaken within three of the AQMAs declared for nitrogen dioxide. Where the historical results represented data for less than a full year, the annual means were calculated using the ratios between the monitoring period and the annual mean at 3 nearby monitoring stations: 2 DEFRA sites Leeds Centre and Bradford Centre and the Leeds' monitoring station at Potternewton (as per box 6.5 in the technical guidance) and predicted values for 2005 obtained based on these results (see Table 4 below).

The short-term monitoring that had been carried out at the Haslewood Close site during 2001/2002 was replaced with a permanent station in 2003.

Table 4. Monitored data for nitrogen dioxide at sites within AQMAs

Site	Monitoring Period	Corrected annual mean (µg.m^{-3})	Predicted 2005 mean (µg.m^{-3})
Haslewood Close[1]	Nov 01 – Sep 02	42 (2002)	39
Haslewood Close[2]	2003	51	49
	2004	45	44
	2005	41	41
	2006	41	36 (2010)
	2007	43	39 (2010)
North Street	May 02 – Oct 02	43 (2002)	40
Carlton Gate	May 01 – Sep 01	43 (2001)	38

Note:

[1] Short term monitoring
[2] Results from permanent monitoring station

No hourly values above 200 µg.m^{-3} have been recorded at any of the three sites.

Further short-term chemiluminescent monitoring has been undertaken at a number of other sites where practicable and diffusion tubes (see below) deployed at others. The monitoring has generally been carried out over periods of less than one year in locations where concerns for air quality have been raised or where officers have considered the locations to represent 'areas of concern'.

A summary of these results is detailed below:

Table 5. Monitored data for nitrogen dioxide at other sites of interest

Site	Monitoring Period	Corrected annual mean ($\mu g.m^{-3}$)	Predicted 2005 (2010 where indicated) mean ($\mu g.m^{-3}$)
Otley Roadside	Feb 01 – May 01	40 (2001)	35
Otley Roadside	Feb 03 – Jun 03	38 (2003)	36
Wetherby	Oct 01 – Apr 02	27 (2002)	25
Kippax	Jan 01 – May 01	31 (2001)	28
Holbeck Moor	Jun 01 – Oct 01	39 (2001)	35
Garden Village, Micklefield	Oct 02 – Jun 03	38 (2003)	36
Ninelands Lane, Garforth	Jun 04 – Jul 05	24 (2005)	24
Kennet Lane, Garforth	Jul 05 – Nov 05	24 (2005)	24
Morley Library	Sep 03 – Dec03	37 (2003)	35
Morley Library	Jan 04 – Dec 04	32 (2004)	31
Morley Library	Jan 05 – Sep 05	29 (2005)	29
Queen Street, Morley	Jun 04 – Dec 04	50 (2004)	41 (2010)
Queen Street, Morley	Feb 06 – Dec 06	49 (2006)	42 (2010)
Queen Street, Morley	Jan 07 – Dec 07	46 (2007)	41 (2010)
Rodillian School, (adj M62)	Sep 05 – Dec 05	39 (2005)	39
Rodillian School, (adj M62)	Jan 06 – Dec 06	42 (2006)	36 (2010)
Castle Head Close, Lofthouse	Jul 06 – Dec 06	43 (2006)	37 (2010)
Jack Lane, Hunslet	Jan 06 – Dec 06	42 (2006)	36 (2010)
Compton Road, Harehills	Mar 07 – Dec 07	44 (2007)	39 (2010)
Copperfield Coll., Cross Green	Aug 07 – Dec 07	32 (2007)	29 (2010)

3.2 DIFFUSION TUBE MONITORING

In addition to the 'real-time' monitoring carried out, a number of locations have been assessed using diffusion tubes. The tubes (produced using a 50% acetone solution to apply the activated component to the diffusion grid) were supplied by AEA Technology and analysed by West Yorkshire Analytical Services. Results from analyses of 'control' tubes co-located with the real-time analysers were supplied to DEFRA and annual correction factors published by DEFRA have been used to adjust the data reported below.

Monitoring has been carried out along major arterial routes leading into/out of the city centre, in the vicinity of properties falling within the city's Air Quality Management Areas and at the 'Areas of Concern' as described above. At least 10 monthly results have been used to obtain the data reported for each site in Table 6 below.

Table 6. Corrected nitrogen dioxide results for 2002 to 2007 obtained from diffusion tubes ($\mu g.m^{-3}$)

Site	2002	2003	2004	2005	2006	2007	Predicted 2010 from 2007	Co-ordinates	Description	AQMA
National Survey										
Whitfield Avenue, LS10 2QE	31	41	33	29	30	30	27	431150 431633	Urban background location reported to National diffusion tube survey	No
Arterial roads										
488 Harrogate Road, LS17 6DL **(A61)**	30	38	28	23	36	31	28	430732 439107	Residential façade next to A61	No
42 Otley Road, LS6 2AL **(A660)**	35	40	28	33	40	36	32	427799 436391	Building façade next to A660 representative of nearby residential property.	No
West Street car park, LS1 4PB				43	50	43	39	429010 433617	City Centre background/roadside. Although no closer than 20m from nearest road, the open site is entirely surrounded by the A64/A58(M) and A65	No
AQMA - Location 1 and adjacent arterial road (A64)										
47-57 Haslewood Close, LS9 7PU (south facing)				41	47	46	41	431262 433703	Closest residential façade to A64/A58M,	Yes
47-57 Haslewood Close, LS9 7PU (west facing)				39	43	42	38	431263 433712	Residential façade further back from A64 but closer to Burmantofts Street.	Yes
47-57 Haslewood Close, LS9 7PU (east facing)				34	40	39	35	431284 433711	Post mounted tube same distance from road (A64) as main residential façade line	Yes

Site	2002	2003	2004	2005	2006	2007	Predicted 2010 from 2007	Co-ordinates	Description	AQMA
York Road Library, LS9 9LN	44	56	45	42	45	46	41	431367 433631	Kerbside of major arterial road (A64/58M), >20m to residential property	No
165 York Rd, LS9 7RD	34	43	33	29	34	36	32	431998 433605	Residential façade next to A64	No
567 York Rd, LS9 6NH	30	39	32	24	31	30	27	433280 434063	Residential façade next to A64	No
AQMA - Location 2										
25 Ladybeck Close LS2 7QX				34	40	41	37	430723 435831	Residential façade close to A58(M) and Eastgate,	Yes
6 Ladybeck Close LS2 7QX				34	42	40	36	430711 433775	Residential façade close to Eastgate and A58(M),	Yes
Reception Building, Ladybeck Close, LS2 7QX				42	47	42	38	430695 433836	Building façade close to A58(M)	Yes
18 Ladybeck Close LS2 7QX				37	45	45	40	430743 433811	Residential façade close to A58(M) and Eastgate,	Yes
AQMA - Location 4										
Caspar Apartments, adj. North Street, LS2 8JS			47	39	44	48	43	430484 434035	Kerbside - nearest residence was at 10m	Yes
Caspar Apartments, adj. Ring Road, LS2 8JS			39	33	35	38	34	430431 434083	Façade (previously residential), close to A64/A58M ring road.	Yes
AQMA - Location 5										
Oatland Heights, LS7 1SG				31	42	39	35	430554 434553	Roadside – 20m to nearest property	Yes
AQMA - Location 6										
12 Marlborough Grange, LS1 4PF			31	25				429283 433746	Roadside – 20m to nearest property	Yes
AQMA - Location 7 and arterial road (A653)										
101 Dewsbury Rd, LS11 5UT				28	36	35	31	430204 431920	Residential façade close to M621 and A653	Yes

Site	2002	2003	2004	2005	2006	2007	Predicted 2010 from 2007	Co-ordinates	Description	AQMA
125 Dewsbury Rd, LS11 5UT	37	46	36	28	36	36	32	430183 431890	Residential façade next to A653.	No
187 Dewsbury Rd, LS11 5EG	38	47	38	37	35	39	35	430107 431396	Residential façade next to A653	No
'Areas of Concern'										
18 Aspen Court, Tingley, WF3 1HH				33	40			427259 426263	Residental close to and north of M62	No
6 Aspen Court, Tingley, WF3 1HH				30	33			427230 426233	Residental close to M62	No
48 Railway Terrace, East Ardsley, WF3 2DY				37	43	42	38	430150 426391	Residental close to and south of M62	No
Haverthwaites Drive, Aberford, LS25 3AT				29	32			443450 438300	Residential close to A1(M) north of M1 junction	No
43 Grange Close, Hunslet, LS10 1SU				34	31	31	28	430878 431930	Residential close to A61	No
110 Jack Lane, Hunslet, LS10 1BW					36	37	33	430716 431897	Residential close to A61	No
7 Blakeney Grove, Hunslet, LS10 3BA					I/D	34	30	430775 430508	Residential close to M621	No
21 Blakeney Grove, Hunslet, LS10 3BA					32	38	34	430821 430508	Residential close to M621	No
45 Blakeney Grove, Hunslet, LS10 3BA					I/D	37	33	430911 430504	Residential close to M621	No
39 Westgate Close, Lofthouse, WF3 3NW					I/D	43	39	433246 425938	Residential close to M62	No
9 Westgate Close, Lofthouse, WF3 3NW					I/D	40	36	433204 425975	Residential close to M62	No
14 Broadland Way, Lofthouse, WF3 3NY					I/D	37	33	433271 425808	Residential close to M62	No

Site	2002	2003	2004	2005	2006	2007	Predicted 2010 from 2007	Co-ordinates	Description	AQMA
33 Broadland Way, Lofthouse, WF3 3NY					I/D	39	35	433197 425846	Residential close to M62	No
Kirkstall Primary School, LS4 2QZ						42	38	427269 434714	Close to A65 and representative of nearby domestic properties	No
2 Norman Row, Kirkstall, LS5 3JL						50	45	426275 435821	Residential façade very close to A65	No
2 Bk Norman Mount, Kirkstall, LS5 3JQ						70		426214 435945	Residential façade very close to A65	No
4 De Lacey Mount, Kirkstall, LS5 3JF						36	32	426213 435956	Residential façade very close to A65	No
2 Haddon Place, Kirkstall, LS4 2JU						40	36	427439 434622	Residential façade very close to A65	No
82 Featherbank Lane (adj. New Road Side), Horsforth, LS18 4NW						50	45	423924 437335	Residential façade very close to A65	No
Company Travel, 253 New Road Side, Horsforth, LS18 4DR						48	43	423267 437505	Façade close to A65	No

Notes: I/D – insufficient data

3.3 PREDICTED ANNUAL MEAN CONCENTRATIONS

In previous reports, the predicted concentrations for 2005 were obtained from the measured data to indicate whether air quality was likely to comply with the 2005 national objectives and on the basis of the results obtained, to determine if further consideration was necessary. This is no longer appropriate.

Advice was sought of the LAQM Review and Assessment helpdesk who made the recommendation that measurements made from 2006 onwards should be compared with the 2005 objectives and that this should provide the basis for decisions on the future course of action.

The 2005 objectives have not been withdrawn although that date has passed. The EU directive on which the 2005 objective was based, requires the 40 $\mu g.m^{-3}$ standard to be achieved in 2010. As an indication, based on the monitored 2007 results, the predicted concentrations for 2010 have been calculated using the existing year-on-year emission factors.

3.4 INTERPRETATION OF MONITORING DATA

3.4.1 The hourly objective for nitrogen dioxide

The 200 $\mu g.m^{-3}$ hourly nitrogen dioxide objective value is being complied with at all monitoring locations, both background and kerbside. The two kerbside locations represent two different "worst case" environments; the first, a congested high street and the second, a heavily trafficked junction on the public transport box in the city centre busy with buses stopping to pick up passengers.

Constructive comments made in relation to the Progress Report submitted in 2007, pointed to the work of Laxen and Marner (*Analysis of the Relationship Between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites, Laxen & Marner, 2003).* Their study concluded that it would be appropriate to base the decision of a likely exceedence of the 1-hour nitrogen dioxide objective on an exceedence of 60 $\mu g.m^{-3}$ as an annual mean.

This guidance has been considered, particularly in relation to the chemiluminescent monitoring carried out at the Corn Exchange site (see Table 2 above). In the last six years (from 2002 to 2007), the annual averages at the site have ranged between 67 and 75 $\mu g.m^{-3}$ with data collection efficiencies in excess of 90% in all but one year of those years (2005) and a maximum number of six hourly exceedences in any single year since monitoring began.

Although the study on which the guidance was formulated analysed the results from a number of different sites, given the level of detailed monitoring carried out at the Corn Exchange site it is thought unlikely that this site would breach the hourly objective of 18 exceedences under any foreseeable circumstances.

Given the exceptional nature of hourly values in excess of 200 $\mu g.m^{-3}$, it is considered unlikely that any environment appropriate for assessment against this hourly objective value will exceed the standard within Leeds. However, a chemiluminescent monitor has now been installed close to the only other location at which a measurement in excess of 60 $\mu g.m^{-3}$ has been recorded – a kerbside diffusion tube located at the gable end of a dwelling immediately adjacent to the A65 at Kirkstall.

3.4.2 The annual average objective for nitrogen dioxide

The annual mean objective of 40 $\mu g.m^{-3}$ is a challenging target to achieve. Suburban background levels are of the order of 30 $\mu g.m^{-3}$ with urban centre (Leeds AURN) site returning concentrations in the high thirties following two years of lower levels (when the measured annual average was 31 $\mu g.m^{-3}$ in both 2004 and 2005).

These results indicate no widespread problem and support the findings of the analysis of the previous review process which indicated that exceedences of the annual mean objective were unlikely further than 10m from the kerb of single carriageway roads or 5m from dual carriageway roads outside major conurbations. (It should be noted that Leeds is not defined as a major conurbation, having a population of less than two million residents).

However, more recently additional monitoring has been carried out at locations where major road redevelopment schemes are taking place, at some of the busier road junctions and at locations that through local knowledge were identified as 'Areas of Concern'.

Monitoring carried out by a combination of chemiluminescent analysers and passive diffusion tubes have identified some areas where the 2005 objective is not being met and other locations where the annual average is below 40 $\mu g.m^{-3}$. The majority of these monitoring locations occur where there is 'relevant exposure' of members of the public.

Although extrapolation of the monitored results using previously published correction factors suggest that some of the exceedences will not continue into 2010, advice from the Review and Assessment helpdesk is that this should be ignored when deciding what action should be taken. The principal reason for this stance is that the 2005 objective has not been revoked and there is an expectation that those objectives will continue to be achieved (and using the Air Quality Action Plan proposals, that steps will be taken to achieve early compliance).

It should also be noted that the EU directive places the obligation for compliance with the conditions in 2010 on central, not local government.

Kerbside concentrations have consistently remained in excess of 40 $\mu g.m^{-3}$ although there have been some decreases since monitoring first began. While the highest concentrations were measured at the Corn Exchange site and are believed to be due to the influence of buses that stop immediately adjacent to this monitoring station, the results suggest that there is the potential for a narrow corridor along busy roads to exist where appropriate receptors are at risk of exceeding the standard. This has been found to be the case at the gable-end of properties adjacent to the A65 (where a chemiluminescent monitor has been installed to support the ongoing diffusion tube monitoring).

Although not a kerbside site, monitoring has been carried out in close proximity to a bus stop/terminus in Morley where vehicles frequently 'lay-over' while waiting for their appointed departure time to arrive. There is a block of residential flats approximately 5 metres from the kerb. Annual averages in excess of the 2005 objective have been obtained from the chemiluminescent analyser monitoring concentrations at the building façade of these properties.

It is believed that meteorological effects in 2007 had a significant effect on the monitored results as can be seen by comparison with the results of monitoring carried out in 2005. Such widespread increases would not have been expected on the basis of the published year-on-year correction factors although it is accepted that 2005, being an unusually unsettled year, led to lower results than might otherwise have been unexpected.

However, the results have been considered in detail and fall into four main categories:

1. No exceedence identified
2. Busy junction and roads in the immediate vicinity
3. Motorway related exposure
4. Engine idling issues.

On the basis of the results, recommendations will be made to adjust the Air Quality Management Order for nitrogen dioxide. Areas that were previously believed to be at risk of failing to achieve the objective may have their designation revoked. However, a number of monitoring locations have been identified as failing to achieve the 2005 objective (in 2007) and these will be put forward as locations to be declared as AQMAs.

3.5 OTHER INFLUENCING SOURCES

No new industrial sources or any other significant sources (including Leeds Bradford Airport) were identified when undertaking the second USA and it was concluded at that stage that no additional work would be necessary as part of this Detailed Assessment.

4.0 AIR QUALITY MODELLING

The Airviro grid model version 3.12 was used to predict nitrogen dioxide concentrations within the Leeds Metropolitan area. Dispersions were produced for city wide, local junctions and motorway locations.

The first models were run using a 2005 emissions database using traffic data from the Leeds "Simulated Assessment of Traffic on Urban Road Networks" (SATURN) model and 2005 meteorological data from the city council's met. station. The model output was verified using 2005 nitrogen dioxide monitoring data from a combination of chemiluminescent analysers and diffusion tubes.

4.1 GENERAL CONCEPT OF THE TRAFFIC EMISSION DATABASE

The road traffic database used for the dispersion modelling was formed from two separate databases with dispersion simulations completed independently and the results then added together. This was done to allow a better representation of the traffic speeds and profiles within the two databases. The first database represented the West Yorkshire Motorway network and the second database represented the central area of Leeds' road network.

- The motorway database generally includes higher percentages of HGVs in the Roadtype profiles and a higher spread of average speeds. The majority of the Motorway links have been modelled as separate 2 way flows where data allowed, with slip roads also included. The data was almost entirely based on annual traffic count data supplied by the WSP group on behalf of the Department for Transport (DfT).

- The Central Area database has lower average speeds and a lower spread of HGV percentages in the traffic profiles. Where the volume is significant, this database also includes Bus percentages together with a number of Bus only road types to represent dedicated bus lanes with different average speeds to the general traffic flows to reflect bus priority measures. Traffic data was based on the SATURN model using a validated 2005 base model with additional information from Leeds City Council's own traffic counts.

The new version of Airviro allows better definition maps to be used. This has helped ensure that the traffic flow links are more accurately positioned geographically than was previously possible.

Both databases utilise Airviro's capability of using a different speed (or emission factor) for periods of the day when traffic is more congested. Each link has been assigned a "free flow" average speed and a "rush hour" average speed. Speed related emission factors are from the Emission Factor Toolkit (EFT) version 2e, published in February 2003 by Bureau Veritas which, in turn, are based on raw data from the NAEI.

The rush hour speed is generally set to activate when the hourly flow of traffic is predicted to be equal to or greater than 6.5% of the annual average daily total (AADT). However, there are areas where this figure has been set lower or higher, based on local knowledge of highway capacity.

In addition, certain larger junctions have been modelled with traffic leaving or approaching the junction modelled separately. In these cases "queuing speeds" have been used rather than the whole link average speed. Some motorway and ring road entry slip roads have been assigned a much higher average speed than would normally be expected in an attempt to reflect the uphill acceleration required to join the main flow of traffic.

The main Inner Ring Road Tunnel has been modelled by representing each of the separate directional flows as a small area source at the exits of the tunnel, with an emission profile set to represent the variation in the flow of the traffic.

4.1.1 Details of the emission databases

Both traffic models have their traffic apportionment based on general “Light” and “Heavy” vehicle type profiles. The proportion of each vehicle type is allocated to each hour of the day for the particular road type, based on the average of a number of representative 24hr detailed traffic counts. In addition, certain roads have “Buses” modelled separately where the flow is significant or different enough to be able to do so.

In the Motorway traffic model each link is allocated as a motorway link with either 5%, 10%, 15%, 20% or 25% HGV content as appropriate and emission factors based on the EFT V2e “Motorway” settings.

The emission rates for the Central Leeds District traffic model are generally based on the “urban” road type within the EFT V2e and each road link is allocated to one of the following categories:

General Roadtype	Roadtype subset	Vehicle Types	Percentage of Vehicle Types on link
Orbital	Inner	Lights Heavies	6, 5, 4, or 3% HGV
	Urban	Lights Heavies	10, 7½, 5, or 2½ % HGV
Radial	Inner	Lights Heavies	10, 7½, 5, 2½ % HGV
	Urban	Lights Heavies	10, 7½, 5, 2½% HGV
Public Transport Box		Lights Heavies Buses	5% HGV 25% or 50% buses
Residential		Lights Heavies	2% HGV
Bus Lane		Buses	100% buses

A further emission database was built for an outlying area of Leeds close to the M1/M62 intersection where monitoring has indicated a potential problem. This was based on the general Motorway database, but with more detail added to intersection slip roads and local road sources added around the area of concern.

There are few significant point sources of oxides of nitrogen from industrial or commercial premises and in accordance with the technical guidance, these were not included in the emission databases.

4.1.2 Future Year Predictions

Each of the 2005 databases was adjusted to represent expected traffic conditions for 2010/11. This date was a chosen as significant current construction schemes will have been completed by that year.

Motorway data was based on future traffic growth figures from DfT agents, (Faber Maunsell) which attempted to take account of new motorway schemes at Wetherby, Ferrybridge and the new East Leeds Link Junction, all of which have become operational since 2005, or are expected to be in use by 2010.

The Central Leeds model used SATURN modelling to attempt to represent the change in traffic flows as a result of future developments such as road schemes under construction (notably the East Leeds Link and the Inner Ring Road Stage7) and other traffic management/junction improvement schemes.

4.1.3 Areas of potential improvement

It is recognised that there are potential weakness in the traffic emission database. Some of the issues raised below are specific to the models built for Leeds and some are probably relevant to the use of dispersion models in general.

- It is not practicable to include every road link, either through modelled or actual traffic counts even for existing situations. As the models are built it becomes apparent that certain areas may have less reliable modelled or actual traffic data than others. However there is a finite resource in terms of being able to acquire the additional information required for any period in time. Modelling predicted flows depends on the reliability of the data and the assumptions taken into account.

- Although careful thought has gone into setting hourly traffic profiles for different groups of vehicles and categories of roadtypes it is not possible to represent every scenario that will occur. Sensitivity testing could be carried out for future modelling work to look at applying inbound and outbound traffic profiling on certain roads

- It has been recognised that some road links may be very congested during the morning or afternoon peak periods, but it is likely to be in one direction only and it may be for much less than a full hour. It was also noted during validation of the model behaviour that despite the AADT flows being adjusted to reflect average flows occurring each month, the model does not account for the average flow in peak hours being much less in a particular week (for example, during school holidays) and interprets the reduction by averaging the data over the full month.

- It has been noted during the modelling exercise that data on rail movements and train emissions are poorly defined. In areas close to the main station, where there are a number of busy rail lines and the general background is high, this may be a weakness in the performance of the dispersion model.

4.2 MODEL VERIFICATION AND ADJUSTMENT

The Airviro model was assessed using a modified version of Example 3 within the published Technical Guidance TG(03). Two modifications were used to improve the performance of the model; an updated formula was used to calculate the nitrogen dioxide (NO_2) from modelled oxides of nitrogen (NOx) emissions and secondly, the inclusion of diffusion tubes in the adjustment process using the NO_2 to NOx calculator, which enabled a NOx value to be calculated for each tube and then compared with the model output.

Air pollution modelling is inherently prone to error, as it involves calculations using variables obtained from emission factors, predictions and extrapolation rather than by direct measurement. Complex systems such as topography and driving patterns have to be simplified. Although the steps taken to produce a good quality emission database have been discussed above, other sources of uncertainty in the Airviro dispersions include:

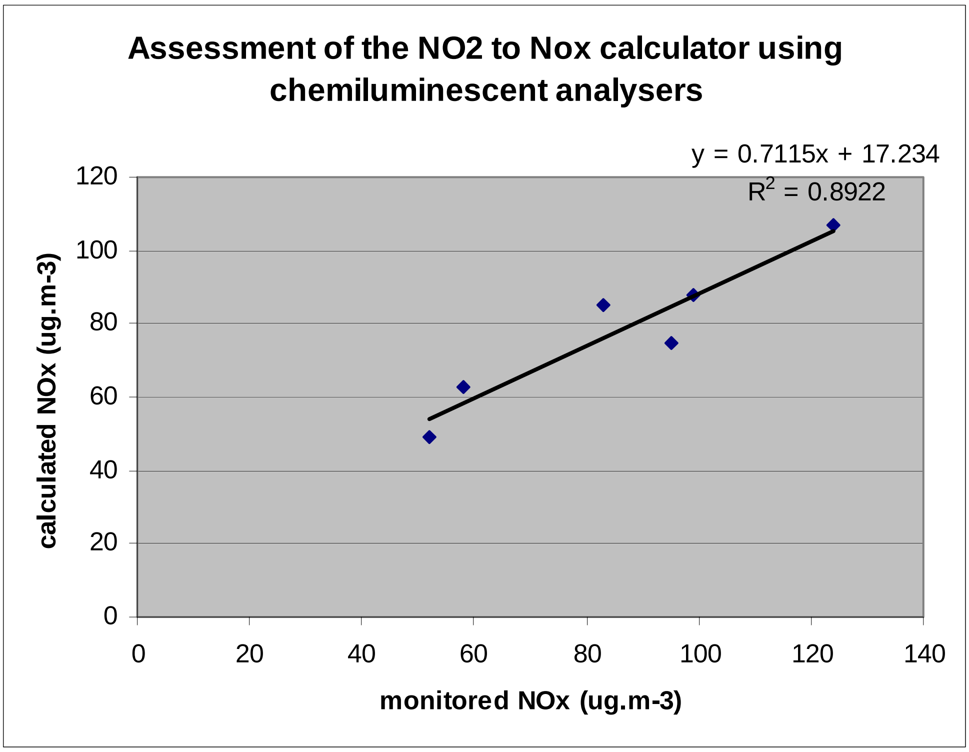
The calculation of NOx values for diffusion tubes
Determination of 2005 background NO_2
Prediction of future background NO_2
Calculation of NOx to NO_2 conversion
Definition of topography.

4.2.1 NO_2 to NOx Calculator for diffusion tube measurements

NOx values for diffusion tubes were calculated using the NO_2 to NOx LAQM tool found on the National Air Quality Archive at:
http://www.airquality.co.uk/archive/laqm/tools/NOxfromNO2calculator2007.xls

The calculator was tested to determine how well it predicted NOx concentrations, by comparing the calculated NOx result from the NO_2 measured by a diffusion tube with the monitored NOx from a co-located real-time analyser (Figure 4)

Figure 4 Comparison of calculated NOx from diffusion tubes with monitored NOx obtained from co-located real-time analyser



On the basis of the confidence in its use, shown in the graph above, the NO_2 to NOx calculator tool for diffusion tubes was used without further correction.

4.2.2 Background nitrogen dioxide concentrations

Background NO_2 and NOx concentrations of 23 and 31 respectively were used in the verification of the 2005 model. These values were monitored at an outer-suburban location to the east of Leeds. As a consequence, a small component of NOx from minor residential roads will have been included that otherwise would not have been taken into account by the model.

Prediction of future years background concentrations made use of the DEFRA year adjustment calculator to be found as an LAQM tool on the National Archive:
http://www.airquality.co.uk/archive/laqm/tools.php?tool=year04

The calculator uses estimates of future emissions. While the current version predicts decreasing concentrations with time, recent monitoring results suggest that the rate of decrease may be overestimated. Indeed, at some locations, concentrations have been found to remain stable while at others, increases have occurred. The reasons for these increases is not entirely clear; the calculator does not take meteorological conditions into account and increases in primary nitrogen dioxide emissions are thought to be responsible in some areas.

For the dispersions in this assessment an NO_2 background concentration of 21 $\mu g.m^{-3}$ in 2010 has been assumed on the basis of the calculator output although it is accepted that this may subsequently prove to be optimistic given the current uncertainty, particularly in relation to primary NO_2 emissions.

4.2.3 NOx to NO_2 conversion within the model

The revised calculation for model verification and adjustment, uses the equation:

$$-0.0719*Ln(NOx)+0.6248$$

to convert modelled NOx to NO_2. The appropriateness of this equation was assessed using data from analysers where both the NOx and NO_2 was known. Results are shown in Table 7.

Table 7. Comparison of monitored and calculated NO_2 obtained from model output

Location	Type of site	Monitored NO_2 ($\mu g.m^{-3}$)	Calculated NO_2 ($\mu g.m^{-3}$)
Compton Rd	kerbside	42	31
Headingley	kerbside	44	29
Haslewood	roadside	41	40
Jack Lane	roadside	38	37
West St	roadside	42	41
Leeds AURN	background	31	40
Millshaw	background	29	32

The equation significantly under estimated the NO_2 at the two kerbside locations, for reasons discussed later these receptors were removed from the verification process. There was good agreement at the three roadside locations, which is important for the model as sensitive receptors would normally be roadside rather than kerbside while the equation over predicts at the two 'background' stations, that are set further back from the road network.

4.2.4 Topography

The current version of Airviro uses limited topographical detail. The data necessary for modelling use comprises an estimate of surface roughness and a relatively coarse land height database. No account is taken of individual buildings or engineering structures such as road cuttings or flyovers. It is understood that future versions of the Airviro model will incorporate the ability to use modern maps with all the topographical information that can now be stored within them.

4.2.5 The model verification process

The Airviro model allows the calculation of values at point receptors, so the comparison between monitored and modelled NO_2 reported below is for specific points rather than grid averages. The year chosen to verify the model was 2005. Background NO_2 and NOx monitored during that year at an outer-suburban site were used in the model adjustment.

Using a modified form of example 3 in the Technical Guidance, the model was initially assessed using all available monitoring data. This assessment is shown in Appendix 2.

It was apparent that the model was underestimating NO_2 concentrations at the kerbside monitoring locations to such an extent that had they remained in the analysis, the whole model would have been unacceptably distorted. It is believed that the underestimate was a consequence of the model underpredicting the NOx at the two locations – possibly due to a canyon effect at the specific locations and influenced by changes to primary NO_2 emissions together with the under performance of the NOx to NO_2 equation discussed above.

The final adjustment spreadsheet for the citywide model excluded these kerbside receptors and is shown in Appendix 3 (excl Headingley and Compton Road results).

The equation applied to the model was

$$(x1*1.358*0.32)+23$$

where

x1 = modelled NOx,
1.358 = adjustment of modelled NOx to monitored roadside component
0.32 = factor to convert NOx to NO_2 based on the equation
$-0.0719*Ln(NOx)+0.6248$ (see above)
23 = background NO_2.

From the citywide dispersion adjusted by this equation it was possible to extract modelled values for receptors where monitoring had taken place. These are shown in Table 8 below together with an indication of the differences between the two.

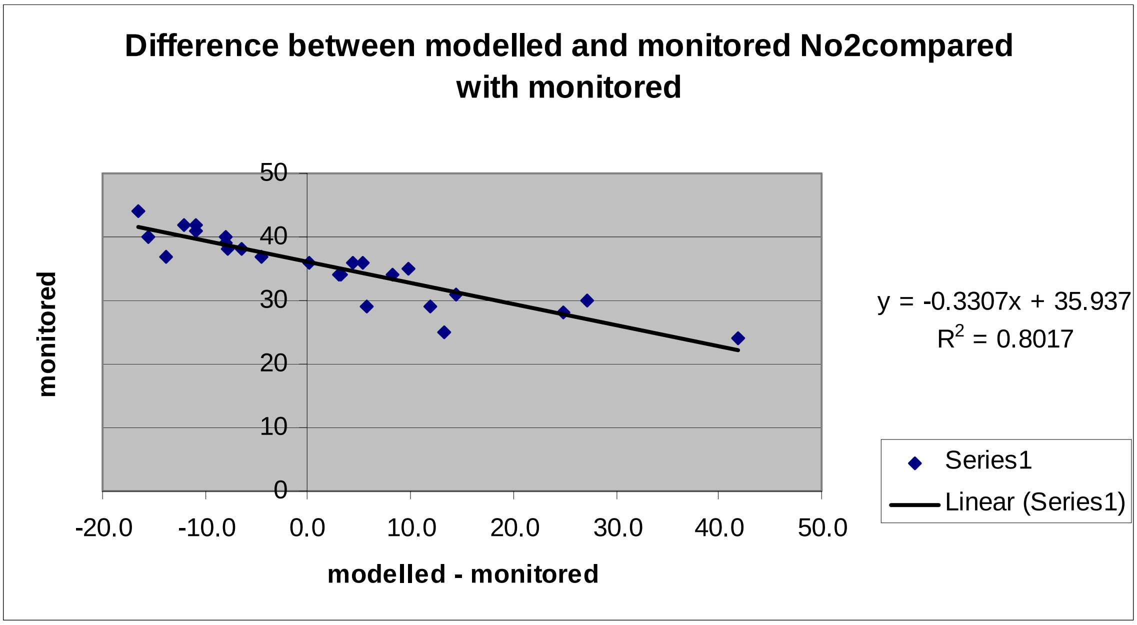
Table 8. Summary of monitored and modelled nitrogen dioxide

Receptor	Monitored NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)	Difference
Headingley (kerb)	44	30	-14
Millshaw	29	30	1
Haslewood	41	38	-3
Leeds Centre	31	36	5
West Street	42	39	-3
Jack Lane	38	36	-2
Compton Rd	42	30	-12
Haddon Place	38	36	-2
Kirkstall School	40	34	-6
University Residence	25	27	2
187 Dewsbury Rd	37	31	-6
Lady Beck Recept	42	39	-3
165 York Rd	34	36	2
21 Blakeney	36	40	4
Oatland Heights	37	36	-1
Caspar ring rd	36	37	1
Rylestone Nursery	29	32	3
567 York Rd	24	34	12
121 Dewsbury Rd	28	36	8
45 Blakeney	35	41	6
Haslewood Gable	44	38	-6
18 Lady Beck	36	39	3
Lady Beck rear	34	28	-6
Casper lamp post	39	37	-2
Marlborough Grove	30	40	10
Haslewood Open	40	38	-2
110 Jack Lane	34	36	2
44 Otley Rd	33	28	-5

In the table above, the average difference between the modelled and monitored NO_2 is 1 $\mu g.m^{-3}$. However, there is considerable variation. Under-estimation of kerbside concentrations – where the concentration is relatively high, possibly due to canyon effects, has already been identified. At other locations over-estimation has occurred and this is believed to arise because of local topographical features – in particular that the road may be in a cutting resulting in lower than expected concentrations..

Figure 5 below has been used to examine the difference between modelled and monitored NO_2 more closely. At monitored concentrations of 40 $\mu g.m^{-3}$ the underestimate is in the order of 10%. As the purpose of the modelling is to highlight potential receptors above 40 µg.m^{-3}, this underestimate must be taken into account and adjusting the final model by +10% has been adopted to highlight areas to be examined in more detail.

Figure 5. Graph of the difference between modelled and monitored NO_2 compared with the monitored value (µg.m^{-3})



For dispersions using the 2010 data base, the background NO_2 was calculated using the DEFRA correction factors, the same F factor was used as it was found that there was negligible change between the 2005 and 2010 factors.

The model results were assessed and reported in two ways: A series of contour maps were produced, and also NO_2 concentrations at a receptor points were extracted from the model. These were a combination of locations where monitoring had been undertaken and also residential facades along the major arterial roads into Leeds and are shown in Appendix 4.

A similar model adjustment process was undertaken for the Motorway model using monitored data from locations close to the motorway network. These produced an adjustment equation for the Motorway of:

$$(((x1*0.655)*0.31)+23)*(0.5028)+19.371$$

Other locations generated similar but unique equations.

4.3 MODELLING RESULTS

The results of model runs and adjustments are shown in Figure A.1 to Figure A.24, contained within the document 'Nitrogen Dioxide Maps and Modelling Runs' that accompanies this DA. These cover the Central Leeds model, its validation against 2005 data and comparative model runs with 2007 meteorological data and with the 2010 database that takes the new road schemes (particularly Stage 7 of the Inner Ring Road and the East Leeds Link to Junction 45 of the M1) into account. Figures A.5 to A.18 concentrate on exceedences based on the validated model and including the +10% correction described above. Figures A.19 to A.24 look at the motorway model and the specific areas of concern raised by the model runs.

4.3.1 The Central Leeds model

Figures A.1 to A.4

The model run with the 2005 database and 2005 meteorological data is shown in Figure A.1 and was used for validation purposes. The model was run a second time (shown in Figure A.2) but with 2007 met data as monitoring results had indicated that the anticipated reduction in levels had not occurred. This model predicted a small deterioration in air quality brought about by the weather conditions – as had been measured and reported above.

The third model (shown in Figure A.3) was run using the 2010 database with traffic flows adjusted to represent the new schemes that will have been completed (work is underway at present) together with modified emission factors. If this is an accurate representation of the situation, many of the identified areas of likely exceedences will no longer pose problems in terms of the annual average nitrogen dioxide concentration.

Figure A.4 shows the validated model with a +10% correction factor applied to adjust the model to take account of the modelling uncertainties. A simplified version, showing only areas exceeding the modelled value of 40 ug.m-3 with the +10% correction factor is shown in Figure A.5. This model has then been used as the basis for the more detailed consideration of specific areas of Central Leeds that are identified in Figures A.6 to A.18.

Figures A.6 to A.18

Each of these figures concentrate on smaller areas of the Central Leeds map and identify areas where the air quality objective for 2005 may have been breached. A small number of residential properties are encompassed in the shaded area of each of the maps. In practice, this is a similar situation to that which arose when the first review and assessment was carried out in 2000 and led to the identification of the City's AQMAs in 2001.

In some areas, the properties form part of a regeneration area and it will be important to ensure that any redevelopment takes air quality issues into account.

In other areas, through monitoring work that has been undertaken, it is known the model has over-predicted the actual concentration. However, the model has provided a useful tool to identify areas where further monitoring is warranted that were not previously thought to be at risk of failing to achieve the air quality objective.

4.3.2 The Motorway model

Figures A.19 to A.24

In a similar way to Central Leeds, the motorway network has been subjected to a detailed assessment. The 2005 scenario is shown in Figure A.19 with a 2010 projection shown in Figure A.20.

Again, areas of possible exceedence are identified in Figures A.21 and A.24

5.0 CONCLUSION

No significant contribution to ground level concentrations of nitrogen dioxide from sources other than road vehicles have been found.

Monitoring of hourly mean values of nitrogen dioxide at kerbside sites has indicated that the hourly objective value (of no more than 18 exceedences of 200 $\mu g.m^{-3}$) is very unlikely to be exceeded – even though the objective may be properly applied at any publicly accessible outdoor location within the Leeds area.

Monitoring at suburban background and urban centre locations has shown that annual mean nitrogen dioxide concentrations are below 40 $\mu g.m^{-3}$. This indicates that the vast majority of the Leeds conurbation will comply with the annual mean objective for nitrogen dioxide. However kerbside annual means greater than 40 $\mu g.m^{-3}$ occur. There is therefore the potential for properties within a narrow band along busy roads (including motorways) to fail the annual mean objective.

The results of targeted chemiluminescent and diffusion tube monitoring have identified a small number of locations where there is ‘relevant exposure’ and exceedences of the annual average air quality objective occur.

Air quality modelling using Airviro software has confirmed that at some locations, principally small areas around the busiest road junctions, the air quality objective is likely to have been approached when taking the inherent uncertainties of the model into account.

It is therefore proposed to review the AQMA declarations in the light of these findings and vary the Air Quality Management Order for nitrogen dioxide accordingly.

PM_{10} (fine) particles

1.0 INTRODUCTION

There were two PM_{10} specific objectives to be achieved by the end of 2004; an annual mean of 40 µg.m^{-3} and a fixed daily mean of 50 µg.m^{-3} that should not be exceeded on more than 35 occasions per year.

PM_{10} was considered as part of Leeds City Council's Stage 3 Review published in December 2000. The review concluded that members of the public could be exposed to concentrations of this pollutant within the City Council area which exceed the specific objectives to be achieved by 31 December 2004. The particular location identified as part of that review was a cluster of houses where solid fuel was used for domestic heating. An Air Quality Management Area was subsequently declared.

Since then more stringent objectives for PM_{10} were discussed with a proposal that they should come into force for 2010. If this proposal had been adopted, the number of days that the 50 µg.m^{-3} limit could be exceeded would have been reduced from 35 days per year to seven and the annual mean value lowered to 20 µg.m^{-3}. In the event, this course of action did not progress but through the recent EU directive, a new annual mean for $PM_{2.5}$ has been introduced together with an exposure reduction target (anticipated to be of 15% from 2010 to 2020)

Two Updating and Screening Assessments (USAs) and an earlier Detailed Assessment (DA) have been carried out. The most recent of these was USA II, that was prepared in September 2006 and reported the following conclusions:

> *'No background or roadside monitoring location with appropriate receptors has exceeded either the annual mean or 35 day standards.*
>
> *'Kerbside monitoring has taken place alongside a heavily congested arterial road and a very busy bus stop rank since 1998, These sites have complied with the standard every year since 2000 apart from 2003. It is evident from the monitoring that for an appropriate receptor to exceed the standard, it would have to be very close to the road and also suffer exceptional meteorological conditions.*
>
> *'The DMRB screening tool for PM_{10} indicated that using the published updated background PM_{10} concentrations for Leeds City Centre, some receptors may be exceeding the PM_{10} standard. Although this finding is to some extent contrary to the monitoring data and probably attributable to the pessimistic background values, a detailed assessment will be required for the city centre. Since the last USA, significant redevelopment of the City centre has taken place. Progressing to a detailed assessment for PM_{10} within the city centre will enable both the apparent DMRB screening exceedences to be examined and a thorough search for sensitive residential receptors to be undertaken.*

‘The AQMA for PM_{10} as a consequence of the domestic use of solid fuel at Garden Village was re-monitored after approximately 25% of the properties were converted to use gas as their primary heating source. Reductions in measured PM_{10} indicate that this area is now unlikely to exceed the 2004 PM_{10} standard and consideration will be given to revocation of the Air Quality Management Order.

‘As part of the proposed detailed assessment for PM_{10}, a review of the developing situation in respect of the quarry that has been the subject of recent complaints will also be undertaken.’

2.0 THE DETAILED ASSESSMENT

This DA reviews and updates the monitoring carried out and other investigations undertaken. Although some modelling work has been undertaken, levels generally are significantly lower that those objective concentrations contained in the air quality strategy.

3.0 MONITORING RESULTS

All PM_{10} monitoring reported here has been carried out using the tapered element oscillating micro-balance (TEOM) method. The Council has both ‘long-term’ sites (at which data is collected on a permanent basis) and has carried out monitoring at number of ‘short-term’ locations, more commonly associated with nitrogen dioxide investigations.

3.1 LONG-TERM MONITORING LOCATIONS

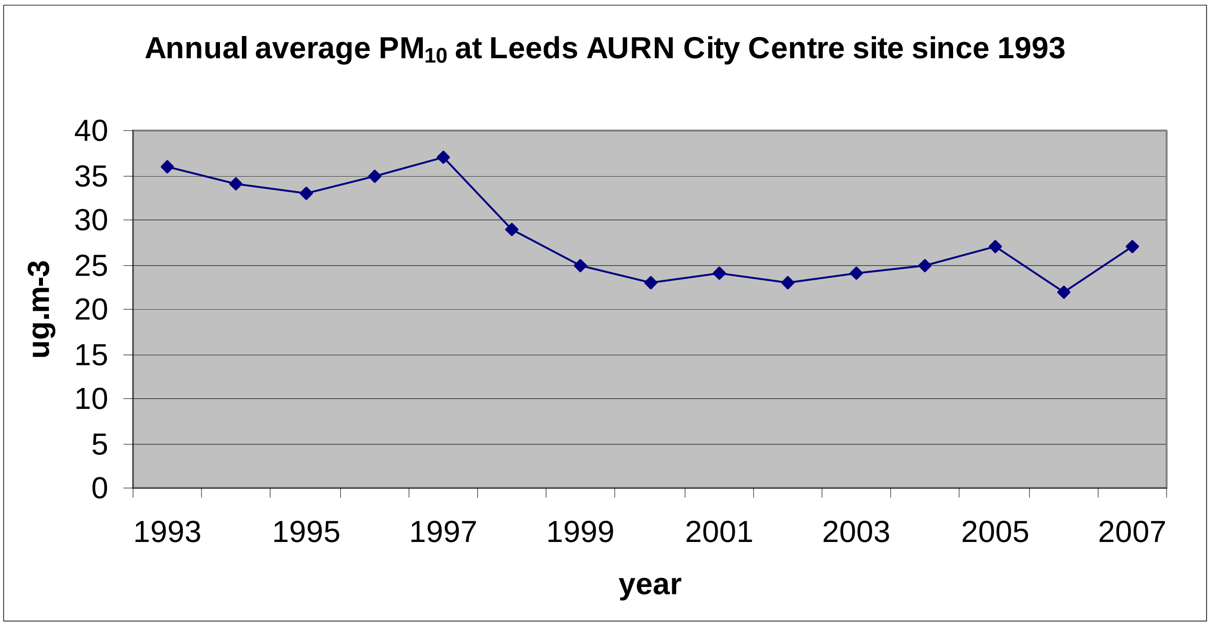
There are four long-term monitoring stations within the Leeds Metropolitan Area. Two of these monitor background concentrations and are appropriate for assessing public exposure against the PM_{10} specific objectives (although one had to be relocated as the building at which it was sited was to be demolished). The other two sites are positioned at kerbside locations which although not directly appropriate environments for assessing the specific objective values, do give worst case information.

The monitored results have been converted to gravimetric units using the appropriate conversion factor and are shown in Table 9 below.

Table 9. Monitored background data for PM_{10} particles at Leeds Centre, Potternewton and Millshaw sites

Year	Leeds Centre AURN site (Queen Square Court)		Potternewton site (Suburban background)		Millshaw site (Suburban background)	
	Annual mean $TEOM_{grav}$ ($\mu g.m^{-3}$)	Number of exceedence days	Annual mean $TEOM_{grav}$ ($\mu g.m^{-3}$)	Number of exceedence days	Annual mean $TEOM_{grav}$ ($\mu g.m^{-3}$)	Number of exceedence days
1993	36	58				
1994	34	51				
1995	33	46				
1996	35	64				
1997	37	59				
1998	28	22				
1999	25	19				
2000	23	5	19	3		
2001	24	8	19	3		
2002	25	13	20	6		
2003	27	30	22	22		
2004	22	4	20	6		
2005	27	14			21	3
2006	24	10			21	1
2007	25	9			22	15

Figure 6. Graph showing annual average $PM_{10(grav)}$ concentrations at the Leeds Centre AURN site



For the two kerbside sites, monitored results have been converted to gravimetric units using the appropriate conversion factor and are shown in Table 10 below.

Table 10. Monitored kerbside data for PM_{10} particles at Corn Exchange and Headingley sites

Year	Corn Exchange		Headingley	
	Annual mean $TEOM_{grav}$ ($\mu g.m^{-3}$)	**Number of exceedence days**	**Annual mean $TEOM_{grav}$ ($\mu g.m^{-3}$)**	**Number of exceedence days**
2000	31 (<90%DATA)	19	28 (<90%DATA)	18
2001	33 (<90%DATA)	19	30	30
2002	32 (<90%DATA)	25	30	25
2003	37	68	34	58
2004			29	26
2005	29	15	27	13
2006	34	38	29	22
2007	31	21	26	13

3.2 SHORT-TERM MONITORING LOCATIONS

The ‘mobile’ monitoring stations have been sited at a number of different locations for shorter periods and the results are shown below. Simple ratios of the results from other stations have been used as correction factors to extrapolate the data to annual means. They have then been converted to gravimetric units using the appropriate conversion factor and are shown in Table 11 below.

As reported in previous the previous DA, the Stage 3 Review identified an area in Micklefield to the east of the city where the 2004 PM_{10} particle objective was likely to be exceeded due to domestic coal burning and an AQMA was subsequently designated. The Action Plan identified measures to be taken to reduce the likelihood of an exceedence of the 2004 objective. In particular, a number of the properties had solid fuel heating systems replaced by gas-fired central heating boilers. Following completion of the works, re-monitoring was carried out to determine the effectiveness of the measures undertaken.

The results of all monitoring are shown in Table 12; the original data on which the AQMA was declared obtained in 1999/2000 and the post-treatment results collected over the winter of 2003/04.

Table 11. Monitored data for PM_{10} particles at 'Short-term' monitoring locations adjusted to annual figures

Site	Monitoring Period	Adjusted annual mean $TEOM_{grav}$ ($\mu g.m^{-3}$)	Number of daily exceedences	
			Monitored	Predicted for year
Aberford	Jul 00 – Jan 01	20 (2000)	1	4
Kippax	Dec 00 – May 01	26 (2001)	5	14
Clay Pit Lane	Jun 01 – Sep 01	22 (2001)	0	6
Holbeck	Jun 01 – Sep 01	22 (2001)	0	6
Wetherby	Sep 01 – Apr 02	19 (2002)	7	2
Haslewood Close	Nov 01 – Jul 02	26 (2002)	10	14
North Street	May 02 – Oct 02	22 (2002)	2	6
Kirkstall Road	Jan 03 – Sep 03	26 (2003)	5	15
Otley Manor Sq	Feb 03 – May 03	32 (2003)	36	36
Morley Library	Jun 03 – Dec 03	26 (2003)	18	15
Morley Library	Jan 04 – Dec 04	21	5	5
Morley Library	Jan 05 – Sep 05	18 (2005)	3	1
Ninelands J&I School, Garforth	Jun 04 – Jun 05	19	8	2
Kennet Lane, Garforth	Jul 05 – Nov 05	19	1	2
Rodillian	Sep 05 – Dec 05	23 (2005)	0	7
Rodillian	Jan 06 – Jun 06	21 (2006)	0	5
Jack Lane	Jan 06 – Dec 06	28	18	22
Copperfield Coll.	Aug 07 – Dec 07	20 (2007)	5	3

Table 12. Monitored data for PM_{10} particles during 'short-term' monitoring exercises at Garden Village, Micklefield adjusted to annual figures

Year	Monitoring Period	Number of months	Adjusted annual mean $TEOM_{grav}$ ($\mu g.m^{-3}$)	Number of daily exceedences	
				monitored	Predicted for year
1999	Feb – Mar & Oct – Dec	5	45	36	
2000	Jan – Jun	6	38	25	
2003	Oct – Dec	3	32	) 11 in total	33
2004	Jan – Jun	6	31	)	31

3.3 INTERPRETATION OF MONITORING DATA

With the exception of the historic monitoring carried out at Micklefield, leading to the declaration of an AQMA, no other monitoring has identified any locations with 'relevant exposure' where the measured annual mean PM_{10} particle value is likely to exceed 40 $\mu g.m^{-3}$ ($TEOM_{grav}$).

In recent years, most monitoring (which has generally been carried out at locations where there were concerns for the nitrogen dioxide levels associated with traffic) has indicated annual average PM_{10} particle concentrations of the order of 25 $\mu g.m^{-3}$ ($TEOM_{grav}$).

In the case of the Micklefield monitoring, the results obtained from the winter of 2003/04 indicate that the works undertaken to replace a proportion of the solid fuel combustion systems found in a number of properties has achieved the desired result of reducing both the annual mean and daily exceedences to acceptable levels. The annual mean result is well below the 40 $\mu g.m^{-3}$ objective and the measured number of exceedences (of 11 for the whole winter) is significantly lower than the 35 occasions per year on which the daily objective figure (of 50 $\mu g.m^{-3}$) may be exceeded.

Monitoring at Ninelands J & I School and Kennet Lane, Garforth was carried out in relation to concerns raised in relation to activities associated with a block manufacturing process. The measurements at the school were close to the main site entrance and continued for a year; Kennet Lane is ‘downwind’ (to the east/north-east) of the major part of the on-site works and continued for almost 5 months. In each case the concentration measured was 19 $\mu g.m^{-3}$ ($TEOM_{grav}$) and at the school site, there were 8 exceedences of the daily mean in 12 months of monitoring.

3.4 OTHER INFLUENCING SOURCES

3.4.1 Road Traffic

DMRB assessments were undertaken by officers in the Transport Policy Division of the Council’s Development Department as part of the first USA, following the recommendations in the technical guidance to identify any locations expected to exceed the 2004 objectives.

There were no locations identified at which the 40 $\mu g.m^{-3}$ objective was likely to be exceeded despite considering receptor points with high traffic flows and high percentages of HGVs/buses in these calculations.

3.4.2 Industrial sources

There are no new significant industrial sources that have been identified since the publication of the last DA and there are no existing sources with substantially increased emissions.

3.4.3 Domestic sources

The majority of the Leeds Metropolitan area is covered by smoke control orders. However there remain a number of small communities (mainly to the south east of Leeds, where there was a strong history of mining) that have domestic properties still using solid fuel as a primary heating source. Monitoring in two areas where there may be a sufficient density of houses burning solid fuel were identified in the last review process.

The situation at Garden Village at Micklefield has been described above and no other areas have been identified as likely to exceed the 2004 objective despite monitoring at a number of 'short-term' locations.

3.4.4 Quarries/landfill/open cast coal/handling of dusty cargos

Although potentially significant sources of PM_{10} within this category have been identified previously, the guidance recommends that relevant exposure within 200m of the sources be considered. There are few receptors within this distance.

Historically records of dust complaints from one landfill and one quarrying process had been received and the quarry had been the cause of more recent concern. As a result, arrangements were in hand to carry out monitoring associated with this activity. However, steps were taken to improve working methods and with the adoption of an alternative site access via an industrial estate remote from residential properties, the operation is no longer a source of complaint and the request by officers to install a mobile monitoring station at an appropriate residential location close to the site was deemed unnecessary by the complainant.

3.4.5 Aircraft

The information reported in the first USA (2 million passengers per annum in 2004 and approximately 500 tonnes of freight per annum) indicated that Leeds Bradford Airport need not be considered in the review.

4.0 CONCLUSION FOR PM_{10}

The 2004 PM_{10} objective values are not likely to be exceeded at any location within the Leeds Metropolitan area at which it is appropriate to apply these objectives. An Air Quality Management Order identified a cluster of houses where solid fuel was the primary source of domestic heating but the replacement with gas fired systems in a number of the properties has addressed this issue.

Annual mean PM_{10} ($TEOM_{grav}$) concentrations of the order of 20 to 25 $\mu g.m^{-3}$ at the AURN Urban Centre and Suburban background monitoring stations have been measured in recent years. The number of daily exceedences at these sites has not been greater than 15 since 2003. Similar values have been found at other locations where mobile monitoring stations have been deployed.

The previous DA concluded:

> *'Until such time as revised objectives are confirmed, it is not proposed to revoke the Air Quality Management Order affecting the properties at Garden Village, Micklefield since it may prove necessary to declare a more widespread AQMA including these properties prior to 2010.'*

With the withdrawal of the 2010 objective values for PM_{10} and the adoption of the EU Directive on particles (ie confirmation that standards to be achieved will concentrate on $PM_{2.5}$), there appears to be little likelihood of the current or future standards being exceeded within the declared AQMA. The ‘major’ source that still exists, coal burning for domestic heating, is likely to reduce further (with a continuing move away from coal-burning) and is not in itself the main source of the much smaller $PM_{2.5}$ particles that are generally attributed to the internal combustion engines of road vehicles.

The results of the continuing monitoring indicate that exceedences throughout the city are unlikely to breach the 2004 standard and are arguably decreasing further. On this basis it is proposed to reconsider the appropriateness of the continued existence of the AQM Order covering the properties at Micklefield.

It is interesting to note that although the 2004 objectives remain in place, the EU have recently published a revised directive relating $PM_{2.5}$ particles that includes both an annual average and an exposure reduction target. The annual average standard has been set at 25 $\mu g.m^{-3}$. Since the definition of PM_{10} particles includes the smaller $PM_{2.5}$ particles, the monitored results suggest that this part of the new directive is likely to be achieved throughout the majority of the city.

APPENDIX 1 – EQUIPMENT SPECIFICATION, DATA COLLECTION, CALIBRATIONS AND VALIDATION OF DATA

EQUIPMENT SPECIFICATION AT EACH MONITORING LOCATION

A summary of the monitoring and data collection equipment deployed at each site is described below:

Corn Exchange (Vicar Lane)
API Nitrogen Oxides Analyser type M200A
R & P TEOM type 1400B

Potternewton (Blake Grove) – now Millshaw
Monitor Labs Nitrogen Oxides Analyser type ML 9841B
R&P TEOM type 1400AB
Odessa data logger type DSM 3260

Headingley Kerbside (Otley Road)
Monitor Labs Nitrogen Oxides Analyser type 9841B
R&P TEOM type 1400AB
Horiba Carbon Monoxide Analyser type APMA360 (no longer in use)
Odessa data logger type DSM 3260

Groundhog Monitoring Stations (Mobile)
Monitor Labs Nitrogen Oxides Analyser type ML 9841B
Monitor Labs Sulphur Dioxide Analyser type ML 9850B
R&P TEOM type 1400AB
Odessa data logger type DSM 3260

West Street Car Park
Horiba Nitrogen Oxides Analyser type APMA370.

Haslewood Close
Monitor Labs Nitrogen Oxides Analyser type ML 9841B

Compton Road
API Nitrogen Oxides Analyser type M200A

Queen Street, Morley
API Nitrogen Oxides Analyser type M200A

Norman Row, Kirkstall
Horiba Nitrogen Oxides Analyser type APMA370.

DATA COLLECTION

There are detail differences both in the way some of the monitoring stations are configured to collect data and in the configuration of equipment used to monitor different pollutants at the same station.

The following description is specific to the nitric oxide (NO) and total oxides of nitrogen (NOx) values collected and used to calculate nitrogen dioxide concentrations.

The Odessa logger calculates 15-minute averages of the analyser output voltage for the NO, NO_2, and NOx channels. A 50mV positive offset is applied to the data to accommodate any downward zero drift which may occur. This raw data is collected by the Airviro Air Quality Management System at the twice a day, where it is stored in a monitoring result database. A protocol then automatically calculates the actual NO and NOx concentration in parts per billion by applying a zero correction and a scaling factor based on calibration of the instrument with nitric oxide of known concentration.

The polling of data from the station is an automatic routine and uses a memory buffer within the logger that has a capacity of 36 hours before data is overwritten. Data is also stored on a cartridge that can retain approximately 6 weeks of information before over-writing occurs. This cartridge can be accessed through separate software thereby preventing a loss of data should communication be lost with the station for more than 36 hours (for example if a mobile phone fault develops during a weekend).

The raw data (mV) is retained within the database after the concentration values (ppb) have been produced. Hourly concentrations are then calculated from the 15-minute values. Although the NO_2 channel output is collected and retained in the database, it is not used. Nitrogen dioxide concentrations in the final data set are based on the difference between NOx and NO.

CALIBRATION

Each monitoring station has a certified 40-litre cylinder of nitric oxide and nitrogen dioxide produced by Air Liquide (UK) Ltd to a specification of ± 5%. In addition to these cylinders there is a cylinder of synthetic air for zero calibration purposes.

The loggers are programmed to initiate a zero and span check at 0100 hours every day using the nitric oxide and zero air cylinders. These automatic calibration results are flagged and stored in a separate database to the ambient data set. A procedure is in place to assess these calibrations daily to check for instrument stability and correct functioning. The daily calibrations are not normally used to scale data. However, in the event of unusual drift of either the zero or span checks they can be used to scale data on a daily basis. Each case is considered on its merits and the fact that extra calibrations have been applied to the data are recorded in a calibration log on the airviro system and in the notes made of the data auditing process for that site.

The NOx analysers are manually checked using zero air and nitric oxide span gas once a week. These weekly calibrations are used to scale the data. At the same time, status information displayed by the instrument on some of its operational parameters are recorded and checked to determine whether the instrument is working within its specification. The inlet filter is changed at this time.

On alternate weeks the analyser is checked with nitrogen dioxide to determine the converter efficiency.

CALIBRATION AUDIT

The certified concentrations of individual nitric oxide and nitrogen dioxide cylinders are checked against small cylinders of the same gases, which have been independently analysed by AEA technology. This allows for cylinder drift to be distinguished from analyser performance changes and consistent data scaling for all sites.

Cylinders typically last 12 months and would be audited a minimum of twice during this time. The audit cylinders are used relatively infrequently and so last longer than 12 months. These audit cylinders are re-analysed once a year (more often if there is any doubt about stability).

The Monitor Labs NOx analysers, because of their internal zero reference system, have very little baseline drift. Experience has shown however that it very difficult to obtain zero grade air that does not have a few parts per billion of NOx contamination. Whenever possible a scrubber is placed in the zero air line to reduce contamination to a minimum.

DATA AUDITING

The raw mV data from each site is kept even after the audit process is complete; similarly, calibration factors applied to data are retained on the system for future reference. This means that it is possible to return to a data set at a later date and review the audit process. The calibration system is dynamic in that changing values in historic calibrations will automatically rescale data. Data that has been audited and regarded as satisfactory is protected from inadvertent changes by removing this calibration link and having a ratified flag attached.

Copies of calibration sheets, diagnostics checks and audit calibrations of cylinders, together with service reports are retained to aid the audit process and for future reference.

The audit process includes assessment of the daily automatic zero and span checks for instrument stability, checking that the correct cylinder concentrations and zero voltages have been used in the calculation of scaling factors and that the scaling factors have been correctly calculated.

Unusual spikes in the data are cross-referenced to calibration dates and times to ensure that the spikes are not unflagged calibrations. When a decision to delete data due to an instrument fault has been made, this is recorded. All data in the database has a status flag, including missing data, it is therefore possible to determine whether values have been edited or deleted from the data set.

The final stage in the process is to calculate the nitrogen dioxide concentration by subtracting corrected nitric oxide values from the corresponding corrected total oxides of nitrogen values. This nitrogen dioxide concentration is then scaled if required depending on the results of the converter efficiency tests. Given the potential for errors in the calibration system, a perfectly functioning catalytic converter may have a measured efficiency of between 95 and 105%. To ensure a consistent approach, values above 100% are assumed to be 100 and not adjusted, values below 100 are adjusted. Efficiencies less than 90% should initiate a service visit.

Should it prove necessary to scale the nitrogen dioxide concentrations then this will mean that the total oxides of nitrogen will need to be recalculated by simply adding the nitric oxide and nitrogen dioxide values.

TEOM PARTICLE SAMPLER

It is not possible to routinely calibrate the TEOM, the instruments k factor is checked during routine servicing. Data auditing removes negative hourly values larger than –5 $\mu g.m^{-3}$ and checks the data set for unusual spikes. These are cross referenced against filter changes and engineer visits, a record of service visits is maintained together with the weekly check lists which record air flow and temperatures.

As with other pollutants, decisions to delete data are recorded and flagged in the data set. Hourly values are rounded to integers and a separate data set is produced that has the 1.3 gravimetric correction factor applied.

Appendix 2 – Preliminary assessment provided by Review and Assessment helpdesk

																	Sum (Mon-Mod)^2
										Average Roads Correction Factor	1.774				Average Roads Correction Factor	0.002	
										Regression Correction Factor	1.438				Regression Correction Factor	1.021	794.7
										Custom Factor 2					Custom Factor 2	0.3094x+24.966	
										Custom Factor 3					Custom Factor 3		
										Custom Factor 4					Custom Factor 4		
Site ID	Site Location	Monitor Type	Site Type	Monitored Total NO2	Monitored Total Nox	Background NO2	Background Nox	Monitored Roadside NO2	Monitored Roads NOx	Modelled Road Contribution Nox	Correction factor	Corrected Modelled Road Contribution Nox	Corrected Total Nox	Modelled Road NO2	Modelled Total NO2	Percentage Difference Modelled/Monitored NO2 (%)	(Mon-Mod)^2
1	headingley	A	R	44	124	22	31	22	93	15.0	6.20	21.6	52.6	7.3	29.3	-33.3%	215.1
2	millshaw	A	R	29	49.0	22	31	7	18	15.7	1.15	22.6	53.6	7.6	29.6	2.2%	0.4
3	haslewood	A	R	41	75.0	22	31	19	44	34.3	1.28	49.3	80.3	15.3	37.3	-9.1%	13.9
4	leeds centre	A	R	31	63.0	22	31	9	32	30.7	1.04	44.2	75.2	13.9	35.9	15.7%	23.8
5	west st	A	R	42	88.0	22	31	20	57	37.2	1.53	53.5	84.5	16.4	38.4	-8.7%	13.2
6	jack lane	A	R	38	85.0	22	31	16	54	29.2	1.85	42.0	73.0	13.3	35.3	-7.1%	7.4
7	compton rd	A	R	42	85.0	22	31	20	54	15.4	3.51	22.2	53.2	7.5	29.5	-29.7%	155.9
8	haddon place	T	R	38	83.1	22	31	16	52.1	30.9	1.69	44.4	75.4	14.0	36.0	-5.4%	4.2
9	Kirkstall sch	T	R	40	90.8	22	31	18	59.8	25.3	2.36	36.4	67.4	11.7	33.7	-15.7%	39.4
10	university res	A	B	25	39.3	22	31	3	8.3	9.1	0.92	13.0	44.0	4.6	26.6	6.4%	2.5
11	187 Dewsbury Rd	T	R	37	79.3	22	31	15	48.3	19.4	2.49	27.9	58.9	9.3	31.3	-15.5%	33.0
12	lady beck reception	T	R	42	98.9	22	31	20	67.9	35.6	1.91	51.2	82.2	15.8	37.8	-10.1%	18.0
13	165 York rd	T	R	34	68.3	22	31	12	37.3	29.4	1.27	42.3	73.3	13.4	35.4	4.0%	1.9
14	21 Blakeney	T	R	36	75.6	22	31	14	44.6	38.9	1.15	56.0	87.0	17.0	39.0	8.3%	9.0
15	Oatland Hts	T	R	37	79.3	22	31	15	48.3	30.2	1.60	43.4	74.4	13.7	35.7	-3.6%	1.7
16	Caspar ring road	T	R	36	75.6	22	31	14	44.6	32.5	1.37	46.7	77.7	14.6	36.6	1.6%	0.3
17	Rylstone Nursery	T	R	29	51.5	22	31	7	20.5	21.1	0.97	30.4	61.4	10.0	32.0	10.3%	8.9
18	567 York Rd	T	R	24	36.4	22	31	2	5.4	26.0	0.21	37.4	68.4	12.0	34.0	41.7%	100.1
19	121 Dewsbury	T	R	28	48.3	22	31	6	17.3	29.0	0.60	41.7	72.7	13.2	35.2	25.7%	51.9
20	45 Blakeney	T	R	35	71.9	22	31	13	40.9	40.7	1.00	58.5	89.5	17.7	39.7	13.3%	21.7
21	haslew gable	T	R	44	107.2	22	31	22	76.2	34.8	2.19	50.1	81.1	15.5	37.5	-14.9%	42.8
22	18 lady beck	T	R	36	75.6	22	31	14	44.6	37.8	1.18	54.4	85.4	16.6	38.6	7.2%	6.7
23	6 lady beck	T	R	34	68.3	22	31	12	37.3	35.2	1.06	50.6	81.6	15.6	37.6	10.6%	13.0
24	ladybeck rear	T	R	37	79.3	22	31	15	48.3	10.3	4.69	14.8	45.8	5.2	27.2	-26.5%	96.4
25	caspar lampost	T	R	39	86.9	22	31	17	55.9	31.9	1.75	45.9	76.9	14.3	36.3	-6.8%	7.1
26	Marlborough Grove	T	R	30	54.7	22	31	8	23.7	39.8	0.60	57.3	88.3	17.3	39.3	31.1%	87.0
27	Haslewood open	T	R	40	90.8	22	31	18	59.8	35.2	1.70	50.6	81.6	15.6	37.6	-6.0%	5.7
28	110 Jack lane	T	R	34	68.3	22	31	12	37.3	29.1	1.28	41.9	72.9	13.2	35.2	3.7%	1.6
29	44 Otley Rd	T	R	33	64.8	22	31	11	33.8	11.6	2.91	16.7	47.7	5.8	27.8	-15.8%	27.2

Appendix 3 – Final adjustment spreadsheet based on initial assessment provided by Review and Assessment helpdesk

										Average Roads Correction Factor	1.392						Average Roads Correction Factor	0.008	Sum (Mon-Mod)^2
										Regression Correction Factor	1.358						Regression Correction Factor	1.000	284.5
										Custom Factor 2							Custom Factor 2		
										Custom Factor 3							Custom Factor 3		
										Custom Factor 4							Custom Factor 4		
Site ID	Site Location	Monitor Type	Site Type	Monitored Total NO2	Monitored Total Nox	Background NO2	Background Nox	Monitored Roadside NO2	Monitored Roads NOx	Modelled Road Contribution Nox	Correction factor	Corrected Modelled Road Contribution Nox	Corrected Total Nox			Modelled Road NO2	Modelled Total NO2	Percentage Difference Modelled/Monitored NO2 (%)	(Mon-Mod)^2
2	millshaw	A	R	29	49.0	23	35	6	14	15.7	0.89	21.3	56.3	56.3	0.33	7.1	30.6	5.7%	2.7
3	haslewood	A	R	41	75.0	23	35	18	40	34.3	1.17	46.6	81.6	81.6	0.31	14.4	38.0	-7.3%	9.1
4	leeds centre	A	R	31	63.0	23	35	8	28	30.7	0.91	41.7	76.7	76.7	0.31	13.0	36.6	18.2%	31.9
5	west st	A	R	42	88.0	23	35	19	53	37.2	1.42	50.5	85.5	85.5	0.30	15.4	39.1	-7.0%	8.7
6	jack lane	A	R	38	85.0	23	35	15	50	29.2	1.71	39.6	74.6	74.6	0.31	12.5	36.1	-5.1%	3.7
8	haddon place	T	R	38	83.1	23	35	15	48.1	30.9	1.56	42.0	77.0	71.9	0.32	13.1	36.7	-3.4%	1.6
9	Kirkstall sch	T	R	40	90.8	23	35	17	55.8	25.3	2.21	34.4	69.4	66.5	0.32	11.0	34.6	-13.6%	29.5
10	university res	A	B	25	39.3	23	35	2	4.3	9.05	0.48	12.3	47.3	50.9	0.34	4.3	27.7	10.9%	7.5
11	187 Dewsbury Rd	T	R	37	79.3	23	35	14	44.3	19.4	2.28	26.3	61.3	60.8	0.33	8.7	32.2	-13.0%	23.1
12	lady beck reception	T	R	42	98.9	23	35	19	63.9	35.6	1.79	48.3	83.3	76.5	0.31	14.8	38.5	-8.4%	12.5
13	165 York rd	T	R	34	68.3	23	35	11	33.3	29.4	1.13	39.9	74.9	70.5	0.32	12.6	36.2	6.3%	4.6
14	21 Blakeney	T	R	36	75.6	23	35	13	40.6	38.9	1.04	52.8	87.8	79.7	0.31	16.0	39.7	10.2%	13.4
15	Oatland Hts	T	R	37	79.3	23	35	14	44.3	30.2	1.47	41.0	76.0	71.3	0.32	12.9	36.5	-1.5%	0.3
16	Caspar ring road	T	R	36	75.6	23	35	13	40.6	32.5	1.25	44.1	79.1	73.5	0.32	13.7	37.3	3.7%	1.7
17	Rylstone Nursery	T	R	29	51.5	23	35	6	16.5	21.1	0.78	28.6	63.6	62.5	0.33	9.3	32.9	13.4%	15.1
20	45 Blakeney	T	R	35	71.9	23	35	12	36.9	40.7	0.91	55.3	90.3	81.4	0.31	16.6	40.3	15.2%	28.2
21	haslew gable	T	R	44	107.2	23	35	21	72.2	34.8	2.07	47.2	82.2	75.7	0.31	14.5	38.2	-13.2%	33.9
22	18 lady beck	T	R	36	75.6	23	35	13	40.6	37.8	1.07	51.3	86.3	78.6	0.31	15.6	39.3	9.1%	10.7
23	6 lady beck	T	R	34	68.3	23	35	11	33.3	35.2	0.95	47.8	82.8	76.1	0.31	14.7	38.3	12.7%	18.7
25	caspar lampost	T	R	39	86.9	23	35	16	51.9	31.9	1.63	43.3	78.3	72.9	0.32	13.5	37.1	-4.9%	3.6
27	Haslewood open	T	R	40	90.8	23	35	17	55.8	35.2	1.59	47.8	82.8	76.1	0.31	14.7	38.3	-4.2%	2.8
28	110 Jack lane	T	R	34	68.3	23	35	11	33.3	29.1	1.14	39.5	74.5	70.2	0.32	12.4	36.0	6.0%	4.2
29	44 Otley Rd	T	R	33	64.8	23	35	10	29.8	11.6	2.57	15.7	50.7	53.3	0.34	5.4	28.9	-12.5%	17.0

Appendix 4 – Modelled NO_2 concentrations at receptor points

Receptor	2005db 2005met +10%	2005db 2007 met+10% with reduced background	Notes
Corn Ex	39.5	38.2	kerbside under estimated
AUN	40	39.7	
Potternewton	28.7	28	
Headingley	32.5	32.8	kerbside under estimated
St Marys	42.3	44.7	
Holbeck Youth Centre	38.6	37.4	
Shannon ST	39.3	38.2	
York Rd Lib	39.7	38.9	
165 YR	39.4	38.6	
Crossgreen	37.9	37.5	
187 DR	34.6	34.6	
466 DR	36.5	36.1	
Rylstone Nursery	35.4	34.5	
567 YR	37.7	39.1	
813 YR	33.7	33.3	
43 Hawkshill	32.5	32	
963 YR	31.5	31.1	
Carlton Gate	42.6	42.3	still an AQMA, but model over estimates because of cutting, monitoring less than 40, possibly no non occupational residental property could consider revoking??
Holbeck Moor View	38.2	37.8	
121 DR	39.2	38.6	
Neville St	37.4	36.8	
Haslewood Cl	41.7	40.6	AQMA
Jack Ln	39.3	39.7	
University Kirkstall	36.7	36.8	
Millshaw	32.8	31.5	
7 Blakeney	43.5	42.9	close to motorway, 2007 tubes suggest less than 40
21 Blakeney	43.9	43.6	close to motorway, 2007 tubes suggest less than 40
45 Blakeney	44.7	45.5	close to motorway, 2007 tubes suggest less than 40
Kirkstall Primary	37.4	37.6	
2 Haddon Pl	40.1	39.2	
Oatland Hts	39.7	39	
Haslewood Gable	41.9	40.9	AQMA
Compton Rd	32.6	32.1	under estimated
18 Lady Beck	43.4	42.7	AQMA
6 Lady Beck	42.1	41.8	AQMA
ladybeck reception	42.3	42	AQMA
ladybeck rear	30.2	29.6	
caspar north st	40.6	40.2	AQMA
caspar ring rd	40.8	40.9	AQMA
west st	43.1	43.5	no sensitive receptors
university headingley background	29.6	29.5	
110 Jack Lane	39.2	39.5	
Marlborough Grove	44.3	44.8	AQMA
Haslewood open	42.1	41.1	AQMA
44 Otley Rd	30.9	33	
43 Grange Close	40.7	40.3	AQMA, but model over estimates because of topography
103 dewsbury Rd	39.7	39.5	
137 Harehills Lne	32	31.5	
131 Harehills Lne	31.8	31.3	
70 Harehills Lne	32.1	31.5	
308 Harehills Lne	32.4	31.6	
331 Harehills Lne	32.4	31.8	
89 Compton Row	33	32.2	
413 Harehills Lne	32.8	32	
Bruce Lawn	45.5	46.4	near Armley Gyratory, now tube in place area due for extensive redevelopment
Bruce Lawn	39.7	39.3	
28 Headingley Lne	37	37.6	
388 Meanwood Rd	31.7	31.3	
374 Meanwood Rd	31.9	31.6	
107 Chapel Town Rd	36.5	34	
64 Scotthall	34	33.6	
51 SH	34.8	33	
495 SH	30.4	29.4	
512 SH	30.4	29.4	
538 SH	27.9	27.3	
615 SH	27.4	26.6	
610 SH	27.4	26.7	
194 Harrogate Rd	27.3	26.6	
220 HR	27.2	26.5	
321 Chapletown Rd	29.8	29.4	
166 Chapletown Rd	31.4	30.8	
70 Headingley Lane	33	33.3	
65 Headingley Lane	33.1	33.3	

APPENDIX 5 – GLOSSARY

AQMA	Air Quality Management Area
AURN	DEFRA's Automatic Urban and Rural Network of air monitoring stations
DA	Detailed Assessment
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges – a DETR document containing air quality information and calculation procedures (in Volume 11)
EDB	Emissions Database
HDV	Heavy Duty Vehicle
LAQM	Local Air Quality Management
mean	arithmetic average
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Oxides of nitrogen (the sum of NO and NO_2)
PM_{10}	Particles with a mean diameter of less than 10 microns (millionths of a metre)
$PM_{2.5}$	Particles with a mean diameter of less than 2.5 microns (millionths of a metre) – ie smaller than PM_{10} particles
SATURN	Simulated Assessment of Traffic on Urban Road Networks – a computer programme used to model road traffic.
TEOM	Tapered Element Oscillating Microbalance – the PM_{10} monitoring method adopted as the UK standard
$TEOM_{grav}$	Measurements obtained with the TEOM monitor, 'converted' to the EU gravimetric reference standard (by multiplying by 1.3)
TG(03)	Technical guidance published by DEFRA
USA	Updating and Screening Assessment
$\mu g.m^{-3}$	micrograms per cubic metre