Horsham District Council

SUSSEX-air Air Quality Partnership

Horsham District Council

Detailed Assessment Report Storrington Air Quality

Local Air Quality Management
Environment Act 1995

June 2010

Executive Summary

Part IV of the Environment Act 1995 requiries local authorities to review and assess current and future air quality in their area against air quality objectives established in the National Air Quality Strategy. Where those objectives are not likely to be met then the local authority is required to designate an Air Quality Management Area (AQMA) at the relevant locations. The local authority must then draw up an Action Plan setting out the measures it intends to take to comply with the air quality objectives within the area covered by the AQMA.

Horsham District Council's previous air quality reports, including the Updating and Screening Assessment (2009) and Progress Report (2010), identified elevated levels of nitrogen dioxide along parts of the High Street and Manleys Hill in Storrington village.

This Detailed Assessment Report presents the results of the most recent monitoring and provides an accurate assessment of the likelihood of the air quality objectives being exceeded at 'relevant' locations in the area. The report has been prepared in accordance with the Local Air Quality Management Technical Guidance Note LAQM.TG(09).

The most recent diffusion tube monitoring carried out in 2009, together with some preliminary data from the automatic analyser in Storrington, has indicated that the annual mean concentration of nitrogen dioxide at the High Street/Manleys Hill/School Hill junction is above the air quality objective for nitrogen dioxide. Based on this detailed assessment the following conclusions have been reached:

- The declaration of an Air Quality Management Area is proposed to include the High Street/Manleys Hill/ School Hill junction and extending along the main route through the village where nitrogen dioxide concentrations are close to exceeding the air quality objective. The declaration will be on the basis of nitrogen dioxide where exceedences of the annual mean objective are predicted at relevant receptor locations.

- The spatial extent of the Air Quality Management Area has been presented in draft form but the exact geographical extent of the AQMA will be subject to consultation with members, local residents and businesses.

- To continue monitoring nitrogen dioxide at all current monitoring locations in order to assess any future changes in air quality. To expand the diffusion tube monitoring network to improve data accuracy and spatial coverage. To report on data from the new automatic monitoring station for nitrogen dioxide and particulate matter.

The full conclusions and recommendations of the Detailed Assessment are contained in Section 5 of this report. A draft AQMA boundary has been drawn up for further consultation and is detailed in Section 6.

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1. Introduction

1.1 Purpose of Report

The report has been produced by the Public Health and Licensing Department to provide a detailed summary of Horsham District Council's air quality monitoring and assessment work in respect of Storrington, West Sussex. The report has been prepared in accordance with the Council's Local Air Quality Management obligations under the Environment Act 2005 as part of the fourth round of review and assessment.

1.2 General Description of Local Authority Area

Horsham District is a predominantly rural area with a population of 126 000. The total area is 205 square miles. Horsham is the main town and the principal administrative and commercial centre within the district with a population of around 40 000.

Horsham District is well served by transport links to London, Gatwick Airport, the M25, the coast and Europe. A network of subsidiary routes connects the villages and small centres of population.

A large proportion of the district is composed of countryside with a varied landscape of woodland, heathland, downland, river valleys and meadows being represented. Areas of Outstanding Natural Beauty, Sites of Special Scientific Interest, and Sites of Nature Conservation Importance overlap the area. At the southern end of the district there is the newly designated South Downs National Park. Agriculture remains a major user of land within the District. Significant industrial premises include two major landfill sites and two brickworks.

1.3 Review and Assessment of Air Quality in Horsham District.

Under the Environment Act 1995, local authorities are required to Review and Assess (R&A) air quality on a regular basis. A review of air quality means a consideration of the levels of pollutants in the air for which objectives are prescribed in Regulations[1], and estimations of likely future levels. An assessment of air quality is the consideration of whether estimated levels for the relevant future period are likely to exceed the levels set in the objectives. A table of reports published is presented in Table 1 below.

The first review and assessment round was completed in 2000. The main conclusion was that the national air quality objectives were not likely to be exceeded at any locations in the District.

This first round of R&A constituted a benchmark against which Horsham District Council measure progress in making improvements to the local air quality. Subsequent progress reports were completed in 2004 and 2005. In 2006 an Updating and Screening Assessment was completed. In all these reports no exceedance of air quality objectives was identified or predicted.

[1] Air Quality Regulations for England (2000; Amendment Regulations 2002)

Guidance issued by the Department for Environment, Food and Rural Affairs (DEFRA) requires those local authorities, who found no exceedence of the air quality objectives in the last Updating and Screening Assessments (USA), to produce a Progress Report (PR) of local air quality.

The Progress Report submitted in 2007 identified an exceedance of the air quality objective for nitrogen dioxide in Storrington and in Cowfold in 2006. The need for a Detailed Assessment to be undertaken at both locations was indicated in the conclusions to the 2007 Progress Report. The data used for the 2007 report was based on diffusion tube monitoring from newly established sites in those locations and the report highlighted the need for continuous monitoring equipment to be installed in order to confirm the results. Steps were taken to secure the necessary funding for the equipment.

The Progress Report presented in 2008 confirmed the exceedance of the air quality objective for nitrogen dioxide at both Cowfold and Storrington. Additional diffusion tubes were introduced into Storrington and Cowfold to supplement monitoring data. However, difficulties in siting the automatic monitoring equipment to undertake detailed monitoring delayed the completion of the Detailed Assessment for Storrington.

The Updating and Screening Assessment submitted in 2009 confirmed continued exceedance of the air quality objective for Nitrogen Dioxide at Storrington and Cowfold on the basis of diffusion tube monitoring results. An automatic monitoring station was finally installed in Storrington in August 2009. Funding has now also been obtained for an automatic monitoring station to be installed in Cowfold. This should be commissioned by July 2010 and a Detailed Assessment for that location will be submitted by November 2010.

The 2010 Progress Report provided an update on air quality within the District and confirmed continued exceedance of the air quality objective for Nitrogen Dioxide at Storrington and Cowfold. The report also indicated that two further areas, in Pulborough and in Horsham town, were close to exceeding the same objective and would be closely monitored during 2010.

Table 1: Previously Published Reports

Year	Report	Conclusions
2000	Review and Assessment	No exceedance of air quality objectives identified or predicted
2003	Review and Assessment	No exceedance of air quality objectives identified or predicted
2004	Progress Report	No exceedance of air quality objectives identified or predicted
2005	Progress Report	No exceedance of air quality objectives identified or predicted
2006	Update and Screening Assessment	No exceedance of air quality objectives identified or predicted
2007	Progress Report	Detailed assessment required for NO_2 in Cowfold and Storrington
2008	Progress Report	Detailed assessment for NO_2 required in Cowfold and Storrington
2009	Update and Screening Assessment	Detailed assessment for NO_2 required in Cowfold and Storrington
2010	Progress Report	Detailed assessment for NO_2 required in Cowfold and Storrington

1.4 General Description of Detailed Assessment Area

Storrington is a relatively large village lying to the south west of the District. It is a historic market centre with a population of around 4,500. In 2003 Storrington and neighbouring Sullington were combined into one Parish.

Storrington has one main shopping street which is formed of the main A283 road which connects the village to Washington (A24) in the east and Pulborough to the west. There is a mixture of historic and more modern buildings along the High Street. The road is narrow in places with both commercial and residential properties positioned close to the kerbside. There are roundabout controlled junctions at both the western and eastern ends of the High Street and two traffic light controlled pedestrian crossings. The High Street suffers from congested traffic particularly at peak times but carries a consistantly high traffic flow throughout the day. There is a relatively high volume of heavy goods vehicles passing through the village.

The roundabout at the eastern end of the village is the junction of the continued A283 and School Hill which is the access road to the main shopping precinct car

park. Both roads continue at an incline from the roundabout. At this junction the carriageway is narrow and the adjacent buildings are very close to the kerb.

The village has a traffic flow of 17005 for 2009 (24 hour 7 day week yearly average on West Street). The percentage of Heavy Duty/Diesel Vehicles (over large Transit size) is 2.8% (annual percentage over a 5 day week). This equates to 504 heavy duty vehicles (HDV's) each week day on average.

The A283 running through Storrington forms a link between the A29 to the west and the A24 to the east, both of which are significant routes for accessing the main A27 coastal road. Locally the perception is that the A283 through Storrington is used as a cut-through to avoid congestion on the A27 at Arundel and Worthing.

The general location of Storrington and it's relationship to the major road links are shown in Figures 1 and 2.

Figure 1: Map of Storrington Village.

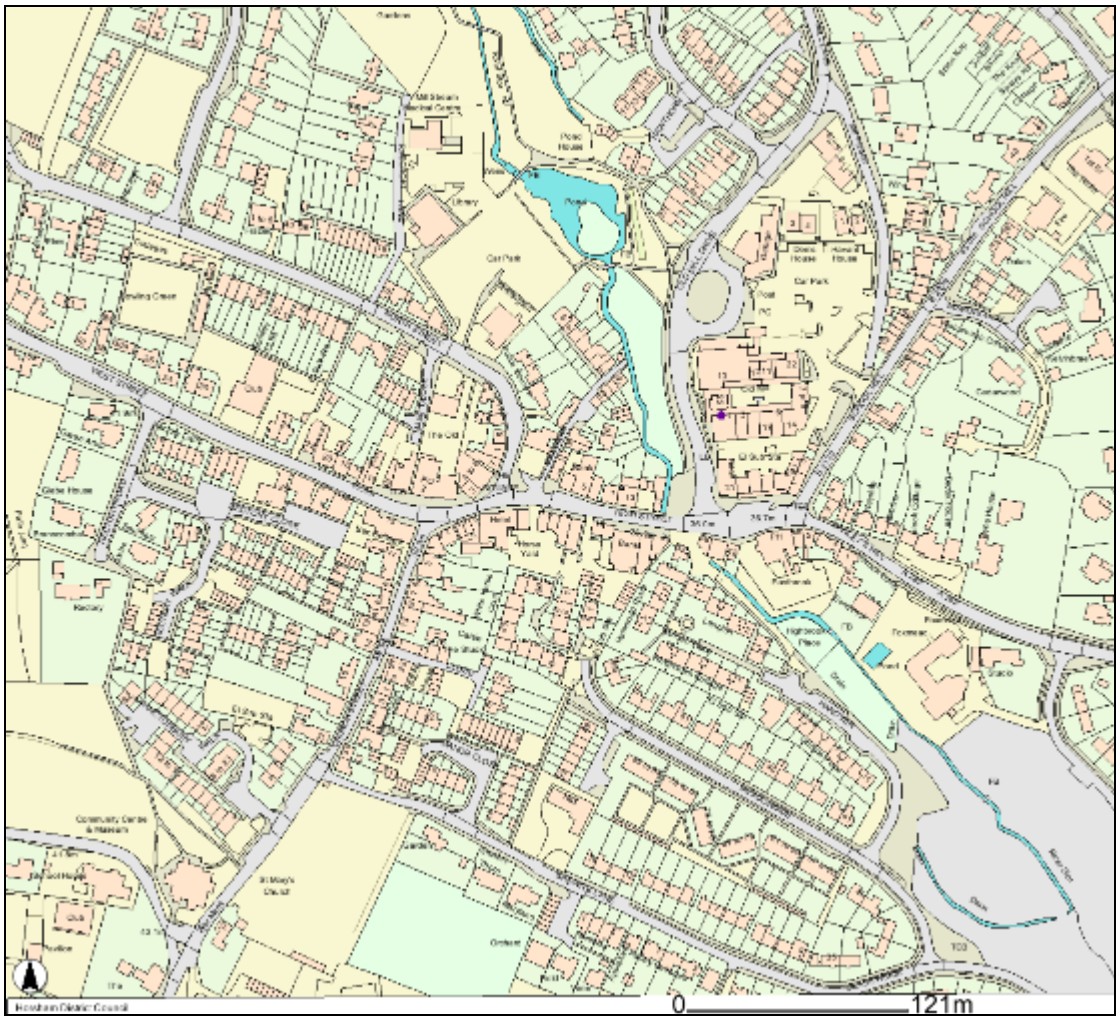
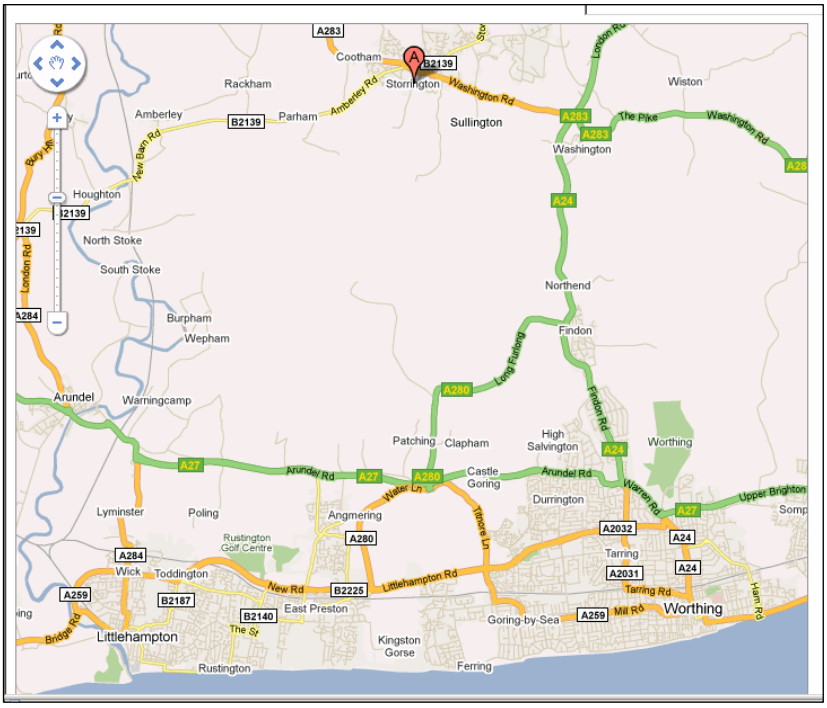


Figure 2: Map of Storrington Road Network.



1.5 Requirement for a Detailed Assessment

The most recent Updating and Screening Assessment (2009) and subsequent Progress Report (2010) identified hotspots along the High Street in Storrington where Nitrogen Dioxide concentrations were consistantly in excess of the annual mean objective. The reports examined all relevant domestic and industrial sources of nitrogen dioxide and PM10 in the vicinity of the Detailed Assessment area and no significant point or fugitive sources were identified.

The most likely source of nitrogen dioxide at these locations is road traffic emissions and concentrations are likely to be elevated due to the narrowness of the road, traffic congestion and the number of heavy goods vehicles. There is also considered to be a risk that levels of particulate matter (PM_{10}) arising from vehicle emissions may also be elevated. However there is no monitoring data available for this pollutant prior to installation of the automatic monitoring station on which to base an assessment. Data from the station is now being collected and will be examined fully once ratified.

The purpose of this Detailed Assessment is to determine, with reasonable certainty, whether or not there is a likelihood of the objectives not being achieved in Storrington village. Where a likely exceedence of the objectives is identified, Horsham District Council are required to determine the magnitude and geographical extent of the exceedence.

1.6 Air Quality Objectives

The air quality objectives applicable to Local Air Quality Management (LAQM) in England are set out in the Air Quality (England) Regulations 2000 (SI 928), and the Air Quality (England) (Amendment) Regulations 2002 (SI 3043). They are shown in Table 2.
This table shows the objectives in units of microgrammes per cubic metre µg/m^3 (for carbon monoxide the units used are milligrammes per cubic metre, mg/m^3). Table 2 includes the number of permitted exceedences in any given year (where applicable).

Table 2: Air Quality Objectives included in Regulations for the purpose of Local Air Quality Management in England.

Pollutant	Concentration	Measured as	Date to be achieved by
Benzene	16.25 μg/m^3	Running annual mean	31.12.2003
	5.00 μg/m^3	Running annual mean	31.12.2010
1,3-Butadiene	2.25 μg/m^3	Running annual mean	31.12.2003
Carbon monoxide	10.0 mg/m^3	Running 8-hour mean	31.12.2003
Lead	0.5 μg/m^3	Annual mean	31.12.2004
	0.25 μg/m^3	Annual mean	31.12.2008
Nitrogen dioxide	200 μg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 μg/m^3	Annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)	50 μg/m^3, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 μg/m^3	Annual mean	31.12.2004
Sulphur dioxide	350 μg/m^3, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 μg/m^3, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 μg/m^3, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

2. Detailed Assessment – Monitoring Scope and Methodology

In order to assess, with reasonable certainty, whether an Air Quality Management Area (AQMA) should be designated, it is important that there is a high level of confidence in any monitoring data and an awareness of the assumptions and uncertainties associated with any modelling used in the assessment. The assessment needs to clearly identify the points of maximum relevant public exposure and the geographical extent of any air quality objective exceedences.

The monitoring strategy employed for the Storrington assessment is based on the following:-

- Enhanced monitoring of nitrogen dioxide and particulate matter by means of a new monitoring station housing continuous analysers affilliated to the Automatic Urban and Rural Network (AURN).
- Retention of existing diffusion tube monitoring sites to provide continuity of data and allow trend analysis.
- Provision of co-located diffusion tubes with the automatic analyser to allow verification of diffusion tube data.
- Provision of new automatic traffic counting equipment to provide accurate traffic data.
- Provision of data collection and ratification contract in accordance with UK national guidance.
- Management of a comprehensive equipment maintenance and calibration contract.
- Use of DMRB modelling to indicate likely extent of the area of air quality objective exceedences.

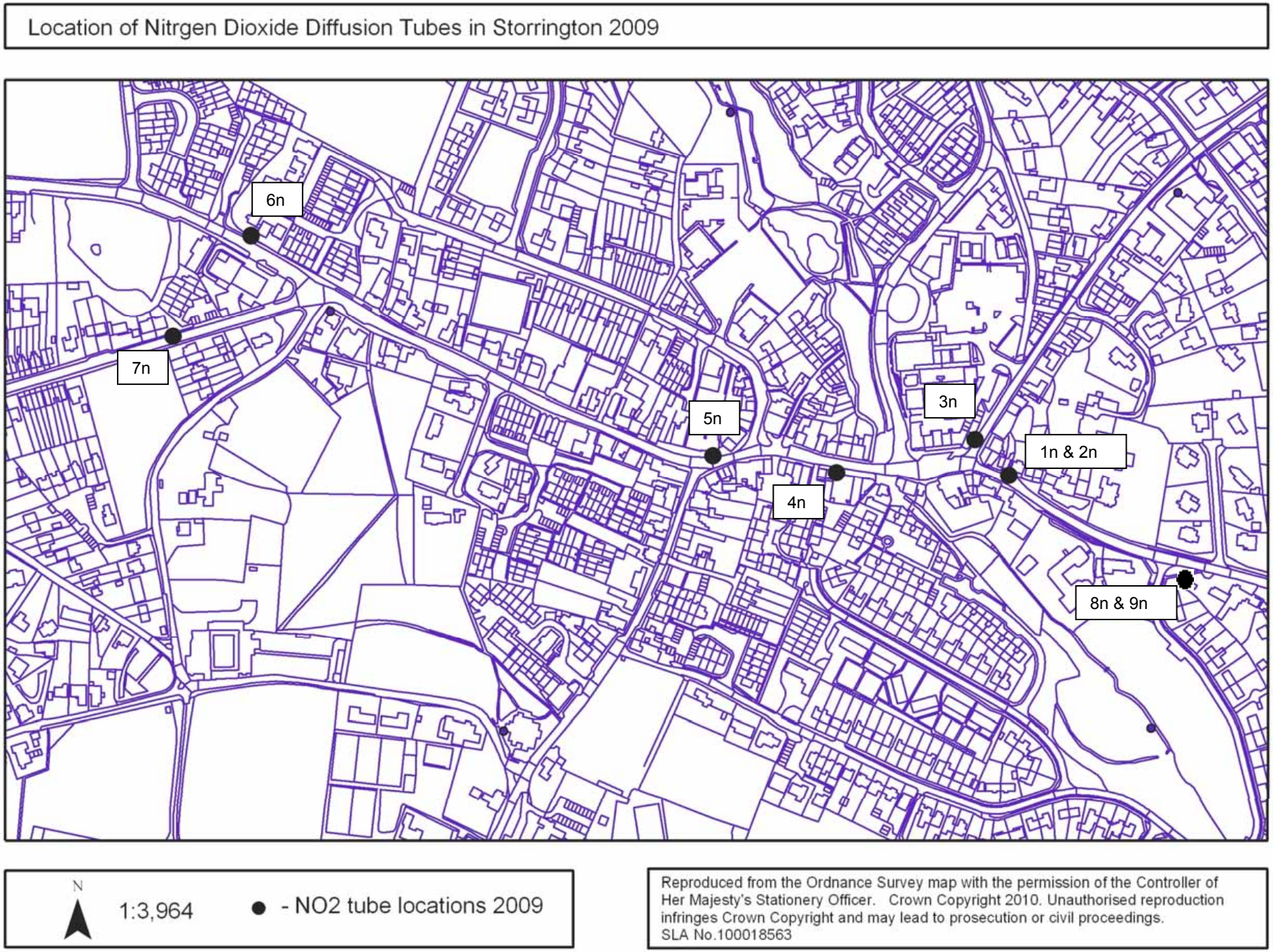
Ideally the assessment would rely, for better accuracy, on the data obtained from the automatic analysers, however the station in Storrington was not commissioned until July 2009.

2.1 Previous Air Quality Monitoring in Storrington

The District maintains a network of passive nitrogen dioxide diffusion tubes. Originally there was one tube in Storrington but, on the basis of the nitrogen dioxide concentrations this tube was returning, the network was extended to additional locations along the High Street and on main access routes serving the village. A duplicate tube was also co-located at one location. Data for these sites is available from 2007 and the results published in previous Progress Reports and the 2009 USA. The results from the diffusion tube survey in Storrington were key to the decision to undertake a detailed assessment.

The locations of the diffusion tube monitoring sites are shown in Figure 3.

Figure 3:

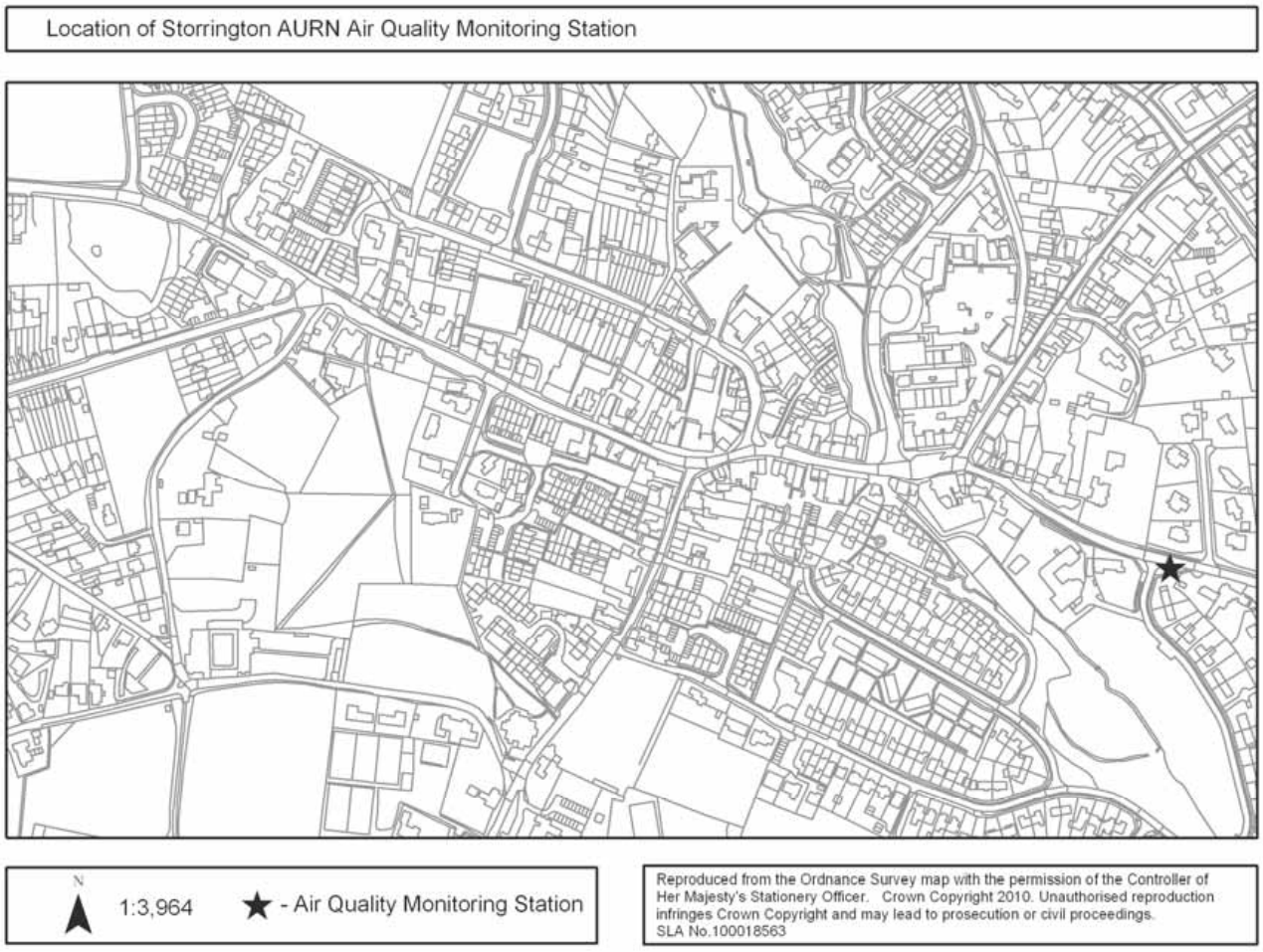

Location of Nitrgen Dioxide Diffusion Tubes in Storrington 2009
6n
7n
5n
3n
1n & 2n
4n
8n & 9n
N
1:3,964
- NO2 tube locations 2009
Reproduced from the Ordnance Survey map with the permission of the Controller of Her Majesty's Stationery Officer. Crown Copyright 2010. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings.
SLA No.100018563

2.2 Air Quality Monitoring in Storrington for Detailed Assessment

To improve upon the detail and accuracy of the monitoring in Storrington a new real time continuous monitoring site was established during 2009. The station houses a nitrogen dioxide chemiluminescence analyser (Thermo 42i supplied by Air Monitors Ltd), and PM_{10} and $PM_{2.5}$ FDMS analysers. The site is affiliated to the Automatic Urban and Rural Network (AURN).

A number of potential locations for the monitoring station were considered along the High Street in Storrington, however these had to be discounted for practical reasons, the primary one being space given that most of the pedestrian areas in the High Street are narrow. A site to the east of the village centre at Manleys Hill was selected as the best alternative. This is a roadside site with relevant public exposure but is located a distance of 148m from the High Street/School Hill junction where the highest nitrogen dioxide concentrations have been recorded by diffusion tube sampling. Ideally the station would have been best sited at this location and Horsham District Council acknowledge that the pollutant concentrations recorded at the continuous monitoring site are likely to be lower than at the High Street/School Hill junction. The location of the monitoring station is shown in Figure 4.

Figure 4: Location of Storrington AURN air quality monitoring station



The monitoring station was installed in July 2009 but was not fully commissioned until October 2009. The site received a post commission audit on 18 January 2010 by AEA Technology. The equipment is covered by comprehensive service and maintenance contracts. The collection and ratification of the data is undertaken by the Environmental Research Group through their contract with the Sussex Air Partnership, of which Horsham District Council is a member.

Unfortunately ratified data from the automatic analysers is available for a period of just less than 3 months in the case of nitrogen dioxide and 4 months for particulate matter. However, in order that the data can at least be used for indicative purposes in the detailed assessment, it has been adjusted to provide an estimated annual mean in accordance with Technical Guidance docume*nt LAQM.TG(09)*.Further monitoring will be needed to eliminate seasonal variations from the dataset and will be reported in the further assessment following declaration of an Air Quality Management Area.

3. Detailed Assessment – Monitoring Results and Analysis

3.1 Automatic Monitoring Data for Nitrogen Dioxide

Technical Guidance document LAQM.TG(09) states that for assessment of data against the annual mean objective for nitrogen dioxide it is possible to use data from a shorter period of monitoring (minimum 3 months). An estimation of the annual mean concentration can be obtained from the short term data by calculation of an adjustment factor derived from nearby, long term continuous monitoring sites.

At the Storrington air quality monitoring site unratified data for nitrogen dioxide is available for the period 20th October 2009 to 31st December 2009, a period of just under the required 3 months. The data capture rate for that period is 96%. Four long term continuous background monitoring sites were identified for calculation of an adjustment factor according to Box 3.2 of the Technical Guidance document (LAQM.TG(09).

The data for Storrington for this period is NOT RATIFIED and the estimate of the annual mean must therefore be considered as an indicative value only. Defra have contracted AEA Technology Ltd. to undertake ratification of data for the site but this is only commencing from 1st January 2010. Ratified data for 2010 will be available for inclusion in the Further Assessment of the detailed assessment area.

With the limitations of the data in mind the calculation of the adjustment factor for short to long-term monitoring is shown in Table 3 below.

Table 3:

Estimation of Annual Mean Concentrations from Short-term Monitoring Data 20/10/09 – 31/12/09 (NOT ratified)			
Storrington AURN – Nitrogen Dioxide Annual Mean 2009			
Long term site	Annual mean 2009 (Am)	Period mean 2009 (Pm)	Ratio (Am/Pm)
Crawley – East Gatwick	28	30	0.933
Eastbourne – Devonshire Park	15	15	1.000
Mole Valley - Dorking	21[a]	26[a]	0.808
Sevenoaks – Greatness Park	21[a]	21[a]	1.000
		Average (R_a)	0.935

[a] Some data for long term sites not fully ratified.

Data for the Storrington station is also available for the period from 1st January 2010 to 30th April 2010. This data is, as yet, unratified however in accordance with Box 3.2 of the Technical Guidance LAQM.TG(09) the data for 2010 has been used to calculate a comparative estimated annual mean for 2009, based on the same period in 2009. The calculation of the adjustment factor for this period is shown in Table 4 below.

Table 4:

Estimation of Annual Mean Concentrations from Short-term Monitoring Data 1/1/10 – 30/4/10 (NOT ratified)			
Storrington AURN – Nitrogen Dioxide Annual Mean 2009			
Long term site	Annual mean 2009 (Am)	Period mean 2009 (Pm)	Ratio (Am/Pm)
Crawley – East Gatwick	28	35	0.800
Eastbourne – Devonshire Park	15	20	0.750
Mole Valley - Dorking	21[a]	28[a]	0.750
Sevenoaks – Greatness Park	21[a]	29	0.724
		Average (R_a)	0.756

[a] Some data for long term sites not fully ratified.

The short-term data for the 4 month period January – April 2010 must also be considered with caution as the data is not ratified and has been adjusted according to 2009 data. It has been calculated for indicative purposes only but the estimated annual means for each period do show a close correlation as can be seen in the summary statistics shown in Table 5 below.

Table 5: Summary statistics for the Storrington AURN station, including an estimate of the annual mean for 2009, as calculated using the short to long-term adjustment factor.

Statistic	Result
Nitrogen dioxide 3 month mean (Oct – Dec 2009) Data capture = 96%	22.5µg/m³
Estimation of nitrogen dioxide annual mean 2009 (adjustment factor = 0.935)	**21.0µg/m³**
N° of exceedances of 200µg/m³ (over 3 month period 20/10/09 – 31/12/09)	0
Maximum hourly concentration (over 3 month period 20/10/09 – 31/12/09)	131µg/m³
Nitrogen dioxide 4 month mean (Jan – Apr 2010) Data capture = 96%	30µg/m³
Estimation of nitrogen dioxide annual mean 2009 (adjustment factor = 0.756)	**22.7µg/m³**
N° of exceedances of 200µg/m³ (over 4 month period 01/01/10 – 30/04/10)	0
Maximum hourly concentration (over 4 month period 01/01/10 – 30/04/10)	141µg/m³

The nitrogen dioxide concentrations calculated by adjustment of short to long-term monitoring data in Table 5 above, indicate that both the long-term annual objective and the short-term hourly objectives are unlikely to be breached at the continuous monitoring station in Storrington. The best estimate of the annual mean for Storrington AURN in 2009 is 21µg/m³.

It should be noted that due to the siting of the continuous monitor in Storrington, the concentration of nitrogen dioxide measured at this location is likely to be lower than has been measured nearer the School Hill/Manleys Hill junction. As of December 2009 diffusion tubes have been co-located with the continuous monitor which will allow a local bias correction factor to be calculated and used for the nitrogen dioxide diffusion tube survey distributed at other key locations in the village. The monitoring station will also provide useful continuous nitrogen dioxide and particulate matter data for the further assessment.

3.2 Nitrogen Dioxide Diffusion Tube Monitoring

There are currently nine diffusion tubes located in Storrington, including two co-location sites. All monitoring locations were sited at potential 'hot-spots' and all have relevant public exposure. The diffusion tubes co-located with the automatic continuous analyser have only been in place since December 2009 and cannot therefore be used to provide an accurate bias adjustment factor. For this assessment a local bias adjustment factor has been calculated from an established roadside site in Horsham town where a second automatic continuous nitrogen dioxide analyser is co-located with triplicate diffusion tubes. The annual mean concentration for each site has also been corrected using the national bias correction factor derived from Air Quality Consultants Ltd database (spreadsheet version number 03/10) based on 8 co-location studies. The full QA:QC data for the diffusion tube monitoring survey and bias adjustment factor calculations are presented in Appendix A.

The locations of the diffusion tubes in Storrington are shown in Figure 3 and the site descriptions are in Table 6.

Table 6: Diffusion Tube Monitoring Locations – Storrington

Site Name	Site Type	OS Grid Ref		Pollutants Monitored	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location
		X	Y				
Storrington 1N	Roadside	508960	114270	NO_2	Y(4.0m)	1.10	Y
Storrington 2	Duplicate	508960	114270	NO_2	Y (4.0m)	1.10	Y
Storrington 3	Roadside	508935	114297	NO_2	Y(2.0m)	1.20	Y
Storrington 4	Roadside	508832	114272	NO_2	Y(2.8m)	2.20	Y
Storrington 5	Roadside	508740	114285	NO_2	Y(1.9m)	1.90	Y
Storrington 6	Roadside	508396	114449	NO_2	Y(7.7m)	1.90	Y
Storrington 7	Roadside	508338	114374	NO_2	Y(6.7m)	1.60	Y
Storrington 8 AURN	Roadside Duplicate	508991	114249	NO_2	Y (9.6m)	4.60	N
Storrington 9 AURN	Roadside Duplicate	508991	114249	NO_2	Y (9.6m)	4.60	N

3.2.2 Diffusion Tube Nitrogen Dioxide Monitoring Results and Trend Analysis.

The Storrington diffusion tube results for 2009 are shown in Table 7**.**

Table 7: Storrington Diffusion Tube Results 2009

Site Ref./Location	Data Capture 2009 %	Annual mean Concentration 2009 (µg/m³) Adjusted by local bias[1]	Annual mean Concentration 2009 (µg/m³) Adjusted by national bias[2]
Storrington 1n duplicate Amen Cottage Manleys Hill	100	**54.8**	**50.4**
Storrington 2n duplicate Amen Cottage Manleys Hill	92	**55.4**	**51.0**
Storrington 3n No3 School Hill	100	**41.3**	**38.0**
Storrington 4n No.22 High Street	100	**47.2**	**43.4**
Storrington 5n No.2 West Street	100	30.4	27.9
Storrington 6n No.1-4 Holly Court, Pulborough Road	100	30.5	28.1
Storrington 7n The Willows Amberley Road	100	27.4	25.2
Storrington AURN duplicate Manleys Hill*	*8*	*31.7**	*29.2**
Storrington AURN duplicate Manleys Hill*	*8*	***48.4****	***44.6****

[1] Local bias adjustment factor of 0.88 obtained from triplicate tube study – Park Way, Horsham.

[2] National bias adjustment factor of 0.81 obtained from UWE website.

* Denotes Diffusion tubes that have not been in position for a sufficient period to give a reliable annual mean for 2009.

The diffusion tube results for 2009 show exceedance of the annual mean nitrogen dioxide objective at 3 of the monitoring sites, Amen Cottage, Manleys Hill; 3 School Hill and 22 High Street. Exceedence of the objective at the School Hill site is dependant on whether the local or national correction factor is used however in both cases the concentration is within 5% of the objective if not exceeding it. There is close agreement between the co-located tubes at Amen Cottage, Manleys Hill. The monitoring sites to the west end of the village, including West Street, Pulborough Road and Amberley Road, did not exceed the objective for 2009.

The Storrington nitrogen dioxide diffusion tube concentrations for the last 3 years are shown in Table 8 below. The concentrations have been corrected using the national bias correction factor applicable to each year.

Table 8: Annual Mean Nitrogen Dioxide Concentrations Storrington 2007-2009

Location	Data Capture 2009 %	Annual mean concentrations Adjusted for Bias+		
		2007 (ug/m³)	2008 (µg/m³)	2009 (µg/m³)
Storrington 1n	100	**55**	**48.1**	**50.4**
Storrington 2n	92	**35**	**51.5**	**51.0**
Storrington 3n	100	**48**	**39.7**	**38.0**
Storrington 4n	100	**40**	**39.8**	**43.4**
Storrington 5n	100	**38**	**32.2**	27.9
Storrington 6n	100	**36**	27.6	28.1
Storrington 7n	100	42	27.1	25.2
*Storrington AURN**	*8*	-	-	*29.2**
*Storrington AURN**	*8*	-	-	*44.6**

+ National bias correction factors: 2007 0.89
2008 0.93
2009 0.81

***** *Denotes Diffusion tubes that have not been in position for a sufficient period to give a reliable annual mean.*

The nitrogen dioxide concentration at the Amen Cottage site (Storrington 1n and 2n) has consistently exceeded the objective level. The School Hill site has shown a decline in annual mean concentration over the past three years, but remains close to the objective level, whilst the concentration at 22 High Street (Storrington 4n) has shown an increase to above the objective. West Street (Storrington 5n), Pulborough Road (Storrington 6n) and Amberley Road (7n) have all shown a significant decrease in the annual mean concentration over the past three years and are now below the objective level.

3.3 Automatic Monitoring Data for Particulate Matter (PM_{10})

The Storrington monitoring station houses both PM_{10} and $PM_{2.5}$ Filter Dynamics Measurement System (FDMS) analysers.

The site was set up to support the detailed assessment work for Storrington where diffusion tube monitoring results indicate exceedance of the nitrogen dioxide objective. As this exceedance is thought to be predominantly traffic related it was decided that particulate monitoring would also be relevant. Data has been collected since August 2009 for this site and therefore the data capture rate of 40% for 2009 is insufficient to determine relevant statistics for that year without adjustment. An estimation of the annual mean PM_{10} concentration for Storrington has been calculated in accordance with Box 3.2 of the Technical Guidance document LAQM.TG(09). Further information on the correction applied to the PM_{10} data is presented in Appendix A.

Data collection and ratification of the data from the automatic analysers is undertaken by AEA Technology Ltd through their contract with Defra as part of the Automatic Urban and Rural Network. The data obtained from the Storrington

FDMS particulate monitor in 2009 has NOT been ratified as the Defra contract with AEA Technology did not commence until 1st January 2010. The calculations have therefore been presented for indicative purposes only and must be considered with caution.

The results are presented in Tables 9 and 10 below.

Table 9: Results of PM_{10} Automatic Monitoring: Comparison with Annual Mean Objective.

Site ID	Location	Monitoring Period	Data Capture for monitoring period [a] %	Data Capture for full calendar year 2009 [b] %	Annual mean concentration (µg/m3) 2009
Storrington AURN	Manleys Hill Storrington	Aug – Dec 2009	96%[a] 5 month monitoring period	40%[b]	**20.4**[c d]

[a] Data capture for 5 month monitoring period August – December 2009.
[b] Data capture for the full calendar year.
[c] Mean value "annualised" as in Box 3.2 of TG(09). Calculation presented in Appendix A: Table A2.
[d] Data for Storrington AURN PM_{10} NOT RATIFIED.

Table 10: Results of PM_{10} Automatic Monitoring: Comparison with 24-hour Mean Objective

Site ID	Location	Data Capture for monitoring period[a] %	Data Capture 2009[b] %	Number of Exceedences of daily mean objective (50 µg/m3). Data capture < 90%, 90th percentile of daily means in brackets.		
				2007	2008	2009
Storrington AURN	Manleys Hill Storrington	96%[a] 5 month monitoring period	40%[b]	-	-	**(27ug/m3)[c]**

[a] Data capture for 5 month monitoring period August – December 2009
[b] Data capture for the full calendar year
[C] Data for Storrington AURN PM_{10} NOT RATIFIED.

The results shown above indicate that both the long term annual mean and the short term daily mean objectives for particulate matter were not exceeded during 2009 at the Storrington AURN site. It should be noted that the mean values for Storrington AURN were based on short term unratified monitoring data only and should be viewed with caution. Also the siting of the continuous monitor in Storrington, is not based on the worst-case location and the concentration of PM_{10} is likely to be lower than might be measured nearer the School Hill/Manleys Hill

junction. Monitoring of PM_{10} and $PM_{2.5}$ will continue and updated results reported in the Further Assessment for the detailed assessment area.

3.4 Monitoring Results and Air Quality Objective Comparisons

The monitoring results from the diffusion tube survey for 2009 indicate that the annual mean concentration of nitrogen dioxide exceeded the national air quality objective at 3 monitoring sites in Storrington.

Results from the continuous monitoring station in Storrington was used for indicative purposes as only short term unratified data was available for 2009. However the calculated estimates of the long term annual mean and short term hourly mean concentrations derived from the automatic analyser did not exceed the air quality objectives for either nitrogen dioxide or PM_{10} in 2009.

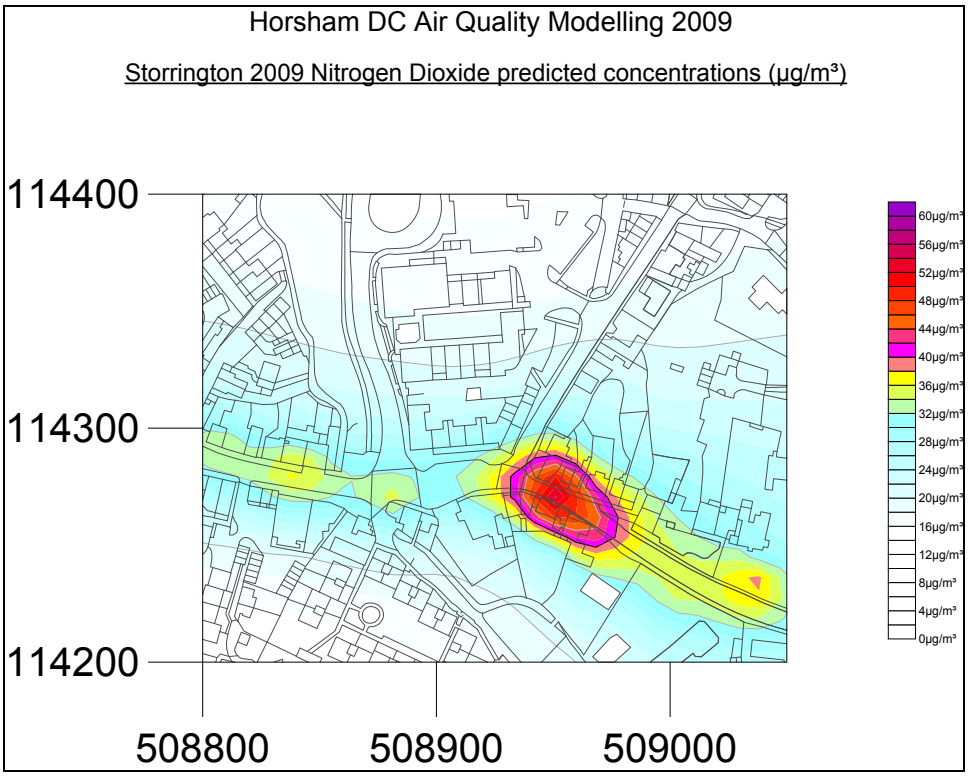
4. Areas of Air Quality Objective Exceedences

Additional assessment work has been carried out to determine the probable area of nitrogen dioxide exceedence in Storrington. The "BREEZE Roads" model has been used to establish the likely spatial extent of air quality exceedences for nitrogen dioxide using monitored results to verify the modelled data. The modelling was undertaken by Project Development Officer for The Sussex Air Partnership on behalf of Horsham District Council and is reproduced in full in Appendix B.

The modelling results shown below, were verified against the monitoring results in 2009, and confirmed that there is the likelihood of exceedences of the annual NO_2 limit of 40µg/m³ for the year 2009. The model was run utilising average meteorological conditions for the year 2009.

The model predicted exceedences of the annual NO_2 air quality objective value of 40µg/m³ for the year 2009 at the 4 specific (pre-selected) receptor locations in Storrington. The locations identified in the modelling were Stor Cottage, Eastbrook; 5 Eastbrook Court; Wayside, Manleys Hill and Virginia Cottage, Manleys Hill. The model concentration map shown below (Figure 5) indicates that there may be a further 2 to 3 properties adjacent which also exceed the annual NO_2 air quality objective value.

Figure 5: 2009 modelled annual average concentrations for NO2 (µg/m^3) at key receptors. (Junction of B2139(School Hill) and A283 (High St/Manleys Hill)).

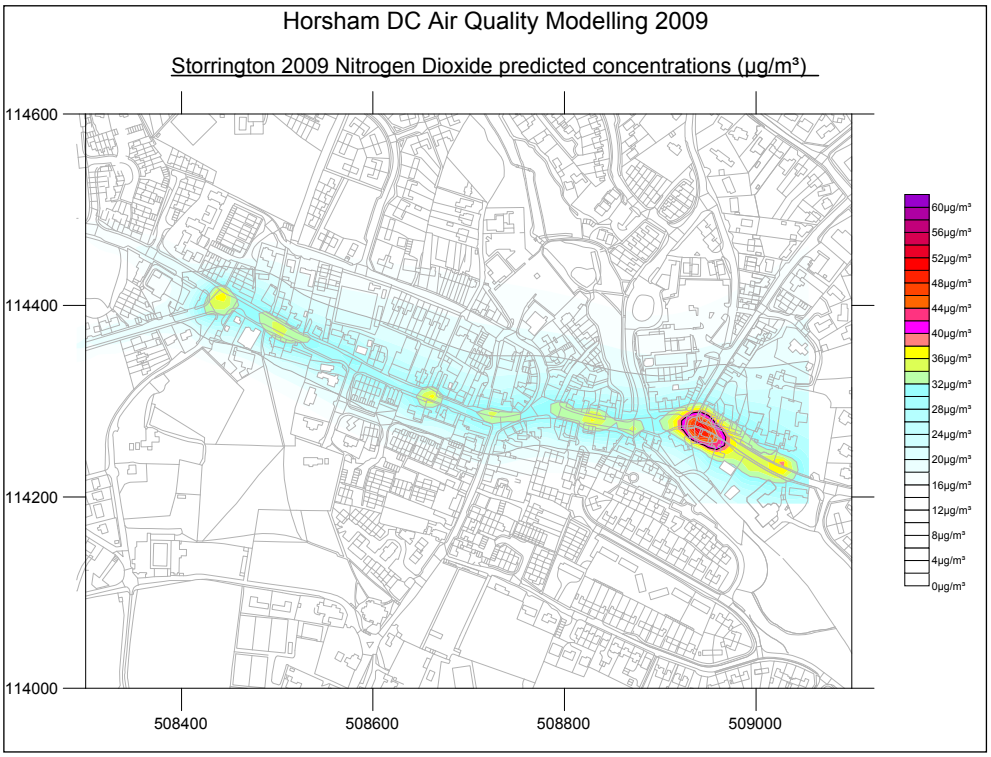


The model also predicted that a further 16 receptors had nitrogen dioxide concentrations above 32µg/m³ (i.e 80% of the UK air quality objective), and given that the margin of error associated with diffusion tubes can be as high as +/- 20%,

these receptors may also need to be considered as potential areas of exceedance. The receptors with a clear exceedance of the objective and those within predicted concentrations above 80% of the objective are shown in Figure 6.

The model concentration map extending along the length of the High Street shown at Figure 6 below shows one main area of exceedance around the Manley Hill/School Hill junction but also several discrete areas of higher nitrogen dioxide concentration along the High Street that do not appear to correspond with any obvious traffic features or any particular receptors. It is possible that this is an artifact of the diffusion tube distribution along that stretch of the road, with the model output showing higher concentrations at the tube locations. In order to determine whether this is the case, and to further refine the concentration map, the Council intends to provide additional diffusion tube sites at strategic locations along the High Street. These results will be reported in the further assessment.

Figure 6: 2009 modelled annual average concentrations for NO2 (µg/m^3).



5. Conclusions and Recommendations

A detailed assessment has been carried out for the High Street in the village of Storrington. This area was identified in the latest Updating and Screening Assessment and Progress Report as having the potential to be in breach of the annual average objective for nitrogen dioxide.

Diffusion tube monitoring in Storrington has indicated that concentrations of nitrogen dioxide are above the air quality objective value at the junction of the B2139 (School Hill) and A283 (High Street/Manleys Hill). The annual mean nitrogen dioxide concentration has also been predicted from modelled data to be within 20% of the air quality objective at other locations along the A283 West Street. The spatial extent of the exceedances can be defined with reasonable certainty and includes areas of relevant public exposure.

An automatic monitoring station has been installed at a suitable location on Manleys Hill to provide additional real-time data. Preliminary (unratified) results from the analyser for 2009 has not indicated an exceedance of the objective at the monitoring site but further data from the analyser will be used to verify future diffusion tube data and to refine modelled pollutant concentrations.

As a result of the above conclusions and in accordance with the Council's statutory obligations under Local Air Quality Management (LAQM) the following recommendations are made:-

1. The declaration of an Air Quality Management Area (AQMA) is proposed to include the stretch of road through the village, formed of the A283 West Street/ High Street, to the junction of the B2139 (School Hill) and A283 (High Street/Manleys Hill). The area to include, as a minimum, all those areas identified as exceeding the air quality objectives, as shown in figures 5 and 6.

2. The declaration will be on the basis of nitrogen dioxide where exceedances of the annual mean objective are predicted at relevant receptor locations.

3. The geographical extent of the AQMA will be subject to further consultation with statutory consultees including local members, parish council, local residents and businesses. The consultation to be conducted within 3 months of the publication of the detailed assessment.

4. A draft boundary for the AQMA is included as part of this detailed assessment for wider consultation purposes. See Chapter 6.

5. The formal boundary of any AQMA to be finalised and the formal AQMA order completed within 4 months of the publication of this report.

6. Monitoring of nitrogen dioxide and particulate matter at current monitoring locations will continue in the form of the diffusion tube survey and the automatic AURN station. This will allow any future changes in air quality to be detected and any emerging trends analysed. Ratified data from the automatic analysers will allow more accurate assessment of nitrogen dioxide concentrations and provide new real-time particulate matter concentrations for both PM_{10} and $PM_{2.5}$.

7. Additional diffusion tubes will be provided along West Street and the High Street to inform an investigation into whether the modelled concentration map is being skewed to some extent by the diffusion tube distribution.

8. All additional monitoring, and in particular the real-time data from the AURN monitoring station, will be reported in a Further Assessment report, required within 12 months of designation of the AQMA. The additional data for 2010 will be used to confirm the conclusion that an AQMA is required for Storrington; to verify the assumptions on which the AQMA was based and to refine the boundaries of the AQMA should further areas of exceedance be identified.

9. Further modelling work will be undertaken with the benefit of the additional real-time data from the AURN station. This will enable more detailed examination of the influence of street canyon effects on the locations showing an exceedance and whether the slight road gradients at Manleys Hill and School Hill are having an impact on pollution concentrations. These details will be reported in the Further Assessment.

10. Following designation of the AQMA in Storrington, preparation of a provisional Air Quality Action Plan will commence in partnership with the Highways Department of West Sussex County Council. The Action Plan to be completed within 18 months of designation of the AQMA.

6. Draft Air Quality Management Area Boundary

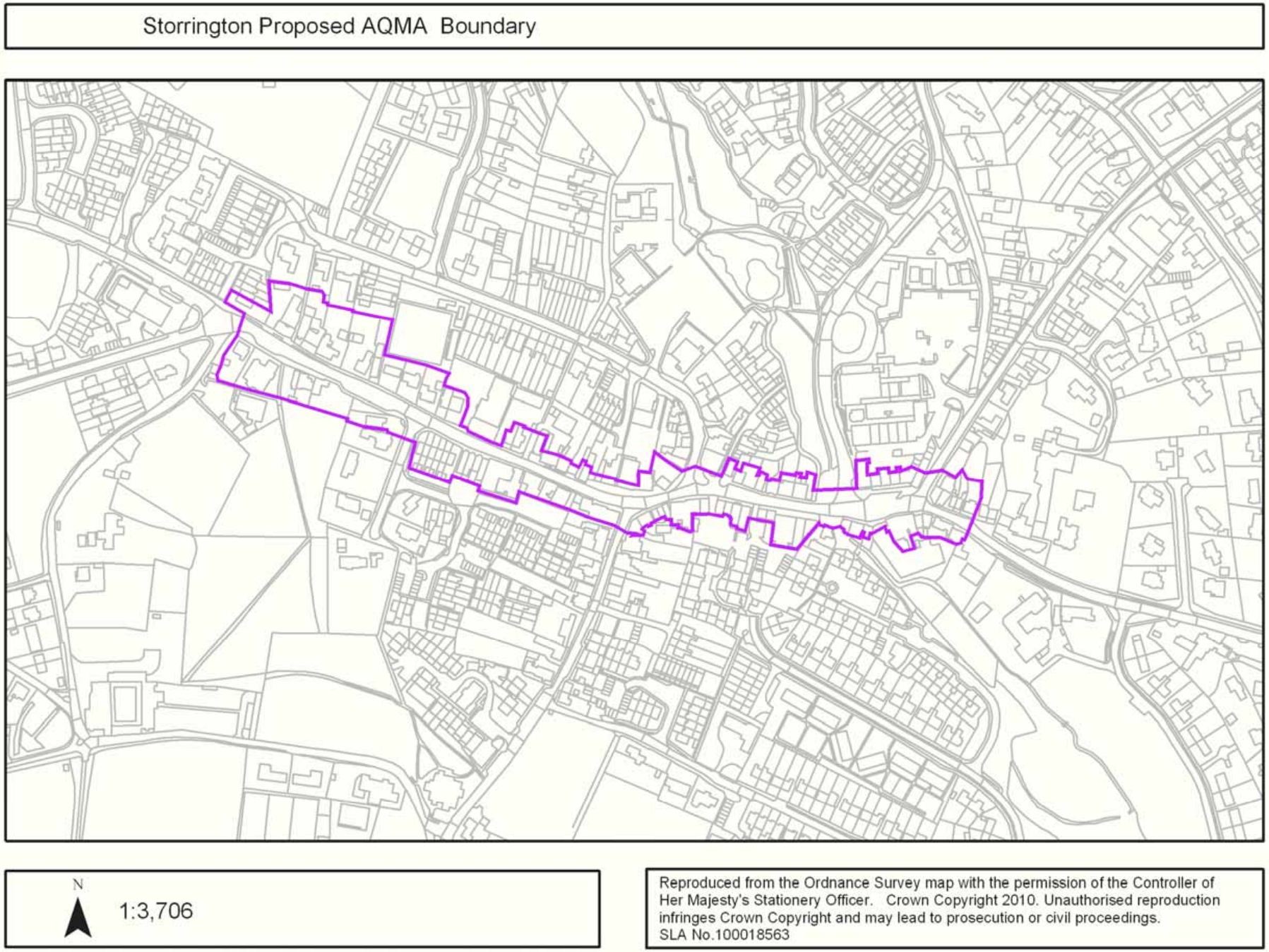
Any boundary for an AQMA must include, as a minimum, all areas of exceedance of the air quality objective; however these areas are based upon predicted pollutant concentrations derived from a dispersion model, the outputs of which carry a degree of uncertainty. In addition the input data used to generate the modelled concentrations for the Storrington detailed assessment is from diffusion tubes which are also inherently uncertain. It is therefore unlikely that the predicted line of exceedence will exactly match the actual line of exceedance. For this reason, and for administrative and communication purposes, it can be better to define the AQMA boundary by reference to physical features.

In the case of Storrington the exceedance relates to the long term nitrogen dioxide objective and is primarily related to traffic emissions, with little or no evidence of any industrial or residential sources of pollution. The main road carries 17000 vehicles a day and has periods of traffic congestion. Monitoring near to the junctions at the west and east ends of the main road through Storrington suggest that nitrogen dioxide concentrations decline beyond the junctions where the traffic splits and speed increases.

The modelled predicted concentrations and the monitored concentrations both confirm that at the School Hill/High Street/ Manleys Hill junction there is a clear exceedance of the objective. Between this junction and at the roundabout at the western end of the village there are discrete areas where the predicted concentrations are within 20% of the air quality objective and, given the accepted margin of error associated with diffusion tube data, could also be in exceedance of the objective. Further more detailed monitoring and modelling will seek to confirm whether this is in fact the case.

In drawing up a draft AQMA boundary the Council has had regard to both the measured and predicted areas of exceedance but also applied an element of judgement and local knowledge to inform the decision. Based on these factors the proposed boundary incorporates the main area of exceedance around the School Hill/High Street/ Manleys Hill junction and extends along the High Street to the junction at the western end of West Street. The boundary also extends partially along School Hill and Manleys Hill as these are busy routes with high levels of congestion at peak times. The draft AQMA is shown in Figure 7 below. This draft will form the basis for further consultation and possible refinement to produce a workable boundary prior to final declaration.

Figure 7: Storrington Proposed Air Quality Management Area boundary



7. Consultation

The external consultation requirements for Detailed Assessment reports are set out in Chapter 5 of the Local Air Quality Management Policy Guidance document LAQM.PG(09) and for Horsham District Council are as detailed below:

External Consultees

- Secretary of State
- Defra
- Environment Agency (Sussex Area Office)
- All neighbouring local authorities – Chichester DC, Arun DC, Adur DC, Worthing BC, Mid Sussex DC, Crawley BC, Brighton & Hove CC, Waverley BC, Mole Valley DC
- West Sussex County Council (Highways Authority)

Internal consultees:

- Chief Executive
- Strategic Planning
- Development Management

For consultation in respect of the AQMA boundary and proposed Action Plan all statutory and the following non-statutory consultees will be consulted.

- Local Member of Parliament
- County / District Councillors
- Parish Council
- Sussex Health Protection Agency
- Local community groups
- Local residents
- Local businesses

8. References

AEAT (2003) UK NO2 Diffusion Tube Network Instruction Manual.
AEA (2009) WASP – Annual Performance Criteria for NO2 Diffusion Tubes used in Local Air Quality Management (LAQM), 2008 onwards, and Summary of Laboratory Performance in Rounds 103-107.
DETR (2000) - The Air Quality (England) Regulations. HMSO
DEFRA (2002) - The Air Quality (England) (Amendment) Regulations. HMSO.
DEFRA (2007) - The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Vol 1 and Vol 2
DEFRA (2009) – Local Air Quality Management Policy Guidance, LAQM.PG(09)
DEFRA (2009) - Local Air Quality Management Technical Guidance. LAQM.TG(09)
The Environment Act (1995)
EPuk (NSCA) – Air Quality Management Areas: A Review of Procedures and Practice for Local Authorities
Defra/Laxen, Marner and Donovan 2007 - Deriving NO2 from NOx for Air Quality Assessments of Roads – Updated 2006
Defra/Laxen and Marner 2003 - Analysis of the relationship between 1-hour and annual mean nitrogen dioxide at UK roadside and kerbside monitoring sites

Appendix A: QA:QC Data

Diffusion Tube Bias Adjustment Factors

The Diffusion Tubes are sourced from Environmental Scientifics Group (formerly Bureau Veritas) in Glasgow using the using 20% TEA in Water preparation method. The national bias adjustment factor was obtained from Air Quality Consultants Ltd database (spreadsheet version number 03/10) based on 8 co-location studies. The bias adjustment factor given for this methodology was 0.81.

Factor from Local Co-location Study

A co-location study is undertaken at the automatic analyser station in Park Way Horsham. This is a roadside monitoring site located 2m from the kerbside. Using the AEA Precision spreadsheet tool a local bias adjustment factor of 0.88 has been calculated.

Results of the 2009 co-location study are given in Table A1 below. The results have also have been included in the national database.

Table A1. 2008 Co-location Study Data for Horsham

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	07/01/2009	04/02/2009	38.0	43.0	41.0	41	2.5	6	6.3	37.8	99.7	Good	Good
2	04/02/2009	04/03/2009	60.0	43.0	58.0	54	9.3	17	23.1	41.1	96.7	Good	Good
3	04/03/2009	01/04/2009	40.0	41.0	32.0	38	4.9	13	12.3	33.3	99.9	Good	Good
4	01/04/2009	29/04/2009	37.0	36.0	35.0	36	1.0	3	2.5	36.1	99.9	Good	Good
5	29/04/2009	03/06/2009	31.0	28.0	32.0	30	2.1	7	5.2	26	100	Good	Good
6	03/06/2009	01/07/2009	38.0	36.0	38.0	37	1.2	3	2.9	28	99.7	Good	Good
7	01/07/2009	29/07/2009	14.0	15.0	13.0	14	1.0	7	2.5	20	98.9	Good	Good
8	29/07/2009	02/09/2009	32.0	31.0	31.0	31	0.6	2	1.4	25	32.4	Good	or Data Captu
9	02/09/2009	30/09/2009	36.0	34.0	37.0	36	1.5	4	3.8	30	62.3	Good	or Data Captu
10	30/09/2009	04/11/2009	34.0	35.0	32.0	34	1.5	5	3.8	32	99.7	Good	Good
11	04/11/2009	02/12/2009	34.0	34.0	31.0	33	1.7	5	4.3	26.8	98.7	Good	Good
12	02/12/2009	14/01/2009	43.0		50.0	47	4.9	11	44.5	38.9	99.5	Good	Good
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Good Overall DC

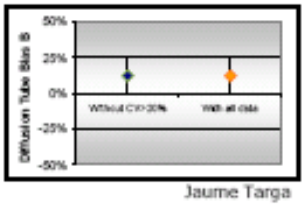
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Park Way Horsham

Precision: 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 10 periods of data	
Bias factor A	0.88 (0.79 - 1)
Bias B	13% (0% - 26%)
Diffusion Tubes Mean:	36 μgm^{-3}
Mean CV (Precision):	8
Automatic Mean:	32 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	32 (29 - 36) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 10 periods of data	
Bias factor A	0.88 (0.79 - 1)
Bias B	13% (0% - 26%)
Diffusion Tubes Mean:	36 μgm^{-3}
Mean CV (Precision):	8
Automatic Mean:	32 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	32 (29 - 36) μgm^{-3}



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Version 03 - November 2006

Discussion of Choice of Factor to Use

For this assessment nitrogen dioxide concentrations from the diffusion tube monitoring sites have been reported using both the national and local bias adjustment factors. The decision as to which is the more appropriate depends on a number of factors. In the case of Storrington the annual mean has been calculated from a 12 month study and a tube exposure time of 1 month. This correlates with the national database and use of the national bias adjustment. However the local bias adjustment factor is calculated from a triplicate co-location site similar to the Storrington tube sites and the overall survey shows good precision.

In comparing the local versus national bias corrected annual mean concentrations for the Storrington sites, the local bias corrected concentrations are higher than the nationally adjusted concentrations by 8.6%. However there is only one site (Storrington 3n) where this difference means that the concentrations reported fall either side of the objective level. At all other sites the calculated concentrations are either well in exceedance of the objective or significantly below the objective irrespective of the bias correction factor used. At the School Hill (Storrington 3n) site the lower concentration value is very close to the objective and therefore, for the purposes of this assessment will be deemed to represent an exceedance of the objective.

Given that the national bias adjustment factor is considered more representative for the diffusion tube survey as a whole, the bias adjustment factor of 0.81 derived from the national survey has been used to correct the diffusion tube results for 2009. The national bias adjusted data for the Storrington diffusion tube sites has also been used for verification of the modelled pollutant concentrations.

QA/QC of Diffusion Tube Monitoring

The diffusion tube data for 2009 has been checked using the AEA Precision spreadsheet tool presented in Table A1. The results of this exercise show that good precision was achieved.

DEFRA advises that local authorities should use diffusion tubes supplied by laboratories that have demonstrated satisfactory performance under the Workplace Analysis Scheme for Proficiency (WASP).

The WASP scheme is an independent analytical performance testing program. The performance of laboratories is further assessed by AEA on behalf of DEFRA as part of the government's support for local air quality management. The list of those laboratories which have performed satisfactorily is provided to local authorities on the Local Air Quality Support web site http://www.laqmsupport.org.uk/index.php

The laboratory supplying diffusion tubes to Horsham District Council is deemed to have had good performance in 2009. (WASP rounds 103-107, Oct 2008 – Oct 2009).

Table A2: Monthly nitrogen dioxide data - Storrington diffusion tubes 2009

HO ref	Site details	Address	Month (2009)													Local bias corrected	National bias corrected
			1	2	3	4	5	6	7	8	9	10	11	12	Annual Mean		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec		0.88	0.81
5	Park Way - Triplicate	AQMS horsham	38	60	40	37	31	38	14	32	36	34	34	43	36.4	32.0	29.5
6	Park Way - Triplicate	AQMS horsham	43	43	41	36	28	36	15	31	34	35	34		34.2	30.1	27.7
7	Park Way - Triplicate	AQMS horsham	41	58	32	35	32	38	13	31	37	32	31	50	35.8	31.5	29.0
13	85176- Storrington 1n	Manleys Hill, Storr duplicate	60	82	63	75	49	75	56	56	67	62	36	66	62.3	**54.8**	**50.4**
14	85977- Storrington2n	Manleys Hill, Storr duplicate	61	80	67	64	51	78	53	44	78	58	58		62.9	**55.4**	**51.0**
15	85978-Storrington 3n	3 School Hill, Storrington	44	67	50	52	36	53	29	42	55	44	39	52	46.9	**41.3**	38.0
16	85979-Storrington 4n	22 High Street, Storrington	58	64	57	63	55	48	41	53	50	50	45	59	53.6	**47.2**	**43.4**
17	85980-Storrington 5n	2 West Street, Storrington	37	51	34	42	31	33	27	23	25	32	30	49	34.5	30.4	27.9
18	85981-Storrington 6n	1-4 Holly Court, Pulb. Road,	40	47	38	37	26	38	28	24	30	30	39	39	34.7	30.5	28.1
19	85982-Storrington 7n	The Willows, Amberley Rd	32	47	25	30	28	35	21	24	35	32	28	37	31.2	27.4	25.2
29	Manleys Hill AURN Co-located	Manleys Hill AUN co-located												36	36.0	31.7	29.2
30	Manleys Hill AURN Co-located	Manleys Hill AUN co-located												55	55.0	**48.4**	**44.6**
Local bias correction based on 2009 triplicate tube data from Park Way Horsham																	
National bias correction based on AEA diffusion tube database (v.03/10)																	

Particulate Matter Monitoring Adjustment

The PM (particulate matter) monitoring data produced in this report is derived from Filter Dynamics Measurement System (FDMS) analysers. The FDMS is a self-referencing airbourne particulate monitor based on Tapered Element Oscillating Microbalance (TEOM) technology, measuring both core and volatile fractions of particles. The Storrington analysers are Model C/B and meet the current equivalence criteria of the European reference method within the UK. The data from the Storrington analysers had NOT been ratified at the time of this Detailed Assessment and any PM_{10} concentrations derived from this data are for indicative purposes only.

Short-term to Long-term Data adjustment

Data has been collected since August 2009 for the new Storrington AURN site and therefore the data capture rate of 40% for 2009 is insufficient to determine relevant statistics for that year without adjustment. An adjustment factor for estimation of the annual mean PM_{10} concentration for Storrington has been calculated in accordance with Box 3.2 of the Technical Guidance document LAQM.TG(09). See Table A2 below.

Table A3: Calculation of Adjustment Factor for Short-term Monitoring Data to Annual Mean Concentration for Storrington PM_{10}

Long Term Site	Site Type	Annual Mean PM10 2009 (Am)	Period Mean PM10 2009 (Pm)	Ratio (Am/Pm)
Eastbourne – Devonshire Park	Background	23 ug/m3 (ratified)	20.6ug/m3 (ratified)	1.117
Ashford – background	Background	18.7 ug/m3 (ratified)	18.3 ug/m3 (ratified)	1.022
			Average (Ra)	**1.0695**

QA/QC of Automatic Monitoring

The Storrington air quality monitoring station is affiliated to the DEFRA Automatic Urban and Rural Network (AURN). AEA Technology is the QA/QC unit for the network with data collection and ratification also undertaken by them. Calibrations are undertaken on a four week period by an approved external Local Site Operator (LSO) and the analysers are maintained under contract with instrument suppliers/manufacturers.

Appendix B :

Air quality modelling methodology (Breeze Roads) Horsham District Council, Storrington 2009.

Introduction:

Modelling of air quality was undertaken for Horsham District Council to identify predicted air quality concentrations in Storrington, West Sussex for the year 2009.

The modelling involves the use of a complex computerised model called "BREEZE Roads" to derive the annual averaged nitrogen dioxide (NO_2) concentrations at specific receptors (mainly residential properties) adjacent to the roads in Storrington.

The modelling predicts the concentration of a pollutant, this case nitrogen dioxide (NO_2), as determined from the input data. The model predicts the concentration of NO_2 from the main emission contributor, traffic, and adds the local background ambient concentration of NO_2 to ascertain the total concentration at a known receptor (location). These results determine whether or not, in a specific year, there may be in exceedance of the air quality objective.

The model uses traffic data and projections, emissions projections and forecasts/models forward to a specific year to determine a predicted concentration. The year 2009 is used as this is a UK nation objective compliance year for many pollutants.

Table B1: UK air quality objectives (2007 UK Air Quality Strategy)

Pollutant	Air Quality Objective	Period	Achieved by
Nitrogen dioxide [NO_2]	*200 µg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31.12.2005
	40 µg/m^3	**Annual mean**	**31.12.2005**

Advice to LA's from DEFRA Laxen & Marner[1] :
Given the difficulty of measuring exceedences of the 1-hour objective at roadside and kerbside locations and of modelling peak 1-hour concentrations, it is suggested that "it would be appropriate for local authorities to base the decision of likely exceedence of the 1-hour nitrogen dioxide objective on an exeedence of 60µg/m³ as an annual mean".

Therefore if there are no exceedences of the annual mean of 60µg/m³, then it is unlikely that the 1-hour objective will be exceeded.

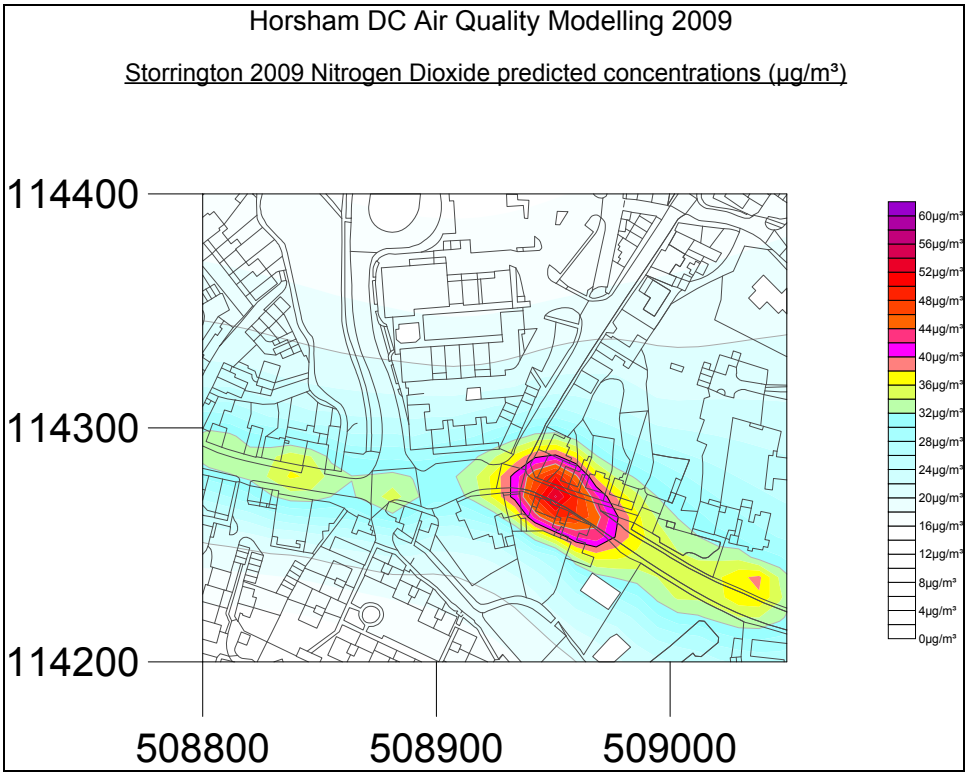
[1] *Defra/Laxen and Marner 2003: Analysis of the relationship between 1-hour and annual mean nitrogen dioxide at UK roadside and kerbside monitoring sites*

Executive Summary

Modelling of the air quality was undertaken for the village of Storrington in West Sussex, to ascertain if there were a likelihood of air quality concentrations exceeding the national and EU air quality objectives. Monitoring with nitrogen dioxide (NO_2) diffusion tubes from 2009 indicated that there is a likely exceedance of the NO_2 likely annual standard threshold of 40 micro grams per cubic metre (µg/m³). Modelling results shown below, were verified (checked) against the monitoring results in 2009, and indicated that there is the likelihood of exceedences of the annual NO_2 limit of 40µg/m³ for the year 2009. The model was run utilising average meteorological conditions for the year 2009.

The model predicted exceedences of the annual NO_2 air quality objective value of 40µg/m³ for the year 2009 at the 4 specific (pre-selected) receptor locations in Storrington. The model concentration map shown below (Figure 1), indicates that there may be a further 2 to 3 properties adjacent which also exceed the annual NO_2 air quality objective value. The locations identified in the modelling were 4 Manley Road, 3 Eastbrook Court, 1 Brook Cottage and Manley House.

Figure B1: 2009 modelled annual average concentrations for NO2 (µg/m^3) at key receptors. (Junction of B2139(School Hill) and A283 (High St/Manleys Hill)).



2. Detailed Modelling Methodology

The Sussex Air Quality Partnership (Sussex-air) Project Development Officer, undertook modelling using the BREEZE Roads model on behalf of Horsham District Council.

2.1. Model:

BREEZE Roads - an advanced dispersion model, which is based on Gaussian plume theory. It requires an amount of input data: site characteristics, meteorological data, traffic information, emission factors, and background pollutant concentrations.

2.2. Input Data:

2.2.1. Emissions modelling Years: 2009.

2.2.2. Meteorological data source:

- Shoreham (09)

2.2.3. Traffic data source: West Sussex County Council

- AADT values were used from manual and automatic traffic counts
  - 24 hour 7 day week yearly average on West St = 17005 for 2009.
  - Heavy Duty/Diesel Vehicles over large Transit size annual %age 5day weeks = 2.8% which = 504 HDVs
  - Speed: 24HR 5 Day week annual average = 24.1mph (38.8 kph),

2.2.4. Background pollutant source:
NOx and NO2 background concentrations were taken from the National Atmospheric Emissions Inventory (NAEI) web-site (www.naei.org.uk) for the grid squares that the specific road section was within.

2.2.5. Emission factors (EF)
Vehicle emission factors were calculated using the "Emission Factors Toolkit" (Final_EF2003 EF Version3a). The emission factor for this road was determined as follows:

The EF inputs were as follows:

- Road type: Urban
- % :Cars (incl. motorcycles), LGV, HGV (rigid), HGV (artic.) and Buses (incl. coaches).
- Speed: kph

3. Site characteristics:

Additional model inputs required for BREEZE Roads were:
Road type: Urban
Road width: relative to road sections Road slope: relative to road sections
Receptor height: 1.8 m (Specific receptors may be higher or lower dependent upon which floor a residential property may be on.)
Surface roughness length: 1 m

4. Derivation of NO2 from modelled NOx results.

BREEZE Roads produces a predicted NOx concentration, sourced from the road emissions, from the model runs = NOx (road). To produce an annual averaged concentration of NO2 i.e. NO2 (total), the NOx (road) results need to be are converted to produce a NO2 (total) value. This value is then used to compare to the UK Air Quality Objective (AQO) limit to determine whether there is an exceedence or not.

5. Model verification and correction factors.

LAQM.TG (09) guidance provides the methodology used to verify the modelled results and determine NO2 concentration that is to be compared to the AQO. The methodology used in this modelling follows LAQM.TG (09) section A3-40 and is set-out in detail in Appendix 2.

6. Street canyon effect.

BREEZE Roads models NOx concentrations that are contributed from the road sources however there is no complex calculation for the effects of a street canyon in the model.

There are sections of the modelled road which could be described as canyons. However these are limited to a few short lengths of road along West Street and Manleys Hill where the carriageway narrows and the building facades are close to the kerb. There is no significant length of road forming a street canyon in Storrington. An assessment was made of the impact of a “canyon effect” on the modelled outputs for Storrington but there was no significant effect on predicted nitrogen concentrations based on the available data.

7. Summary of results

The summary of results outlines the modelling of selected roads and identifies the predicted concentrations of NO2 at specific receptor locations. The receptor locations are those locations of residential properties adjacent to roads where people may be exposed to pollutants. The modelled predictions are expressed as the annual average concentration in micrograms per cubic meter (µg/m^3). The modelling predictions reflect the relative predicted pollutant levels at each property and identifies if any of these properties were estimated to either breach or be within a certain percentage or near breach of the UK Air Quality Objectives (AQO) for nitrogen dioxide (NO2). The annual average AQO limit for NO2 is 40µg/m^3.

Three (4) locations/receptors have been identified as likely to have been in exceedence of the UK Air Quality Objectives (AQO) limit

Table B2: Modelled NO2 concentrations at locations which are predicted to have exceeded the AQO limit (40µg/m^3) for 2009.

Sensitive receptors	NO2 (total) (µg/m^3)	% of Air Quality Objective
Stor Cottage, Eastbrook	54.9	137%
5 Eastbrook Court	46.3	116%
Wayside, Manleys Hill	43.2	108%
Virginia Cottage, Manleys Hill	50.9	127%

The modelling results for all other sensitive receptors are given in the following table B3.

Table B3: Predicted annual model results for year 2009.

Receptors	Modelled results (µg/m³)	% of Air Quality Objective
6 Amberley Rd	19.05	48%
Chapters(Amb Rd)	17.68	44%
1 Amberley Rd	18.56	46%
6 Holly Close	19.90	50%
5 Holly Close	32.06	80%
61 West St	31.75	79%
57 West St	31.59	79%
53 West St	33.93	85%
42 West St	35.64	89%
44 West St	33.24	83%
40 West St	33.58	84%
36a West St	27.78	69%
36 West St	28.77	72%
34 West St	30.77	77%
30 West St	30.22	76%
51 West St	27.59	69%
6 Rectory Cottages	25.93	65%
1 Rectory Cottages	27.31	68%
2nd floor flats 29 West St	28.54	71%
23 West St	34.98	87%
20 West St	37.50	94%
4 West St	32.06	80%
9 The Square	28.57	71%
1 West Street	33.14	83%
White Horse Hotel	32.35	81%
1 High St	32.03	80%
3 High St	35.40	89%
13 High St	37.94	95%
26 High St	32.79	82%
38 High St	35.73	89%
23 High St	29.41	74%
29 High St	30.37	76%
Anchor Inn	36.65	92%
Stor Cottage Eastbrook	**54.89**	**137%**
5 Eastbrook Court	**46.27**	**116%**
Wayside Manley's Hill	**43.18**	**108%**
Virginia Cottage Manley's Hill	**50.92**	**127%**
3 School Hill	26.46	66%

Appendix B: Modelled concentration maps.

Figure B2: 2009 modelled annual average concentrations for NO2 (µg/m^3).

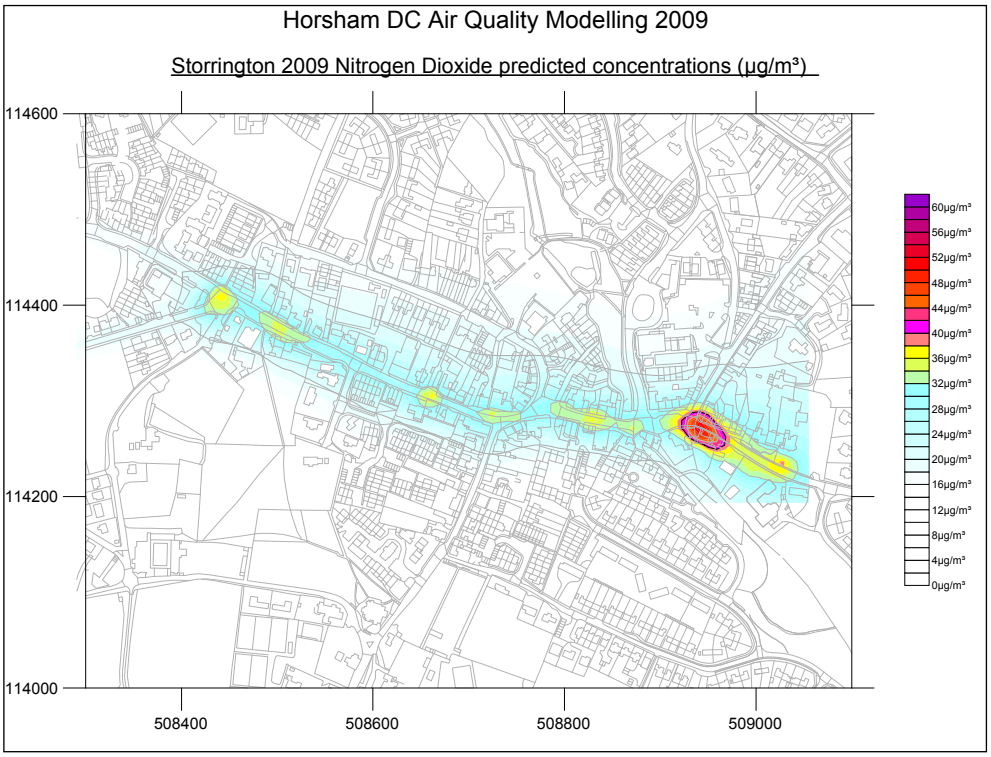
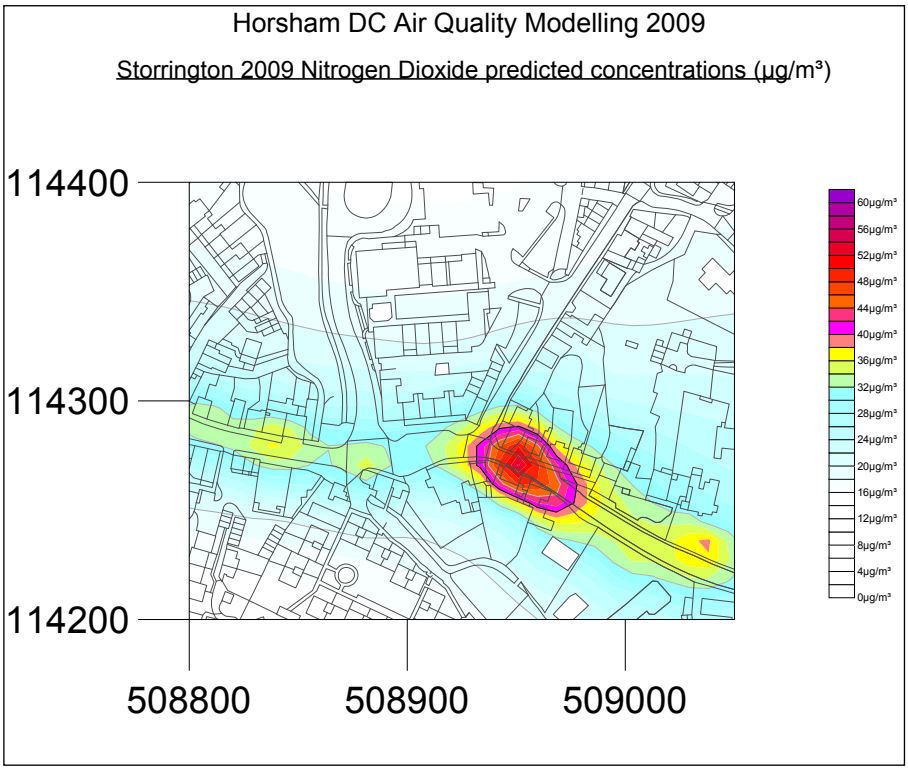


Figure B3 : 2009 modelled annual average concentrations for NO2 (µg/m^3)- locations likely to exceed air quality objectives.



Appendix B2: Model verification and correction factors:

Modelling methodology

The verification of the modelled or predicted pollutant concentrations is required to ascertain the accuracy of modelled results. A comparison of the measured versus the modelled NOx output from the model is undertaken to determine this. The methodology used to verify the modelled results follows LAQM TG (09) section A3-40. The modelled results are compared to the local measured NO2 diffusion tubes to determine the adjustment factors used for the modelled results.

In 2009 there were 7 locations in Storrington where nitrogen dioxide (NO2) diffusion tubes monitored throughout the year. These sites were road-side locations adjacent to roads. These locations were:

Table B4: 2009 NO2 diffusion tube results

ID	Reference	2009 annual bias adjusted NO2 conc. (µg/m^3)
13	85176- Storrington 1n	**50.4**
14	85977-Storr. duplicate Storrington2n	**51.0**
15	85978-3 School Hill Storrington 3n	38.0
16	85979-22 High Street Storrington 4n	**43.4**
17	85980-Storrington PO Storrington 5n	27.9
18	85981-Holly Court Storrington 6n	28.1
19	85982-The Willows Storrington 7n	25.2

a) NOx correction factor (CF):

Following LAQM TG (09) guidance, results from the modelled NOx (road contribution) were compared to the monitored NO2 (converted to NOx (road contribution)). The monitored NO2 was converted to NOx using the LAQM "NOx to NO2 conversion spreadsheet" (Vers 2.1, J Abbott & S Cooke, 22 Jan 2010).

The "General inputs" for the spread sheet are as follows:

Year : 2009

Local Authority: Horsham District

Traffic mix: All other urban UK traffic

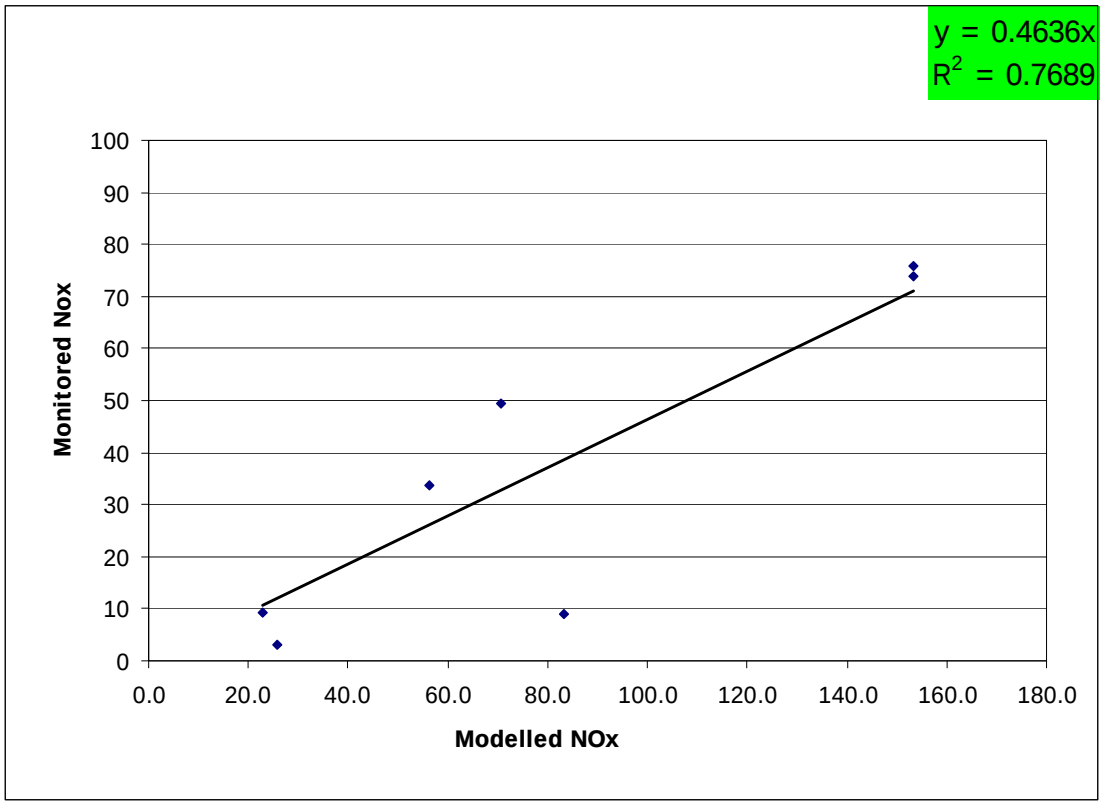
Determination of "roadside NOx (µg/m^3)" from NO2 diffusion tubes:The measured annual averaged Total NO2 concentrations were converted to "roadside NOx" by removing the background NO2 (11.6µg/m^3) concentration and calculating the NOx component using the "NOx to NO2 conversion spreadsheet".

The measured roadside NOx (above) and the modelled roadside NOx was compared to determine the local NOx adjustment figure for 2009.

Table B5: Measured NO2 diffusion tube conversion to measured NOx.

Site ID	Total NO_2 ($\mu g/m^3$)	Background NO_2 ($\mu g/m^3$)	Road NO_2 ($\mu g/m^3$)	Road NOx ($\mu g/m^3$)	Modelled NOx ($\mu g/m^3$)
13	**50.4**	11.63	38.8	73.76	153.4
14	**51.0**	11.63	39.3	75.82	153.4
15	38.0	11.63	26.4	33.66	56.4
16	**43.4**	11.63	31.8	49.46	70.8
17	27.9	11.63	16.3	8.87	83.2
18	28.1	11.63	16.4	9.17	22.9
19	25.2	11.63	13.6	2.96	25.7

Graph B1: Modelled versus monitored NOx (road) results.



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The resulting regression slope in graph 1 determines the adjustment factor for the modelled output to correlate to the actual measured NOx at this location (y = 0.4636x).

The NOx adjustment factor = 0.4636

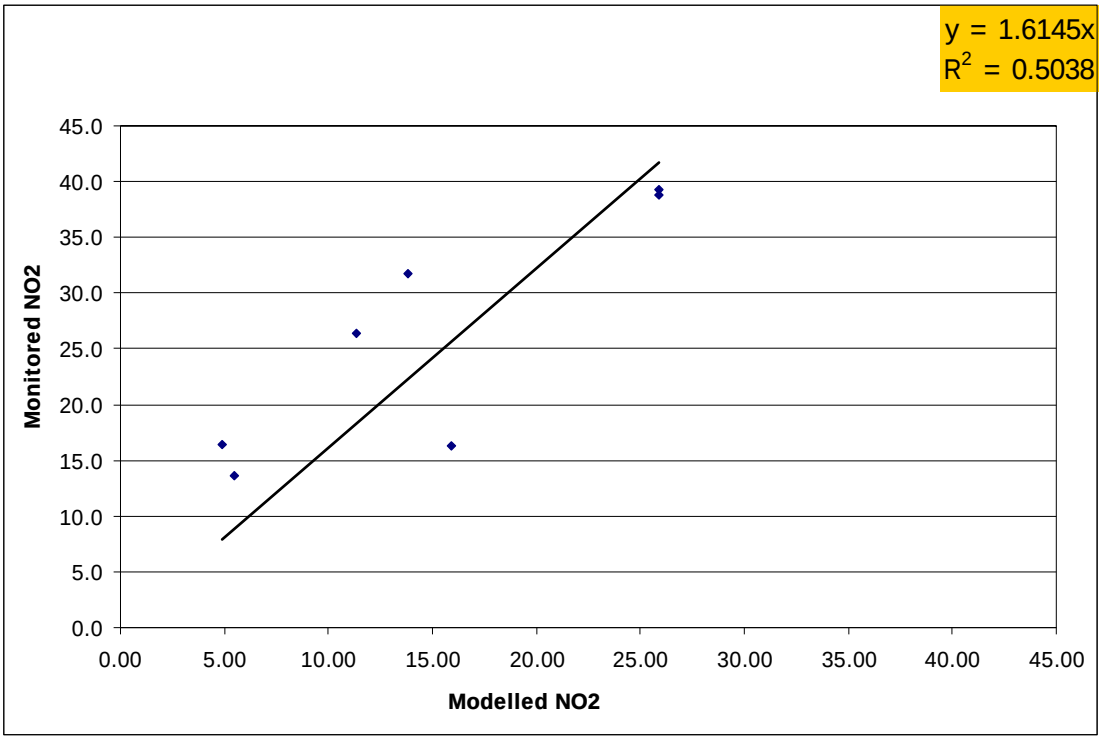
b) **NO2 (secondary) adjustment factor:**

The NOx adjustment factor was applied to the modelled output and then compared to the results of the 3 diffusion tubes for final verification. The following results are comparison of "adjusted modelled road NO2 contribution"(x-axis) versus "monitored road NO2 contribution"(y-axis).

Table B6: Measured versus (NOx adjusted) modelled NO2 results

Site ID	Monitored roadside NO2	Modelled roadside NO2
13	**38.8**	**25.87**
14	**39.3**	**25.87**
15	**26.4**	**11.32**
16	**31.8**	**13.84**
17	**16.3**	**15.92**
18	**16.4**	**4.88**

Graph B2: Comparison of measured versus (NOx adjusted) NO2 results.



The resulting regression slope in graph B2 determines the adjustment factor for the modelled output to correlate to the actual measured NO2 at this location (y = 1.6145x).

The NO2 (secondary) adjustment factor = 1.6145

c) Full adjustment calculation

1. Modelled road contribution NOx is multiplied by NOx adjustment factor = "adjusted road-NOx".
2. Input the "adjusted road-NOx" into the "NOx to NO2 calculator" + background NOx = "road-NO2".
3. The "road NO2" is multiplied by the NO2 (secondary) adjustment factor + background NO2 = Total NO2 (adj. total)

Full adjustment calculation:

- NOx (mod)*NOx(f) = NOx(adj road)
- NOx(adj road) + NOx (bkgrd) input into "NOx to NO2" calculator = "NO2 (road)"
- "NO2 (road)" * NO2 (secondary) + NO2 (bkgrd) = NO2 (adj. total)

Appendix 3: Interpreting NO2 annual average results and 1 hour exceedences of UK objectives

Advice to LA's from DEFRA Laxen & Marner[2] :

Given the difficulty of measuring exceedences of the 1-hour objective at roadside and kerbside locations and of modelling peak 1-hour concentrations, it is suggested that "it would be appropriate for local authorities to base the decision of likely exceedence of the 1-hour nitrogen dioxide objective on an exeedence of 60µg/m³ as an annual mean".

Therefore if there are no exceedences of the annual mean of 60µg/m³, then it is unlikely that the 1-hour objective will be exceeded.

[2] *Defra/Laxen and Marner 2003: Analysis of the relationship between 1-hour and annual mean nitrogen dioxide at UK roadside and kerbside monitoring sites*

References:

DEFRA LAQM TG (09)	Technical Guidence 2009
[1]Defra/Laxen, Marner and Donovan 2007	Deriving NO2 from NOx for Air Quality Assessments of Roads – Updated 2006
[2]Defra/Laxen and Marner 2003	Analysis of the relationship between 1-hour and annual mean nitrogen dioxide at UK roadside and kerbside monitoring sites

Appendix C: Abbreviations and Glossary

AADT	Annual Average Daily Traffic (vehicles per day)
AQEG	Air Quality Expert Group
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network (air quality monitoring)
BREEZE roads	Computerised model for predicting pollutant concentrations
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EA	Environment Agency
EF	Emission Factor
FDMS	Filter Dynamics Measurement System
HDV	Heavy Duty Vehicles, ie, all vehicles more than 3.5 tonnes including Heavy Goods Vehicles and buses
HGV	Heavy Goods Vehicles greater than 7.5 tonnes in weight
LA	Local Authorities
LAQM	Local Air Quality Management
LDV	Light Duty Vehicles (includes passenger cars and other vehicles < 3.5 gross vehicle weight).
LGV	Light Goods Vehicles
µg/m³	micrograms per cubic metre in air
NO	Nitrogen monoxide, also termed Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides (NO + NO_2)
OS	Ordnance Survey
PM_{10}	Airborne particulate matter with a (equivalent aerodynamic) diameter of ten microns (10 µm) or less
$PM_{2.5}$	Airborne particulate matter with a (equivalent aerodynamic) diameter of 2.5 microns (2.5 µm) or less
QA/QC	Quality Assurance and Quality Control
TEOM	Tapered Element Oscillating Microbalance
UKAS	United Kingdom Accreditation Service
UWE	University of the West of England
WASP	Workplace Analysis Scheme for Proficiency

Appendix D: Location Photographs

Photograph 1: High Street/ School Hill/ Manleys Hill junction looking east towards Manleys Hill.

Photograph 2: High Street looking west from High Street/ School Hill/ Manleys Hill junction

Photograph 3: School Hill looking north from High Street/ School Hill/ Manleys Hill junction

Photograph 4: Storrington AURN site Manleys Hill looking east.

Photograph 5: High Street, Storrington looking west.

Photograph 6: West Street looking west towards the West Street/ Amberley Road/ Pulborough Road roundabout junction