Nottingham City Council

Local Air Quality Management

Detailed Assessment 2008

Annex 1 – Supplementary Information for Nitrogen Dioxide

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Environment and Regeneration
Noise & Pollution Control Team
Lawrence House
Talbot Street
Nottingham
NG1 5NT

Summary

In 2008 Nottingham City Council undertook monitoring and modelling work for a Detailed Assessment for nitrogen dioxide and particles, PM_{10} to fulfil its responsibilities under the Local Air Quality Management process - as set out in Part IV of the Environment Act (1995) and the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007.

The results were reported in the Local Air Quality Management Detailed Assessment Consultation Document. The report concluded that amendments to the existing AQMAs No.2 and No.3 for nitrogen dioxide were necessary due to monitored and modelled exceedences of the annual mean nitrogen dioxide Air Quality Objective also that; no further action was required for PM_{10}. It was submitted to Defra in May 2008 for approval.

Defra's Review and Assessment Appraisal consultants accepted the findings for PM_{10} but their commentary about nitrogen dioxide stated that for the Detailed Assessment report to be completed satisfactorily - "The authority needs to address a) the exceedences identified outside of the proposed AQMAs and b) the verification of the model against the diffusion tube data, which may account for the model not identifying all exceedences." The exceedences referred to in a) relate to three diffusion tube monitoring sites.

This report i.e. Detailed Assessment – Annex 1 Supplementary Information for Nitrogen Dioxide has been prepared with the focus on these two aspects.

The annual mean air quality objective for nitrogen dioxide is 40 $\mu g/m^3$; the 2007 and 2008 monitoring show that levels in excess of this were measured at a number of monitoring sites both within and outside the existing Air Quality Management Areas No.2 and No.3. This air quality objective was not exceeded at some of the other monitoring sites. These results are consistent with the data reported in the Consultation Document.

Modelling work and verification has been undertaken using the methodology outlined in the technical guidance as recommended in the Review and Assessment Appraisal. The modelling predicts exceedence of the nitrogen dioxide annual mean Air Quality Objective along and nearby a number of the City's main traffic routes.

There are areas of the City, mostly near and within existing AQMAs, where both modelling and monitoring results demonstrate that the nitrogen dioxide annual mean objective has been exceeded at locations with relevant exposure of members of the public. This is consistent with the 2006 modelling undertaken for the Consultation Document however the areas of exceedence are more extensive.

The 2007 modelling and monitoring both indicate exceedence of the Air Quality Objective at the three monitoring sites mentioned above where previously the monitoring showed exceedence but the 2006 modelling did not.

This report confirms previous findings that it is necessary to amended the existing Air Quality Management Areas. The proposals being: AQMA No.2 - City Centre to extend it to the north, north-west and south of the city centre (and include the three diffusion tube sites) and to remove the south-west part where there is no relevant public exposure; AQMA No.3 - Dunkirk to re-align the boundary to extend it to the south-west and exclude the QMC hospital.

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Abbreviations

AADT	Annual Average Daily Traffic
ADMS	Atmospheric Dispersion Modelling System
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQMS	Air Quality Monitoring Station
AQO	Air Quality Objective
AURN	Automatic Urban and Rural Network
CERC	Cambridge Environmental Research Consultants
DA	Detailed Assessment
Defra	Department for Environment, Food and Rural Affairs
DT	Diffusion Tube
HGV	Heavy Goods Vehicles
LAQM	Local Air Quality Management
LAQM PG(09)	Local Air Quality Management Policy Guidance
LAQM TG (09)	Local Air Quality Management Technical Guidance
LGV	Light Goods Vehicles
LTP	Local Transport Plan
NO_2	Nitrogen dioxide
NOx	Oxides of nitrogen
PM_{10}	Particles 10 microns or less in diameter
PR	Progress Report
R & A	Review and Assessment
TG	Technical Guidance
USA	Update Screening and Assessment

Detailed Assessment - Further Investigation for Nitrogen Dioxide

Introduction/ Purpose

As part of the Local Air Quality Management (LAQM) process an Updating and Screening Assessment (USA) was undertaken in 2006. The report concluded that it was necessary to undertake a Detailed Assessment (DA) for nitrogen dioxide and for particles, PM_{10} (2 roads).

LAQM guidance states that the objective of a Detailed Assessment is "to provide an accurate assessment of the **likelihood** of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation or amendment of any necessary AQMAs." Authorities should "use quality assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective".

Nottingham City Council undertook monitoring and modelling work for the DA and reported it in 'Local Air Quality Management Detailed Assessment Consultation Document May 2008' (DA 2008). The report concluded that no further action was required for PM_{10} and proposed that amendments to the existing AQMAs No.2 & No.3 for nitrogen dioxide were necessary due to monitored and modelled exceedences of the annual mean nitrogen dioxide Air Quality Objective (AQO).

In May 2008 the Detailed Assessment Consultation Document was submitted to the Department for Environment, Food and Rural Affairs (Defra) for approval. Subsequently the PM_{10} findings were accepted whilst those for nitrogen dioxide were not.

The Review and Assessment Appraisal Report commentary stated that for the DA report to be completed satisfactorily "The authority needs to address a) the exceedences identified outside of the proposed AQMAs and b) the verification of the model against the diffusion tube data, which may account for the model not identifying all exceedences. The model verification should follow the procedure set out in TG (03), whereby the road contribution is verified separately from the background".

In February 2009 Technical Guidance TG (03) was replaced by Technical Guidance LAQM.TG (09) and this has been used to inform the work that has been undertaken to address these specific points.

This report, which is a supplement to the DA 2008, gives details and analysis of the 2007 and 2008 nitrogen dioxide monitoring results and of the additional modelling that has been carried out. This is followed by proposals for amendments to the existing Air Quality Management Areas No.2 & No.3.

The two documents:- i) 'Nottingham City Council Local Air Quality Management Detailed Assessment Consultation Document May 2008' (DA 2008) and; ii) 'Nottingham City Council Local Air Quality Management Detailed Assessment 2008 – Annex 1 Further Information for Nitrogen Dioxide September 2009' (DA-Annex 1) should be considered together.

Since the DA 2008 was completed subsequent rounds of R & A have been carried out: - Progress Report July 2008 and Updating Screening and Assessment April 2009, both of which confirmed the USA 2006 findings with regard to nitrogen dioxide exceedences. Both of these reports have been accepted by Defra.

Information regarding all of Nottingham City Council's Review and Assessment and LAQM reports is given in Appendix A.

The reports are available on the Council's website:
http://www.nottinghamcity.gov.uk/sitemap/services/environment/pollution/air_pollution/air_quality.htm

Monitoring Information

The DA 2008 gives information about the continuous automatic monitoring and diffusion tube sites within the Nottingham City area including their mapped locations; summaries of the nitrogen dioxide and PM_{10} continuous monitoring data for the years 2004 to 2006 and diffusion tube annual mean nitrogen dioxide concentrations for 2006.

The 2007 and 2008 nitrogen dioxide monitoring data measured at the continuous automatic sites are shown in Tables 1 to 4 below. The results are for 12 months ratified data unless otherwise stated.

Whilst the National Air Quality Objectives are given in DA 2008 Table 1, those for nitrogen dioxide are repeated here for ease of comparison with the monitored results.

Annual Mean 40 $\mu g/m^3$

I hour mean 200 $\mu g/m^3$ not to be exceeded more than 18 times a year.

Both objectives were to be achieved by 31 December 2005 (and maintained thereafter).

Table 1

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at AURN, Clinton Street East, City Centre

	NO_2 μgm^{-3}		Objective exceeded?
	2007	2008	
Annual mean	33.3	33	No
Maximum 1 hour mean	183	233 6 occurrences >= 200 μgm^{-3}	No
Data Capture %	96.7	97.8	

Table 2

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at AQMS, Queens Medical Centre, Clifton Boulevard

	NO_2 μgm^{-3}		Objective exceeded?
	2007	2008	
Annual mean	34	35	No
Maximum 1 hour mean	135.6	151	No
Data Capture %	98.8	92.7	

Table 3

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at CG NOx, Carter Gate, City Centre

	NO_2 μgm^{-3}		Objective exceeded?
	2007	2008	
Annual mean	42.4	44	**Yes**
Maximum 1 hour mean	406.8 3 occurrences >= 200 μgm^{-3}	179	No
Data Capture %	91.9	98.3	

Table 4

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at LS NOx, Lace Street, Dunkirk

	NO_2 μgm^{-3}		Objective exceeded?
	2007*	2008	
Annual mean	43.7	41	**Yes**
Maximum 1 hour mean	149	237 4 occurrences >= 200 μgm^{-3}	No
Data Capture %	79.5	93.9	

*9 months data 01.04.2007 to 31.12.2007 ratified

The 2007 and 2008 bias adjusted nitrogen dioxide diffusion tube monitoring data are shown in Table 5 below. The raw data and details of the bias adjustment factors applied are given in Appendix B.

Table 5

2007 and 2008 Annual Mean Nitrogen Dioxide Concentrations - Diffusion Tube Measurement

Site Type	Tube Id	Site	2007 Bias Adjusted Annual Mean NO_2 μgm^{-3}	2008 Bias Adjusted Annual Mean NO_2 μgm^{-3}
R	A	Ilkeston Road (NS)	27.7	26
UB	B	Noel Street Baths (NS)	25.1	22
UB	W	Ransom Drive (NS)	6.1	5
R	C	Clifton Boulevard	29.6	31
R	D	Beeston Road (1)	**50.4**	**47**
R	F	Beeston Road (2)	**52.5**	**55**
R	G	Beeston Road (4)	39.4	**45**
R	H	Beeston Road (3)	**45.8**	38
Su	I	Derby Road (1)	33.1	33
R	J	Derby Road (2)	32.7	34
R	K	Castle Boulevard	**44.2**	**42**
R	M	Canning Terrace	**46.5**	**49**
R	N	Upper Parliament St.	**47.1**	**52**
R	O	Shakespeare St.	***54.0**	**51**
R	P	Mansfield Road	**47.0**	**49**
R	Q	Woodborough Road	**51.7**	**48**
R	S	Carter Gate	**40.6**	**44**
R	T	Queens Road	**45.8**	**52**
R	U	Trent Bridge	30.5	****51**
R	V	Alfreton Rd./Bentinck Rd.	38.2	35

All 11 - 12 months averages except * 7 mths and ** 9 mths

R = Roadside UB =Urban background Su = Suburban NS = national survey

Concentrations above the annual mean NO_2 AQO are highlighted in bold typeface.

2007 and 2008 Monitoring Data Analysis

The above results show that neither of the AQOs for nitrogen dioxide (annual mean=40μg/m^3 and I hour mean = 200μg/m^3 not to be exceeded more than 18 times per year) were exceeded at the AURN and the AQMS which are non-roadside continuous monitoring sites.

This contrasts with the results for the roadside continuous monitoring sites CG NOx and LS NOx. The 2007 and 2008 NO_2 concentrations were between 41 and 44μg/m^3 therefore the annual mean AQO was exceeded both years at both sites. The 1 hour mean AQO was not exceeded at either site.

The 2007 and 2008 diffusion tube NO_2 levels are broadly consistent with the 2006 results and show exceedences of the annual mean AQO at some sites within or nearby existing AQMAs or where traffic flows have significantly altered as a result of traffic schemes such as Turning Point.

The proposed amended AQMAs outlined in the DA 2008 encompassed most of the additional diffusion tube sites where exceedences of the annual mean AQO were identified.

The R & A Appraisal comments about exceedences outside the proposed amended AQMAs relate to the three diffusion tube monitoring sites, K, T and U. Table 5 above shows that in 2007 and 2008 at sites K and T the annual mean NO_2 AQO was exceeded which is consistent with the 2006 data. NO_2 levels at site U have varied between exceeding and not exceeding 40μg/m^3 between 2006 and 2008 - given this and its location near a busy 6 lane, main traffic route it is reasonable to consider it as a site of likely exceedence of the annual mean NO_2 AQO.

In respect of the 1 hour AQO the guidance advises Local Authorities that it can be assumed that exceedences of this objective are only likely to occur where annual mean nitrogen dioxide concentrations are equal to or greater than 60μg/m^3. No continuous monitoring or diffusion tube annual mean nitrogen dioxide concentrations for 2007 and 2008 were greater than 55μg/m^3.

Generally, it is reasonable to assume from the last three years' monitoring results that nitrogen dioxide levels won't significantly reduce for the next few years and therefore the annual mean AQO is likely to continue to be exceeded in parts of the Nottingham city area.

Modelling Information

Nottingham City Council carries out modelling using the Atmospheric Dispersion Modelling System (ADMS) by Cambridge Environmental Research Consultants, CERC. ADMS-Urban is an advanced dispersion model - information can be input on road traffic, traffic composition, flows and speeds; industrial and domestic sources, background pollutant data and meteorology. The model can be used for predicting concentrations for single point sources or for complex urban areas; outputs can be numerical or displayed as contour plots.

Whilst comprehensive validation of the model has been carried out by CERC and others (see the CERC website www.cerc.co.uk) in order to have confidence in the model predictions for the Nottingham City area verification work is undertaken as part of the modelling exercise. Model verification involves comparison between modelled and monitored pollutant concentrations at relevant locations and considering the various uncertainties associated with differences between the results. Verification may lead to the conclusion that an adjustment factor should be applied to the predicted pollutant concentrations so that they more accurately represent the monitoring information for the area.

Previous modelling work undertaken by Nottingham City Council for the Review and Assessment process led to the declaration of the existing AQMAs No 2 and 3 and to the proposed amendments outlined in the DA 2008. The modelling approach used then was to compile an emission inventory of road traffic information, area and industrial sources and use meteorological data from a nearby weather station as well as monitored background pollutant concentrations from an AURN rural site.

Following verification work a model adjustment factor was derived by comparison between monitoring and modelled data at the continuous monitoring sites. Modelling was used to predict nitrogen dioxide levels and the model adjustment factor applied to give the final concentrations. The modelling information and results for 2006 are presented in the DA 2008.

The most recent guidance, LAQM TG (09) Annex 3 states that where the modelled/monitored NO_2 comparison indicates a model adjustment is required then the NOx concentrations should be verified and adjusted (if necessary) before they are used within empirical equations or models. It also comments that “The adjustment of NOx is often carried out on

the component derived from local Road Traffic Emissions – the Road Contribution" therefore the 2007 modelling presented in this report has been carried out using this methodology .

2008 has not been modelled for a number of reasons: 2008 meteorological data has not been obtained; 2008 is not considered a typical year; modelling 2008 would lead to further delay in completing the DA and the amendment of the AQMAs; there are differences in the findings between 2006 and 2007 and to add a further year could potentially add complications that don't alter the outcomes. Also the recently published new traffic emission factors need to be incorporated into the modelling undertaken for future rounds of R & A but are not currently available for the model.

Model Verification and Adjustment

The model verification and adjustment approach specified in LAQM TG (09) Annex 3 has been followed with advice and guidance from the R & A helpdesk.

In respect of verification the guidance says that where modelling underestimates total nitrogen dioxide concentrations then adjusted modelled predictions of road source contribution NOx should be used to predict total annual mean nitrogen dioxide concentrations.

The following is a précis of the adjusted road contribution NOx methodology for which only roads are modelled:

a) Determine an estimate of the monitored road source contribution NOx.

b) Compare monitored road NOx with modelled road NOx and derive an adjustment factor to apply to the modelled road source contribution NOx.

c) Determine the corrected total annual mean NO_2 from the adjusted modelled road source contribution NOx.

Full details of the methodology can be found in LAQM TG (09) Annex 3 Box A3.6. The guidance is available on Defra's website:
http://www.defra.gov.uk/environment/airquality/local/guidance/index.htm

Modelling information about model inputs and outputs; verification and the derived adjustment factor is given in Appendix C.

Uncertainties associated with monitoring and modelling processes arise for a number of reasons including:-

- Measured data uncertainty – partly reflected by the precision and accuracy of the monitoring systems.
- Model uncertainty - the model algorithms are mathematical approximations to the way the atmosphere behaves (e.g. chemistry, dispersion).The parameters used in the model set-up (e.g. surface roughness) are mathematical constants used to represent a physical characteristic.
- Input data uncertainty - emissions are either monitored with their inherent error or derived; estimated background concentrations; meteorological data; source geometry. All of these carry a degree of error.

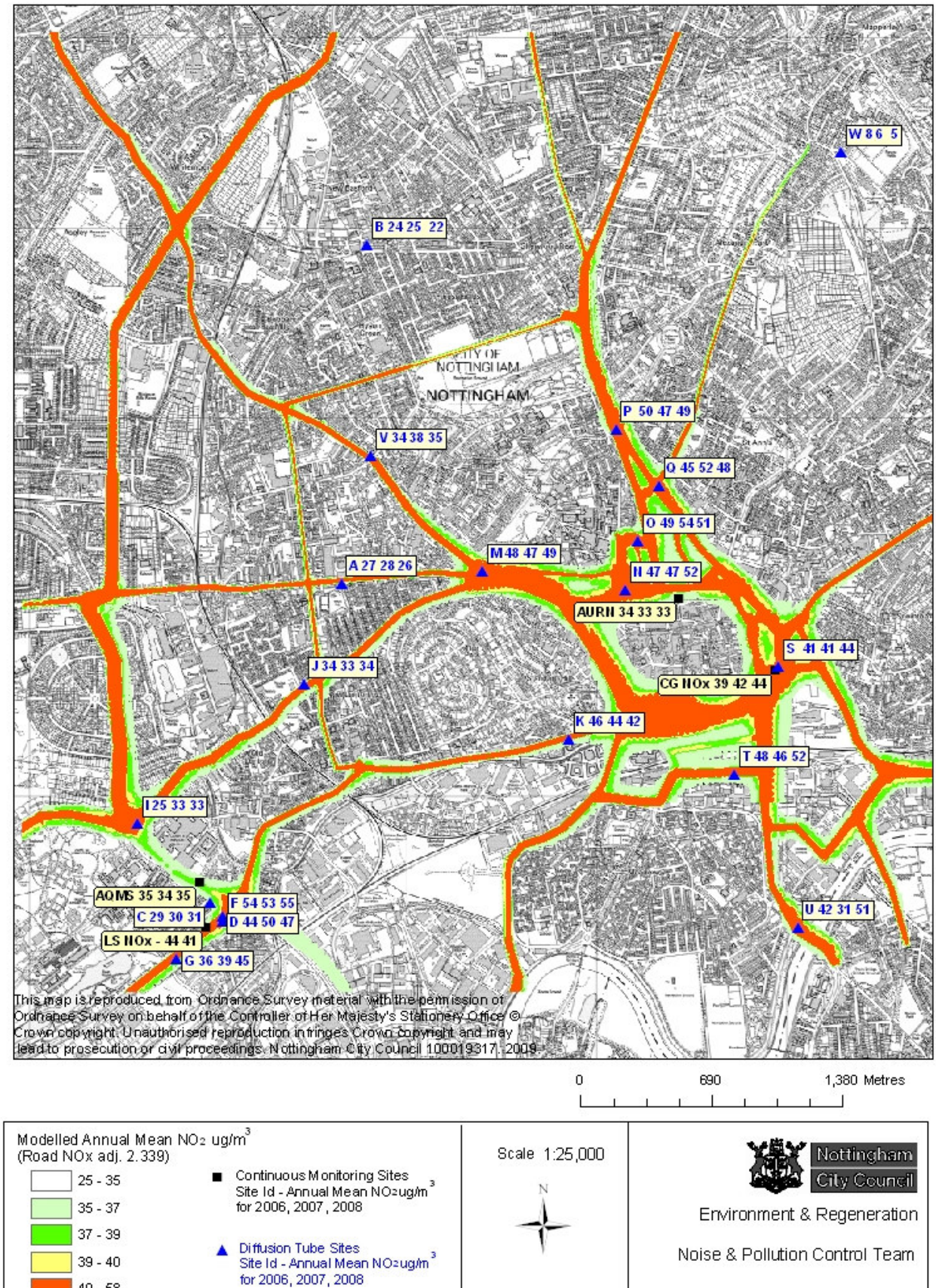
It is generally recognised that differences between monitored and modelled results are likely to be due to a combination of the above. While such uncertainties cannot be eliminated where possible they have been minimised by verification of the modelling; checking model inputs and ensuring a good standard of QA/QC of the monitoring equipment and data.

Following verification, road source contribution NOx was modelled for 25 x 1 km^2 areas (this allowed the appropriate background to be added) in the city. The adjustment factor was applied to the road source contribution NOx model output and the corrected annual mean NO_2 concentrations determined.

Figure 1 shows mapped contours for the corrected predicted 2007 annual mean NO_2 concentrations. The monitored annual mean NO_2 concentrations for 2006, 2007 and 2008 at continuous and diffusion tube sites are also shown.

Figure 1

2007 Adjusted Modelled Total Annual Mean Nitrogen Dioxide Concentrations



Modelling Data Analysis

The modelling predicts that the annual mean nitrogen dioxide Air Quality Objective may not have been met in all locations with relevant exposure during 2007. Generally outside the AQMAs the areas of predicted exceedence are along the modelled roads which, in some instances, extend to properties either side. Currently no monitoring takes place near some of these roads, so the diffusion tube monitoring programme will be need to be expanded to cover these areas to better inform future rounds of R & A.

Considering sites where exceedences of the annual mean AQO were measured there is good agreement between the modelled and monitored nitrogen dioxide levels. This applies to most of the sites - LS NOx, F, G, H, S, N and CG NOx within the existing AQMAs.

Tubes such as P, Q, M, F, D and G were placed as result of previous rounds of R & A; the modelling is in agreement with monitoring results and confirms exceedence of the annual mean AQO. These areas of exceedence are consistent with the 2006 modelling presented in the DA 2008.

At T, K & U the sites referred to the R & A DA 2008 appraisal, the road source contribution NOx modelling methodology predicts exceedence of the AQO and this is consistent with the diffusion tube monitoring results.

Figure 1 also shows that NO_2 levels were over estimated at roadside DT sites such A, C, J, and V which are on heavily trafficked routes into and out of the city. The information below shows tube distances from the kerb and the 2007 monitored and modelled annual mean NO_2 concentrations.

Site Id	Distance from Kerb (m)	2007 Monitored Annual Mean NO_2 μgm^{-3}	2007 Modelled Annual Mean NO_2 μgm^{-3}
A	6	27.7	34.8
C	13	29.2	35.5
J	12	32.7	35.7
V	6	35.7	38.2

At site I, the monitored and modelled concentrations were 33.1$\mu g/m^3$ and 42.7$\mu g/m^3$ respectively. The tube is located on the façade of a residential property 25m from the kerb of a major traffic junction which, because it is not within 15m of the kerb is not considered a

roadside site. It is classified as a ‘Suburban’ site - the most suitable of the monitoring descriptions options given in LAQM TG (09).

The tubes at these five sites A, C, J, V and I are all located on the facades of residential properties or sensitive receptors. The sites are typical of much of the Nottingham City inner area encompassed by the ring road in that; the main traffic routes are characterised by relatively wide roads with residential properties either side, quite often set back from the roadside.

The monitored 2006, 2007 and 2008 nitrogen dioxide concentrations have been similar year on year at each of these sites and the annual mean AQO has not been exceeded.

The over estimation of concentrations is probably mainly due to the use of the national background estimated data since this contribution to total nitrogen dioxide levels is much greater than the road contribution.

Nottingham City has two urban background diffusion tube sites, B and W that are part of the National Nitrogen Dioxide Survey. For 2007 at site B the national background map NO_2 unmodified concentration was 27.2μg/m^3 compared with the diffusion tube annual mean NO_2 of 25.1μg/m^3. Site W is more distant from the City centre and the comparison is poor, the respective values being 22.4μg/m^3 and 6.1μg/m^3. The area around site W was not part of the 25 x 1 km^2 areas that were modelled for this report.

Conclusions of the Detailed Assessment 2008 – Annex 1

The supplementary information (to the DA 2008) presented in this report indicates that, in keeping with previous rounds of R & A, the nitrogen dioxide annual mean AQO of 40µg/m^3 is likely to be met in the majority of the Nottingham City area. However there are parts of the City, mostly near and within existing AQMAs, where both modelling and monitoring results demonstrate that the objective has been exceeded at locations with relevant exposure of members of the public. This is consistent with the 2006 modelling exercise undertaken for the DA 2008.

At other locations, the modelling suggested exceedence occurred however some of these were monitoring sites and their results showed that the annual mean AQO was not exceeded.

None of the continuous monitoring sites measured exceedence of the hourly nitrogen dioxide AQO of 200µg/m^3 no more than 18 times per annum.

Nottingham City Council needs to expand its diffusion tube monitoring programme to cover those areas where modelling suggests exceedence but the degree of uncertainty is such that it is not appropriate to include them in Air Quality Management Areas at the moment. Additional monitoring information will assist in informing future rounds of Review and Assessment.

Nottingham City Council has identified with reasonable certainty, that the nitrogen dioxide annual mean Air Quality Objective has been exceeded and is likely to continue to be exceeded in parts of its area. Therefore it is necessary to modify both of the existing Air Quality Management Areas to reflect the findings of the modelling and monitoring.

Progressing Local Air Quality Management.

Amendments to the Existing Air Quality Management Areas

The Environment Act 1995 Section 83 (2) states 'An order under this section may, as a result of a subsequent air quality review,-

(a) be varied by a subsequent Order; or

(b) be revoked by such an Order,

if it appears on that subsequent Air Quality Review that the Air Quality Standards and Objectives are being achieved, and are likely throughout the relevant period to be achieved, within the designated area.

Proposed Air Quality Management Areas Amendments

In determining the boundaries of the amended AQMAs - the 2007 monitoring data; the predicted modelled contours; the advice given in the guidance LAQM TG (09), PG (09) and by the R & A help desk have been taken into account. The geographical extent of the amended AQMAs has been defined where predicted annual mean nitrogen concentrations are 39µg/m^3 or greater and there is relevant exposure of members of the public. A concentration of 39µg/m^3 was chosen to account, in part, for the numerous uncertainties associated with the modelled inputs and outputs.

The boundary lines of the AQMAs have been drawn by aligning to them to defined features such as roads and therefore the perimeters of the AQMAs tend to cover a slightly greater area than the modelled exceedence contours.

As shown in Figure1 page 14 there are a number of locations, outside the existing AQMAs, where both modelled and monitored annual mean nitrogen dioxide concentrations show exceedence of the AQO. Where there is relevant exposure of members of the public these areas have been incorporated into the amended AQMAs.

LAQM TG (09) says that “Provided that the data are “fit for purpose”, then precedence should always be given to measured concentrations over those that have been predicted using a model”. Consequently the sites where 2006, 2007 and 2008 measured annual mean nitrogen dioxide levels were less than 40µg/m^3 but the modelling predicts exceedence of the AQO have not been included.

Also where the modelling predicts exceedence but there is no monitoring data these locations have not been included because it is evident that the modelling over predicts concentrations at some similar sites that are monitored and in the absence of measurements the level of uncertainty is relatively high.

Nottingham No:2 Air Quality Management Area – Nitrogen Dioxide

The current AQMA No:2 is located in the City centre. It is proposed to amend the area as shown in Figure 2 below. The amendment extends the AQMA to the north, north-west and to the south along roads where there are residential properties nearby and removes a bus station and a bus depot.

The southernmost perimeter of the amendment ends at north side of Trent Bridge. The neighbouring authority is Rushcliffe Borough Council and the boundary of their AQMA for nitrogen dioxide is at the south side of Trent Bridge.

Nottingham No:3 Air Quality Management Area – Nitrogen Dioxide

This AQMA is located in the Dunkirk area of the City. It is proposed to amend the area as shown in Figure 3 below. The amendment extends the AQMA along a road to incorporate the residential properties that border it. It removes an area around a major junction where three years of diffusion tube monitoring have shown that the annual mean AQO has not been exceeded although the modelling predicts exceedence. The junction is a large multi-lane roundabout with the ring road passing underneath it which means it is complex to model and while the model output for this area could be considered the worst case scenario it has to be interpreted with caution.

The amendment also removes the QMC Hospital campus from the AQMA - three years of continuous monitoring at the site have shown that neither of the nitrogen dioxide AQOs have been exceeded.

Figure 2 Proposed Variation of AQMA No:2 Nitrogen Dioxide – City Centre Area

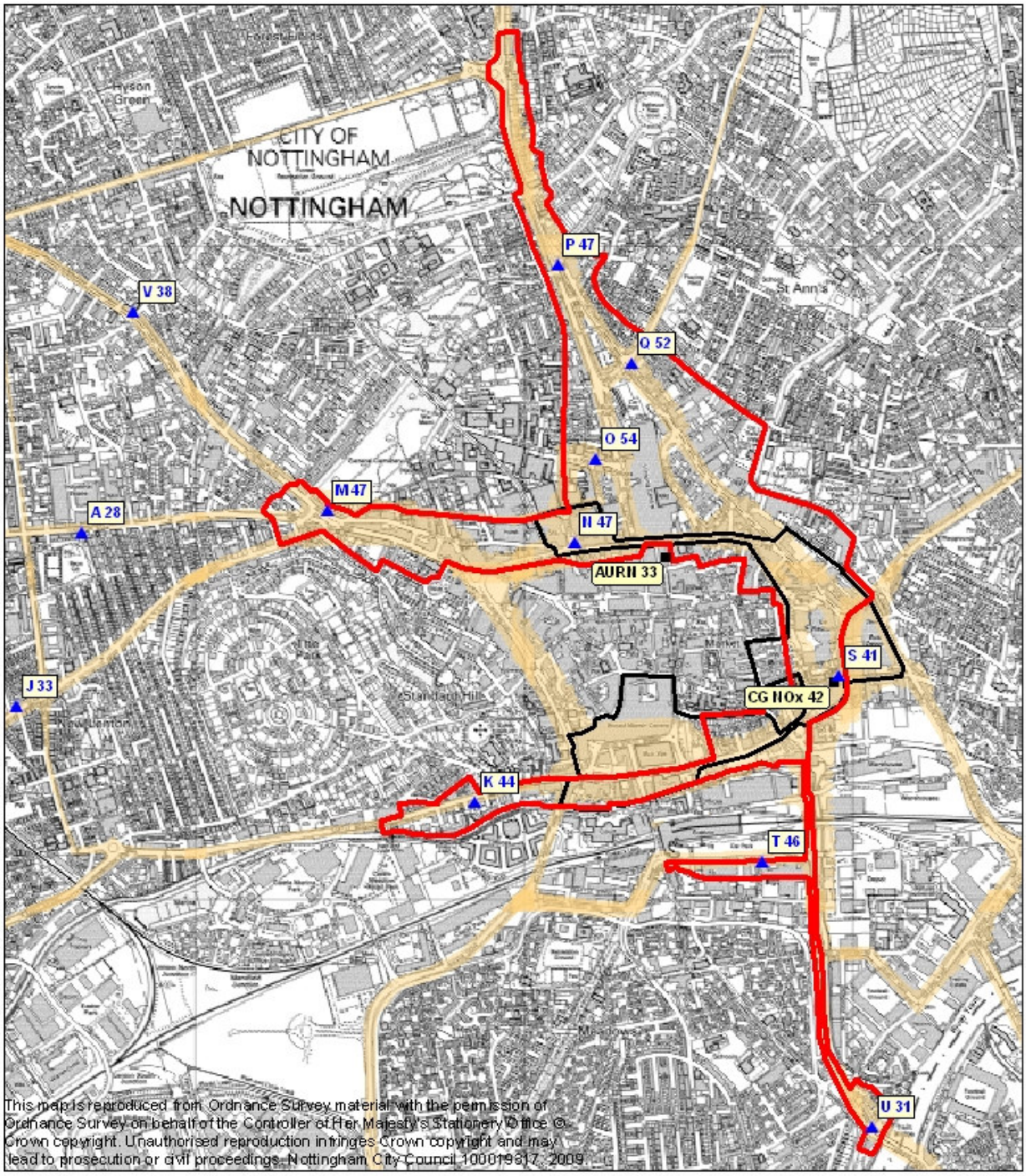
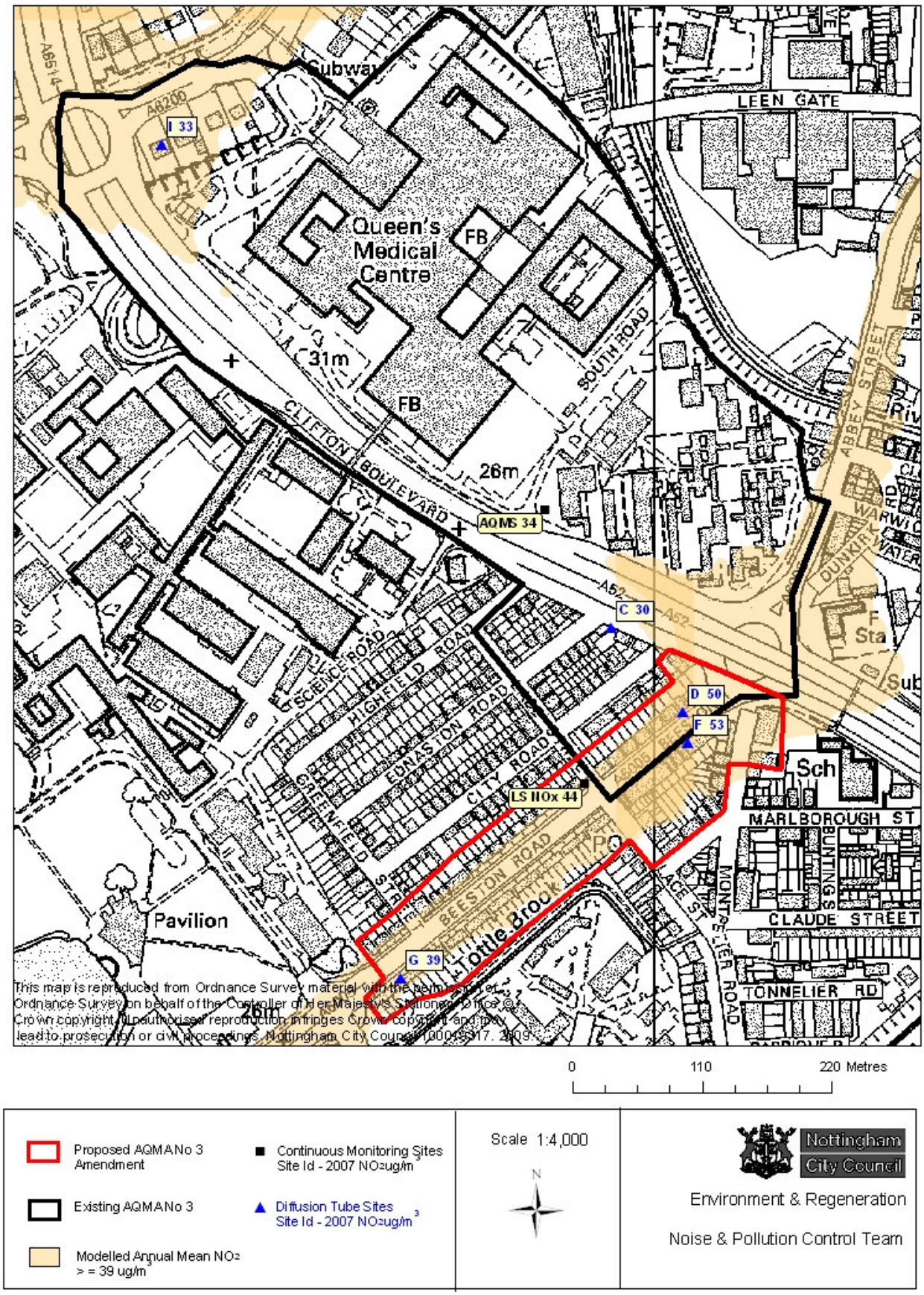


Figure 3 Proposed Variation of AQMA No:3 Nitrogen Dioxide – Dunkirk Area



What Happens Next

As required by the Policy Guidance, LAQM.PG(09), Nottingham City Council will consult all relevant statutory consultees, local stakeholders, businesses and members of the public on the Detailed Assessment Consultation Document May 2008 and Detailed Assessment – Annex 1 Supplementary Information for Nitrogen Dioxide September 2009 including the proposed amendments to the AQMAs.

After consultation and acceptance by Defra of the reports and varied AQMAs proposals, in order to comply with the LAQM.PG (09), Nottingham City Council is expected to finalise the boundaries for the amended AQMAs and to make the Orders for the amended Air Quality Management Areas within four months of receipt of Defra's comments.

Air Quality Actions Plans

For the existing AQMAs, road traffic is the major contributor to exceedences of the annual mean NO_2 AQO and consequently Nottingham City Council has integrated the required AQAP into its Local Transport Plan (LTP) which is available on the Council's website. This approach will be continued for the amended AQMAs. The integration of Action Plans with Local Transport Plans or Local Implementation Plans is advocated in the PG (09) as a systematic way to join up air quality management and transport planning.

Further Assessment of Air Quality within an AQMA

Section 84 (1) of the Environment Act 1995 requires Local Authorities to undertake a further assessment of existing and likely future air quality in an AQMA. Section 84 (2) requires the further assessment to be made within twelve months of designating (or varying) the AQMA. There is also a requirement to consult on the further assessment and make it available to the public.

For the variation of an AQMA, the guidance states that "If there is only to be a minor extension to an existing AQMA order, such as the encompassing of a few further buildings or inclusion of a road junction, as long as the authority has access to substantial information about the area of extension or can reliably extrapolate from information it has about the area originally designated, Defra, ….. would not expect that authority to have to undertake an extensive further assessment." A more comprehensive assessment is expected if the order is varied by a more substantial change, for example going from a few streets to a whole borough designation.

The Next Annual Air Quality Report

Local authorities are required to prepare annual air quality reports between subsequent rounds of reviews and assessments to ensure continuity in the LAQM process. According to the timetable shown in LAQM TG (09) Box 1.3 the next step is for a Progress Report to be completed by the end of April 2010. All authorities are expected to complete this, "**regardless of whether they are undertaking a Detailed Assessment or not**".

References

AEA Energy & Environment (Feb 2008) **Diffusion Tubes for Ambient NO_2 Monitoring: Practical Guidance for Laboratories and Users Issue 1a**

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

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Part IV of the Environment Act 1995 Local Air Quality Management: Policy Guidance (PG 09)

Department for the Environment, Food and Rural Affairs (February 2009)
Part IV of the Environment Act 1995 Local Air Quality Management Technical Guidance LAQM.TG (09)

Department for the Environment, Food and Rural Affairs (2007) **The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007**

Environment Act 1995

Nottingham City Council (2000 - 2008) **Previous Review and Assessment Reports:**

City of Nottingham
Air Quality Review & Assessment First & Second Stage April 2000

City of Nottingham
Air Quality Review & Assessment Second & Third Stage Report 2001

City of Nottingham
Local Air Quality Management: Stage Four Review & Assessment of Nottingham's Air Quality Management Areas July 2003

City of Nottingham
Local Air Quality Management: Updating and Screening Assessment October 2003

City of Nottingham
Local Air Quality Management: Detailed Assessment August 2004

City of Nottingham
Local Air Quality Management: Progress Report April 2005

Nottingham City Council
Local Air Quality Management: Updating and Screening Assessment June 2006

Nottingham City Council
Local Air Quality Management: Detailed Assessment Consultation Document May 2008

Nottingham City Council (March 2006) **Local Transport Plan, LTP 2005/7-2010/11**

Websites

www.cerc.co.uk

http://www.defra.gov.uk/environment/airquality/local/guidance/index.htm

Nottingham City Council Website http://www.nottinghamcity.gov.uk

http://www.nottinghamcity.gov.uk/sitemap/services/environment/pollution/air_pollution/air_quality.htm

http://www.nottinghamcity.gov.uk/sitemap/services/transport_and_streets/transport_planning/cdt_local_transport_plan.htm

Appendix A

Previous Review and Assessment Reports

Table A1 Previous Review and Assessment Reports

Title	Date	Outcome	**AQMA Declared/ Revoked? (**Date of AQMA Order/s)
City of Nottingham Air Quality Review & Assessment First & Second Stage	April 2000	Third stage assessment for sulphur dioxide, nitrogen dioxide and particulates, PM10 necessary. No further assessment of 1, 3 Butadiene, benzene, carbon monoxide and lead required.	-
City of Nottingham Air Quality Review & Assessment Second & Third Stage Report	September 2001	Areas of the city where unlikely to meet air quality objectives for nitrogen dioxide or sulphur dioxide. Proposed 1 AQMA for SO_2 and 2 AQMAs for NO_2	**Declared** AQMA No:1 (Sulphur dioxide) (2002) AQMA No:2 (Nitrogen dioxide) (2002) AQMA No:3 (Nitrogen dioxide) (2002)
City of Nottingham Local Air Quality Management Stage Four Review & Assessment of Nottingham's Air Quality Management Areas	July 2003	Determined that AQOs for sulphur dioxide – hospital chimney and nitrogen dioxide – traffic sources, unlikely to be exceeded by 'due dates' therefore no Air Quality Action Plans needed	-
City of Nottingham Local Air Quality Management Updating and Screening Assessment	October 2003	Necessary to proceed to a Detailed Review and Assessment for nitrogen dioxide with respect to a number of roads and for sulphur dioxide in the vicinity of the Nottingham Main-line Station.	-
City of Nottingham Local Air Quality Management Detailed Assessment	August 2004	Sulphur dioxide 15-minute mean AQO likely to be met at locations of 'relevant exposure' at Nottingham Mainline Station. Nitrogen dioxide annual mean AQO likely to be met. Concluded insufficient monitoring data available to	-

Title	Date	Outcome	**AQMA Declared/ Revoked? (**Date of AQMA Order/s)
		allow revocation of any of the AQMAs.	
City of Nottingham Local Air Quality Management Progress Report	April 2005	Concluded that SO_2 monitoring data sufficient to propose revocation of AQMA No:1 (Sulphur dioxide). Necessary to maintain AQMAs No 2 & 3 (nitrogen dioxide)	-
Nottingham City Council Local Air Quality Management Updating and Screening Assessment:	June 2006	Necessary to proceed to a Detailed Assessment for PM_{10} for 2 roads in the city centre and for nitrogen dioxide for a number of roads and junctions based on guidance criteria and some diffusion tube data. AQMA No:1 (Sulphur dioxide) to be revoked - agreed by Defra	**Revoked** AQMA No:1 2002 (Sulphur dioxide) (5 April 2007)
** Nottingham City Council Local Air Quality Management Detailed Assessment Consultation Document	May 2008	Conclusion that no further action required for PM_{10} - accepted by Defra **Proposed amendments to existing AQMAs No.2 & No.3 for nitrogen dioxide.** ****Further work for nitrogen dioxide being undertaken following comment and assessment by Defra**	-
Nottingham City Council Local Air Quality Management Progress Report	July 2008	Concluded that there was no need to undertake a further detailed assessment - accepted by Defra	-
2009 Air Quality Updating and Screening Assessment for Nottingham City Council	April 2009	Concluded that there was no need to undertake an additional detailed assessment because all areas of potential exceedence are being considered in the revised DA May 2008 - accepted by Defra	

** The further work referred to is the subject of this report

Appendix B

Nitrogen Dioxide Diffusion Tube Information

Table B1 2007 and 2008 Diffusion Tube Unbiased Annual Mean Nitrogen Dioxide Concentrations

Tube Id	Site	2007		2008	
		Annual Mean NO_2 μgm^{-3}	Data Capture %	Annual Mean NO_2 μgm^{-3}	Data Capture %
A	Ilkeston Road (NS)	30.2	100	30.0	92
B	Noel Street Baths (NS)	29.0	100	24.3	100
W	Ransom Drive (NS)	7.0	100	5.8	92
C	Clifton Boulevard	34.2	100	35.5	100
D	Beeston Road (1)	58.3	92	52.3	100
F	Beeston Road (2)	60.7	92	62.3	100
G	Beeston Road (4)	45.6	100	51.5	100
H	Beeston Road (3)	52.9	100	42.3	100
I	Derby Road (1)	38.3	100	37.0	100
J	Derby Road (2)	37.8	100	38.5	100
K	Castle Boulevard	51.1	100	47.3	100
M	Canning Terrace	53.8	100	55.3	100
N	Upper Parliament St.	54.5	92	58.3	100
O	Shakespeare St.	62.4	58	56.8	100
P	Mansfield Road	54.3	100	54.3	100
Q	Woodborough Road	59.8	100	54.0	100
S	Carter Gate	46.9	92	49.8	100
T	Queens Road	52.9	100	58.5	100
U	Trent Bridge	35.3	100	51.0	75
V	Alfreton Rd./Bentinck Rd.	44.2	100	39.0	100

NS = national survey

Nitrogen Dioxide Diffusion Tube, Bias Adjustment and QA/QC Information

2007

During 2007 Nottingham City Council's diffusion tubes were supplied and analysed by Bureau Veritas Laboratories. The tubes were prepared using a 10% solution of TEA (triethanolamine) in de-ionised water. The tubes were exposed on site for one month before being returned for laboratory analysis.

Diffusion Tube Bias Adjustment Factor

A co-location study of triplicate diffusion tubes at three of the sites that monitor nitrogen dioxide continuously i.e. AURN, CG NOx and LS NOx between January 2007 and December 2007 was undertaken.

A bias adjustment factor was derived for AURN and CG NOx sites both of which had 12 months of data and data capture greater than 90%. These values were then averaged to give a single value. The averaged bias adjustment factor A = 0.865 was applied to the raw diffusion tube nitrogen dioxide concentrations. The bias adjusted annual means are shown in Table 5.

This approach was used because the two sites used represent urban background and roadside locations respectively. They are consistent with the majority of Nottingham City's diffusion tube sites and for some sites it would be difficult to determine which of the bias adjustment factors to use.

QA/QC

The laboratory is UKAS accredited and is required to take part in other proficiency schemes. Bureau Veritas Laboratories participate in a number of QA/QC monitoring systems to demonstrate satisfactory performance.

More detailed information regarding 2007 bias adjustment and diffusion tube QA/QC can be found in the Progress Report July 2008.

2008

Since April 2008 Nottingham City Council's diffusion tubes have been supplied and analysed by Gradko International, Hampshire. The tubes are prepared using a 20% solution of triethanolamine (TEA) in de-ionised water. The tubes are exposed on site for one month before being returned for laboratory analysis.

Diffusion Tube Bias Adjustment Factor

The R&A Helpdesk Database 2008 bias adjustment factor for Gradko 20% TEA in water tubes = 0.92.

The R&A Helpdesk Database 2008 bias adjustment factor for Casella/../Bureau Veritas 10% TEA in water tubes = 0.81.

The bias adjusted annual means shown in Table 5 are based on 12 months' data, January to December 2008 using the following calculation:

Ave Jan to Mar 10% TEA NO_2 x 0.81 = Y
Ave Apr to Dec 20% TEA NO_2 x 0.92 = Z

Annual mean NO_2 = (Y x 0.25) + (Z x 0.75) i.e. 25% of 10% TEA value + 75% of 20% TEA value.

Example

Y = 37 x 0.81 = 29.97
Z = 35 x 0.92 = 32.20

Annual mean NO_2 = (29.97 x 0.25) + (32.2 x 0.75) = 31.6 $\mu g/m^3$

QA/QC

Gradko International (diffusion tube supplier and analyst) is UKAS accredited; is assessed annually for compliance to ISO 17025 and participates in other proficiency schemes.

Gradko have confirmed that:

- their procedures have been amended to follow the guidance issued on behalf of Defra (AEA Energy & Environment, Feb 2008) relating to the preparation, extraction, analysis and calculation procedures for passive NO_2 diffusion tubes

- that most of these procedures were in force before the guidance was introduced and any amendments necessary in achieving compliance were minimal.

Gradko also participate in a number of QA/QC monitoring systems to demonstrate satisfactory performance:

- The Workplace Analysis Scheme for Proficiency (WASP) programme to ensure uniformity in data throughout the year. Only laboratories that are in the WASP scheme are used for analysing tubes from the National Nitrogen Dioxide Diffusion Tube Network.

- The monthly field inter-comparison exercise with other laboratories to enable assessment of bias and precision undertaken by AEA Energy & Environment.

- An external QC scheme to check solutions run by AEA Energy & Environment.

More detailed information regarding 2008 bias adjustment and diffusion tube QA/QC can be found in the Updating and Screening Assessment Report April 2009.

Appendix C

Nitrogen Dioxide Modelling Information

ADMS-Urban v2.3 – an atmospheric dispersion model was used to predict pollutant concentrations within the Nottingham City area.

Model Verification and Adjustment

The LAQM TG (09) guidance identifies that dispersion models may perform differently at kerbside, roadside and background sites. It also says “In most cases, local authorities are concerned with the predictions closer to roadside sites as these are more at risk of exceeding the air quality objectives and model verification is generally based on these locations.”

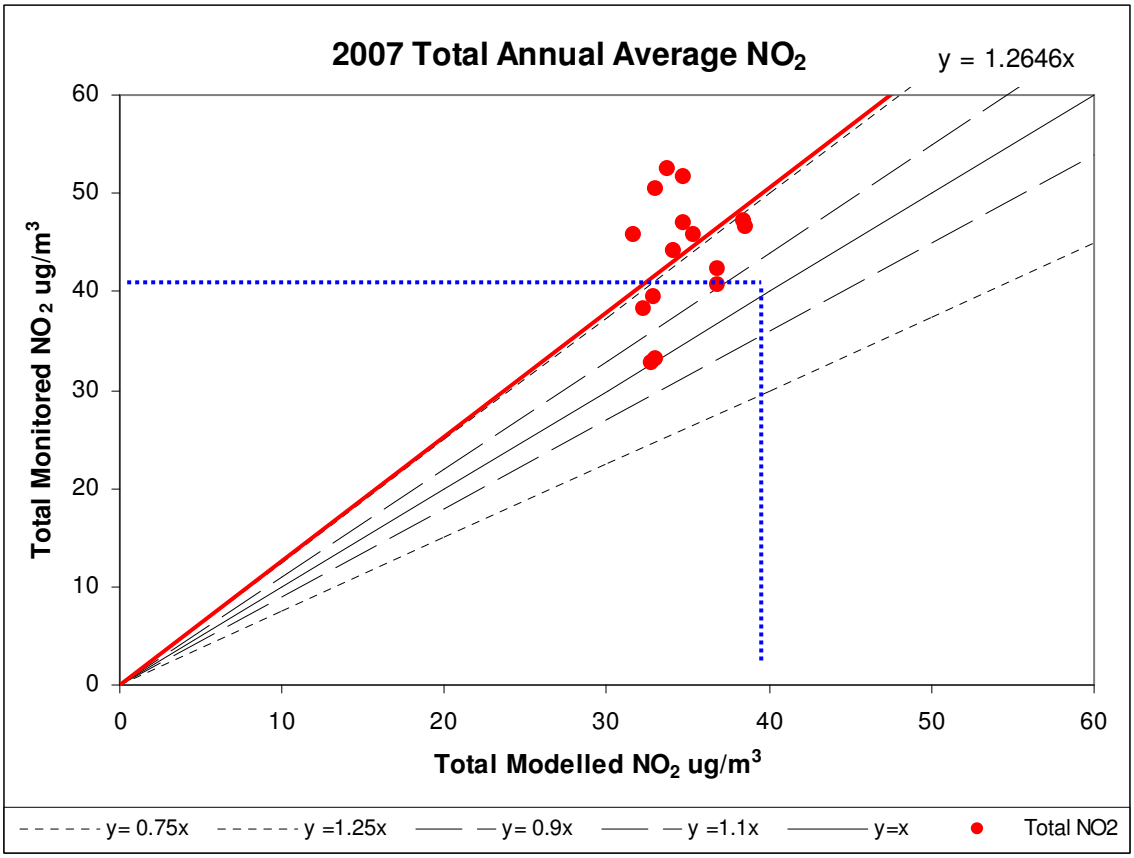
Initially the 2007 verification was carried out using the methodology outlined in the DA 2008 i.e. information was input on road traffic, traffic composition, flows and speeds; industrial and domestic sources, background pollutant data and meteorology.

Long term modelling was used to predict annual mean NO_2 concentrations and 99.8 percentile for NO_2 (i.e.1 hour mean equivalent to 18 exceedences) across the area and at specific locations.

However from comparison between monitored and modelled annual mean NO_2 concentrations it was apparent that the model under predicted NO_2 concentrations at a number of sites as shown in Graph C1 below. The graph shows the monitored v modelled NO_2 levels and it shows that a number of points are not within +/- 25% of the 1:1 regression line. The monitored data is for continuous and diffusion tube roadside sites.

In situations such as this, LAQM TG (09) advises that where adjustment needs to be undertaken it should be based on NOx (not NO_2) also that it should be applied to the ‘road source contribution’ NOx and not to total NOx concentrations.

Graph C1



Therefore following the methodology outlined in LAQM TG (09) Annex 3 ADMS Urban was used to model 2007 annual mean road source contribution NOx for the verification and modelling exercises.

Model Inputs

Traffic data

LGV and HGV traffic flows from 2007 AADT supplied by the Nottingham City Council's Transport Projects Section and the average speed for each link either supplied or determined previously for earlier modelling work. DMRB 2003 emission factors for 'urban' roads were used.

Meteorological Data

The 2007 hourly sequential data meteorological data from the Watnall station approximately 8 miles north of Nottingham.

Model Outputs

Long term modelling was used to predict annual mean road contribution NO_x concentrations for 25 x 1km^2 areas of the City. This approach enabled the appropriate background to be applied to each 1km^2. Both points and contour outputs were produced.

Background NOx and NO_2 Data

Nottingham City has two urban background diffusion tube sites, B and W that are part of the National Nitrogen Dioxide Survey. For 2007 at site B the national background map NO_2 unmodified concentration was 27.2µg/m^3 and this compares reasonably well with the diffusion tube annual mean NO_2 of 25.1µg/m^3. Site W is more distant from the City centre and the comparison is poor, the respective values being 22.4µg/m^3 and 6.1µg/m^3. The area around site W was not part of the 25 km^2 that were modelled for this report. The mapped locations of these sites can be seen in Figure 1 page 14.

The total background 1 x1 km NOx levels given in the national background maps are disaggregated into various source contributions. This allowed the trunk road and A road NOx - which were explicitly modelled - to be removed from the total NOx (where appropriate) before using the data in calculations thus avoiding double counting.

Where the total NOx was modified in this way the national background NO_2 data was adjusted using the LAQM Tools – 'NO_2 Adjustment for NO_x Sector Removal' calculator.

The background NOx and NO_2 data, LAQM Tools spreadsheets and calculator referred to in this appendix can be found on the website www.airquality.co.uk/laqm/tools.php

Model Adjustment Methodology

A number of steps were followed to determine an adjustment factor that could be applied to model predictions:

a) Estimate the monitored road source contribution NOx

For continuous data this involved taking the local estimated background NOx from the total measured NOx.

The local estimated background NOx for each location was found from the national background maps.

For diffusion tube data, the LAQM Tools - NOx to NO_2 spreadsheet was used to calculate road source contribution NOx since no direct measurement of NOx is possible with diffusion tubes.

b) Compare monitored road source contribution NOx with modelled road source contribution NOx

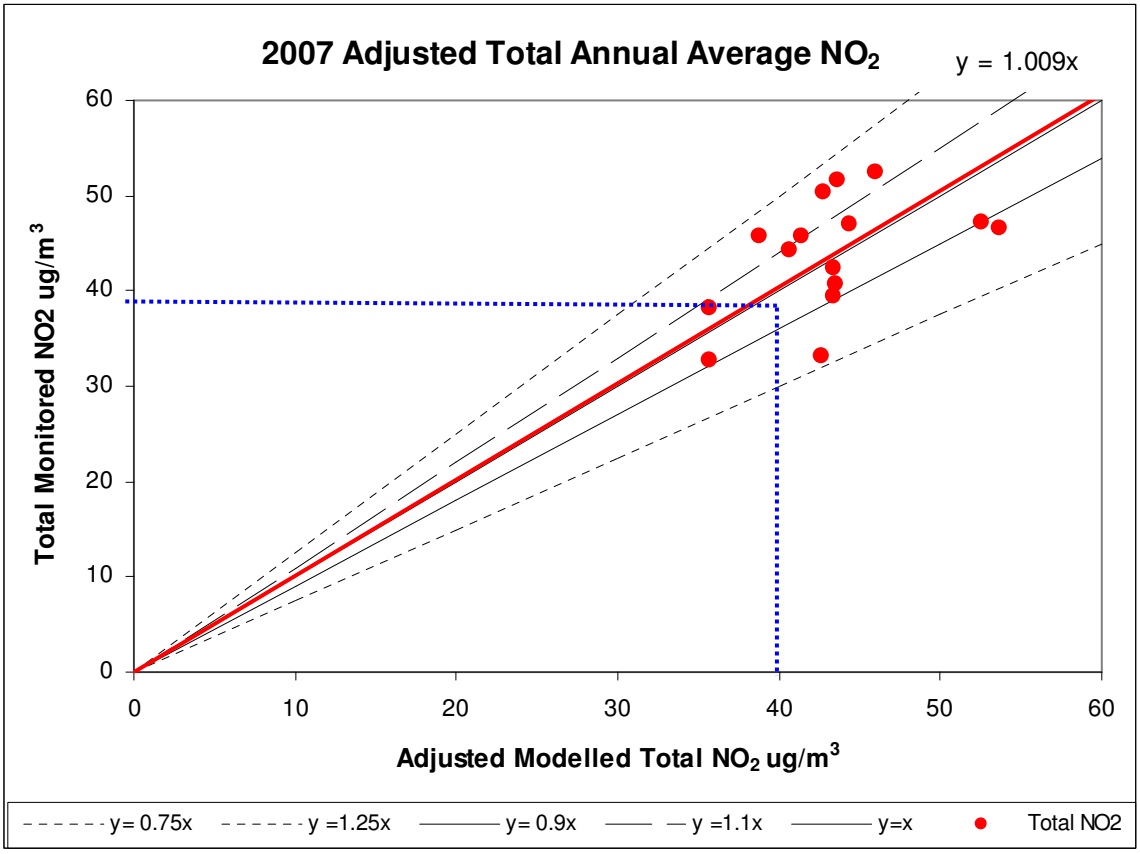
From a graph of monitored road source contribution NOx versus modelled road source contribution NOx, linear regression was used to determine an adjustment factor, the equation for the line was y=2.339x.
The modelled road source contribution NOx was multiplied by 2.339 to give the adjusted modelled road source contribution NOx

c) Determine the corrected total annual mean NO_2

The LAQM Tools - NOx to NO_2 spreadsheet was used to calculate the adjusted total annual mean NO_2 concentrations. The spreadsheet calculation required both the adjusted modelled road source contribution NOx and the adjusted background NO_2 concentrations to be input.

Graph 2 below shows the monitored total NO_2 v corrected modelled total NO_2 and the linear regression line through zero which is very close to the 1:1 line of regression.
All points are within +/- 25% of the 1:1 regression line and this indicates that it is reasonable to apply the derived adjustment factor to the modelling output.

Graph C2



Predicted Annual Mean Nitrogen Dioxide Concentrations

Annual mean nitrogen dioxide concentrations in the modelled areas were determined by applying the model adjustment factor to the modelled annual mean NOx for roads (i.e. road source contribution NOx) and then using the LAQM Tools - NOx to NO_2 spreadsheet to calculate the adjusted total annual mean NO_2 concentrations. The mapped adjusted predicted annual mean nitrogen dioxide concentrations are shown in Figure 1 page 14.