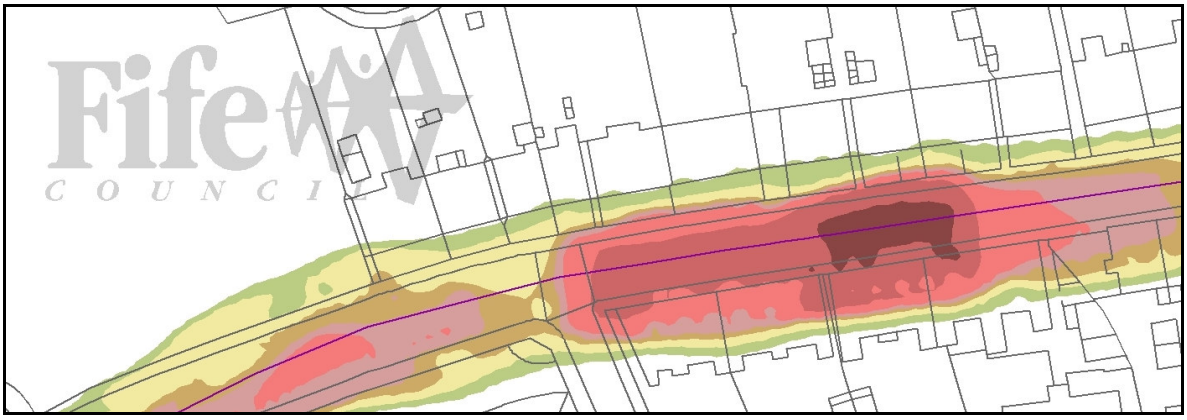

Detailed Assessment of Air Quality

Appin Crescent, Dunfermline

Report to Fife Council
AEA/ENV/R/3096
ED05550009 Issue 2
January 2011

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Executive Summary

Under the Environment Act 1995, Local authorities are required to review and assess the air quality in their areas following a prescribed timetable to determine whether the air quality objectives are likely to be met. Where the likelihood of exceedences of air quality objectives has been identified in areas of relevant public exposure, an Air Quality Management Area (AQMA) should be declared, and followed by a further assessment and the formulation of an action plan to work toward eliminating exceedences.

This modelling study utilises ADMS-Roads in consultation with recently published vehicle emissions factors, ambient measurements, traffic counts and meteorological data for the area.

The study concludes that there are current exceedences of the NO_2 annual mean objective in Appin Crescent, Dunfermline. The spatial extent of the exceedences is quite small, though the Council should consider declaring the area as an AQMA, with the size of the declared area being slightly larger than the minimum required to reflect unavoidable uncertainty in the modelling.

In light of this Detailed Assessment, Fife Council should consider declaring an AQMA at Appin Crescent, Dunfermline encompassing as a minimum all residential properties which lie within the 40 µg.m^{-3} contour in the dispersion plots. To account for potential uncertainty in the dispersion modelling, Fife Council should consider declaring an area larger than the minimum required. Fife Council should now also proceed with a Further Assessment and work towards preparing an Air Quality Action Plan for the area concerned.

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1. Introduction

1.1 National Air Quality Strategy

All local authorities (LAs) are obliged to review and assess air quality under the Environment Act 1995. A requirement of the Act was that the UK Government prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The AQS was published in January 2000 with a revised version published in July 2007.

Within the AQS, national air quality objectives are set out and LAs are required to review and assess air quality against these objectives. Table 1-1 lists the objectives included in Regulations for the purposes of Local Air Quality Management (LAQM) with dates by which they should be achieved.

Table 1-1 Objectives included in the Air Quality Regulations and subsequent Amendments for the purpose of Local Air Quality Management.

National Air Quality Objectives			
Pollutant	**Air Quality Objective**		**Date to be achieved by**
	Concentration	**Measured as**	
Benzene			
All authorities	16.25 µg.m^{-3}	running annual mean	31.12.2003
Authorities in England and Wales only	5 µg.m^{-3}	annual mean	31.12.2010
Authorities in Scotland and Northern Ireland only	3.25 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 Authorities in England, Wales and Northern Ireland only	10.0 mg.m^{-3}	maximum daily running 8-hour mean	31.12.2003
Authorities in Scotland only	10.0 mg.m^{-3}	running 8-hour mean	31.12.2003
Lead	0.5 µg.m^{-3} 0.25 µg.m^{-3}	annual mean annual mean	31.12.2004 31.12.2008
Nitrogen dioxide	200 µg.m^{-3} not to be exceeded more than 18 times a year 40 µg.m^{-3}	1 hour mean annual mean	31.12.2005 31.12.2005
Particles (PM_{10}) (gravimetric)[a] All authorities	50 µg.m^{-3} not to be exceeded more than 35 times a year 40 µg.m^{-3}	24 hour mean annual mean	31.12.2004 31.12.2004
Authorities in Scotland only	50 µg.m^{-3} not to be exceeded more than 7 times a year 18 µg.m^{-3}	24 hour mean annual mean	31.12.2010 31.12.2010
Sulphur dioxide	350 µg.m^{-3} not to be exceeded more than 24 times a year 125 µg.m^{-3} not to be exceeded more than 3 times a year 266 µg.m^{-3} not to be exceeded more than 35 times a year	1 hour mean 24 hour mean 15 minute mean	31.12.2004 31.12.2004 31.12.2005

a. Measured using the European gravimetric transfer sampler or equivalent.

1.2 Purpose of the Detailed Assessment

This study is a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedences of the air quality objectives for NO_2 in the vicinity of Appin Crescent, Dunfermline.

1.3 Locations where the Air Quality Objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Table 1-2 summarises examples of where air quality objectives for NO_2 should and should not apply.

Table 1-2 Examples of where the NO_2 Air Quality Objectives should and should not apply

Examples of where the Air Quality Objectives should/should not apply			
Averaging Period	**Pollutants**	**Objectives *should* apply at …**	**Objectives should *not* generally apply at …**
Annual mean	NO_2	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1 hour mean	NO_2	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks and railway stations etc. which are not fully enclosed. Any outdoor locations to which the public might reasonably be expected to have access.	Kerbside sites where the public would not be expected to have regular access.

1.4 Overview of the approach taken

The general approach taken to this further assessment was to:

- Collect and interpret data from previous review and assessment reports
- Collect and analyse all available traffic data, air quality monitoring data and background concentration data for use in the models
- Identify potential hotspots where it is likely that the AQS objectives would not be met
- Model NO_2 concentrations surrounding these hotspots
- Produce contour plots of the modelled pollutant concentrations
- Recommend whether Fife Council should declare an AQMA and provide guidance on its minimum extent

The methodologies outlined in Technical Guidance LAQM.TG(09)[1] were used throughout this detailed assessment.

1.5 Conclusions of previous reports for NO_2

The previous Detailed Assessment (2008) for Appin Crescent, Dunfermline did not predict any exceedences of the NO_2 objective. The report advised that, given the quite elevated concentrations of NO_2 in the area, increased monitoring should be carried out. The monitoring campaign was extended and exceedences were observed in the data, thereby necessitating this Detailed Assessment.

[1] Local Air Quality Management Technical Guidance LAQM.TG(09), Defra, 2009

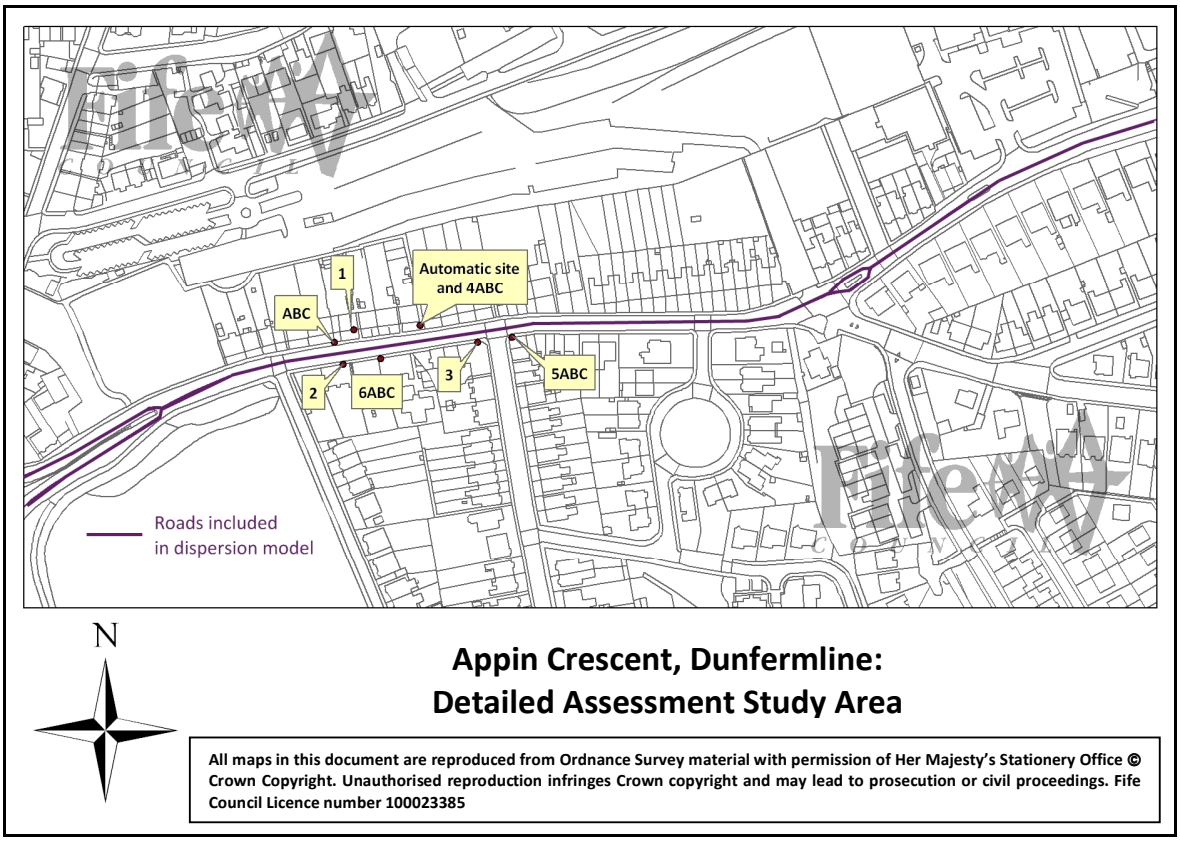
2. Study Location

This Detailed Assessment is concerned with Appin Crescent in Dunfermline, Fife. The location experiences high volumes of traffic on the A907 through a relatively built up residential area.

Fife Council have been monitoring for NO_2 in Appin Crescent for a number of years, though the monitoring campaign has been recently enhanced to take account of the latest technical guidance in assessing air pollutant behaviour in this area.

Figure 2.1 shows the study area and the centerline of the road segments included, with the current locations of NO_2 monitoring. Only the contribution from the A907 has been included in the study as it is thought that other roads contribute very little to NO_2 concentrations at the relevant locations.

Figure 2.1 Appin Crescent, Dunfermline



3. Information used to support this assessment

3.1 Maps

Fife Council provided OS Landline data of the study area and a road centreline layer. This enabled accurate road widths and the distance of the housing to the kerb to be determined in the GIS system.

3.2 Road traffic data

3.2.1 Average flow, speed and fleet split

Daily traffic flow data and the percentage of different vehicle classes were derived from a traffic count study carried out in Appin Crescent and Halbeath Road in 2009/10. The Appin Crescent traffic count point (grid ref 309870, 687713) is near the centre of the study area so provides confidence that the traffic data used are appropriate for the assessment. However, Fife Council indicated that the fleet split from Appin Crescent may not be reliable so it was agreed that the Appin Crescent flows would be used in combination with the splits from Halbeath Road. Speed data was provided for the study area (average speed=27mph) so a combination of this plus slower speeds (to reflect congestion) were used as appropriate.

3.2.2 Emissions factors

The most recent version of the Emissions Factors Toolkit[1] (EfT V4.1) was used in this assessment and the factors derived were used in the ADMS-Roads model in preference to the dated emission factors in the current version of the model. Parameters such as traffic volume, speed and fleet composition are entered into the EfT, and an emissions factor in grams of NOx/second/kilometre is generated for input into the dispersion model. The version of the EfT used incorporates the latest emission factors published in 2009 by the Department for Transport.

[1] http://laqm1.defra.gov.uk/documents/tools/EFT_Version_4_2.zip

4. Ambient monitoring

4.1 Nitrogen dioxide

NO_2 concentrations are monitored by diffusion tube at locations throughout Fife and some locations lie within the area modelled in this assessment. Details of the type, locations, and concentrations recorded by the automatic analyser and diffusion tubes are given below.

4.1.1 Monitoring QA/QC

As outlined in Technical Guidance LAQM.TG(09), it is important to have QA/QC procedures in place in order to ensure that the air quality monitoring data are reliable and credible. The following list outlines basic data requirements:

- Accuracy;
- Precision;
- Traceability to national/international metrology standards;
- Long-term consistency.

The QA/QC procedures employed by Fife Council are described below.

Automatic Monitoring

In order to satisfy the requirements outlined above, the following QA/QC procedures were implemented:

- 3-weekly calibrations of the NOx analyser,
- 6-monthly audits and servicing of the monitoring site,
- Data ratification.

Calibrations of the NOx analyser were carried out using certified compressed gas standards (ISO17025). This ensured that the calibration gas was traceable to national and international standards. In addition to the 3 weekly calibration visits included; changing of the sample inlet filter and checking the analysers diagnostics for any faults. This in turn improved the data quality and minimised data loss.

Audits of the monitoring site consisted of a number of performance checks to identify any faults with the equipment. The calibration cylinder was also checked against another gas standard in order to confirm the gas concentration. Any identified faults were forwarded on to the service unit for repair.

The final stage of the QA/QC process was to ratify the data. During ratification, all calibration, audit and service data are collated and the data is appropriately scaled. Any suspect data identified are deleted therefore ensuring that the data are of a high quality.

Diffusion Tubes

Diffusion tubes used by Fife Council are supplied and analysed by Tayside Scientific Services (formerly Dundee City Council Scientific Services). The laboratory participates in 3 schemes that ensure that the NO2 tube results meet acceptable standards. These are;

- The WASP scheme, run by the Health and Safety Laboratory. Each month one tube is sent for testing. Results are compared with other participating labs and feedback on performance provided.

- Every three months 3 tubes and a blank for analysis are supplied for exposure at an intercomparison site operated as part of the Support to Local Authorities for Air Quality Management contract funded by the Scottish Government, Defra and the other DAs. Again, results are compared with other participating labs and feedback on performance provided.
- Each month a QC NO2 solution is also provided via this contract. This solution is run as an internal check for NO2 tubes in the laboratory. The solution is tested after every 21 NO_2 tube samples.

Tayside Scientific Services also use in-house quality assurance standards. The tube preparation method is 20%TEA (triethanolamine) in water.

4.2 Monitoring data- NO_2

Fife Council currently monitors NO_2 across the authority using passive diffusion tubes and NOx/NO_2 using continuous analysers, although not all of these sites are pertinent to this assessment. There are seven monitoring locations in Appin Crescent; one is the automatic analyser with triplicate collocation study (denoted 4ABC), three other triplicate diffusion tubes (denoted ABC, 5ABC and 6ABC), and three single diffusion tube sites (denoted 1, 2 and 3). The locations of the monitoring sites are shown in the map in Figure 2.1 and below in Table 4-1.

The monitoring data used in the assessment spans the period August 2009 to July 2010 and this assessment is being carried out as a consequence of observed exceedences in the monitoring data from additional diffusion tubes installed in 2009.

The 2009/10 data from the diffusion tubes at the relevant locations has been bias adjusted using the locally calculated factor from the collocation study. The bias adjustment factor was 0.84 for the period of interest. A copy of the bias adjustment spreadsheet used is provided in Appendix 2.

A summary of relevant monitoring data for August 2009 to July 2010 is presented in Table 4-1. There were no exceedences of the hourly mean NO_2 objective at the automatic monitoring site during the period of interest (see Appendix 5).

Table 4-1 Monitoring data collected in Appin Crescent for August 2009-July 2010

Site	Type	OS x,y	Data Capture 2009/10 (%)	Annual mean (µg m^{-3})
Automatic analyser	R	309926, 687722	98.9	31.4
ABC	R	309881, 687713	100	34.7
1	R	309891, 687720	100	29.2
2	R	309886, 687702	100	**42.2**
3	R	309956, 687713	100	**40.3**
4ABC	R	309962, 687722	100	32.5
5ABC	R	309974, 687716	100	39.6
6ABC	R	309905, 687705	100	**50.1**
Exceedences of the annual mean objective in **bold**				
K = Kerbside, 0-1m from the kerb of a busy road R = Roadside, 1-5m from the kerb				

5. Modelling- NO_2

5.1 Modelling methodology

Annual mean concentrations of NO_2 for 2009 have been modelled within the study area using ADMS Roads (version 2.3). Although the assessment is concerned with 2009, a more up to date monitoring data set has been used for verification (August 2009-July 2010) as it was felt this data represents the best contemporary understanding of the pollution climate in Appin Crescent.

The model was verified and outputs were adjusted by comparing the modelled predictions for road NO_x with local monitoring results. In this case, the modelled results were compared to the results gathered by the automatic analyser, and diffusion tubes. Further information on model verification is provided in Appendix 1.

Hourly sequential meteorological data for 2009 for RAF Leuchars was used (approx 50 km from the study area). A surface roughness of 0.5 m was used in the modelling to represent the urban conditions in the model domain. A limit for the Monin-Obukhov length of 30 m was applied.

The intelligent gridding option was used in ADMS-Roads which provides spatially resolved concentrations along the roadside, with a wider grid spaced at approximately 30 m being used to represent concentrations further away from the road. These predictions were added to ArcGIS 9.3 and values between grid points were derived using interpolation in the Spatial Analyst tool. This allows contour concentrations to be produced and added to the base map provided by Fife Council.

Background concentrations of NOx were derived from the recently updated Defra maps[1]. A CSV file containing concentrations across Fife Council was obtained and the appropriate grid square was selected with the appropriate concentration for the assessment.

A mapped NOx background concentration of 17.8 $\mu g.m^{-3}$ was used in this assessment.

5.1.1 Treatment of modelled NOx road contribution

It is necessary to convert the modelled NOx concentrations to NO_2 for comparison with the relevant objectives. The recently published Defra NOx/NO_2 model[2] was used to calculate NO_2 concentrations from the NOx concentrations predicted by ADMS-Roads. The model requires input of the background NOx, the modelled road contribution and the proportion of NOx released as primary NO_2. For the purposes of this assessment we have assumed that 19% of NOx is released as primary NO_2- the value associated with the "UK Traffic" option in the model.

5.1.2 Validation of ADMS-Roads

In simple terms, validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4, and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and DEFRA.

[1] http://laqm1.defra.gov.uk/review/tools/background.php
[2] http://laqm1.defra.gov.uk/review/tools/monitoring/calculator.php

5.1.3 **Verification of the model**

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. LAQM.TG(09) recommends making the adjustment to the road contribution only and not the background concentration these are superimposed onto. The approach outlined in Example 2 of LAQM.TG(09) has been used, and a correction factor was calculated which was applied to all modelled data.

The model generated in this study was verified using all available monitoring sites. The comparison of monitored against modelled NO_x revealed that the model under-predicted the Road NOx component when compared with the local measurements.

As such, the modelled Road NO_x contribution required adjustment by an average factor of 2.3 to bring the predicted NO_2 concentrations within good agreement of those results obtained from the monitoring data. This factor was applied to all Road NO_x concentrations predicted by ADMS Roads, with the final NO_2 model predictions being calculated using the Defra NO_x/NO_2 model.

After the NOx/NO_2 model was run, no further adjustments were made to the data. Numerical

Table 6-1 and Figure 6.1 below show the predicted modelled concentrations at each of the monitoring points in the model domain.

Both sites 2 and 6(ABC) are locations with relevant exposure, and exceedences of the annual mean NO_2 objective are predicted at these locations. Locations 3 and 5(ABC) are predicted to be very close to the objective, so the Council may wish to include the buildings surrounding these locations in any subsequent AQMA declaration.

Table 6-1 and

Figure **6.1** show model agreement with the NO_2 monitoring data after adjustment. Full model verification data is provided in Appendix 1.

Adjusting modelling data to diffusion tubes will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has notable uncertainty). The adjusted model agrees well with available local monitoring and has therefore been assessed to perform sufficiently well for use within this assessment without further adjustment.

6. Modelling Results: NO_2

6.1 Numerical

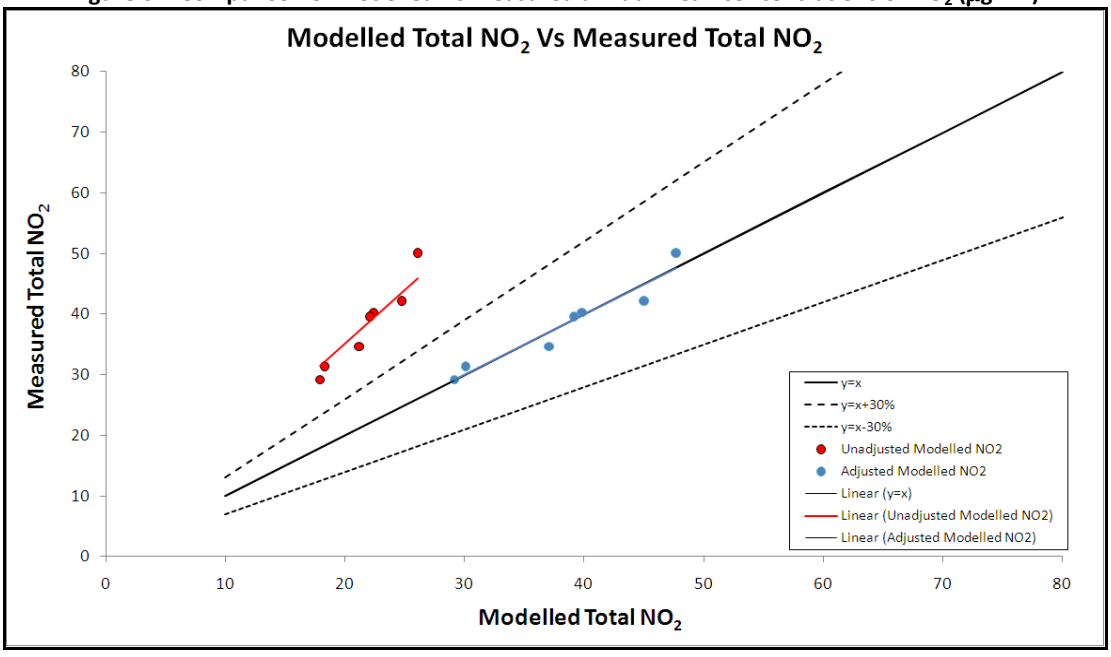
Table 6-1 and Figure 6.1 below show the predicted modelled concentrations at each of the monitoring points in the model domain.

Both sites 2 and 6(ABC) are locations with relevant exposure, and exceedences of the annual mean NO_2 objective are predicted at these locations. Locations 3 and 5(ABC) are predicted to be very close to the objective, so the Council may wish to include the buildings surrounding these locations in any subsequent AQMA declaration.

Table 6-1 Modelled/measured NO_2 concentrations in model domain after adjustment

Site	NO_2 Concentration (µg m^{-3})		Difference (%)
	Modelled (roadNOx component x 2.3)	Measured	
Auto analyser+4ABC	30.1	31.4	-4.2
ABC	37.1	34.7	6.9
1	29.2	29.2	0
2	45.0	42.2	6.6
3	39.8	40.3	-1.2
5ABC	39.1	39.6	-1.3
6ABC	47.7	50.1	-4.8

Figure 6.1 Comparison of modelled Vs measured annual mean concentrations of NO_2 (µg m^{-3})



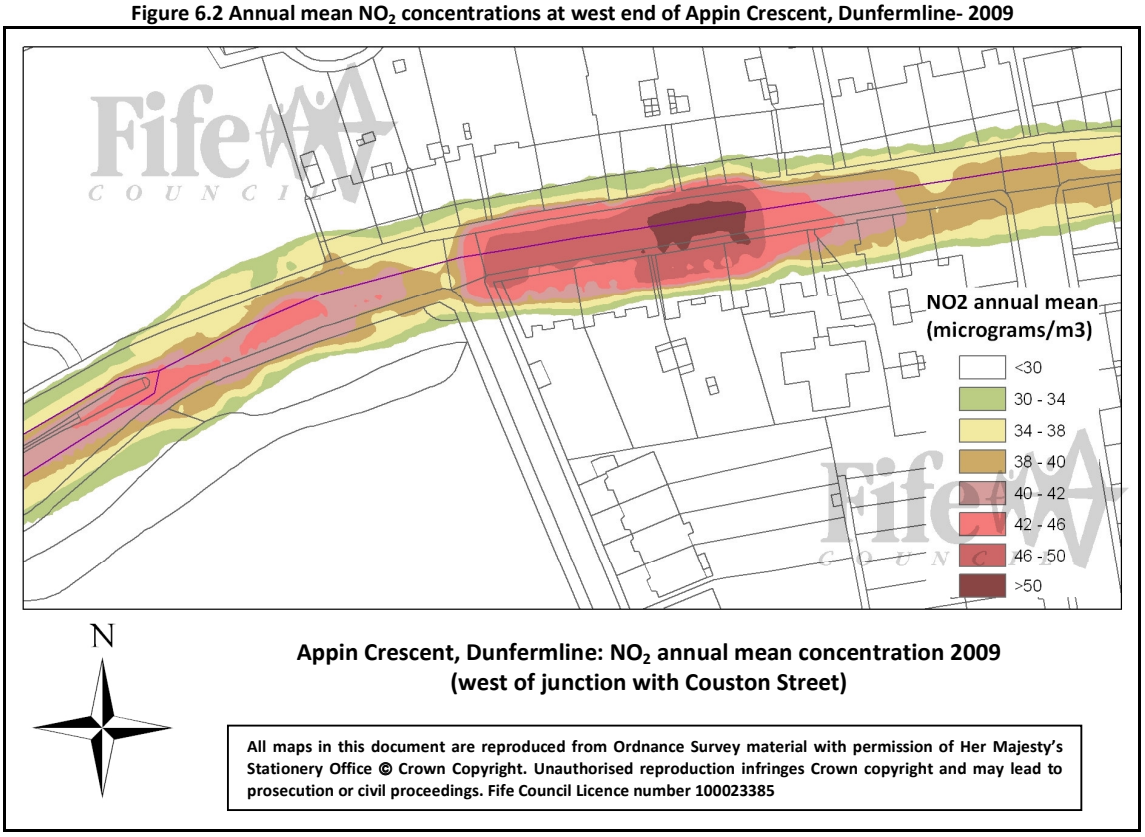
6.2 Contour plots

Figures 6.2 and 6.3 show contour plots with predicted NO_2 annual average concentrations during 2009 at Appin Crescent, Dunfermline. The contour plots have been prepared using the Inverse Distance Weighting function in the Spatial Analyst extension of ArcGIS 9.3.

It has been confirmed by the monitoring and subsequent modelling that the 40 $\mu g.m^{-3}$ annual average objective has been exceeded in 2009 at locations with relevant exposure, but that the exceedences are not predicted to extend east significantly beyond the junction with Couston Street.

To assist with locating any AQMA that the Council wish to declare Figure 6.4 shows the 40 and 38 $\mu g.m^{-3}$ contour lines which are derived from the raster files using the surface analysis tool in ArcGIS.

Figure 6.2 Annual mean NO_2 concentrations at west end of Appin Crescent, Dunfermline- 2009



Appin Crescent, Dunfermline: NO_2 annual mean concentration 2009 (west of junction with Couston Street)

Figure 6.3 Annual mean NO_2 concentrations at east end of Appin Crescent, Dunfermline- 2009

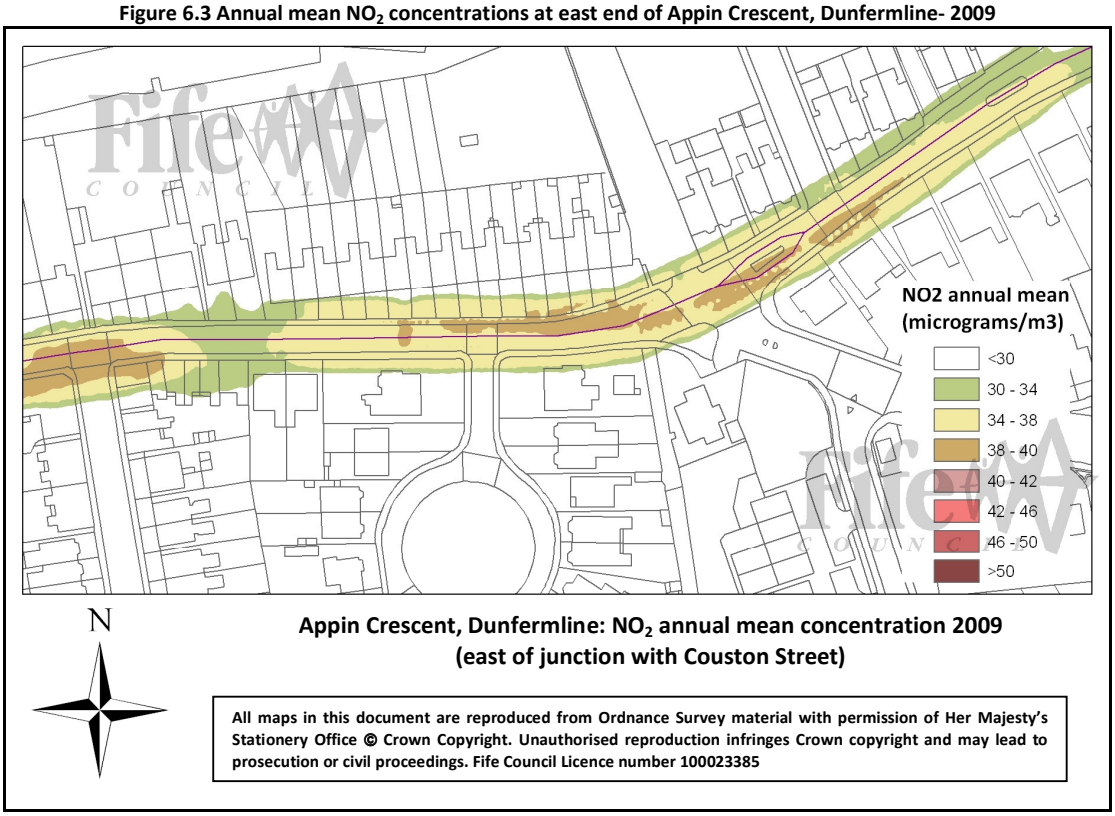
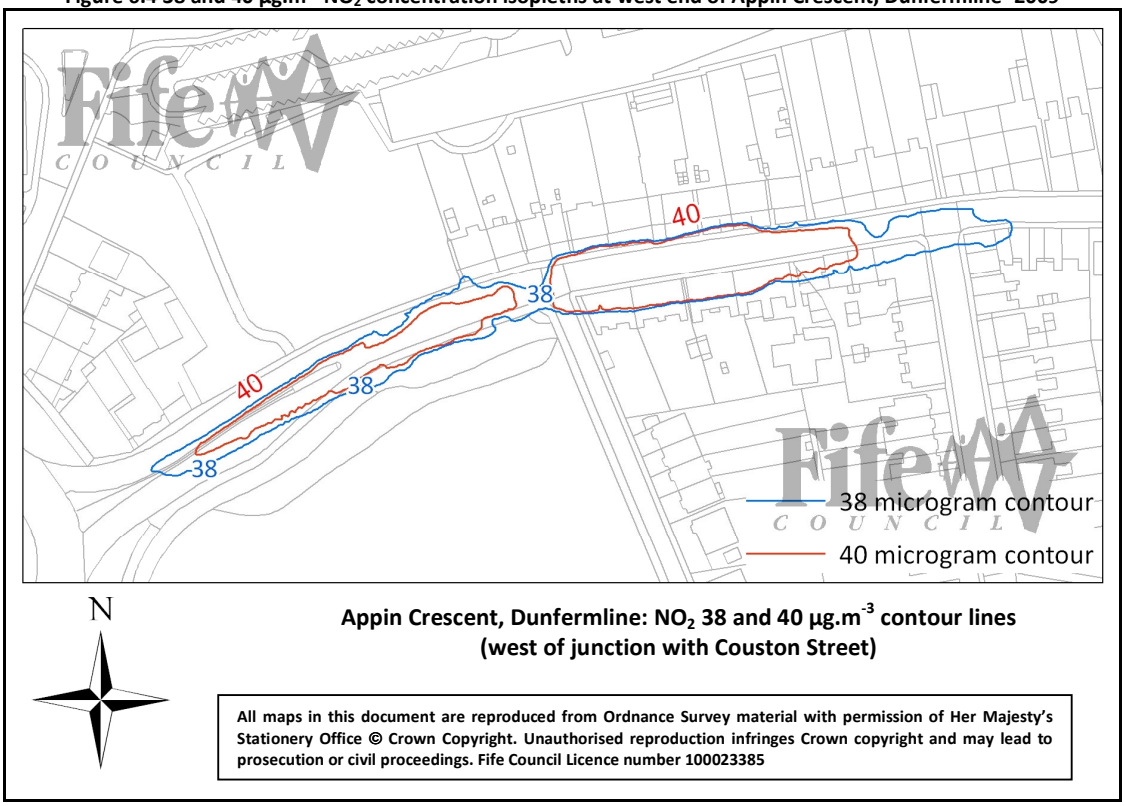


Figure 6.4 38 and 40 µg.m^{-3} NO_2 concentration isopleths at west end of Appin Crescent, Dunfermline- 2009



7. New Developments in Dunfermline

There are development plans already in existence that could have air quality implications for the Appin Crescent area. While quantifying what the impact of these might be on local air quality is outwith the scope of this assessment, it is useful to describe these here.

7.1 Fife Council Structure Plan

The Fife Council Structure Plan 2006-2026 was approved by the Scottish Government in May 2009. The following air quality related extracts are from the written statement for this plan produced in May 2009:

Chapter 2: The Settlement Strategy (Pages 19-20)

Strategic Land Allocations- Dunfermline

"Dunfermline will be expanded, growing out through development to the South West/West/North around a revitalised city centre to further enhance the attractiveness of this small city over the next 30-40 years. Significant improvements to the transport infrastructure will allow its population to grow to 50,000 over the 20 year life of this Plan.

New and improved infrastructure will deliver benefits for the existing community. Green corridors/Green Belt designations will be formed to protect the historic setting of the city. Within the period to 2026, 80ha of employment land for business use, a minimum of 3,800 new houses, and the provision, by the private sector, of public transport rapid transit corridors and a distributor ring road will be developed and integrated with the existing city commencing from 2011.

Development will commence in the South West/West in the 2011 to 2016 period to deliver early strategic infrastructure. The potential to connect a light rapid transit network to Edinburgh City and West Edinburgh will be addressed in the context of the Forth Replacement Crossing. The city centre will be the focus of further retail development.

Further capacity for both employment land and housing within this area will be developed post-2026. A green belt defined in the Local Plan will protect Dunfermline from coalescence with towns to the west and south west. Additional housing arising from the 1,280 unit strategic allocation to the Dunfermline and West Fife HMA as set out in Proposals PH1 and PH3 may be assigned to the expansion of Dunfermline SW/W/N following further assessment.

Further housing units at Dunfermline SW/W/N may be considered if it is demonstrated through the masterplan and business plan that they are essential to deliver the strategic transport and other infrastructure required to secure the regeneration of the area."

Chapter 3: Implementing the Strategy-Transportation (Page 43)

"Policy t1: Transport and Development proposals must:

- be accessible to, or be able to be made accessible to, the existing or planned public transport network;
- provide or use walking and cycle routes which are, or can be, linked into established and planned networks;
- be located where road network capacity is or can be made available, but only after access by other, more sustainable, modes of transport has been maximised; and
- be acceptable in relation to air quality objectives.

7.2 Fife Council Dunfermline and West Fife Local Plan

The draft Fife Council Dunfermline and West Fife Local Plan remains on timetable to be adopted in 2012. Relevant air quality related extracts from this Plan are as follows:

Para.2.52

The Local Plan sets objectives to safeguard and improve the environment by:

- Ensuring new development accords with the principles of sustainability and encourages more walking, cycling and the use of public transport in preference to the use of private cars

Para.2.89

The Local Plan objectives for developing the transport network are:

- Providing for a pattern of land use which reduces unnecessary travel and increases the use of sustainable transport options;
- Assisting the implementation of Fife's Local Transport Strategy;
- Safeguarding options for future development of the transport network; and
- Supporting improvements to regional transport connections including those to the rest of Central Scotland and beyond.

Other road initiatives

There is also specific reference to a proposed bypass for Appin Crescent in the Fife Council Dunfermline and West Fife Local Plan (Local Plan Proposal DUN 075: "*Appin Crescent Bypass. Diversion to north of Appin Crescent at Leys Road, Dunfermline*").

Reference to this bypass is also made in the Fife Council West Area Transport Plan 2005-2010 (extract from Section 4.2.4 Dunfermline Central West, Page 68, "*Proposal: Halbeath Corridor Improvements. Appin Crescent By-Pass*" and "*Comment: Developer led as part of city centre Master Plan and Dunfermline Local Transport Plan*"). Further details on this can be found on the official Fife Council website (www.fifedirect.org.uk).

In anticipation of the Forth Replacement Crossing, Fife Council has published a Proposal of Application Notice for a "Park and Choose" facility at Halbeath, Dunfermline (Planning Ref.10/04570/PAN. Date Published 02 Dec 2010). The description of the proposal is a "Major Application for a Park and Choose site comprising car park, hub building with associated bus stances & taxi rank and a recycling point". Fife Council has contracted air quality consultants to undertake an air quality impact assessment of this proposed development. Further details on this development proposal can viewed on the online planning applications pages of the Fife Council website (www.fifedirect.org.uk).

8. Summary and Conclusion

This Detailed Assessment utilised ADMS-Roads in consultation with recently published vehicle emissions factors, ambient measurements, traffic counts and meteorological data for the area.

The study concludes that there are current exceedences of the NO_2 annual mean objective in Appin Crescent, Dunfermline. The spatial extent of the exceedences is quite small though the Council should consider declaring the area as an AQMA, with the size of the declared area being slightly larger than the minimum required to compensate for unavoidable uncertainty in the modelling.

In light of this Detailed Assessment, Fife Council should consider declaring an AQMA at Appin Crescent, Dunfermline encompassing as a minimum all residential properties which lie within the 40 $\mu g.m^{-3}$ contour in the dispersion plots. To compensate for potential uncertainty in the dispersion modelling, Fife Council should consider declaring an area larger than the minimum required. Fife Council should now also proceed with a Further Assessment and work towards preparing an air quality action plan for the area concerned.

9. References

AEA. Air Quality Detailed Assessment for Fife Council 2008 : Appin Crescent, Dunfermline. January 2009.

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10. Acknowledgements

AEA are grateful for the support received by Douglas Mayne, Kenny Bisset and Jane Findlay of Fife Council in completing this assessment.

11. Appendices

Appendix 1 Model Verification

It is appropriate to verify the ADMS Roads model in terms of primary pollutant emissions of nitrogen oxides (NO_x = NO + NO_2). The model has been run to predict annual mean RoadNO_x concentrations during 2009 at the automatic analyser and diffusion tubes located at Appin Crescent.

The model output of RoadNOx (the total NO_x originating from road traffic) has been compared with the measured RoadNO_x, where the measured RoadNOx contribution is calculated as the difference between the total NO_x and the background NO_x value. Total measured NO_x for each diffusion tube was calculated from the measured NO_2 concentration using the 2010 version of the Defra NO_x/NO_2 model.

An adjustment factor was determined as the average of the difference between modelled RoadNO_x contribution and the measured RoadNO_x contribution, as shown in the table below. **A factor of 2.3 was calculated** in this instance. This factor was then applied to the modelled RoadNO_x concentration for each modelled point to provide adjusted modelled RoadNO_x concentrations. The appropriate background concentration was added to these concentrations in order to determine the adjusted total modelled NO_x concentrations. The total annual mean concentrations were then determined using the NO_x/NO_2 model.

Comparison of unadjusted RoadNO_x Vs Measured RoadNO_x and primary adjustment factor (2.34)

X	Y	Location	Predicted Modelled Road NOx	Background NOx	Total Modelled NOx Prediction	Total Modelled NO2 Prediction	Total Measured NO2	(Measured-Modelled)/Measured*100
309926	687722	Auto analyser+4ABC	20.74	17.8	38.54	21.44	31.4	-31.71974522
309885.9	687683.2	Appin Cr ABC	19.89	17.8	37.69	21.05	34.7	-39.33717579
309891	687720	Appin Cr 1	16.50	17.8	34.3	19.5	29.2	-33.21917808
309885.6	687701.9	Appin Cr 2	36.01	17.8	53.81	28.01	42.2	-33.62559242
309956.1	687713.4	Appin Cr 3	31.13	17.8	48.93	25.98	40.3	-35.53349876
309974	687716	Appin Cr 5ABC	29.78	17.8	47.58	25.41	39.6	-35.83333333
309905.1	687704.9	Appin Cr 6ABC	43.57	17.8	61.37	31.03	50.1	-38.06387226

X	Y	Location	Road NOx required to match measured NO2	Total (Road + BG) NOx Required to match measured NO2	(Measured Road NOx/Modelled Road NOx)/Measured Road NOx x 100	Required Road NOx/ Modelled Road NOx	Adjusted modelled RoadNOx	(Measured Road NOx/Adjusted Modelled Road NOx)/Measured Road NOx x 100
309926	687722	Auto analyser+4ABC	44.51	62.31	-53.4037295	2.146094503	47.64187463	7.036339318
309885.9	687683.2	Appin Cr ABC	53.26	71.06	-62.65490049	2.677727501	45.68933878	-14.21453476
309891	687720	Appin Cr 1	38.94	56.74	-57.62711864	2.36	37.90216641	-2.665212088
309885.6	687701.9	Appin Cr 2	75.1	92.9	-52.0505992	2.085531797	82.71860682	10.14461627
309956.1	687713.4	Appin Cr 3	69.29	87.09	-55.07288209	2.225827176	71.50875397	3.202127241
309974	687716	Appin Cr 5ABC	67.2	85	-55.68452381	2.256548019	68.40766762	1.797124438
309905.1	687704.9	Appin Cr 6ABC	101.43	119.23	-57.04426698	2.327977966	100.0846903	-1.326342956
				PRIMARY ADJUSTMENT		**2.3**		

The results show that the model is under predicting the RoadNO_x contribution. This is a typical experience with this and the majority of other road dispersion models, and probably arises from deriving predictions for a complex situation using what are quite simple metrics as model inputs.

Appendix 2- Diffusion Tube Bias Adjustment

A locally calculated bias adjustment factor was used to correct the diffusion tube data in this assessment (bias factor= 0.84).

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

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	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data
1	08/01/10 -	03/02/2010								43	97		Good
2	03/02/10 -	03/03/2010	56.4	57.0	55.3	56	0.9	2	2.1	45	100	Good	Good
3	03/03/10 -	31/03/2010	32.9	32.0	31.1	32	0.9	3	2.2	40	99	Good	Good
4	31/03/10 -	28/04/2010	31.4	34.4	34.2	33	1.7	5	4.2	29	100	Good	Good
5	28/04/10 -	02/06/2010	29.9	29.1	31.0	30	1.0	3	2.4	23	100	Good	Good
6	02/06/10 -	30/06/2010	28.7	29.0	27.3	28	0.9	3	2.3	21	99	Good	Good
7	30/06/10 -	04/08/2010	21.3	22.0	21.4	22	0.4	2	0.9	17	100	Good	Good
8	29/07/09 -	02/09/2009	30.7	30.4		31	0.2	1	1.9	19	100	Good	Good
9	02/09/09 -	30/09/2009	25.5	25.2	25.2	25	0.2	1	0.4	24	100	Good	Good
10	30/09/09 -	04/11/2009	38.0	38.8	42.5	40	2.4	6	6.0	33	97	Good	Good
11	04/11/09 -	02/12/2009	54.9	53.5	52.6	54	1.2	2	2.9	34	96	Good	Good
12	02/12/09 -	08/01/2010	50.5	47.9	47.1	49	1.8	4	4.4	49	100	Good	Good
13													
											Overall survey -->	Good precision	Good Overall DC

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

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:

Precision: 11 out of 11 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%

Bias calculated using 11 periods of data

Bias factor A: 0.84 (0.74 - 0.97)

Bias B: 20% (4% - 36%)

Diffusion Tubes Mean: 36 μgm^{-3}

Mean CV (Precision): 3

Automatic Mean: 30 μgm^{-3}

Data Capture for periods used: 99%

Adjusted Tubes Mean: 30 (27 - 35) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA

Bias calculated using 11 periods of data

Bias factor A: 0.84 (0.74 - 0.97)

Bias B: 20% (4% - 36%)

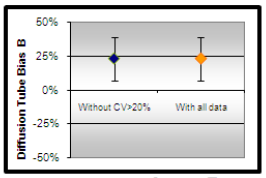
Diffusion Tubes Mean: 36 μgm^{-3}

Mean CV (Precision): 3

Automatic Mean: 30 μgm^{-3}

Data Capture for periods used: 99%

Adjusted Tubes Mean: 30 (27 - 35) μgm^{-3}



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Version 03 - November 2006

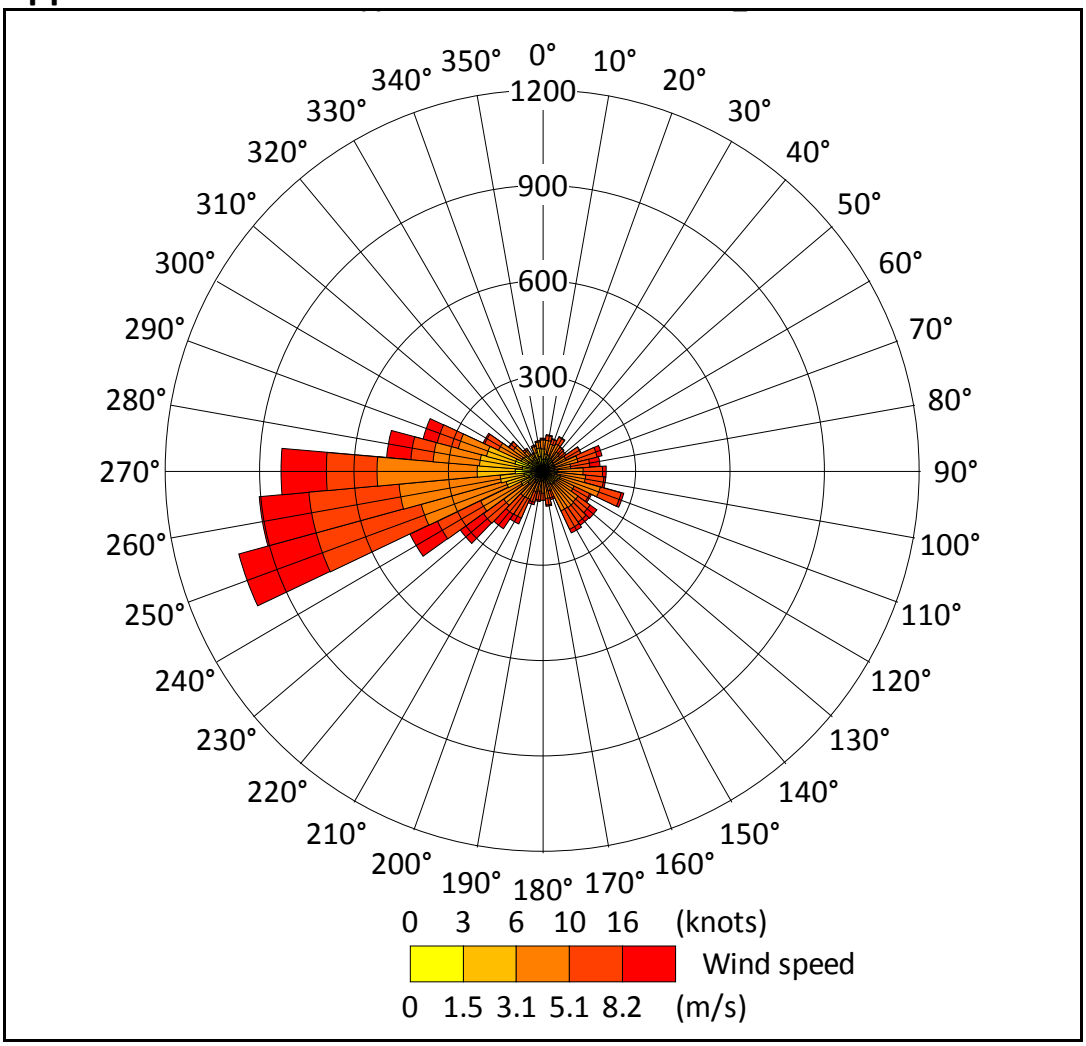
Appendix 3- Traffic data

Appin Crescent: flows and % vehicle splits (speed=27mph)

	Flow	Motorcycles	Cars	LGV	HGV	Buses
mon	19531	0.14	89.18	6.93	1.89	1.87
tue	19981	0.11	88.78	7.24	2.05	1.81
wed	20231	0.13	88.96	7.13	1.99	1.78
thur	20980	0.13	89.13	7.09	1.95	1.71
fri	21919	0.13	90.07	6.46	1.67	1.67
sat	20639	0.20	93.88	3.75	0.63	1.54
sun	16628	0.24	95.12	3.20	0.39	1.05
5 day	20552	0.13	89.24	6.96	1.91	1.76
7 day	20026	0.15	90.62	6.04	1.54	1.65

Note fleet splits taken from Halbeath Road

Appendix 4 ADMS Wind Rose- Leuchars 2009



Appendix 5 Air Pollution Report: Appin Crescent

Produced by AEA on behalf of Fife Council

FIFE DUNFERMLINE
29 July 2009 to 04 August 2010

Appin Crescent. The monitoring site is located on a busy trunk road (A907) through Dunfermline.

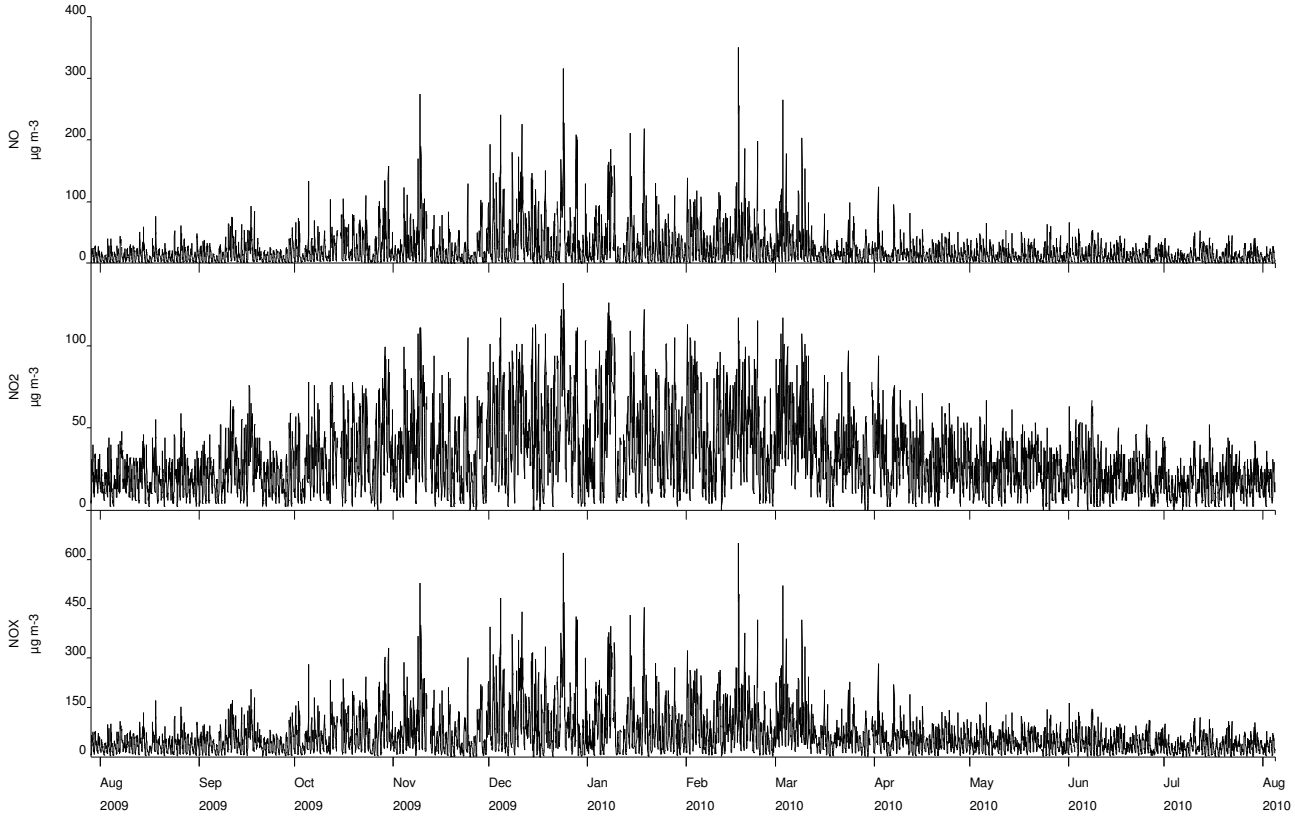
POLLUTANT	NO	NO_2	NO_X
Maximum hourly mean	350 µg m^{-3}	138 µg m^{-3}	651 µg m^{-3}
Maximum daily mean	133 µg m^{-3}	91 µg m^{-3}	294 µg m^{-3}
99.8th percentile of hourly means	204 µg m^{-3}	115 µg m^{-3}	416 µg m^{-3}
Average	21 µg m^{-3}	31 µg m^{-3}	64 µg m^{-3}
Data capture	98.9 %	98.9 %	98.9 %

All mass units are at 20'C and 1013mb
NO_X mass units are NO_X as NO_2 µg m^{-3}

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	0	0
Nitrogen Oxides (NO_2)	Annual mean > 30 µg m^{-3}	1	-

Produced by AEA on behalf of Fife Council

Fife Dunfermline Air Monitoring
Hourly Mean Data for 29 July 2009 to 04 August 2010



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