Air Quality Consultants

Further Assessment of Air Quality in the Commercial Road AQMA – Borough of Poole Council

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Experts in air quality management & assessment

Document Control

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Executive Summary

This report is the Further Assessment of nitrogen dioxide concentrations within the Commercial Road Air Quality Management Area (AQMA), Poole.

Nitrogen dioxide concentrations within and around the Commercial Road AQMA have been assessed through diffusion tube monitoring and detailed dispersion modelling. The results indicate that the annual mean nitrogen dioxide objective was exceeded in 2010 within the AQMA, and also at locations of relevant exposure outside of the AQMA. It is therefore recommended that the AQMA should be extended to include, as a minimum, the properties along Commercial Road, which the model suggests were exceeding the objective in 2010.

Three receptor locations have been used to provide an overview of source contributions. The most significant components in all cases are cars and background concentrations. At each of the receptors, the split between each source type is similar. Buses and HGVs provide proportionally more emissions than their numbers would suggest. This highlights the importance of keeping all sources under consideration when contemplating measures to include within the action plan.

Contents

1 Introduction

1.1 This report is the Further Assessment of nitrogen dioxide concentrations within the Commercial Road Air Quality Management Area (AQMA), Poole. The report is one of a series produced by, and on behalf of, Borough of Poole Council, which periodically review and assess air quality within the borough. Borough of Poole Council accepts the conclusions of this report and intends to implement all recommendations.

The Air Pollutant of Concern

1.2 Nitrogen dioxide is associated with adverse effects on human health. At high levels nitrogen dioxide causes inflammation of the airways. Long-term exposure may affect lung function and respiratory symptoms. Nitrogen dioxide also enhances the response to allergens in sensitive individuals (Defra, 2007).

The Air Quality Objectives

1.3 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality Regulations, 2000 (Stationery Office, 2000) and the Air Quality (England) (Amendment) Regulations 2002, (Stationery Office, 2002). The relevant objectives for this assessment are provided in Table 1.

Table 1: Relevant Air Quality Objectives

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour mean	200 $\mu g/m^3$ not to be exceeded more than 18 times a year
	Annual mean	40 $\mu g/m^3$

1.4 The objectives for nitrogen dioxide were to be achieved by 2005, and continue to apply in all future years thereafter. The air quality objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). For the annual mean objective, relevant exposure is mainly limited to residential properties, schools and hospitals. The 1-hour objective applies at these locations as well as at any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully enclosed.

1.5 Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded where the annual mean concentration is below 60 $\mu g/m^3$ (Defra, 2009). Therefore, 1-hour nitrogen dioxide concentrations will only be considered if the annual mean concentration is above this level.

1.6 The European Union has also set limit values for nitrogen dioxide. Achievement of these values is a national obligation rather than a local one. The limit values for nitrogen dioxide are the same levels as the UK objectives, and are to be achieved by 2010 (Stationery Office, 2007). The objectives are the same as, or more stringent than, the limit values, thus it is appropriate to focus on the objectives.

Introduction to Review and Assessment

1.7 The Air Quality Strategy (Defra, 2007) provides the policy framework for air quality management and assessment in the UK. As well as providing the air quality objectives listed above, it also sets out how the different sectors: industry, transport and local government can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular Reviews and Assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date.

1.8 Review and Assessment is carried out as a series of rounds. Local Air Quality Management Technical Guidance (LAQM.TG(09)) (Defra, 2009) sets out a phased approach to the current round of Review and Assessment. This prescribes an initial Updating and Screening Assessment (USA), which all authorities must undertake. It is based on a checklist to identify any matters that have changed since the previous round. If the USA identifies any areas where there is a risk that the objectives may be exceeded, which were not identified in the previous round, then the Local Authority should progress to a Detailed Assessment.

1.9 The purpose of the Detailed Assessment is to determine whether an exceedence of an air quality objective is likely and the geographical extent of that exceedence. If the outcome of the Detailed Assessment is that one or more of the air quality objectives are likely to be exceeded, then an Air Quality Management Area (AQMA) must be declared. Subsequent to the declaration of an AQMA, a Further Assessment should be carried out, 1) to confirm that the AQMA declaration is justified and that the appropriate area has been declared, 2) to ascertain the sources contributing to the exceedence, and 3) to calculate the magnitude of reduction in emissions required to achieve the objective. This information can be used to inform an Air Quality Action Plan, which will identify measures to improve local air quality.

Key Findings of Previous Review and Assessment Reports

1.10 The 2004 Progress Report indicated a risk of exceedences of the NO_2 annual mean objective at four separate locations; Poole Road, Ashley Road, Commercial Road and Mountbatten Roundabout. The Council subsequently proceeded to a Detailed Assessment at each of these locations.

1.11 Detailed dispersion modelling results in the 2005 Detailed Assessment indicated that Poole Road and Commercial Road were likely to achieve the annual mean NO_2 objective. Possible exceedences of the objective were identified at some locations on the southern side of Ashley Road and at properties in the vicinity of the Mountbatten Arms Roundabout. The Council did not declare an AQMA because results for Ashley Road were only marginally above the 2005 annual average objective for NO_2, and for the Mountbatten Roundabout there was no relevant exposure where the diffusion tube was located. With agreement from Defra, the Council decided to undertake further investigation in terms of monitoring at these two locations. This involved a three-month continuous monitoring programme at Ashley Road and relocation of the diffusion tube site at Mountbatten Roundabout to Dolberry Road South where relevant exposure was situated.

1.12 The 2006 Detailed Assessment for Ashley Road included a three-months continuous monitoring survey at a location representative of relevant exposure. Detailed dispersion modelling indicated that the NO_2 objective would not be exceeded at three metres height (where residential dwellings exist). Based on these findings, the Council did not declare an AQMA at Ashley Road.

1.13 The 2006 Updating and Screening Assessment concluded that all pollutants were deemed likely to meet their respective air quality objectives. A Detailed Assessment was not required for any of the pollutants.

1.14 The 2007 Progress Report concluded that a Detailed Assessment was required for nitrogen dioxide at Commercial Road, Longfleet Road and Ashley Road. Subsequently in 2008 three-months continuous monitoring of NO_2 was undertaken at Commercial Road. Detailed dispersion modelling was also undertaken at Longfleet Road, Commercial Road and the surrounding local road network. The modelling at Commercial Road indicated possible exceedences of the NO_2 objective at three metres height representative of relevant exposure. It was recommended that more extensive diffusion tube monitoring be carried out, including a co-location study with a continuous monitor, to enable improved verification of the model.

1.15 For Longfleet Road, contour plots indicated probable exceedences of the objective at several receptors and possible exceedences at the majority of receptors in 2007. As the verification on Longfleet Road could only be based on concentrations measured at one diffusion tube, it was recommended that further diffusion tube monitoring should be undertaken at this location in conjunction with a co-location study with a continuous monitoring station in Poole, to provide a greater degree of confidence in the model verification process.

1.16 The 2008 Detailed Assessment was based on additional diffusion tube monitoring at Commercial Road and Longfleet Road. This assessment updated the results in the previous Detailed Assessment and provided improved model verification in accordance with the latest technical guidance, LAQM.TG(09). Contour plots at ground-floor height indicated very likely exceedences of the air quality objective in Commercial Road in 2007. Predictions at a worst-case first-floor height of 3.0 meters, where representative exposure exists, indicate probable exceedences of the annual mean objective at 2 Station Road.

1.17 For Longfleet Road, modelling suggested that maximum concentrations of NO_2 were likely to occur at Longfleet Road, near Poole General Hospital. As receptors were located farther away from the kerb, concentrations experienced at these locations were not considered to be of particular concern. Exceedences of the annual mean NO_2 objective were likely to be possible at a few residential properties in 2007 near the junction of High Street with Elizabeth Road.

1.18 The Updating and Screening Assessment in 2009 again reiterated that for nitrogen dioxide (NO_2), monitoring results indicated exceedences of the annual mean NO_2 objective at Ashley Road, Commercial Road and Longfleet Road (although for the latter, a reduction in NO_2 concentrations was monitored at the existing long-term site).

1.19 An AQMA was declared at Commercial Road, coming into force on 1st September 2010. This report constitutes the Further Assessment for this AQMA.

1.20 A Detailed Assessment is currently being undertaken for Ashley Road (consisting of 3 months of continuous monitoring and modelling). Monitoring commenced in November 2010, with submission of the Detailed Assessment to Defra due by April 2011.

1.21 Further diffusion tube monitoring was undertaken at Longfleet Road in 2009, at locations of relevant exposure. This was reported in the 2010 Progress Report and it was concluded that there are no exceedences of objectives at sites of relevant exposure along Longfleet Road.

Scope

1.22 Guidance within LAQM.TG(09) (Defra, 2009) explains that a Further Assessment report allows authorities to:

- confirm their original assessment, and thus ensure they were correct to designate an AQMA in the first place and that the boundaries are appropriate;
- calculate more accurately what improvement in air quality, and corresponding reduction in emissions, would be required to attain the air quality objectives within the AQMA;
- refine their knowledge of sources of pollution, so that the air quality Action Plan may be appropriately targeted;

- take account of any new guidance issued by Defra and the Devolved Administrations, or any new policy developments that may have come to light since declaration of the AQMA;
- take account of any new local developments that were not fully considered within the earlier Review and Assessment work. This might, for example, include the implications of new transport schemes, commercial or major housing developments etc, that were not committed or known of at the time of preparing the Detailed Assessment;
- carry out additional monitoring to support the conclusion to declare the AQMA;
- corroborate the assumptions on which the AQMA has been based, and to check that the original designation is still valid, and does not need amending in any way; and
- respond to any comments made by statutory consultees in respect of the Detailed Assessment.

2 Study Area and AQMA Location

2.1 The Commercial Road AQMA encompasses properties near to the junction with Station Road (Figure 1). The majority of properties along Commercial Road are commercial, but with relevant exposure for the annual mean objective in the residential units at first floor level. There are no locations additional to those relevant for the annual objective that are relevant for the 1-hour objective. Commercial Road is a busy shopping street and in some places is 'canyon' like. The junction of Commercial Road and Station Road has recently had some improvements made to the signalling, which has changed priorities at the junction, and affecting queuing on the different arms.

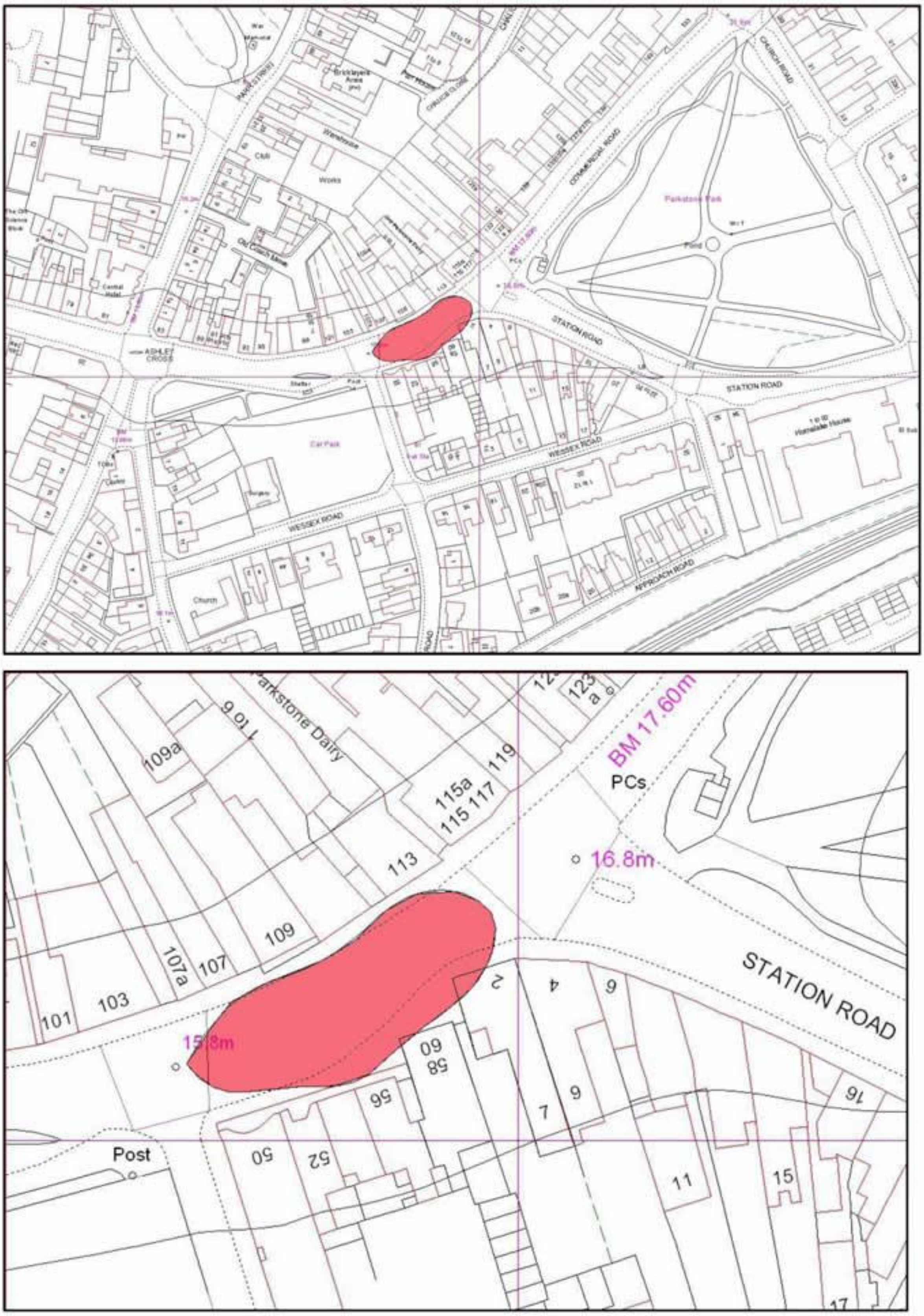

Figure 1: Commercial Road AQMA.

3 Local Developments since Declaration of the AQMA

New and Proposed Local Developments

3.1 As outlined above, priorities at the traffic lights have been changed at the Commercial Road/ Station Road junction. This has affected queuing on the different arms of the junction.

National Developments

3.2 The latest guidance from Defra in LAQM.TG(09) (Defra, 2009) has been followed regarding NOx to NO_2 relationships. All the latest tools associated with the release of LAQM.TG(09) (Defra, 2009) have been used for this assessment.

4 New Monitoring and Modelling Data

New Monitoring

4.1 The Council set up an automatic air quality monitor on Commercial Road, for 6 months (25th May to 25th November, 2010) and also implemented 3 additional diffusion tube monitoring sites for the same period. The existing diffusion tube on Commercial Road was in place for the whole calendar year. This assessment has therefore been based on real time and diffusion tube monitoring.

Bias Adjustment of Diffusion Tubes

4.2 Diffusion tube measurements may exhibit substantial bias compared to the reference method (real time chemiluminescent analyser) for measuring nitrogen dioxide. As a result, LAQM.TG(09) recommends that Local Authorities should apply a 'bias adjustment factor', which is determined by undertaking a co-location study with a real time analyser. If this cannot be undertaken within the local authority area, then a default factor made available within a spreadsheet on the Defra LAQM support website should be used (Defra, 2011). The Council uses Gradko (through Bureau Veritas) to supply and analyse diffusion tubes (50% TEA in acetone method). For this study, the 2010 data have been adjusted using the locally derived factor for the tubes which were only in place for 6 months (locally derived factor available for the 6 month period), and for the tube which has been in place for 12 month period, the national factor has been used (see Appendix 3).

Diffusion Tube Data

4.3 The diffusion tube monitoring locations in close proximity to the AQMA are shown in Figure 2. The automatic monitor is co-located with triplicate diffusion tubes. Monitoring data are presented in Table 2.

Table 2: Diffusion Tube Data within the Cross Street Study Area[a]

	Within AQMA	OS Grid Coordinates		Annual mean nitrogen dioxide ($\mu g/m^3$)		
		X	Y	2008[b]	2009[c]	2010[d]
Automatic Monitor						
Automatic monitor	N	403518	91568	n/a	n/a	**49.7**
Diffusion Tubes						
Monitor	N	403518	91568	n/a	n/a	**49.7**
12 Station Road	N	403530	91516	n/a	n/a	**52.4**
113 Commercial Road	N	403483	91532	n/a	n/a	**55.3**
109 Commercial Road	N	403474	91526	n/a	n/a	**56.5**
Existing Tube	Y	403484	91513	**41.3**	**44.7**	37.0

[a] Values in bold are exceedences of the objective.

[b] Bias adjusted by the Council using a national factor of 0.93 (using national factors in version 03/09 of the bias adjustment spreadsheet).

[c] Bias adjusted by the Council using a national factor of 0.99 (using national factors in version 03/10 of the bias adjustment spreadsheet).

[d] see Appendix 2 and 3 for details of adjustments made to the diffusion tube and real time data

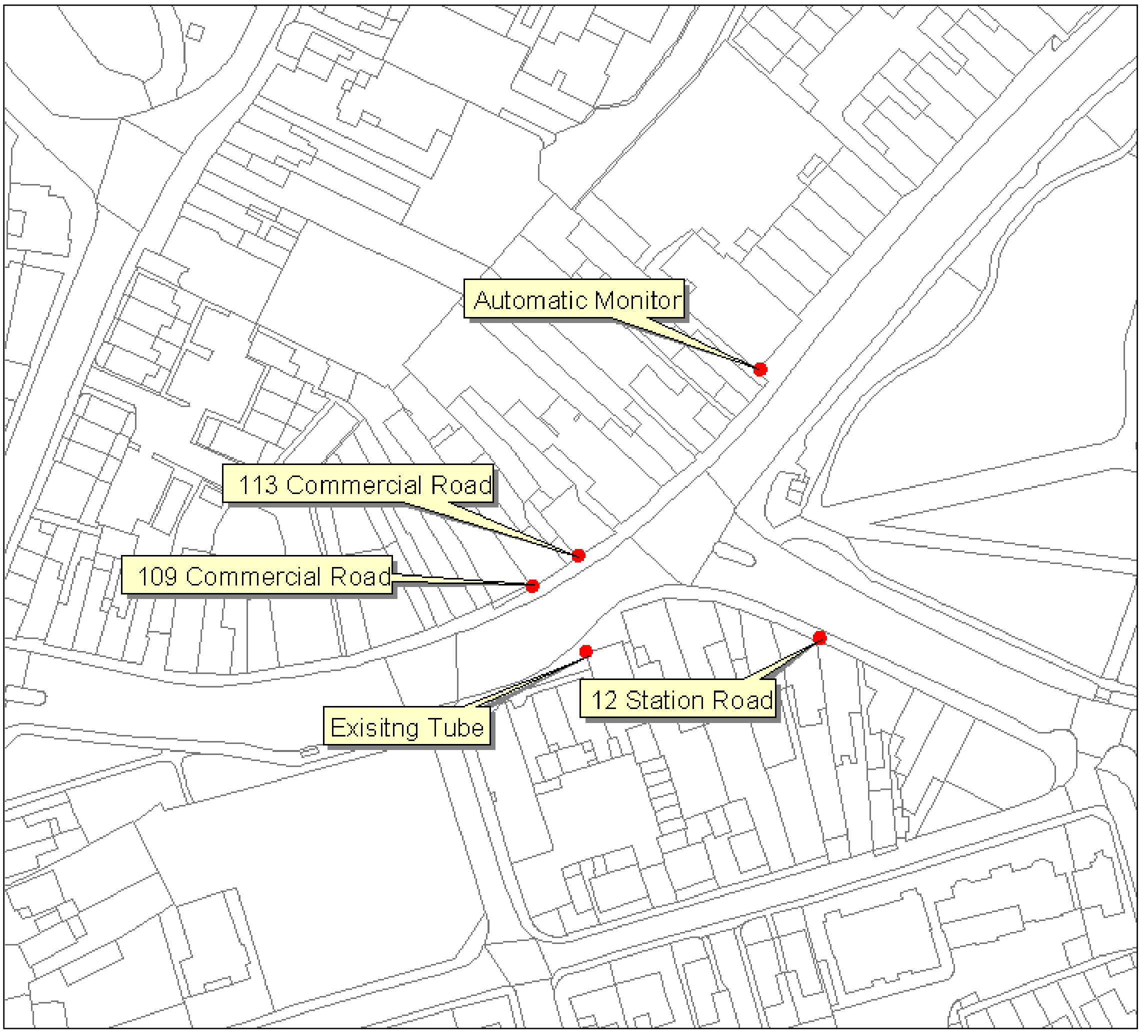

Figure 2: Monitoring locations in close proximity to the AQMA.

4.4 All of the diffusion tube sites (other than the Existing Tube) and the real time monitoring site measured an exceedence of the annual mean objective within the study area in 2010. There is relevant residential exposure at first floor level near to all the monitoring sites. Concentrations of nitrogen dioxide do not exceed 60 μg/m^3. The Technical Guidance TG(09), issued by the Department for Environment Food and Rural Affairs (Defra), regards this concentration as being indicative of a potential failure of the 1-hour objective. It is therefore concluded that it is unlikely that the hourly objective is being exceeded at this location.

4.5 Measured concentrations at the existing diffusion tube site were above the objective in 2008 and 2009, but not in 2010. Concentrations are higher on the opposite side of the road.

4.6 Uncertainty is inherent in all measured data. However, the short-term nature of real time and diffusion tube monitoring adds to the uncertainty as further adjustments have had to be made to estimate annual means (see Appendix 2 and 3). The results for the Existing Tube have been adjusted in a slightly different way, and give a lower annual mean concentration. It is considered that the data have been adjusted in the most robust way, but some caution should be applied when considering the monitoring data from the six-month survey in terms of absolute concentrations.

New Modelling

4.7 Annual mean concentrations of nitrogen dioxide from road sources in 2009 have been modelled within the study area using ADMS Roads (version 2.3). Details of the input parameters are set out below, whilst further details of the dispersion modelling methodology are set out in Appendix 1.

Road Traffic Impacts

4.8 The contribution of emissions from road traffic to the annual mean concentrations of nitrogen dioxide within each study area has been modelled using ADMS Roads (version 3). The following input data have been used:

- Borough of Poole Council provided 12 hour flows, split into a number of vehicle classes, for Station Road, Commercial Road, Bournemouth Road, Springfield Road and Church Street. These flows were adjusted to Annual Average Daily Traffic (AADT) flows using factors provided by Borough of Poole Council. There will be uncertainty associated with these traffic data, however, the conclusions of the assessment are unlikely to be particularly sensitive to this uncertainty. All of the traffic flows used in this assessment have been assumed to have the national diurnal flow profiles published by the Department for Transport (DfT, 2009).
- Detailed fleet composition data were provided, and therefore the emissions from each vehicle class were calculated using ADMS Roads (version 3) for each vehicle class individually. This enabled data to be determined for detailed source apportionment;
- Speeds have been based on the speed limit, but also take into account the proximity to a junction, length of queues and traffic speeds observed during the site visit;
- The locations of roads and buildings (including road width) have been obtained using OS Landline mapping information;
- Meteorological data from Bournemouth Airport in 2010 have been used.

4.9 The model has been verified by comparing the predicted results with local measurements (within the study area), and the model output adjusted accordingly. Details of model verification are presented in Appendix 1.

Modelling Uncertainty

4.10 Uncertainty is inherent in all measured and modelled data. All values presented in this report are the best possible estimates, but uncertainties in the results might cause over- or under-predictions. All of the measured concentrations presented have an intrinsic margin of error. Defra (2010b) suggests that this is of the order of plus or minus 20% for diffusion tube data and plus or minus 10% for automatic measurements. The model results rely on traffic data provided by Borough of

Poole Council and any uncertainties inherent in these data will carry into this assessment. There will be additional uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example: it has been assumed that wind conditions measured at Bournemouth during 2010 will have occurred throughout the study areas during 2010; and it has been assumed that the dispersion of emitted pollutants will conform to a Gaussian distribution over flat terrain. An important step in the assessment is verifying the dispersion model against the measured data. By comparing the model results with measurements, and correcting for the apparent under-prediction of the model, the uncertainties can be reduced.

4.11 Recently however, a disparity between the road transport emission projections and measured annual mean concentrations of nitrogen oxides and nitrogen dioxide has been identified by Defra (Carslaw et al, 2011). This applies across the UK, although there is considerable inter-site variation. Whilst the emission projections suggest that both annual mean nitrogen oxides and nitrogen dioxide concentrations should have fallen by around 15-25% over the past 6 to 8 years, at many monitoring sites levels have remained relatively stable, or have even shown a slight increase.

4.12 The precise reason for this disparity is not known, but is thought to be related to the actual on-road performance of diesel vehicles when compared to the calculations based on the Euro standards. It may therefore be expected that nitrogen oxides and nitrogen dioxide concentrations will not fall as quickly in future years as the current projections indicate. However, at this stage, there is no robust evidence upon which to carry out any revised predictions.

Concentrations at Specific Receptors

4.13 Locations representing worst-case residential exposure along the roads within the study area have been selected for modelling. In total twenty-two residential receptors have been modelled at various heights, reflecting the heights of the actual receptors (i.e. many locations only have relevant exposure at first floor level and have thus been modelled as such).

4.14 Receptor locations are shown in Figure 3. Annual mean nitrogen dioxide concentrations predicted for each of these receptors are presented in Table 3. The highest predicted concentration in 2010 is 42.8 µg/m^3, at Receptor 3. Concentrations are also predicted to exceed the annual mean objective at Receptors 7 and 21. There are no predicted annual mean concentrations greater than 60 µg/m^3. Modelled concentrations are lower than measured concentrations because in most circumstances receptors are further from the ground than the diffusion tubes, or in some cases, at ground-floor level but slightly set back from the road.

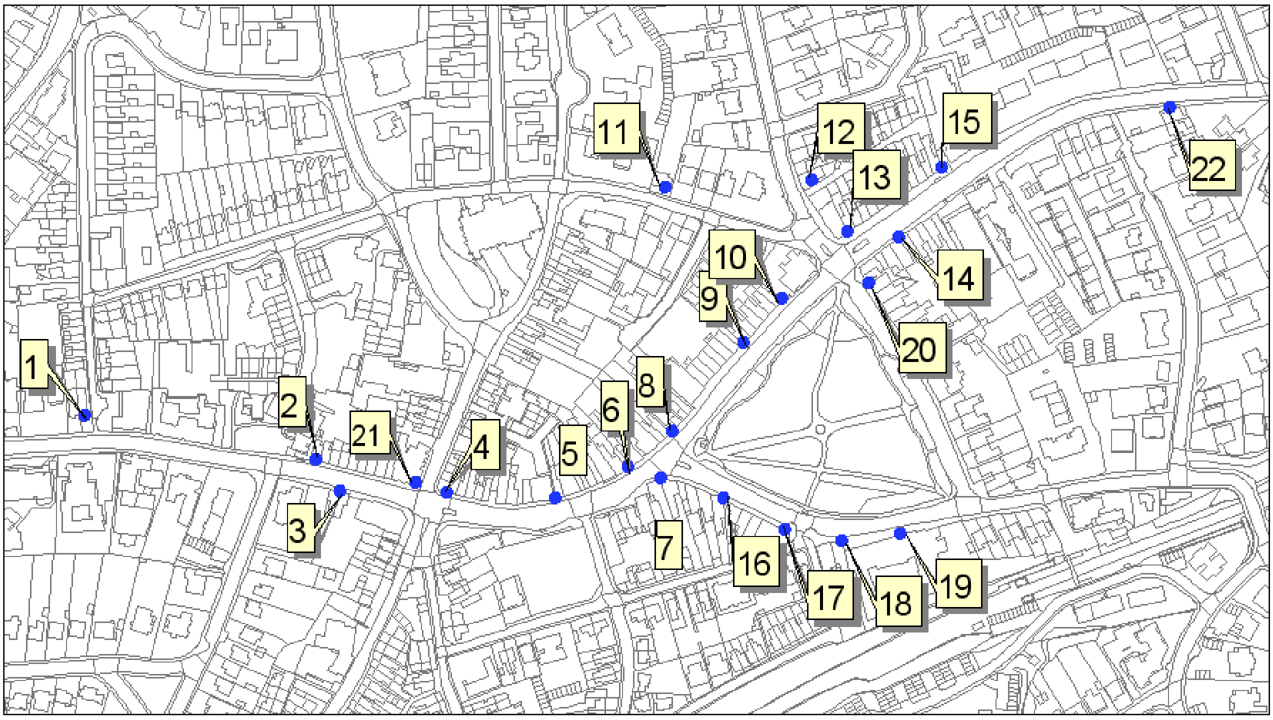

Figure 3: Receptor Locations.

Table 3: Predicted Annual Mean Concentrations of Nitrogen Dioxide ($\mu g/m^3$) in 2010[a]

Receptor	Location	Height modelled at	Annual Mean ($\mu g/m^3$)
1	49 Commercial Road	1.5	23.6
2	65 Commercial Road	5	22.8
3	24 Commercial Road	4.5	**42.8**
4	85 Commercial Road	4.5	25.9
5	101 Commercial Road	4.5	26.3
6	111 Commercial Road	4.5	39.5
7	4 Station Road	5	**41.1**
8	123 Commercial Road	5	29.1
9	139 Commercial Road	4.5	24.5
10	149 Commercial Road	4.5	24.5
11	47 Church Road	1.5	18.3
12	2 Springfield Road	1.5	20.7
13	3 Bournemouth Road	4.5	30.0
14	10 Bournemouth Road	4.5	31.1
15	25 Bournemouth Road	4.5	25.5
16	12 Station Road	5	27.1
17	30 Station Road	5	24.3
18	34 Station Road	4.5	22.7
19	Homelake House, 40 Station Road	1.5	24.7
20	35 Church Road	5	24.6
21	81 Commercial Road	5	**41.3**
22	20 Ardmore Road	1.5	30.4
Objective			**40**

[a] Values in bold are predicted exceedences of the objective.

4.15 Concentrations have also been predicted for a number of additional receptors to enable the extent of the exceedence area to be to be determined (Figure 4). These confirm that there are relevant locations outside of the current AQMA at which concentrations are likely to have exceeded the annual mean nitrogen dioxide objective in 2010. These results are included in full in Appendix 4.

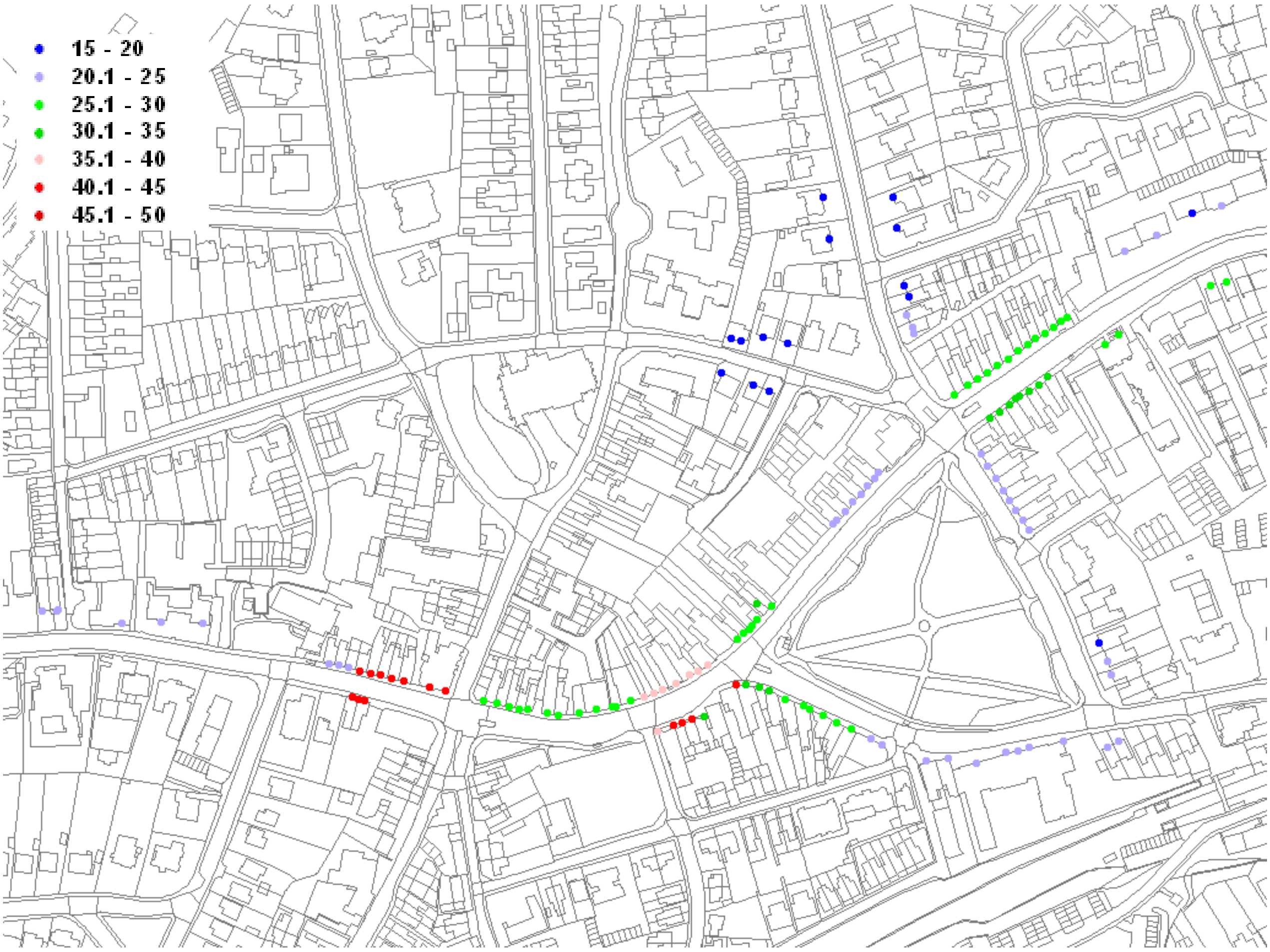

Figure 4: Predicted Concentrations of Nitrogen Dioxide (μg/m^3) at all modelled receptors in 2010.

4.16 The AQMA boundary should therefore be amended to include, as a minimum, those relevant locations where exceedences have been predicted further down Commercial Road.

5 Source Apportionment

5.1 In order to develop an appropriate action plan it is necessary to identify the sources contributing to the objective exceedences within the AQMA. The data presented here can be used to inform future decisions, and have been calculated in line with guidance provided in LAQM.TG(09) (Defra, 2009).

5.2 Figure 6 and Table 4 set out the relative contributions of traffic emissions. The following categories have been modelled:

- Ambient Background (Bkgd);
- Motorcycle (MCL);
- Cars;
- Light Goods Vehicles (LGV);
- Buses and Coaches (PSV)
- Other Goods Vehicles 1 + 2 (OGV1+2);

5.3 The three receptors identified previously have been used to provide an overview of source contributions. Table 4 and Figure 5 show the most significant components in all cases are cars and background concentrations. At each of the receptors, the split between each source type is similar. Buses and HGVs provide proportionally more emissions than their numbers would suggest.

Table 4: Predicted Contribution of Each Source Type to the Total

Receptor	Annual Mean Concentration (µg/m^3)						
	Bkgd	**MCL**	**Car**	**LGV**	**Bus**	**HGV**	**Total**
3	15.1	0.1	12.2	3.6	7.0	4.9	42.8
7	15.1	0.1	12.0	3.6	6.3	4.0	41.1
21	15.1	0.1	11.4	3.3	6.7	4.6	41.3
	% Contribution to Total						
	Bkgd	**MCL**	**Car**	**LGV**	**Bus**	**HGV**	**Total**
3	35.4	0.2	28.5	8.3	16.3	11.4	100.0
7	36.8	0.1	29.2	8.8	15.4	9.7	100.0
21	36.6	0.2	27.7	8.1	16.2	11.2	100.0
	% Contribution to local emissions						
	Bkgd	**MCL**	**Car**	**LGV**	**Bus**	**HGV**	**Total**
3	n/a	0.3	44.0	12.8	25.2	17.7	100.0
7	n/a	0.2	46.2	14.0	24.3	15.3	100.0
21	n/a	0.3	43.8	12.7	25.5	17.8	100.0

Receptor 3 = 24 Commercial Road

Receptor 7 = 4 Station Road

Receptor 21 = 81 Commercial Road

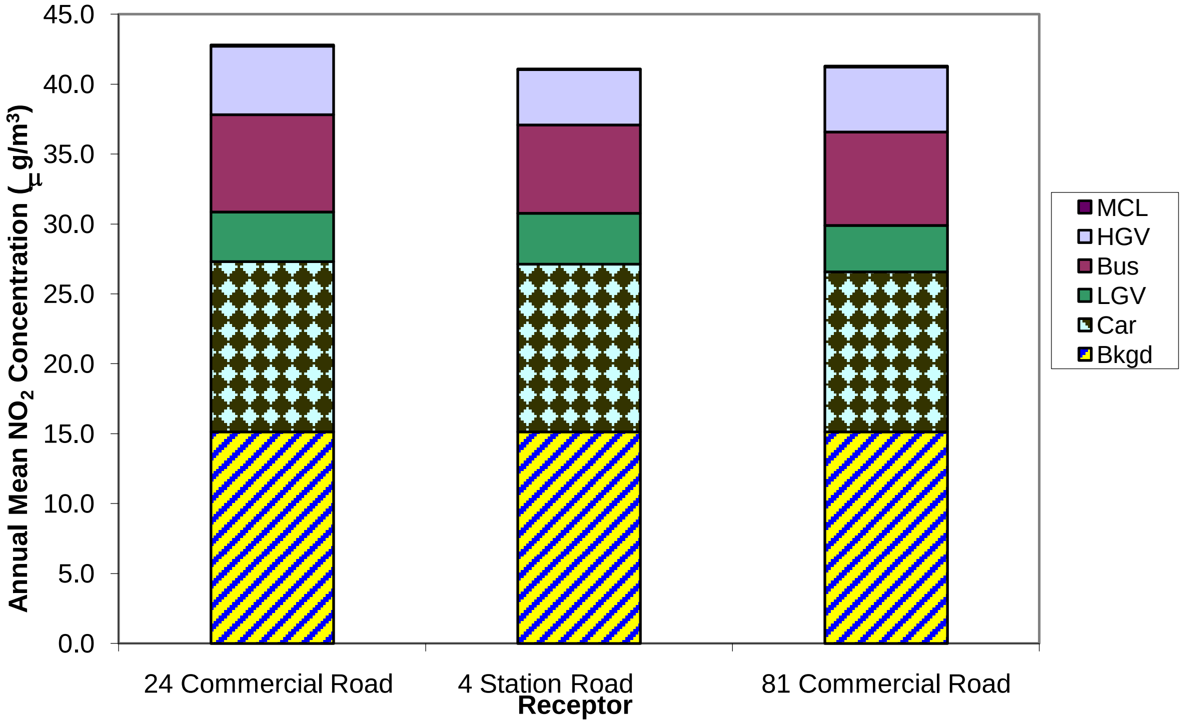

Figure 5: Relative Contribution of Each Source Type to the Total Predicted Annual Mean Nitrogen Dioxide Concentration (μg/m^3) at Receptor Locations.

6 Air Quality Improvements Required

6.1 The degree of improvement needed in order for the annual mean objective for nitrogen dioxide to be achieved is defined by the difference between the highest measured or predicted concentration and the objective level (40 $\mu g/m^3$).

6.2 The highest nitrogen dioxide concentration is that measured at 24 Commercial Road (42.8 $\mu g/m^3$), requiring a reduction of 2.8 $\mu g/m^3$ in order for the objective to be achieved.

6.3 In terms of describing the reduction in emissions required, it is more useful to consider nitrogen oxides (NOx). This has been calculated in line with guidance presented in LAQM.TG(09) (Defra, 2009). Table 5 sets out the required reduction in local emissions of NOx that would be required at three of the diffusion tubes where an exceedence was measured in 2010, in order for the annual mean objective to have been achieved. At 24 Commercial Road, local emissions would need to have been 12% lower in order to meet the objective.

Table 5: Improvement in Annual Mean Nitrogen Dioxide Concentrations and in Emissions of Oxides of Nitrogen at Receptors in 2010.

Receptor	Required reduction in annual mean nitrogen dioxide concentration ($\mu g/m^3$)	Required reduction in emissions of nitrogen oxides from local roads (%)
24 Commercial Road	2.8	12.0
4 Station Road	1.1	4.4
81 Commercial Road	1.3	6.0

7 Summary and Conclusions

7.1 Nitrogen dioxide concentrations within and around the Poole AQMA have been assessed through automatic and diffusion tube monitoring, and detailed dispersion modelling. The results indicate that the annual mean nitrogen dioxide objective was exceeded in 2010 within the AQMA, and also at locations of relevant exposure outside of the AQMA.

7.2 It is therefore recommended that the AQMA should be extended to include, as a minimum, the properties along Commercial Road where the model identified exceedences of the objective in 2010.

7.3 Three receptor locations have been used to provide an overview of source contributions. The most significant local component in all cases is cars. At each of the receptors, the split between each source type is similar. Buses and HGVs provide proportionally more emissions than their numbers would suggest. This highlights the importance of keeping all sources under consideration when contemplating measures to include within the action plan.

8 References

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9 Glossary

Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.
Exceedence	A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.
AQMA	Air Quality Management Area
ADMS Roads	Atmospheric Dispersion Modelling System for Roads.
NOx	Nitrogen oxides
NO_2	Nitrogen dioxide.
$\mu g/m^3$	Microgrammes per cubic metre.
Roadside	A site sampling between 1 m of the kerbside of a busy road and the back of the pavement. Typically this will be within 5 m of the road, but could be up to 15 m (Defra, 2009).
HGV	Heavy Goods Vehicle
LGV	Light Goods Vehicle
OGV 1	Other Goods Vehicles 1 (this broadly correspond to Rigid Heavy Goods Vehicles).
OGV 2	Other Goods Vehicles 2 (this broadly correspond to Articulated Heavy Goods Vehicles).
MCL	Motorcycles
TEA	Triethanolamine – used to absorb nitrogen dioxide

A1 Dispersion Modelling Methodology

A1.1 Annual mean concentrations of nitrogen dioxide during 2010 have been modelled using the Atmospheric Dispersion Modelling System (ADMS). ADMS is one of the dispersion models accepted for modelling within LAQM.TG(09) (Defra, 2009). Road sources were modelled using ADMS Roads (version 3).

Traffic Data:

A1.2 Traffic data were provided by Borough of Poole Council. A summary of the Annual Average Daily Traffic (AADT) flows entered into the model is provided in Table A1.1.

Table A1.1: Summary of AADT Flows (2010)

	MCL	Cars/ Taxi	Bus/ Coach	LGV	OGV1+2	Total
Station Road	114	11,144	44	1,249	102	12,653
Commercial Road (S)	250	22,534	380	2,464	380	26,007
Commercial Road (N)	180	13,004	342	1,597	324	15,448
Bournemouth Road	263	14,717	347	1,756	350	17,433
Church Road (S)	10	1,996	2	309	48	2,366
Springfield Road (S)	52	5,174	13	761	93	6,093
Springfield Road (N)	27	3,174	5	538	85	3,828
Church Road (N)	17	2,357	6	322	23	2,725

Background Concentrations:

A1.3 Background concentrations of nitrogen dioxide have been taken from the national maps of background concentrations available from the Defra LAQM Support website (Defra, 2011). The background concentrations used in the modelling are presented in Table A1.2.

Table A1.2: Background Concentrations (µg/m^3)

	NOx	NO_2
2010	20.6	15.1

Model Verification:

A1.4 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides ($NOx = NO + NO_2$). The models have been run to predict annual mean road-NOx concentrations during 2010 at the roadside monitoring sites within the study area.

A1.5 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the ‘measured’ road-NOx. Measured road-NOx was calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the recently updated NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2011).

A1.6 A primary adjustment factor was determined as the slope of the best fit line between the ‘ measured’ road contribution and the model derived road contribution, forced through zero (Figure A1.1). This factor was then applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The total nitrogen dioxide concentrations were then determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the recently updated NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2011). A secondary adjustment factor was finally calculated as the slope of the best fit line applied to the adjusted data and forced through zero (Figure A1.2).

A1.7 The following primary and secondary adjustment factors have been applied to all modelled nitrogen dioxide data:

- Primary adjustment factor : 3.59
- Secondary adjustment factor: 1.001

A1.8 The results imply that the model is slightly under-predicting the road-NOx contribution. This is a common experience with this and most other models. The final NO_2 adjustment is minor.

A1.9 Figure A1.3 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship.

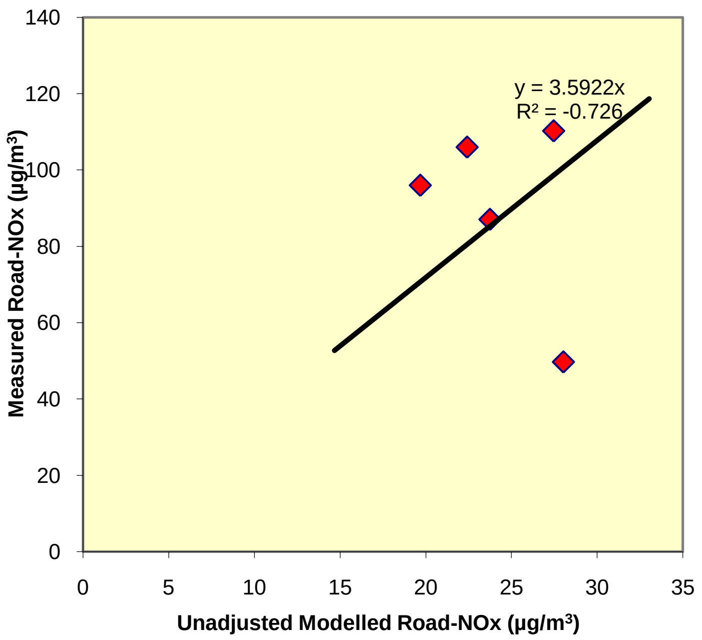

Figure A1.1: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations

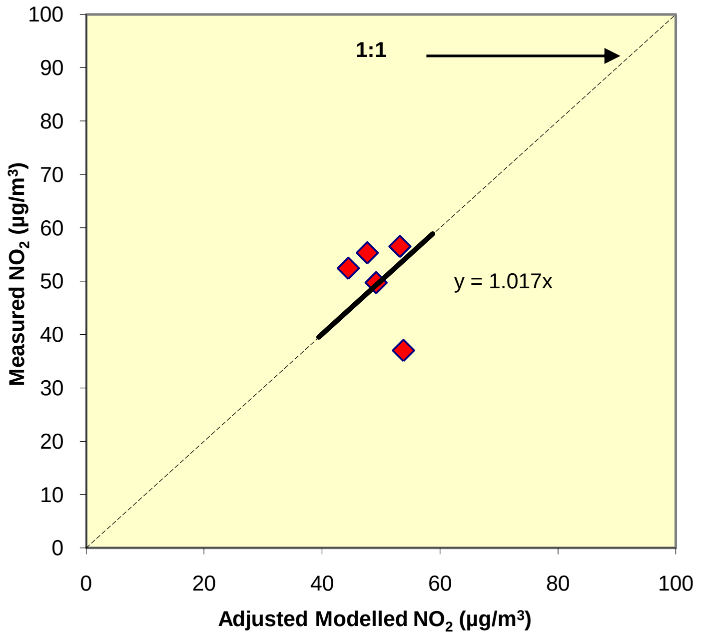

Figure A1.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations

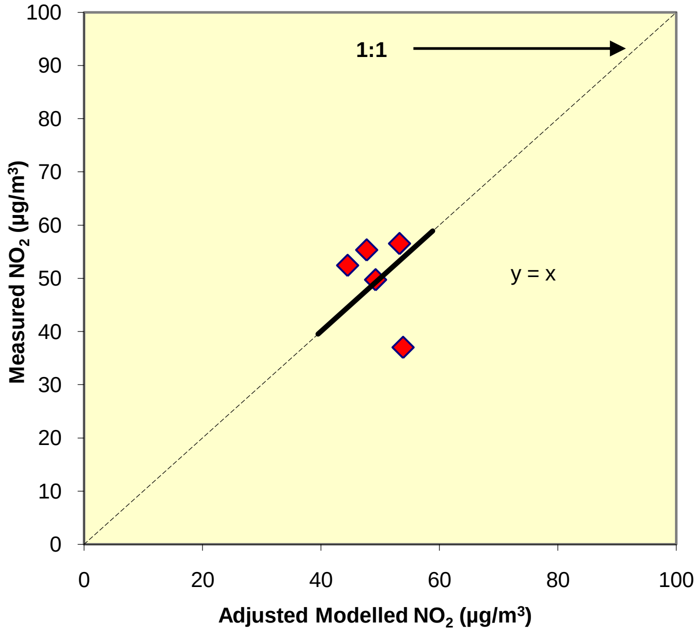

Figure A1.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations

A2 Adjustment of Short-Term Data to Annual Mean

A2.1 The three additional diffusion tubes were in place for 6 months only. They do not represent a full calendar year. Therefore, in accordance with the guidance set out in Box 3.2 of LAQM.TG(09), the data have been adjusted to an annual mean, based on the ratio of concentrations during the short-term monitoring period (6 months; June – November 2010 inclusive) to those over the 2010 calendar year.

A2.2 Guidance suggests that at least three background sites operated as part of the Automatic Urban and Rural Network (AURN) where long-term data are available should be used for the adjustment. Because the period of monitoring is largely over the summer, this method produced a large adjustment factor. It is considered that as Poole is a holiday location, and traffic and NO_2 is likely to be proportionally higher in the summer than in other locations, it is probably more relevant to use local roadside diffusion tube data to adjust the short-term period mean than background real time sites. Diffusion tubes in the rest of Poole have therefore been used and the data are included below. In addition, the Existing Tube had three months of data missing (January, July and October), and the results for this tube have been adjusted in the same way.

A2.3 The annual mean nitrogen dioxide concentrations and the period means for each of the diffusion tube sites from which adjustment factors have been calculated for the 6 month period (June to November) are presented in Table A2.1, along with the Overall Factor.

Table A2.1: Data used to Adjust Short-term Monitoring Data to 2010 Annual Mean

Site	June to November 2010	Annual mean 2010	Factor
Ashley Road	37.9	43.3	1.14
Commercial Rd	40.8	41.1	1.01
Herbert Avenue	24.9	26.6	1.07
Gravel Hill	32.6	34.4	1.06
Stokes Ave/Wimborne Rd	19.9	22.9	1.15
Pottery Junction	34.9	36.7	1.05
Parkstone R/about	31.3	32.2	1.03
Dolberry Road North	23.6	24.8	1.05

West Quay Road	28.6	29.2	1.02
Longfleet Road	36.8	37.0	1.01
Dorset Way/Darbys Lane	35.6	39.3	1.10
Poole Road	32.1	35.6	1.11
Lindsay Road	35.2	37.1	1.05
Blandford Road	21.0	25.2	1.20
Overall Factor			**1.07**

A2.4 The annual mean nitrogen dioxide concentrations and the period means for each of the diffusion tube sites from which adjustment factors have been calculated for the existing diffusion tube (February to June, August to September and November to December) are presented in Table A2.1, along with the Overall Factor.

Table A2.1: Data used to Adjust Short-term Monitoring Data to 2010 Annual Mean

Site	Feb to Jun, Aug to Sep and Nov to Dec 2010	Annual mean 2010	Factor
Ashley Road	44.2	43.3	0.98
Commercial Rd	41.1	41.1	1.00
Herbert Avenue	26.6	26.6	1.00
Gravel Hill	35.7	34.4	0.97
Stokes Ave/Wimborne Rd	23.4	22.9	0.98
Pottery Junction	36.9	36.7	0.99
Parkstone R/about	32.3	32.2	0.99
Dolberry Road North	24.3	24.8	1.02
West Quay Road	28.5	29.2	1.02
Longfleet Road	36.5	37.0	1.01

Dorset Way/Darbys Lane	40.6	39.3	0.97
Poole Road	35.4	35.6	1.00
Lindsay Road	38.0	37.1	0.98
Blandford Road	25.4	25.2	0.99
Overall Factor			**0.99**

A3 Bias Adjustment factors

Diffusion Tube Bias Adjustment Factors

9.1 Bureau Veritas (Gradko) 50% TEA in acetone diffusion tubes have been deployed across the district. The factor for 2010 available from the bias adjustment factor spreadsheet is 0.93 (version 03/11 available at: http://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html)

Factor from Local Co-location Studies (if available)

9.2 Diffusion tubes have been co-located, in triplicate, with the continuous monitor in Commercial Road, to establish the bias of the diffusion tubes compared to the continuous monitoring data.

Commercial Road (25th May to 25th November)			
	Annual Mean		
Diffusion Tube (triplicate)	41.28		
Chemiluminescent	46.47	Bias adjustment factor	1.126

Discussion of Choice of Factor to Use

9.3 For the tubes which were running for the same 6 month period as the real time analyser, the local bias adjustment factor has been used, which reflects the correct period of monitoring. As the local factor was only for 6 months, this could not be applied to the existing tube, which was in place for 12 months. Therefore the national bias adjustment factor, which is lower than the local one, has been used.

9.4 It is recognised that the treatment of data in two different ways, within a small area is not ideal. However, as all monitoring sites have been included in the model verification, and the modelled results have been used to assess the extent of the AQMA, the uncertainty in the overall conclusion has been kept to a minimum.

A4 Modelled Results at All Receptors

Receptor number	X	Y	Z	NO_2 (µg/m^3)[a]
1	403151.4	91560.82	1.5	23.7
2	403157.7	91561.41	1.5	23.6
3	403191	91554.52	4.5	22.5
4	403210.6	91555.97	1.5	25.0
5	403231.8	91554.55	1.5	24.1
6	403307.1	91517.63	4.5	**42.9**
7	403312.7	91516.2	4.5	**42.7**
8	403300.3	91533.81	4.5	24.1
9	403305.4	91532.6	4.5	24.3
10	403295.1	91535.01	4.5	23.9
11	403310.6	91531.4	4.5	**42.6**
12	403315.9	91530.05	4.5	**42.4**
13	403321.4	91528.61	4.5	**42.2**
14	403326.8	91527.2	4.5	**42.2**
15	403332.6	91525.67	4.5	**42.1**
16	403345.6	91522.66	5	**41.6**
17	403354.2	91521.25	5	**41.3**
18	403372.8	91516.1	4.5	25.9
19	403380.2	91514.55	4.5	25.9
20	403385.6	91513.44	4.5	26.0
21	403390.6	91512.44	4.5	26.1
22	403395.3	91511.52	4.5	26.2
23	403404.7	91509.76	4.5	26.5
24	403411.2	91509.31	4.5	26.5
25	403421.2	91510.02	4.5	26.2
26	403430.2	91511.51	4.5	26.0
27	403439.8	91513.48	4.5	26.4
28	403461.1	91501.27	4.5	38.9
29	403468.6	91503.69	4.5	**40.2**
30	403473.4	91505.05	4.5	**40.9**
31	403478.4	91506.67	4.5	**41.4**
32	403483.8	91508.4	4.5	33.8
33	403447.1	91515.87	4.5	27.1
34	403454	91518.16	4.5	36.7
35	403458.9	91520.05	4.5	37.5
36	403463.1	91521.87	4.5	38.2
37	403469.8	91525.01	4.5	39.4
38	403477.5	91528.55	4.5	39.6
39	403486.4	91534.47	4.5	40.0
40	403500.7	91546.94	5	29.3
41	403504	91549.7	5	29.2
42	403508.4	91553.95	5	29.0
43	403511.3	91557.05	5	28.8
44	403510.5	91564.88	1.5	32.3
45	403517.7	91563.94	4.5	30.0
46	403499.6	91524	5	**41.1**
47	403504.6	91523.71	5	33.4
48	403511.8	91522.65	5	32.2
49	403517.5	91520.69	5	30.7
50	403525.5	91517.39	5	28.9
51	403550.9	91606.61	4.5	24.5

52	403554.9	91611.09	4.5	24.4
53	403558.9	91615.52	4.5	24.3
54	403562.7	91619.73	4.5	24.4
55	403566.4	91623.94	4.5	24.4
56	403570.4	91628.36	4.5	24.5
57	403588.7	91703.85	1.5	20.5
58	403586.3	91709.88	1.5	20.1
59	403587	91719.16	1.5	19.4
60	403584.9	91724.74	1.5	19.2
61	403547.3	91748.37	1.5	17.9
62	403581.5	91754.21	1.5	18.3
63	403516.6	91672.25	1.5	19.0
64	403509.5	91675.46	1.5	18.8
65	403514.5	91699.41	1.5	18.1
66	403526.1	91696.19	1.5	18.3
67	403498.3	91698.15	1.5	18.2
68	403493.2	91680.95	1.5	18.5
69	403617.4	91675.05	4.5	29.7
70	403622.1	91678.2	4.5	29.5
71	403626.9	91681.45	4.5	29.3
72	403631.8	91684.79	4.5	29.1
73	403637.2	91688.45	4.5	28.9
74	403642.4	91692.02	4.5	28.7
75	403646.8	91695.01	4.5	28.6
76	403651.2	91698.01	4.5	26.4
77	403655.7	91701.04	4.5	26.0
78	403659.9	91703.94	4.5	25.8
79	403664.4	91706.97	4.5	25.6
80	403628.2	91658	4.5	31.8
81	403632.8	91661.37	4.5	31.5
82	403638.2	91665.44	4.5	31.3
83	403643.3	91669.09	4.5	31.0
84	403648.1	91672.29	4.5	30.8
85	403652.8	91675.43	4.5	30.6
86	403657.4	91678.51	4.5	30.3
87	403685.8	91695.45	5	26.2
88	403692.5	91700.45	5	26.2
89	403696	91742.25	1.5	20.3
90	403711.6	91749.59	1.5	20.4
91	403738.9	91724.79	1.5	26.3
92	403729.7	91761.17	1.5	19.8
93	403745.4	91765.27	1.5	20.1
94	403747	91727.39	1.5	25.7
95	403544.3	91769.34	1.5	17.7
96	403579.3	91768.55	1.5	18.0
97	403623.7	91639.71	5	24.6
98	403627.3	91634.19	5	23.5
99	403631.1	91628.1	5	22.5
100	403634.8	91622.22	5	21.8
101	403638.1	91617.03	5	21.4
102	403641.3	91611.93	5	21.0
103	403644.9	91606.51	5	20.6
104	403647.9	91601.9	5	20.4
105	403683.1	91545.48	1.5	19.9
106	403687	91535.8	1.5	20.3
107	403689.1	91528.72	1.5	20.8
108	403692.8	91495.74	1.5	22.3

109	403687	91493.09	1.5	21.9
110	403664.6	91496.15	1.5	24.4
111	403648.3	91492.66	1.5	24.5
112	403636.2	91489.79	1.5	24.5
113	403620.5	91485.02	1.5	23.9
114	403607.3	91487.2	4.5	22.7
115	403596.2	91485.62	4.5	23.2
116	403533.7	91513.83	5	27.6
117	403543.8	91508.81	5	26.4
118	403551.3	91505.03	5	25.7
119	403557.7	91501.9	5	25.2
120	403568	91496.79	5	24.6
121	403610.4	91670.32	4.5	30.0

[a] These are the results presented in Figure 4.