55 Air Quality Cumulative Impact Assessment

This section describes the local air quality impacts within 10km of the proposed scheme. It also quantifies the emissions of greenhouse gases and other wider-scale air pollutants.

Baseline air quality across most of this area is very good, but in the centre of Aberdeen, air quality is so poor that the Council has had to declare an Air Quality Management Area. The impacts of the proposed scheme would range from Moderate adverse to Substantial beneficial. Most of the adverse effects would be close to the proposed scheme, where relatively few people live. Beneficial air quality impacts are expected across much of the city, including the Air Quality Management Area, and also near to roads outwith the city that would be relieved by the proposed scheme. Very many more people would benefit from improved air quality than would suffer worsened air quality and in the vicinity of the proposed scheme, air quality would remain good by national standards.

The proposed scheme would increase the emissions of greenhouse gases and other wider-scale air pollutants, but in a national context, these increases would be extremely small.

55.1 Introduction

55.1.1 This section addresses the cumulative air quality impacts of the proposed scheme. It takes account of the local air quality impacts outwith the route corridors dealt with in Chapters 14, 29 and 44, i.e. alongside other roads affected by the proposed scheme. It also presents an assessment of the wider-scale impacts of the scheme, including regional and global impacts.

55.1.2 Exhaust emissions from road vehicles can:

- increase levels of air pollution experienced by local people and thus potentially harm human health (such impacts are termed ‘local air quality impacts’);
- increase levels and deposition rates of air pollutants that may harm particularly sensitive vegetation;
- increase levels of secondary air pollution in the atmosphere over a wider area, including ozone concentrations and acid deposition (such impacts are termed ‘wider-scale impacts’);
- increase the levels of greenhouse gases in the atmosphere and thus contribute to climate change.

55.1.3 This chapter covers each of these topics in turn. Local air quality impacts and air quality impacts on vegetation are caused by changes to the concentrations of air pollutants in ambient air. The wider-scale impacts and greenhouse gases are best assessed by describing the change in emissions that the scheme would bring about.

55.1.4 A road scheme can influence local air quality not only close to the new road, but also across a much larger road network. This is because a new road will alter driving patterns and thus change the numbers of vehicles on many roads; as well as potentially reducing congestion and changing driving speeds. Where a new road brings vehicles into an area, air quality is likely to deteriorate. At the same time, air quality is likely to improve near to those roads that are relieved by the new road.

55.1.5 Nationally, there are two local air pollutants of particular concern from road traffic: nitrogen dioxide and fine particles (normally measured as PM_{10} – particulate matter less than 10 micrometres diameter), i.e. these are the pollutants most likely to exceed the air quality objectives. Air quality assessments carried out by Aberdeen City Council (e.g. Aberdeen City Council 2003a) and Aberdeenshire Council (e.g. Aberdeenshire Council, 2005), as well as the Stage 2 Assessment for the northern section of the proposed scheme (Mouchel Consulting, 2002, 2003), have confirmed that these are the only two pollutants of potential concern from road traffic in this area. The assessment thus addresses the impacts of the proposed scheme on ambient concentrations of both nitrogen dioxide and PM_{10}. Concentrations of oxides of nitrogen (NOx, which covers nitrogen dioxide and nitric oxide) are also assessed in relation to areas of sensitive vegetation. Carbon dioxide emissions are treated as an indicator for total greenhouse gas emissions. The pollutants of potential concern regarding wider-scale impacts are carbon monoxide, hydrocarbons, oxides of nitrogen and PM_{10}.

55.1.6 Ambient concentrations and emissions in the year 2005 are assumed to represent existing conditions. For the purposes of this assessment, 2011 has been assumed to be the opening year for the proposed scheme, even though opening is expected to be later than this. The assumed opening year of 2011 will be the worst-case year for local air quality impacts, since emissions from road transport and many other sectors will reduce in future years. In terms of the wider-scale impacts, the opening year may not represent the worst-case year, and in this case the design year (2027) has also been assessed.

55.2 Approach and Methods

Study Area

55.2.1 The study area for this assessment extends 10km from the proposed scheme in each direction. It thus includes the whole of Aberdeen and extends north as far as Newburgh and Pitmedden, west to Inverurie, Dunecht and Crathes, and south to Inverbervie. The assessment of local air quality and air quality impacts on vegetation describes impacts at specific sensitive locations within this area. In terms of wider-scale impacts and greenhouse gases, the assessment sums the emissions from every road included in the transport model that is within this study area.

Policy Context

55.2.2 This assessment has been carried out in accordance with DMRB Volume 11, Section 3, 2003 and with reference to the following documents:

- The Environment Act 1995, Part IV;
- The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2000;
- The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, 2003;
- The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: A consultation document for further improvements in air quality, 2006;
- The Air Quality (Scotland) Regulations 2000;
- The Air Quality (Scotland) Amendment Regulations 2002;
- The UK Climate Change Programme (2006);
- Scotland’s Climate Change Programme (2006).

55.2.3 During May 2007, the Highways Agency published Advice Note HA 207/07 (Highways Agency, 2007), which supersedes Volume 11, Section 3, Part 1 of the DMRB (Highways Agency, 2003). The local and wider-scale air quality assessments reported in this chapter were carried out prior to May 2007 and thus reference the previous publication. It is considered that if these assessments were to be carried out following the May 2007 guidance, the conclusions would be unaltered. The most significant change introduced by Advice Note HA207/07 is a revised method for calculating greenhouse gas emissions. The greenhouse gas calculation has thus been updated to take account of the latest guidance contained in Advice Note HA207/07. Reference has also been made to: Interim Advice Notes 54/04 and 61/05 (Highways Agency, 2004 and 2005), which were issued as a supplement to DMRB Volume 11.3 (IAN 61/05 is now incorporated within Advice Note HA 207/07 (Highways Agency, 2007)); the Scottish Transport Appraisal Guidance (Scottish Executive, 2006a); and the consultation draft of Scotland’s National Transport Strategy (Scottish Executive, 2006b). The implications of the above documents in terms of this air quality assessment are outlined below.

Local Air Quality

55.2.4 The significance of both existing and future pollutant concentrations is best assessed by reference to the national air quality standards and objectives, established by the Government 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 the costs, benefits, feasibility and practicality of achieving the standards. The objectives are prescribed within the Air Quality (Scotland) Regulations 2000 and the Air Quality (Scotland) Amendment Regulations 2002. The objectives for nitrogen dioxide were to be achieved by 2005 and will continue to apply in each subsequent year. The current objectives for PM_{10} were to be achieved by 2004 and will continue to apply in each subsequent year. The current PM_{10} objectives are, however, supplemented by a set of more stringent objectives to be applied from 2010 onward. A summary of these objectives is provided in Table 55.1. Patterns across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded unless the annual mean nitrogen dioxide concentration is greater than 60 $\mu g/m^3$ (Laxen and Marner, 2003). Therefore, 1-hour mean nitrogen dioxide concentrations will only be considered if the annual mean concentration is likely to be above this level.

55.2.5 The European Union has also set limit values for both nitrogen dioxide and PM_{10} and the UK has a legal obligation to meet these limits nationally. The EU limit value for nitrogen dioxide is the same level as the UK objective but is to be achieved by the later date of 2010. The EU limit values for PM_{10} are the same level as the 2004 UK objectives, and had to be achieved by 2005. Thus, assessing against the nitrogen dioxide and PM_{10} objectives for Scotland, as set out in Table 55.1, provides the most stringent approach.

55.2.6 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2000 and its 2003 Addendum set out how different sectors can contribute to achieving the air quality objectives established in the Regulations. Local Authorities are seen to play a particularly important role and must each carry out a review and assessment of air quality in their area in order to identify whether the objectives will be achieved by the relevant date. If this is not expected to be the case, the Authority must declare an Air Quality Management Area (AQMA), and prepare an action plan for improvements in air quality. The AQMA can be larger than the area of exceedence if the Local Authority believes that this is beneficial.

55.2.7 The air quality objectives only apply at locations where members of the public are likely to be exposed to air pollution for the time period specified in the objective. Thus, for the annual mean and 24-hour objectives that are the focus of this assessment, the primary receptors will be residential properties. However, in order to ensure that all potentially sensitive locations were accounted for, the assessment has included sensitive non-residential receptors such as schools.

Table 55.1 – Air Quality Objectives for Pollutants Relevant to this Scheme, as Defined in the Air Quality (Scotland) Regulations 2000 and Amendment Regulations 2002

Pollutant	Air Quality Objective		Strategy Compliance Date
	Concentration $\mu g/m^3$	Measured as:	
Nitrogen dioxide (NO_2)	200	1 hour mean; not to be exceeded more than 18 times per year	31 December 2005
	40	Annual mean	31 December 2005
Particles (PM_{10}) (gravimetric)	50	24 hour mean; not to be exceeded more than 35 times per year	31 December 2004
	40	Annual mean	31 December 2004
	50	24 hour mean; not to be exceeded more than 7 times per year	31 December 2010
	18	Annual mean	31 December 2010

Air Quality Impacts on Vegetation

55.2.8 There is evidence that elevated concentrations of NOx can damage particularly sensitive vegetation. In addition, there is evidence that the deposition of reactive nitrogen from the air can damage certain habitats. Critical levels have been defined to prevent gaseous pollutants directly affecting plants. Defra (2001) defines a critical level as *'the concentration of a pollutant in the atmosphere, below which vegetation is unlikely to be damaged according to present knowledge'*. In addition to the critical levels, critical loads have been defined to prevent the long-term effects of deposition. Defra (2001) defines critical loads as *'the amount of pollutant deposited below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge'*.

55.2.9 In the UK, the statutory nature conservation agencies use a critical level for NOx of 30 $\mu g/m^3$ at internationally designated conservation sites and SSSIs. The same level is also set as an EU Limit Value, which only applies more than 20 km from towns with more than 250,000 inhabitants or more than 5 km from other built-up areas. The critical loads are specific to different types of habitat.

Wider-Scale Impacts

55.2.10 The UK has international commitments to reduce emissions of a range of pollutants through United Nations Economic Commission for Europe (UNECE) protocols. These are pollutants which can act on both local and regional scales. The DMRB Volume 11.3 defines the pollutants that are of greatest concern and which provide the best indication of emissions from road traffic. These are carbon monoxide, hydrocarbons, NOx and PM_{10}.

Greenhouse Gases

55.2.11 The Kyoto Protocol recognises six greenhouse gases but carbon dioxide is the main greenhouse gas in the UK (UKCCP, 2006) and is used as the key indicator for assessing the impacts of transport options on climate change.

55.2.12 The UK Government has a legally-binding target under the Kyoto Protocol to reduce its greenhouse gas emissions by 12.5% below 1990 levels by around 2010 (excluding aviation emissions). There is also an EU goal to stabilise carbon dioxide concentrations at 550 parts per million. In line with this target, the UK Government has set itself domestic goals which go beyond those required under the Kyoto Protocol. These are to reduce carbon dioxide emissions by 20% below 1990 levels by 2010 and to reduce carbon dioxide emissions by 60% by around 2050; with real progress evident by 2020. The UK Climate Change Programme (UKCCP, 2006) aims to deliver these reductions. The UK transport sector currently (2004) accounts for 27% of total carbon dioxide emission, and a range of policies is already in place to deliver savings from this sector (UKCCP, 2006). The UK Government estimates that, as a result of these measures, carbon dioxide emissions from the transport sector in 2010 will be 13% lower than they would have been if the measures were not in place (UKCCP, 2006). This does not, however, mean that emissions are expected to fall. For the UK as a whole, carbon dioxide emissions from transport rose by 8% between 1990 and 2000 and, based on the assumptions within the UKCCP, are expected to rise by a further 8% between 2000 and 2010 (UKCCP, 2006). The UK Government accepts that a growing economy will have a rising demand for transport fuel and that emission reductions from other sectors will need to compensate for the increases in emissions from transport and also that additional policy measures will be required to reduce carbon dioxide emissions from transport (UKCCP, 2006).

55.2.13 The 'Scottish Share' of the emissions reductions set in the UK's domestic goal has been calculated as 1.7 million tonnes of carbon per year from 1990 to 2010 (Scottish Executive, 2006c – emissions based on all greenhouse gases converted into carbon equivalent units). The Scottish Executive has set its own domestic target not only to achieve its 'Share', but to exceed it by 1 million tonnes of carbon per year by 2010 (SCCP, 2006). Approximately 17% of Scotland's greenhouse gas emissions come from the transport sector (SCCP, 2006). As in the UK as a whole, transport emissions have been increasing and, based on the assumptions behind the SCCP, are expected to continue to increase concurrently with reductions in emissions from other sectors (SCCP, 2006). The Scottish Executive is pursuing several policy routes to reduce emissions from the transport sector. The consultation paper on Scotland's National Transport Strategy (NTS, 2006) describes a number of measures such as promoting new technology and cleaner fuels; managing demand and promoting modal shift away from private car use. Some of these issues are discussed in Chapter 2 (Need for the Scheme).

55.2.14 Delivering carbon savings is a central feature of Scotland's NTS. The Scottish Executive intends to present a 'carbon balance sheet' for transport in future reviews of the NTS. This will present the impact of all Scottish transport policies and projects that are expected to have a significant impact on carbon, whether positive or negative. This recognises the need to do more than simply focus on the positive contribution transport will be making without showing how this relates to the negative impact of other Scottish transport policies and projects. The aim will be to show that the Scottish Government – through its own actions – is continually reducing the overall impact of Scottish transport measures. The National Transport Strategy also states that this does not mean that any one single project, or policy, which increases emissions cannot go ahead. Greenhouse gas emissions are thus being addressed on national and international platforms. Local measures will undoubtedly be important, but any impacts must be assessed with regard to the overall picture in both Scotland and the UK as a whole.

<u>Assessment Criteria</u>

55.2.15 As described in Chapter 5 (Overview of Assessment Process), impact significance has been determined with respect to the sensitivity of the baseline conditions and the magnitude of potential impact.

55.2.16 There is no official guidance for the UK on defining air quality impact magnitude and significance, and the criteria used in this assessment, and described below, are ultimately based on professional judgement. They are, however, the same as those defined by the Irish National Roads Authority in its Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes (NRA, 2006) and are presented as an example in the Planning for Air Quality guidance prepared by the National Society for Clean Air and Environmental Protection (NSCA, 2006).

<u>Sensitivity</u>

55.2.17 In terms of the sensitivity criteria generally used within the ES (i.e. low, medium and high), all of the sensitive receptors at which air quality has been assessed are judged to be of high sensitivity. This is because the air quality objectives protect the health of all members of the public, and in terms of ecosystem effects, the UK statutory nature conservation agencies treat all relevant SSSIs and other officially designated sites as sensitive.

<u>Impact Magnitude</u>

55.2.18 The definition of impact magnitude is solely related to the degree of change in pollutant concentrations. The impact magnitude criteria are provided in Table 55.2.

Table 55.2 – Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude	**Increase/decrease**	
	Annual Mean NO_2 / PM_{10}	**Days PM_{10} >50 $\mu g/m^3$**
very large	> 25%	> 25 days
large	15-25%	15-25 days
medium	10-15%	10-15 days
small	5-10%	5-10 days
very small	1-5%	1-5 days
extremely small	<1%	increase/decrease <1 day

Impact Significance

55.2.19 Impact significance takes account of the impact magnitude and also of the absolute concentrations and how they relate to the air quality objectives or other relevant standards. The impact significance criteria defined in Table 55.3 are consistent with the terminology generally used within the ES except that the additional category of 'Very Substantial' has been added. This criterion is commonly used in air quality assessments (e.g. NRA, 2006) to describe large or very large changes where an air quality objective would be breached.

Table 55.3 – Air Quality Impact Significance Criteria

Absolute Concentration in Relation to Objective	Magnitude of Impact (Change in Concentration)					
	extremely small	very small	small	medium	large	very large
Decrease With Scheme						
Above Objective With Scheme	Slight beneficial	Slight beneficial	Substantial beneficial	Substantial beneficial	Very Substantial beneficial	Very Substantial beneficial
Above Objective Without Scheme and Below Objective With Scheme	Slight beneficial	Moderate beneficial	Substantial beneficial	Substantial beneficial	Very Substantial beneficial	Very Substantial beneficial
Below (but not well below) Objective Without Scheme	Negligible beneficial	Slight beneficial	Slight beneficial	Moderate beneficial	Moderate beneficial	Substantial beneficial
Well Below Objective Without Scheme	Negligible beneficial	Negligible beneficial	Slight beneficial	Slight beneficial	Slight beneficial	Moderate beneficial
Increase With Scheme						
Above Objective Without Scheme	Slight adverse	Slight adverse	Substantial adverse	Substantial adverse	Very Substantial adverse	Very Substantial adverse
Below Objective Without Scheme and Above Objective With Scheme	Slight adverse	Moderate adverse	Substantial adverse	Substantial adverse	Very Substantial adverse	Very Substantial adverse
Below (but not well below) Objective With Scheme	Negligible adverse	Slight adverse	Slight adverse	Moderate adverse	Moderate adverse	Substantial adverse
Well Below Objective With Scheme	Negligible adverse	Negligible adverse	Slight adverse	Slight adverse	Slight adverse	Moderate adverse

Note: Below Objective = >75% of the objective level
Well Below Objective = <75% of the objective level

Assessment Methods

Local Air Quality

55.2.20 Air quality monitoring methods and collated data are summarised in this chapter, with further technical detail provided in Appendix A14.1

55.2.21 Information on the existing levels of nitrogen dioxide has been obtained from direct measurements made over a 12-month period using passive diffusion tubes at 17 monitoring sites, selected to represent concentrations across the study area. Diffusion tube data have been corrected for laboratory bias as per guidance from Defra and the Devolved Administrations (DAs), as explained in full in Appendix A14.1.

55.2.22 The measurements made specifically for this assessment have been supplemented with results of measurements made by Aberdeen City Council and Aberdeenshire Council, as part of ongoing monitoring programmes. Full details of both sets of measurements are presented in Appendix A14.1 and only summarised in this chapter. As explained in Appendix A14.1, the monitoring data provided by the Councils were the most recent available at the time that this assessment was undertaken.

55.2.23 DMRB Volume 11.3 recommends that if a scheme is likely to give rise to significant impacts, the Stage 3 Assessment should involve detailed dispersion modelling. As the proposed scheme is likely to influence a very large area, some of which has been designated as an AQMA, detailed dispersion modelling has been undertaken.

55.2.24 Dispersion calculations were performed using the AAQuIRE model (described in detail at www.fabermaunsell.com), which is one of the models accepted by Defra and the DAs (2006b) for use in air quality review and assessment, and which is suitable for use in DMRB Stage 3 air quality assessments. The road-transport component of this model is based around the internationally validated CALINE model. The meteorological data required for modelling pollutant dispersion were taken from the Meteorological Office site at Dyce Airport, which is located within the study area and is thus ideally suited for this purpose. When modelling began, hourly data for 2005 were the most recent available and were therefore the most appropriate for use in this assessment.

55.2.25 The traffic data used in the air quality assessment were supplied by MVA. This is explained in more detail in Section 4.5 of Chapter 4 (The Proposed Scheme), and Section 5.3 of Chapter 5 (Overview of Assessment Process). The future-year traffic data have been provided for the year 2012, but have been entered into the dispersion model assuming the year is 2011. Because of anticipated trends in traffic volumes and vehicle emissions, this is a worst-case approach.

55.2.26 All of the roads contained within the MVA traffic model within 10km of the proposed scheme have been entered into every run of the dispersion model. MVA advised that some of the flows on roads in Aberdeenshire may have been under predicted. This issue is discussed in paragraph 55.2.41 under Limitations to the Assessment.

55.2.27 The model has been verified and calibrated against the full set of local measurements from both the study-specific passive diffusion tube monitoring and the measurements provided by Aberdeen City Council, as described in Appendix A14.1 (Air Quality). The measurements provided by Aberdeenshire Council have not been used to verify the model due to the potential for under prediction of baseline flows in Aberdeenshire, as discussed above in paragraph 55.2.26.

55.2.28 In order to describe the most significant impacts of the proposed scheme, 1059 sensitive receptors have been chosen across the study area. This selection was based on professional judgement and as shown in Figures 55.1a-c, they represent locations considered likely to experience the full range of scheme-related impacts. Receptors are positioned on the roadside façade of each property. As air quality has been assessed at such a large number of receptors, numerical results are only presented for a selection of 40 receptors, which are labelled as CR1 to CR40 in Figures

55.1a-c. The labelled receptors were chosen to aid description of the results. They include the locations with largest predicted impacts, as well as other locations that it is helpful to highlight. The results for the other receptors are summarised in Figures as described subsequently. The 24-hour PM_{10} results are not shown in Figures as annual mean PM_{10} data are more likely to exceed the 2010 objectives, and the Figures therefore represent the worst-case scenario. Both the annual mean and the 24-hour PM_{10} results are discussed in the text and presented in the Tables.

55.2.29 The model requires information on background conditions within the study area. As almost all road traffic in the region has been modelled explicitly, it would be inappropriate to use the national background concentration maps published by Defra and the DAs (2006a) without removing the road-traffic component of these data. The method used to transform the background concentration data is described in Appendix A14.1.

Overall Local Air Quality Impacts

55.2.30 DMRB IAN 54/04 (Highways Agency, 2004) sets out an approach to calculate the overall local air quality impact of a scheme based on the webTAG, 2006 methodology, for use as part of a Stage 2 assessment. There is no requirement to follow this method in a Stage 3 assessment, but the results provide a very useful indication of the overall scheme impacts. The Scottish Transport Appraisal Guidance (STAG) explains that the guidance provided in IAN 54/04, and thus webTAG should be followed (Scottish Executive, 2006a).

55.2.31 The webTAG assessment summarises the overall local changes in exposure to both nitrogen dioxide and PM_{10}. It produces a numerical assessment score that takes account of the changes in concentration and the number of residential properties exposed to these changes. It relies on property counts in 50m bands out to 200m from the centre of every road (the road traffic model includes traffic on the vast majority of the road network, but some of the minor roads are not included). The local application of the DMRB spreadsheet (Highways Agency, 2003) is then used to model the concentrations at 20m, 70m, 115m and 175m from the centre of each of these roads without and with the proposed scheme. The predicted concentrations are then multiplied by the number of properties in each distance band. The link-specific scores for the without scheme option are then subtracted from the link-specific scores for the with scheme option. A negative score thus indicates an overall improvement in air quality for that link. The sum of the link-specific assessment scores for each option is the net assessment score and a negative score represents an overall improvement in air quality for the scheme. The DMRB screening model is recommended in webTAG. It is considered sufficiently robust for this assessment; even though more detailed dispersion modelling has been used to predict absolute ambient concentrations in relation to the air quality objectives. As each run of the DMRB model does not include all roads within the network, the background concentrations obtained from Defra and the DAs (2006a) have not been adjusted as described in Appendix A14.1.

55.2.32 Where a single residential property is close to more than one of the links in the traffic model, the effect that each link would have on that property is counted separately. The overall assessment score sums all of these impacts together. In addition, webTAG requires the total number of properties that would experience improved air quality to be calculated, as well as the number that would experience a deterioration in air quality as a result of the scheme. No guidance is provided in webTAG on how to assign an increase or decrease for those properties near to more than one road (where one road might increase and the other decrease concentrations). The pragmatic assumption has been made that each house will be primarily influenced by the road that it is closest to. While there will be exceptions to this rule, they will be relatively few in number and will not significantly bias the assessment.

55.2.33 Every road that is included in the traffic model and that is within 10km of the proposed scheme has been included in this assessment. Residential properties have been counted using Ordnance Survey Address Point data and thus the location of each house it taken as the position of the Address Point, not of the exterior walls. This simplification will introduce relatively little error.

Air Quality Impacts on Vegetation

55.2.34 In accordance with Interim Advice Note (IAN) 61/05 to the DMRB (Highways Agency, 2005), an assessment of potential impacts on vegetation has been carried out. All officially designated sites (i.e. SACs, SPAs, cSPAs, Ramsar sites or SSSIs) within 200m of any of the roads included in this assessment (i.e. any road that is included in the traffic model and which is within 10km of the proposed scheme) were identified. In addition, to support the assessment in Chapter 40 (Ecology and Nature Conservation), one site, which is more than 200m from any road, has been included. Those sites within 200m of the proposed scheme itself have been discussed in previous chapters of this ES and are thus not dealt with here.

55.2.35 NOx and nitrogen dioxide concentrations for the base year (2005), and the year of opening (2011) both with and without the Scheme, have been calculated using the DMRB screening model (Highways Agency, 2003), with results adjusted following the latest guidance from Defra and the DAs regarding the relationship between NOx and nitrogen dioxide (Laxen et al., 2007) (the DMRB screening model is recommended in IAN 61/05 and is considered sufficiently robust for this assessment; even though more detailed dispersion modelling has been used to predict absolute ambient concentrations in relation to the air quality objectives. As the DMRB model does not include all roads within the network, the background concentrations obtained from Defra and the DAs (2006a) have not been adjusted as described in Appendix A14.1). Estimates of nitrogen deposition have been calculated following the method set out in IAN 61/05. The method, which is described in detail in IAN 61/05, adjusts the local estimates of total nitrogen deposition published on the UK Air Pollution Information System website (APIS, 2007) and takes specific account of the effect of local NOx emissions. IAN 61/05 recommends a deposition velocity for nitrogen dioxide of 0.001 m/s, which, when multiplied by the concentration gives a deposition rate (m/s x $\mu g/m^3$ = $\mu g/m^2/s$, which is then transformed into kg-N/ha/yr). For the site that is more than 200m from any road (Red Moss of Netherley), the DMRB screening model is inappropriate for predicting ambient concentrations of NOx and nitrogen dioxide. This is because the model is only designed to perform at distances up to 200m from a road. For this site, concentrations have thus been predicted using the AAQuIRE dispersion model as described above.

Wider-Scale Impacts

55.2.36 The total emissions of carbon monoxide, hydrocarbons, oxides of nitrogen and PM_{10} from all of the roads contained within the traffic model and within 10km of the proposed scheme have been predicted for existing conditions (2005), 2011 without and with the proposed scheme, and 2027 without and with the proposed scheme, using the regional section of the DMRB screening model (Highways Agency, 2003). Emissions in 2027 have been calculated assuming an assessment year of 2025, since the DMRB screening model does not extend to 2027. As in the local assessment, the traffic data used were supplied by MVA. This is explained in more detail in Chapter 4 (The Proposed Scheme) paragraph 4.5.16, Future Traffic Conditions and Chapter 5 (Overview of Assessment Process) Section 5.3, Traffic data.

Greenhouse Gases

55.2.37 The total emissions of carbon dioxide have been calculated following the approach set out in DMRB Advice Note HA 207/07 (Highways Agency, 2007).

Limitations to Assessment

55.2.38 All values presented here are the best possible estimates, but uncertainties in the results might cause over-predictions or under-predictions. Where choices have been necessary, a worst-case approach has been applied. The assessment will thus tend on the side of overestimating the negative impacts of the scheme.

55.2.39 All of the measurements presented in this chapter and Appendix A14.1 (Air Quality) have an intrinsic margin of error. Defra and the DAs (2006c) suggest that this is of the order of +/- 20% for diffusion tube data and +/- 10% for automatic measurements. The model results rely on MVA's strategic transport model and thus any uncertainties inherent in these data will carry into this assessment.

55.2.40 There will be additional uncertainties introduced as the modelling has simplified real-world processes into a series of algorithms. For example: it has been assumed that during each year, the vehicle fleet around within the study area will conform to the national (UK) average composition; it has been assumed the emissions per vehicle conform to the factors published in DMRB Volume 11.3; it has been assumed that wind conditions measured at Dyce airport during 2005 will occur throughout the study area during 2011; and it has been assumed that the subsequent dispersion of emitted pollutants will conform to a Gaussian distribution over flat terrain. As is explained in Appendix A14.1, an important step in the assessment is verifying the dispersion model against the measured data. By comparing the model results with measurements, the combined influence of the majority of these uncertainties can be assessed. This comparison is given in Figure A14.7 and Table 14.5.1 of Appendix A14.1 (Air Quality). The comparison shows that there is no significant bias in the results and that the model performs consistently well across both built-up urban areas and open rural areas.

55.2.41 As explained in paragraph 55.2.26, some of the traffic flows may have been under-predicted. This will only have occurred further north, west or south of the proposed scheme. The effect in these outer fringes of the study area is consistent for all traffic levels across all scenarios. It is unlikely, however, to significantly affect the changes in traffic levels brought about by the proposed scheme. This has the potential to introduce bias rather than uncertainty, which, as explained in paragraph 55.2.27, has not been corrected for through the model verification set out in Appendix A14.1. Where absolute flows are under-predicted, then the impact magnitude (percentage change) will be over-stated, as the flows due to the scheme are not under-predicted. The absolute concentrations may, however, be under-estimated. Impact significance is based on both impact magnitude and absolute concentrations. It is considered highly unlikely that concentrations would be close to any of the relevant air quality objectives in the remote locations where the baseline flows may have been under-predicted, and so this issue is likely to be inconsequential.

55.2.42 The assessment is limited to certain pollutants which have been shown by other assessments to be the pollutants of greatest concern. It does not take account of all chemical species that might be released into the air, but it is considered that impacts associated with other pollutants will be smaller than those associated with the pollutants that have been considered.

55.2.43 The UK Government's Air Quality Expert Group (AQEG) has published a draft report on trends in primary nitrogen dioxide in the UK (AQEG, 2006). This examines evidence that shows that while NOx emissions have fallen in line with predictions made a decade previously, the composition of NOx has, in some urban environments, changed. This may have caused nitrogen dioxide levels at some locations to fall less rapidly than was expected. As is explained in Appendix A14.1, the latest guidance from Defra and the DAs has been followed regarding the relationship between NOx and NO_2, but there is still uncertainty as to whether this relationship will continue to apply in 2011. Any effect is likely to be greatest close to roads in the centre of Aberdeen, especially near to roads with a high proportion of buses, where future baseline concentrations may have been underestimated. The issue of primary nitrogen dioxide would not be expected to alter the comparison between concentrations with and without the proposed scheme. The implications for the conclusions of this assessment are therefore judged to be negligible.

55.2.44 The limitations to the assessment should be borne in mind when considering the results set out in subsequent sections. While the model should give an overall accurate picture, i.e. one without bias, there will be uncertainties for individual receptors. Clearly in future years the uncertainties are likely to be greater than they are now. The results are 'best estimates' and are treated as such in the discussion.

55.2.45 The STAG assessment method assesses the change in concentrations across a very large area, and uses the DMRB screening model (analysing the influence of each road separately) along with estimates of background concentrations provided by Defra and the DAs (2006a). The results from the dispersion modelling show that the proposed scheme is likely to alter these background concentrations (increasing them near to the proposed scheme and reducing them across the city). On balance, this will over-estimate the negative effects of the proposed scheme and under-estimate the benefits as reported in the STAG assessment.

55.2.46 Total emissions from the network have been calculated using predicted annual average speeds on each link. Appendix A55.1 explains that this might cause some of the predictions to misrepresent actual emissions across the range of speeds common on congested roads. On balance, this issue is likely to under-predict the benefits of the proposed scheme in those areas where it relieves congestion. In addition, no allowance has been made in these calculations for traffic queuing at junctions. This will also tend to have underestimated the benefits of the scheme where it relieves congestion. Work is on-going within Transport Scotland to develop improved ways to calculate total emissions allowing for congestion during peak hours and delays at junctions.

55.3 Baseline Conditions

Local Air Quality

55.3.1 Aberdeen City Council and Aberdeenshire Council have both carried out reviews and assessments of air quality over a number of years. Aberdeenshire Council has not identified any likely exceedences of the air quality objectives and has not declared any AQMAs (Aberdeenshire Council, 2005). Aberdeen City Council has identified a large number of objective exceedences within the City and has declared an Air Quality Management Area for both nitrogen dioxide and PM_{10}. The AQMA includes Market Street, Union Street, King Street (between Castle Street and Roslin Terrace), Virginia Street, Commerce Street, Guild Street (between Market Street and Stirling Street) and Holburn Street (between Great Southern Road and Union Street). It is shown in Figure 55.1a. Aberdeen City Council has produced an Air Quality Action Plan to improve local air quality (ACC, 2006).

55.3.2 The results below are summarised according to the type of location in which the measurements were taken. Air quality in very built-up urban areas tends to be poorer than in suburban and rural areas. In order to simplify discussion of the air quality data, an area termed 'inner city' has been defined. This area extends from the Bridge of Don to the north, to Nigg in the south, and to Middlefield, Summerhill and Braeside in the west.

Nitrogen Dioxide

55.3.3 Annual mean concentrations of nitrogen dioxide have been measured using passive diffusion tubes by Aberdeen City Council and Aberdeenshire Council and also at 17 sites run specifically for this study. Details of the methods and results are given in Appendix A14.1 and the locations of the sites, with the concentrations measured, are shown in Figures A14.1, A14.3 and A14.4. Table 55.4 summarises the range of measurements.

55.3.4 Aberdeen City Council measured annual mean nitrogen dioxide concentrations in 2004, which have been used to infer 2005 values ranging from 33 to 69 $\mu g/m^3$ within the AQMA. Only two of these sites were below the annual mean objective; these being at the extreme northern and southern edges of the AQMA. The highest concentration was on Market Street. Annual mean concentrations were above 60 $\mu g/m^3$ at a number of sites, indicating that the 1-hour objective may also have been exceeded.

55.3.5 Outwith the AQMA, but within the inner city, measurements are available both from Aberdeen City Council and from this current study. Both datasets show exceedences of the annual mean nitrogen dioxide objective. The Council measured exceedences of the objective level adjacent to Auchmill Road (A96), South Anderson Drive (A90) near to Bridge of Dee, and Wellington Road (A956) south of the River Dee. The measurements made for this current study also show an exceedence of the objective along Auchmill Road. Outwith the AQMA and inner city area, measurements from both the Council and this current study show existing concentrations are below the annual mean nitrogen dioxide objective.

55.3.6 Nearly all measurements made outwith the inner city have shown concentrations to be well below the objective, even close to busy roads. The only exception is the junction of the A93 with Baillieswells Road, where a concentration of 31 μg/m^3 was recorded. Most background sites outwith the inner city measured concentrations below 10 μg/m^3, with some below the limit of detection for diffusion tubes (i.e. concentrations were too small to measure). The measurements in surrounding towns made by Aberdeenshire Council are also well below the objective, even close to roads.

Table 55.4 – Summary of Annual Mean Nitrogen Dioxide Concentrations in 2005 Measured using Passive Diffusion Tubes μg/m^3

Measurements Made by/for	Site Description	Range of Measured Annual Mean Nitrogen Dioxide Concentration (μg/m^3)
This Study	Roadside and kerbside Sites within the inner city	22 – **44**
	Roadside and kerbside Sites outwith the inner city	15 – 31
	Background Sites outwith the inner city	<5 – 11
Aberdeen City Council	Roadside and kerbside sites within the AQMA	33 – **69**
	Roadside and kerbside sites outwith the AQMA	21 – **49**
	Urban background sites	14 – 17
Aberdeenshire Council	Stonehaven,	9 – 21
	Westhill	11 & 15
	Inverurie	10 – 26
	Peterhead and Mintlaw	15 – 23
Objective		**40**

Note: Data are adjusted for bias as described in Appendix A14.1. Those for Aberdeen City Council are inferred from measurements made during 2004.

Values in bold are above the objective.

55.3.7 Aberdeen City Council and the UK Government have measured nitrogen dioxide using automatic monitors at three sites near to the centre of Aberdeen, as shown in Figure A14.2. The results are summarised in Table 55.5. The City Council operated additional automatic monitors, but at the time that this report was written, reliable data were not available (see Appendix A14.1). Both Market Street and Union Street are kerbside sites within the City Centre AQMA. The Automatic Urban and Rural Network (AURN) site is an urban background site just outside of the AQMA. The results show that the annual mean nitrogen dioxide objective is likely to have been exceeded within the AQMA, but that concentrations were well below the objective level at the AURN site, which is approximately 75m from the nearest busy road (A956).

55.3.8 Figures 55.1a-c show modelled existing concentrations of nitrogen dioxide at 1059 sensitive receptors. Most of the receptors represent worst-case residential exposure and the remainder represent air quality monitoring sites. The predicted results at these receptors are summarised as ranges in Table 55.6. A direct comparison of the model results with the measurements is given in Appendix A14.1.

Table 55.5 – Measured and Projected Nitrogen Dioxide and PM_{10} Concentrations at Three Automatic Monitoring Stations during 2005

Site	Annual Mean Nitrogen Dioxide Concentration ($\mu g/m^3$)	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Number of Exceedences of 50 $\mu g/m^3$ as a 24-hour PM_{10} Concentration
Aberdeen Centre AURN (Errol Place)	24	19	4
Market Street	48	-	-
Union Street	44	19	2
Objective Level	**40**	**40**	**35**

Note: As is explained in Appendix A14.1, Aberdeen City Council advised use of their 2003 data rather than more recent results. Thus, the results for Market Street and Union Street are taken from measurements made during 2003 and projected to 2005 using factors published by Defra and the DAs (2006a). The number of 24-hour PM_{10} exceedences at Union Street has been estimated based on the relationship with the annual mean set out in Defra (2003b). No PM_{10} data were available from Market Street during 2003. All PM_{10} data are presented in gravimetric equivalent units. See Appendix A14.1 for further details.

Table 55.6 – Summary of Modelled Existing (2005) Nitrogen Dioxide and PM_{10} Concentrations at the 1059 Receptors Used in this Assessment

Site Description	Range of Predicted Annual Mean Nitrogen Dioxide Concentration ($\mu g/m^3$)	Range of Predicted Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Range of Predicted Number of Exceedences of 50 $\mu g/m^3$ as a 24-hour mean PM_{10} Concentration
Sites within the AQMA (all roadside or kerbside)	30 **– 80**	19 – 30	2 – 29
Roadside or kerbside sites outwith the AQMA but within the inner city	14 – **55**	15 – 26	0 – 14
Urban background sites outwith the AQMA but within the inner city	10 – 36	13 – 21	0 – 5
Roadside and kerbside sites outwith the inner city	10 – 35	11 – 21	0 – 5
Background sites outwith the inner city	2 – 10	10 – 18	0 – 1
Objective	**40**	**40**	**35**

Note: All PM_{10} data are presented in gravimetric equivalent units. The 2004 objectives for PM_{10} are shown because the 2010 objectives do not apply in 2005. Where receptors are close to minor roads, it is difficult to definitively classify a site as roadside or background. Within the city, the selection is based on whether a site is within 30m of a road with >5000 vpd. Outwith the city, the selection is based on whether the predicted existing annual mean nitrogen dioxide concentration is greater than 10 $\mu g/m^3$. These classifications do not influence the conclusions of the assessment. Values in bold are above the objective.

55.3.9 Within the AQMA, the model results show the annual mean nitrogen dioxide objective was exceeded in 2005 at every location along King Street, Union Street, and Market Street, with the highest concentration, 80 $\mu g/m^3$, at the junction of Union Street and Market Street. Since the nearest monitoring site was almost 100m from this junction, it is unsurprising that the maximum modelled value in Table 55.6 exceeds the maximum measurement in Table 55.4. Most of the receptors along Holburn Street also exceeded the objective. In total, concentrations at 50 of the 56 receptors within the AQMA are likely to have exceeded the objective in 2005. The only sections of the AQMA where exceedences are not predicted are Virginia Street and Commerce Street. A large number of properties outside of the AQMA, but within the inner city, also show objective exceedences during 2005 (exceedences are predicted at 30 of the 272 receptors in this area). Outwith the inner city, concentrations in 2005 were much lower, and no objective exceedences were predicted.

55.3.10 Those locations with annual mean concentrations of nitrogen dioxide above 60 $\mu g/m^3$ may also have experienced exceedences of the 1-hour nitrogen dioxide objective. There may thus have been exceedences of this objective within, but not outwith, the AQMA.

55.3.11 A range of national and international measures to reduce emissions from road transport and other sectors is expected to improve local air quality between 2005 and 2011. Local measures introduced by Aberdeen City Council are also expected to improve local air quality at the worst-case locations. Figures 55.2a-c show the predicted concentrations across the study area in 2011 without the proposed scheme in place. The results are summarised as ranges in Table 55.7. They show local traffic-control measures (such as closing parts of Union Street to vehicles and making parts of Market Street bus-only) are expected to reduce concentrations by more than 50% between 2005 and 2011 at the worst-case receptor on the junction of Union Street and Market Street and thus prevent the objective from being exceeded in 2011 at this location. Of the 50 predicted exceedences within the AQMA in 2005, only six are expected to remain in 2011. These are all on King Street and Market Street (south of the bus-only area).

Table 55.7 – Summary of Modelled Nitrogen Dioxide and PM_{10} Concentrations at the 1059 Receptors Used in this Assessment in 2011 Without the Proposed Scheme in Place

Site Description	Range of Predicted Annual Mean Nitrogen Dioxide Concentration ($\mu g/m^3$)	Range of Predicted Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Range of Predicted Number of Exceedences of 50 μg/m3 as a 24-hour mean PM_{10} Concentration
Sites within the AQMA (all roadside or kerbside)	22 – **53**	16 – **24**	0 – **11**
Roadside or kerbside sites outwith the AQMA but within the inner city	11 – **43**	14 – **24**	0 – **10**
Urban background sites outwith the AQMA but within the inner city	7 – 27	13 – **19**	0 – 2
Roadside and kerbside sites outwith the inner city	6 – 28	11 – **21**	0 – 4
Background sites outwith the inner city	2 – 8	10 – 17	0 – 1
Objective	**40**	**18**	**7**

Note: All PM_{10} data are presented in gravimetric equivalent units. The 2010 objectives for PM_{10} are shown. Whether or not the objective will be exceeded has been calculated based on unrounded numbers. For example a concentration of 17.6 does not represent an exceedence of the annual mean PM_{10} objective, but a concentration of 18.4 does. Values in bold are above the objective.

55.3.12 Outwith the AQMA but within the inner city, the 30 predicted exceedences of the annual mean nitrogen dioxide objective in 2005 (paragraph 55.3.9) will reduce to four by 2011. These are all south of the AQMA and are shown in Figure 55.2b. The largest annual mean nitrogen dioxide concentration (43 $\mu g/m^3$) outwith the AQMA in 2011 is expected at a property on the junction of Victoria Road with Menzies Road.

55.3.13 Outwith the inner city, annual mean nitrogen dioxide concentrations in 2011 are expected to be well below the objective levels, with extremely low concentrations (less than 5 $\mu g/m^3$) predicted in rural areas.

55.3.14 No exceedences of 60 $\mu g/m^3$ are expected in 2011 at any of the receptors, even those within the AQMA, and thus exceedences of the 1-hour nitrogen dioxide objective are unlikely.

55.3.15 The discussion presented above provides an overview of baseline local air quality across the entire study area. It is, however, useful to focus on specific locations within this area so that the impacts of the scheme can be more easily and more precisely defined. The figures described above identify 40 selected receptors which have been chosen to represent the most significant impacts of the scheme. These receptors are labelled CR1-CR40 in Figures 55.1 and 55.2. The predicted annual mean nitrogen dioxide concentrations at each of these receptors in 2005 and in 2011 without the proposed scheme are set out in Table 55.8. Five of the six selected receptors within the AQMA show exceedences of the annual mean nitrogen dioxide objective in 2005 (Receptors CR1-CR4 and CR6). In keeping with the results described above, in 2011, only two of these exceedences remain (CR2 and CR6). Objective exceedences are expected at three of the 10 receptors outwith the AQMA but within the inner city in 2005 (CR9, CR12 and CR15). By 2011, concentrations at all three of these locations are expected to be below the objective. Concentrations at receptor CR11 are, however, expected to have increased above the objective level by 2011. The predicted increase at this receptor is associated with planned changes to the local road network, including opening Palmerston Place to join with the A956. Outwith the inner city, all predicted concentrations are below the objective in 2005 and well below the objective in 2011.

Table 55.8 – Predicted Annual Mean Nitrogen Dioxide Concentrations at 40 Receptors Without the Proposed Scheme µg/m^3

Location	2005	2011
Sites within the AQMA (all roadside or kerbside)		
Receptor CR1	**41**	32
Receptor CR2	**54**	**53**
Receptor CR3	**43**	27
Receptor CR4	**80**	40
Receptor CR5	34	27
Receptor CR6	**58**	**41**
Sites outwith the AQMA but within the inner city (all roadside or kerbside)		
Receptor CR7	32	24
Receptor CR8	33	24
Receptor CR9	**45**	34
Receptor CR10	31	22
Receptor CR11	39	**40**
Receptor CR12	**43**	26
Receptor CR13	25	21
Receptor CR14	36	26
Receptor CR15	**47**	36
Receptor CR16	40	29
Roadside and kerbside sites outwith the inner city		
Receptor CR17	16	12
Receptor CR18	16	12
Receptor CR19	12	9
Receptor CR20	12	9
Receptor CR21	24	18
Receptor CR22	12	9
Receptor CR23	16	11
Receptor CR24	18	14
Receptor CR25	12	9
Receptor CR26	10	8
Receptor CR27	31	24
Receptor CR28	35	28
Receptor CR29	25	18
Receptor CR30	22	16
Receptor CR31	19	16
Receptor CR32	22	16
Receptor CR33	15	11
Receptor CR34	18	13
Background sites outwith the inner city		
Receptor CR35	5	4
Receptor CR36	4	4
Receptor CR37	10	7
Receptor CR38	5	4
Receptor CR39	5	3
Receptor CR40	9	7
Objective	**40**	**40**

Note: Values in bold are above the objective.

PM$_{10}$

55.3.16 Aberdeen City Council and the UK Government have both measured PM$_{10}$ concentrations within Aberdeen. The position of each monitor is shown in Figure A14.2. The results are summarised in Table 55.5. Results from both sites show that existing concentrations are well below the 2004 objectives.

55.3.17 The modelled results presented in Figures 55.3a-c and summarised in Table 55.6 show that no exceedences of the 2004 PM$_{10}$ objectives are likely to have been experienced at any of the receptors in 2005. The spatial patterns of both annual mean and 24-hour PM$_{10}$ concentrations follow those previously described for nitrogen dioxide, with the largest concentrations in the AQMA, lower concentrations at roadside sites outside of the AQMA but within the inner city, and even lower concentrations outwith the city.

55.3.18 Concentrations of PM$_{10}$ in 2011 will be smaller than those in 2005, but with the more stringent objective in place, there will be a large number of objective exceedences. As shown in Figures 55.4a-c, exceedences are expected across much of the inner city and also close to the A96 and the B997 outwith the inner city. Table 55.7 confirms that even the less demanding 24-hour PM$_{10}$ objective is likely to be exceeded both within and outwith the AQMA.

55.3.19 Table 55.9 summarises the predicted PM$_{10}$ concentrations in 2005 and in 2011 without the proposed scheme at each of the 40 selected receptors. As has been discussed above, in 2005, no exceedences of the PM$_{10}$ objectives are expected. However, in 2011, because more stringent objectives will apply in Scotland, exceedences of the annual mean objective are expected at five of the selected receptors within the AQMA (CR1-CR3, CR5 and CR6), at nine of the receptors outwith the AQMA but within inner city (CR7-CR13, CR15 and CR16), and at two of the receptors outwith the city (CR27 and CR28). Exceedences of the 24-hour PM$_{10}$ objective are also expected at one of the selected receptors within the AQMA (CR2) and one within the inner city (CR15).

Table 55.9 – Predicted PM_{10} Concentrations at 40 Receptors Without the Proposed Scheme

Location	Annual Mean Concentration (µg/m^3)		No Days > 50 µg/m^3	
	2005	2011	2005	2011
Sites within the AQMA (all roadside or kerbside)				
Receptor CR1	23	**21**	7	5
Receptor CR2	26	**24**	15	**11**
Receptor CR3	22	**18**	7	1
Receptor CR4	30	18	29	1
Receptor CR5	20	**18**	3	2
Receptor CR6	25	**20**	12	3
Sites outwith the AQMA but within the inner city (all roadside or kerbside)				
Receptor CR7	21	**19**	5	3
Receptor CR8	20	**18**	3	2
Receptor CR9	24	**21**	10	5
Receptor CR10	21	**19**	4	2
Receptor CR11	21	**22**	5	6
Receptor CR12	21	**18**	5	1
Receptor CR13	18	**18**	2	2
Receptor CR14	19	17	2	1
Receptor CR15	26	**24**	14	**10**
Receptor CR16	21	**19**	5	2
Roadside and kerbside sites outwith the inner city				
Receptor CR17	12	12	0	0
Receptor CR18	17	16	1	0
Receptor CR19	12	11	0	0
Receptor CR20	13	12	0	0
Receptor CR21	16	15	0	0
Receptor CR22	14	13	0	0
Receptor CR23	15	14	0	0
Receptor CR24	17	16	1	0
Receptor CR25	13	13	0	0
Receptor CR26	12	12	0	0
Receptor CR27	19	**18**	2	1
Receptor CR28	21	**20**	4	3
Receptor CR29	18	17	1	1
Receptor CR30	17	16	1	0
Receptor CR31	15	15	0	0
Receptor CR32	14	14	0	0
Receptor CR33	14	14	0	0
Receptor CR34	14	13	0	0
Background sites outwith the inner city				
Receptor CR35	11	10	0	0
Receptor CR36	11	10	0	0
Receptor CR37	13	12	0	0
Receptor CR38	12	11	0	0
Receptor CR39	15	14	0	0
Receptor CR40	18	17	1	1
Objective	**40**	**18**	**35**	**7**

Note: Results are expressed as gravimetric equivalent. Whether or not the objective will be exceeded has been calculated based on unrounded numbers. For example a concentration of 17.6 does not represent an exceedence, but a concentration of 18.4 does.

Values in bold are above the objective.

Air Quality at Areas with Potentially Sensitive Vegetation

55.3.20 Table 55.10 lists each of the protected ecosystems within 200m of any of the roads included in this assessment that have not already been described in air quality Chapters 14, 29, or 44. For ease of interpretation, the different boundaries of the SSSI, SPA and Ramsar sites that include the Sands of Forvie and Ythan Estuary have been grouped together. As explained in Chapter 14 (Air Quality), Corby, Lily and Bishops Lochs SSSI has been subdivided into two sections in response to its geographical structure (i.e. it is physically subdivided). Only the western section is discussed here, since the eastern section was discussed in Chapter 14 (Air Quality). Table 55.10 also includes a site which does not require assessment under the DMRB Volume 11.3. This is Red Moss of Netherley SAC, which is more than 200m from any existing or proposed road. It has been included to assist with the assessment described in Chapter 40 (Ecology and Nature Conservation).

55.3.21 Table 55.10 also shows the range of predicted critical loads for each site. These have been defined following the advice in IAN 61/05 to the DMRB and references therein (e.g. the air pollution information system website (apis, 2006)) and following discussion with the specialists involved in preparing Chapters 10, 25 and 40 (Ecology and Nature Conservation chapters). Three of the sites (River Dee, Loch of Skene and Nigg Bay) have been scoped out of further assessment as they will not be sensitive to nitrogen deposition.

Table 55.10 – Site Specific Critical Loads for Nitrogen Deposition

Site	Designation	Critical Load (kg-N/ha/yr)
Corby, Lily and Bishops Lochs West	SSSI	10 – 25
River Dee	SAC	Not applicable
Sands of Forvie (including Ythan Estuary and Meikle Loch)	SSSI, SPA, Ramsar	10 – 20
Scotstown Moor	SSSI	10 – 20
Loch of Skene	SSSI, SPA, Ramsar	Not applicable
Nigg Bay	SSSI, SAC	Not applicable
Garron Point	SSSI	10 – 20
Red Moss of Netherley	SAC	5 – 10

Note: River Dee and Loch of Skene will not be sensitive to nitrogen deposition because the deposition of reactive oxides of nitrogen to bulk water will be so slow that any effects will be negligible (Marner and Harrison, 2004). Nigg Bay is designated as a geological SSSI and thus nitrogen deposition is unlikely to be a significant issue at this site.

55.3.22 Table 55.11 sets out the predicted baseline annual mean NOx concentrations at each site. Existing concentrations are likely to be well below the critical level of 30μg/m^3 as an annual mean NOx concentration at all sites except for Scotstown Moor, which is adjacent to an urban area. Even here, concentrations will be below the critical level. Concentrations are expected to fall between 2005 and 2011 for reasons explained previously.

Table 55.11 – Predicted NOx Concentrations Near to Potentially Sensitive Ecological Sites

Site	Distance from Road Centre (m)	Annual Mean NOx Concentration (µg/m^3)	
		2005	2011 Without Scheme
Corby, Lily and Bishops Lochs West	29	9	7
	50	8	6
	100	6	5
	200	5	4
Sands of Forvie (including Ythan Estuary and Meikle Loch)	22	5	4
	50	4	3
	100	3	3
	200	3	2
Scotstown Moor	4	23	16
	50	17	13
	100	16	12
	200	15	12
Garron Point	130	7	5
	150	7	5
	200	7	5
Red Moss of Netherley	Northern edge of site	5	4
	Western edge of site	4	4
	Eastern edge of site	4	4
	Southern edge of site	5	4
Critical Level		**30**	**30**

Note: for each site, the shortest distance represents the roadside edge of that site. Subsequent distances are defined according to a 50m transect from the centre of the road. A different approach has been taken with Red Moss of Netherley since a different model has been used to calculate concentrations and the site is roughly equidistant from several roads.

55.3.23 Predicted baseline nitrogen deposition rates at each site are shown in Table 55.12, together with the site-specific critical loads (critical levels refer to concentrations, critical loads refer to deposition fluxes). Critical loads are usually given as ranges defined in relation to the different habitats within the SSSI. Existing rates of nitrogen deposition are expected to be within the range of critical loads (i.e. exceeding the value at the bottom of the range, but below that at the top of the range) at all sites except Red Moss of Netherley SAC, at which they will exceed the upper bound of the critical load range in the existing baseline. Rates of deposition are expected to reduce between 2005 and 2011 but only at Sands of Forvie will this be sufficient to bring the baseline levels below the critical loads.

Table 55.12 – Nitrogen Deposition Fluxes Near to Potentially Sensitive Ecological Sites

Site	Distance from Road Centre (m)	Nitrogen Deposition (kg-N/ha/yr)		
		2005	2011 Without Scheme	Site-Specific Critical Load
Corby, Lily and Bishops Lochs West	29	12	11	10 – 25
	50	12	11	
	100	12	11	
	200	12	11	
Sands of Forvie (including Ythan Estuary and Meikle Loch)	22	10	9	10 – 20
	50	10	9	
	100	10	8	
	200	10	8	
Scotstown Moor	4	13	11	10 – 20
	50	13	11	
	100	13	11	
	200	13	11	
Garron Point	130	12	10	10 – 20
	150	12	10	
	200	11	10	
Red Moss of Netherley	Northern edge of site	14	13	5 – 10
	Western edge of site	14	13	
	Eastern edge of site	14	13	
	Southern edge of site	15	13	

Note: for each site, the shortest distance represents the roadside edge of that site. Subsequent distances are defined according to a 50m transect from the centre of the road.

Wider-Scale Air Quality

55.3.24 Table 55.13 sets out the predicted baseline emissions of carbon monoxide, total hydrocarbons, nitrogen oxides and PM_{10} from all of the roads included in the traffic model and that are within 10 km of the proposed scheme.

55.3.25 Emissions of all four pollutants are expected to fall between 2005 and 2011. This is despite the fact that the number of vehicle-kilometres travelled is expected to increase over the same period. The reason for the reduction relates to a range of technological improvements which will reduce emissions per vehicle. The influence of improving technology can be anticipated with some confidence as policy measures that require the implementation of this technology are already in place.

55.3.26 Over the period between 2011 and 2027, emissions of oxides of nitrogen and PM_{10} are expected to continue to fall, while emissions of carbon monoxide and total hydrocarbons will increase. Over the same period, the number of vehicles on roads is expected to increase. The reductions in emissions of oxides of nitrogen and PM_{10} relate, as above, to expected improvements in technology. For emissions of the other two pollutants, technological improvements are unlikely to offset the growth in traffic and very small increases are expected by 2027.

Table 55.13 – Total Emissions of Regional Pollutants from the Modelled Road Network within 10km of the proposed scheme. All values are in tonnes per year

	Carbon Monoxide	Total Hydrocarbons	Nitrogen Oxides	PM_{10}
2005	1,942	266	1,436	50
2011 Without Scheme	1,590	212	1,025	32
2027 Without Scheme	1,622	215	792	26

Greenhouse Gases

55.3.27 Table 55.14 sets out the predicted baseline emissions of carbon dioxide from all of the roads included in the traffic model that are within 10km of the proposed scheme. These have been calculated following the approach described in DMRB Advice Note 207/07.

Table 55.14 – Total Emissions of Carbon Dioxide from the Entire Modelled Road Network within 10km of the Proposed Scheme

Year	Kilotonnes of Carbon Dioxide (as Carbon) per year
2005	104
2011 Without Scheme	109
2027 Without Scheme	110

Note: UNECE, UKCCP (2006) SCCP (2006) and Highways Agency (2007) report carbon dioxide emissions in units of carbon. A tonne of carbon is equal to 3.7 tonnes of carbon dioxide (the full mass of the gas molecule is made up of the carbon atom and the two oxygen atoms).

55.3.28 The increase in the number of road vehicles between 2005 and 2027 is expected to more than offset the improvements in emissions of carbon dioxide per vehicle over the same period. Carbon dioxide emissions are thus expected to increase between 2005 and 2011 and to continue to increase between 2011 and 2027. The same trend is expected from transport emissions across Scotland and across the whole of the UK. The anticipated reductions in total carbon dioxide emissions from all sources during the same period reflect the expectation that reductions from other sectors will more than offset the increase from road transport.

55.4 Potential Impacts

Local Air Quality

Nitrogen Dioxide

55.4.1 Figures 55.5a-c show the predicted annual mean nitrogen dioxide concentrations in 2011 with the proposed scheme in place at each of the modelled receptors, while Figures 55.6a-c show the changes attributable to the proposed scheme, defined according to the descriptive criteria set out in Table 55.3. A summary of the predicted concentrations for the separate site categories is provided in Table 55.15, with the predicted impacts in these categories summarised in Table 55.16. Results for the 40 selected receptors are set out in Table 55.17, with baseline results repeated for ease of comparison. The locations of these 40 selected receptors are shown on the Figures.

55.4.2 There would be fewer exceedences of the annual mean nitrogen dioxide objective within Aberdeen City Council's AQMA with the proposed scheme (illustrated by comparison of Figure 55.5a with Figure 55.2a); with six of the 56 AQMA-receptors exceeding without the proposed scheme and five exceedences with the scheme in place. Furthermore, Table 55.15 shows that even at those locations where objective exceedences persist, the scale of exceedence would be smaller than in the baseline case. This pattern is illustrated by Receptors CR6 and CR2 in Table 55.17. CR6 is expected to exceed the objective in the baseline but to achieve it with the proposed scheme. CR2 would exceed the objective with or without the proposed scheme, but the proposed scheme would, nevertheless, bring about a Substantial beneficial impact. Table 55.17 shows that even where no objective exceedences are expected within the AQMA in the baseline case (e.g. Receptors CR1 and CR4), the scheme would bring about Slight improvements in air quality. Figure 55.6a and Table 55.16 both show that across all 56 of the modelled receptors within the AQMA, the changes brought by the proposed scheme range from Negligible beneficial to Substantial beneficial. There are no locations within the AQMA at which an adverse air quality impact is expected as a result of the proposed scheme.

55.4.3 Outwith the AQMA but within the inner city, there would be fewer exceedences of the annual mean nitrogen dioxide objective with the proposed scheme (illustrated by comparison of Figure 55.5b with Figure 55.2b); with four of the 272 receptors exceeding the objective in 2011 without the proposed scheme, this halving to two with the scheme. One of the locations brought below the objective by the proposed scheme would be adjacent to College Street, immediately south of the AQMA. The other is Receptor CR11, which is adjacent to Palmerston Place. Exceedences of the annual mean objective outside of the AQMA would persist in 2011 even with the proposed scheme, but the magnitude of exceedence would be reduced (Table 55.15). Of the 272 receptors within the inner city but outwith the AQMA, two would experience Negligible adverse impacts, while 270 would experience beneficial impacts, ranging from Negligible to Substantial. The adverse impacts would be associated with increased traffic flows on the A96 immediately northwest of King Street (CR14 in Table 55.17) and on Balgownie Road immediately south of the Parkway. The beneficial impacts (e.g. CR7-CR13, CR15 and CR16) would be associated with an overall reduction in traffic and congestion on the majority of main roads. Tables 55.15 and 55.16 show beneficial impacts at urban background sites, which emphasises that the air quality benefits of the proposed scheme would be widespread, and not just confined to roadside locations.

55.4.4 Outwith the inner city, no exceedences of the annual mean nitrogen dioxide objective are expected in 2011 with the proposed scheme (Figure 55.5c and Table 55.15). The impacts of the proposed scheme range from Moderate adverse to Moderate beneficial (Figure 55.6c and Table 55.16). The most significant adverse impacts are within the immediate proximity of the proposed scheme (e.g. CR25, CR31, and CR35-CR39 in Table 55.17). These have been discussed in detail in Chapters 14, 29 and 44 (Air Quality chapters). Adverse impacts are also expected along a number of other roads, as shown in Figure 55.6c, where traffic emissions would increase as a result of the proposed scheme (e.g. CR34 and CR40). Conversely, Figure 55.6c shows that beneficial impacts are expected along roads that would be relieved by the proposed scheme, (e.g. CR17-CR24, CR26-CR30, CR32 and CR33).

Table 55.15 – Summary of Modelled Nitrogen Dioxide and PM_{10} Concentrations at the 1059 Receptors Used in this Assessment in 2011 With and Without the Proposed Scheme in Place

Site Description	Range of Predicted Annual Mean Nitrogen Dioxide Concentration (µg/m^3)		Range of Predicted Annual Mean PM_{10} Concentration (µg/m^3)		Range of Predicted Number of Exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} Concentration	
	Without Scheme	**With Scheme**	**Without Scheme**	**With Scheme**	**Without Scheme**	**With Scheme**
Sites within the AQMA (all roadside or kerbside)	22 – **53**	22 – **49**	16 – **24**	16 – **23**	0 – **11**	0 – **8**
Roadside or kerbside sites outwith the AQMA but within the inner city	11 – **43**	9 – **42**	14 – **24**	13 – **23**	0 – **10**	0 – 7
Urban background sites outwith the AQMA but within the inner city	7 – 27	7 – 26	13 – **19**	13 – **19**	0 – 2	0 – 2
Roadside and kerbside sites outwith the inner city	6 – 28	3 – 26	11 – **21**	10 – **20**	0 – 4	0 – 3
Sites that are currently background outwith the inner city, including those that would be near to the proposed scheme	2 – 8	2 – 12	10 – 17	10 – 17	0 – 1	0 – 1
Objective	**40**		**18**		**7**	

Note: All PM_{10} data are presented in gravimetric equivalent units. The 2010 objectives for PM_{10} are shown. Whether or not the objective would be exceeded has been calculated based on unrounded numbers. For example a concentration of 17.6 *does not represent an exceedence of the annual mean PM_{10} objective, but a concentration of 18.4 does. Values in bold are above the objective.*

Table 55.16 – Summary of Predicted Impacts for Nitrogen Dioxide and PM_{10} at the 1059 Receptors Used in this Assessment in 2011

Site Description	Range of Predicted Annual Mean Nitrogen Dioxide Impacts	Range of Predicted Annual Mean PM_{10} Impacts	Range of Predicted Number of Exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} Concentration
Sites within the AQMA (all roadside or kerbside)	Negligible beneficial to Substantial beneficial	Negligible beneficial to Moderate beneficial	No Change to Moderate beneficial
Roadside or kerbside sites outwith the AQMA but within the inner city	Negligible adverse to Substantial beneficial	Slight adverse to Substantial beneficial	No Change to Moderate beneficial
Urban background sites outwith the AQMA but within the inner city	Negligible adverse to Slight beneficial	Negligible beneficial to Moderate beneficial	No Change to Negligible beneficial
Roadside and kerbside sites outwith the inner city	Moderate adverse to Moderate beneficial	Moderate adverse to Substantial beneficial	No Change to Negligible beneficial
Sites that are currently background outwith the inner city, including those that would be near to the proposed scheme	Moderate adverse to Moderate beneficial	Moderate adverse to Slight beneficial	Negligible adverse to No Change

Table 55.17 – Predicted Annual Mean Nitrogen Dioxide Concentrations at 40 Receptors With and Without the Proposed Scheme µg/m^3

Receptor	2005	2011 Without Scheme	2011 With Scheme	Impact Magnitude	Impact Significance
Sites within the AQMA (all roadside or kerbside)					
CR1	**41**	32	29	small decrease	Slight beneficial
CR2	**54**	**53**	**48**	small decrease	Substantial beneficial
CR3	**43**	27	26	very small decrease	Negligible beneficial
CR4	**80**	40	39	very small decrease	Slight beneficial
CR5	34	27	25	small decrease	Slight beneficial
CR6	**58**	**41**	39	small decrease	Substantial beneficial
Sites outwith the AQMA but within the inner city (all roadside or kerbside)					
CR7	32	24	21	medium decrease	Slight beneficial
CR8	33	24	23	small decrease	Slight beneficial
CR9	**45**	34	27	large decrease	Moderate beneficial
CR10	31	22	20	medium decrease	Slight beneficial
CR11	39	**40**	38	small decrease	Substantial beneficial
CR12	**43**	26	23	small decrease	Slight beneficial
CR13	25	21	20	small decrease	Slight beneficial
CR14	36	26	27	very small increase	Negligible adverse
CR15	**47**	36	31	medium decrease	Moderate beneficial
CR16	40	29	24	large decrease	Slight beneficial
Roadside and kerbside sites outwith the inner city					
CR17	16	12	10	large decrease	Slight beneficial
CR18	29	22	18	large decrease	Slight beneficial
CR19	12	9	5	very large decrease	Moderate beneficial
CR20	12	9	4	very large decrease	Moderate beneficial
CR21	24	18	15	medium decrease	Slight beneficial

CR22	12	9	7	large decrease	Slight beneficial
CR23	16	11	10	medium decrease	Slight beneficial
CR24	18	14	12	small decrease	Slight beneficial
CR25	12	9	13	very large increase	Moderate adverse
CR26	11	8	6	very large decrease	Moderate beneficial
CR27	31	24	21	medium decrease	Slight beneficial
CR28	35	28	24	medium decrease	Slight beneficial
CR29	25	18	16	small decrease	Slight beneficial
CR30	22	16	15	small decrease	Slight beneficial
CR31	19	16	20	very large increase	Moderate adverse
CR32	22	16	13	large decrease	Slight beneficial
CR33	15	11	4	very large decrease	Moderate beneficial
CR34	18	13	15	large increase	Slight adverse
Sites outwith the inner city that are currently classed as background, including those that would be near to the proposed scheme (and thus would no longer be classed as background With Scheme)					
CR35	5	4	7	very large increase	Moderate adverse
CR36	4	4	5	very large increase	Moderate adverse
CR37	10	7	12	very large increase	Moderate adverse
CR38	5	4	10	very large increase	Moderate adverse
CR39	5	3	8	very large increase	Moderate adverse
CR40	9	7	8	large increase	Slight adverse
Objective	**40**	**40**	**40**	**-**	**-**

Note: Values in bold are above the objective.

Impact magnitude descriptors and objective exceedences are calculated from unrounded numbers. For example, the predicted concentration at Receptor CR40 in 2011 with no scheme is 6.6 μg/m^3, while the predicted concentration in 2011 with the proposed scheme is 7.9 μg/m^3. Rounded numbers (i.e. 7 μg/m^3 and 8 μg/m^3) are presented in the table to make it simpler to read. However, if the change were calculated using the rounded numbers that are presented in the Table, a change of 1 μg/m3, or 14% would be derived. A 14% change would be described as "medium" according to the criteria set out in Table 55.2. However, when the change is calculated using unrounded numbers, the calculated change is 1.3 μg/m^3, or 20%. This change is thus assigned a "large increase" according to the criteria set out in Table 55.2.

PM_{10}

55.4.5 Figures 55.7a-c show the predicted annual mean PM_{10} concentrations in 2011 with the proposed scheme in place at each of the modelled receptors. Figures 55.8 a-c show the changes in annual mean PM_{10} concentrations attributable to the proposed scheme: defined according to the descriptive criteria set out in Table 55.3. A summary of the predicted concentrations for the separate site categories is provided in Table 55.15, with the predicted impacts in these categories summarised in Table 55.16. Results for the 40 selected receptors are set out in Table 55.18, with baseline results repeated for ease of comparison. The locations of these 40 selected receptors are shown on Figures 55.7 and 55.8.

55.4.6 There would be fewer exceedences of the annual mean PM_{10} objective within Aberdeen City Council's AQMA with the proposed scheme than without it (illustrated by comparison of Figure 55.4a with Figure 55.7a); with 41 of the 56 AQMA-receptors exceeding without the proposed scheme and only 38 exceedences with the scheme in place. Furthermore, Table 55.15 shows that even at those locations where objective exceedences would persist, the scale of exceedence would be smaller than in the baseline case. This pattern is illustrated by Receptors CR2 and CR3 in Table 55.18. CR3 is expected to experience an exceedence of the objective in the baseline case, but no exceedence with the proposed scheme. CR2 is expected to experience an objective exceedence with or without the proposed scheme, but the proposed scheme would still improve air quality. None of the predicted changes in concentration within the AQMA are large (e.g. CR1 to CR6) and often appear unchanged after rounding (e.g. CR4). However, Figure 55.8a and Table 55.16 both show that across all 56 of the modelled receptors within the AQMA, the changes brought by the proposed scheme would be beneficial. There are no locations within the AQMA at which an adverse air quality impact is expected.

55.4.7 Outwith the AQMA but within the inner city, there would be fewer exceedences of the annual mean PM_{10} objective with the proposed scheme than without it (illustrated by comparison ofFigure 55.7b with Figure 55.4b), with 133 of the 272 receptors in this area exceeding the objective in 2011 without the proposed scheme and only 105 predicted exceedences with the scheme in place. The locations that would be brought below the objective are widespread; being adjacent to many different roads across the city (e.g. CR8, CR12, CR13 and CR16). It is clear (from Figure 55.7b and from Tables 55.15 and 55.18) that objective exceedences would persist in 2011, but the magnitude of the exceedence would be lessened by the proposed scheme (e.g. CR7, CR9, CR10, CR11 and CR15). Figure 55.8b shows that of the 272 receptors within the inner city but outwith the AQMA, two would experience adverse impacts (while 270 would show benefits). The adverse impacts, ranging from Negligible to Slight, are both expected at receptors adjacent to the A96: one immediately northwest of King Street (CR14) and one near to the River Don. Figure 55.8b also shows that elsewhere within the inner city, including numerous receptors adjacent to the A96, beneficial impacts are expected. These are expected to range from Negligible to Substantial, with most of the Substantial benefits near to North Anderson Drive (e.g. CR9 and CR10), but Substantial benefits also expected beside the A90 south of Bridge of Dee (e.g. CR7), Auchmill Road (CR15) and the A956 at Ellon Road (e.g. CR16). Table 55.16 shows that beneficial impacts would also occur at urban background sites, which emphasises that the air quality benefits of the proposed scheme would be widespread, and not just confined to roadside locations.

55.4.8 Outwith the inner city, there would be fewer exceedences of the annual mean PM_{10} objective with the proposed scheme than without it (illustrated by comparison of Figure 55.7c with Figure 55.4c), with five of the 731 receptors in this area exceeding without the proposed scheme and only three exceedences with the scheme in place. The difference is caused by improvements along the A96 at Auchmill Road (e.g. CR27). Even at those locations where exceedences persist, the proposed scheme would improve conditions (e.g. CR28). There are no locations where the proposed scheme would cause an exceedence. Figure 55.8c shows that the proposed scheme would bring about changes ranging from Moderate adverse to Substantial beneficial outwith the inner city. As with nitrogen dioxide (paragraph 55.4.4), most of the adverse impacts are expected in the immediate proximity of the proposed scheme (e.g. CR25, CR31 and CR35-CR39). These have been discussed in detail in air quality Chapters 14, 29 and 44 respectively. Adverse impacts are also expected along a number of other roads as shown in Figure 55.8c, where traffic emissions would increase as a result of the proposed scheme (e.g. CR34 and CR40). Conversely, beneficial impacts are expected along those roads that would be relieved by the proposed scheme (e.g. CR17-CR24, CR26-CR30, CR32 and CR33).

55.4.9 The spatial pattern of 24-hour PM_{10} impacts follows that described for annual mean PM_{10} impacts (in the modelling, one statistic is calculated directly from the other – see Appendix 14). Without the proposed scheme, four of the 1059 receptors are expected to exceed the 24-hour objective (two within the AQMA (e.g. CR2) and two outwith the AQMA but within the inner city (e.g. CR15). With the proposed scheme only one of the 1059 receptors would exceed the 24-hour objective. This is receptor CR2 and, as is shown in Table 55.19, the proposed scheme would reduce the number of exceedence days at this location.

Table 55.18 – Predicted Annual Mean PM_{10} Concentrations at 40 Receptors With and Without the Proposed Scheme $\mu g/m^3$

Receptor	2005	2011 Without Scheme	2011 With Scheme	Impact Magnitude	Impact Significance
Sites within the AQMA (all roadside or kerbside)					
CR1	23	**21**	**21**	very small decrease	Slight beneficial
CR2	26	**24**	**23**	very small decrease	Slight beneficial
CR3	22	**18**	18	very small decrease	Moderate beneficial
CR4	30	18	18	very small decrease	Slight beneficial
CR5	20	**18**	18	very small decrease	Moderate beneficial
CR6	25	**20**	**20**	very small decrease	Slight beneficial
Sites outwith the AQMA but within the inner city (all roadside or kerbside)					
CR7	21	**19**	**18**	small decrease	Substantial beneficial
CR8	20	**18**	18	very small decrease	Moderate beneficial
CR9	24	**21**	**20**	small decrease	Substantial beneficial
CR10	21	**19**	**18**	small decrease	Substantial beneficial
CR11	21	**22**	**21**	very small decrease	Slight beneficial
CR12	21	**18**	18	very small decrease	Moderate beneficial
CR13	18	**18**	18	very small decrease	Moderate beneficial
CR14	19	17	17	extremely small increase	Negligible adverse
CR15	26	**24**	**23**	small decrease	Substantial beneficial
CR16	21	**19**	17	small decrease	Substantial beneficial
Roadside and kerbside sites outwith the inner city					
CR17	12	12	11	small decrease	Slight beneficial
CR18	17	16	15	small decrease	Slight beneficial
CR19	12	12	11	small decrease	Slight beneficial
CR20	13	12	11	small decrease	Slight beneficial
CR21	16	15	15	very small decrease	Slight beneficial
CR22	14	13	12	small decrease	Slight beneficial
CR23	15	14	13	very small decrease	Slight beneficial
CR24	17	16	16	very small decrease	Slight beneficial
CR25	13	13	14	medium increase	Moderate adverse
CR26	12	12	11	small decrease	Slight beneficial
CR27	19	**18**	17	very small decrease	Moderate beneficial
CR28	21	**20**	**19**	small decrease	Substantial beneficial
CR29	18	17	16	very small decrease	Slight beneficial
CR30	17	16	16	very small decrease	Slight beneficial
CR31	15	15	16	small increase	Slight adverse
CR32	14	14	13	very small decrease	Slight beneficial
CR33	14	14	12	medium decrease	Moderate beneficial
CR34	14	13	14	very small increase	Slight adverse
Sites outwith the inner city that are currently classed as background, including those that would be near to the proposed scheme (and thus would no longer be classed as background With Scheme)					
CR35	11	10	11	small increase	Slight adverse
CR36	11	10	11	small increase	Slight adverse
CR37	13	12	14	medium increase	Moderate adverse
CR38	12	11	12	medium increase	Slight adverse
CR39	15	14	15	small increase	Slight adverse
CR40	18	17	17	very small increase	Slight adverse

Receptor	2005	2011 Without Scheme	2011 With Scheme	Impact Magnitude	Impact Significance
Objective	**40**	**18**	**18**	**-**	**-**

Note: All PM_{10} data are presented in gravimetric equivalent units. Values in bold are above the objective. Whether or not the objective would be exceeded has been calculated based on unrounded numbers. For example a concentration of 17.6 does not represent an exceedence, but a concentration of 18.4 does. Impact magnitude descriptors are also based on unrounded numbers. For example, the predicted concentration at Receptor CR40 in 2011 with no scheme is 17.1 μg/m^3, while the predicted concentration in 2011 with the proposed scheme is 17.3 μg/m^3. Both numbers round to 17 μg/m^3, even though the model predicts a 1.2% increase in annual mean concentration. In such cases, the relative impact of the scheme (i.e. whether air quality will deteriorate) can be predicted with some confidence, but if the change was calculated after rounding, this detail would be lost. Thus, in the case of Receptor CR40, the receptor is assigned a "very small increase" based on the criteria set out in Table 55.2.

Table 55.19 – Predicted Number of Exceedences of 50 μg/m^3 as a 24-hour PM_{10} Concentration at 40 Receptors With and Without the Proposed Scheme (days)

Receptor	2005	2011 Without Scheme	2011 With Scheme	Impact Magnitude	Impact Significance
Sites within the AQMA (all roadside or kerbside)					
CR1	7	5	4	very small decrease	Slight beneficial
CR2	15	**11**	**8**	very small decrease	Slight beneficial
CR3	7	1	1	no change	No Change
CR4	29	1	1	no change	No Change
CR5	3	2	1	extremely small decrease	Negligible beneficial
CR6	12	3	3	no change	No Change
Sites outwith the AQMA but within the inner city (all roadside or kerbside)					
CR7	5	3	1	very small decrease	Negligible beneficial
CR8	3	2	1	extremely small decrease	Negligible beneficial
CR9	10	5	3	very small decrease	Negligible beneficial
CR10	4	2	2	no change	No Change
CR11	5	6	5	very small decrease	Slight beneficial
CR12	5	1	1	no change	No Change
CR13	2	2	1	extremely small decrease	Negligible beneficial
CR14	2	1	1	no change	No Change
CR15	14	**10**	7	very small decrease	Slight beneficial
CR16	5	2	1	very small decrease	Negligible beneficial
Roadside and kerbside sites outwith the inner city					
CR17	0	0	0	no change	No Change
CR18	1	0	0	no change	No Change
CR19	0	0	0	no change	No Change
CR20	0	0	0	no change	No Change
CR21	0	0	0	no change	No Change
CR22	0	0	0	no change	No Change
CR23	0	0	0	no change	No Change
CR24	1	0	0	no change	No Change
CR25	0	0	0	no change	No Change
CR26	0	0	0	no change	No Change
CR27	2	1	1	no change	No Change
CR28	4	3	2	very small decrease	Negligible beneficial
CR29	1	1	0	extremely small decrease	Negligible beneficial
CR30	1	0	0	no change	No Change
CR31	0	0	0	no change	No Change
CR32	0	0	0	no change	No Change

Receptor	2005	2011 Without Scheme	2011 With Scheme	Impact Magnitude	Impact Significance
CR33	0	0	0	no change	No Change
CR34	0	0	0	no change	No Change
Sites outwith the inner city that are currently classed as background, including those that would be near to the proposed scheme (and thus would no longer be classed as background With Scheme)					
CR35	0	0	0	no change	No Change
CR36	0	0	0	no change	No Change
CR37	0	0	0	no change	No Change
CR38	0	0	0	no change	No Change
CR39	0	0	0	no change	No Change
CR40	1	1	1	no change	No Change
Objective	**35**	**7**	**7**	**-**	**-**

Note: Values in bold are above the objective.
Impact magnitude descriptors are based on unrounded numbers

Overall Local Air Quality Impacts

55.4.10 In order to produce a more general picture of overall changes in local air quality, the method recommended in the local air quality section of the Scottish Transport Appraisal Guidance (STAG) has been used (see paragraphs 55.2.30 to 55.2.33). The results are presented in Table 55.20 (the link-specific calculations are given in Appendix A55.1). The first row of Table 55.20 gives the overall STAG assessment scores, which are negative for both nitrogen dioxide and PM_{10}, showing the net positive benefit that the proposed scheme would have on local air quality. The table also shows the total number of properties included in the assessment. This allows the average change in concentrations at all properties within the study area to be calculated. This average change is a reduction of 0.2 $\mu g/m^3$ in annual mean nitrogen dioxide concentrations and a reduction of 0.1 $\mu g/m^3$ in annual mean PM_{10} concentrations across the 97,636 properties.

55.4.11 The STAG methodology also requires each property to be attributed a positive or negative score, depending on whether it is likely to experience a deterioration (positive) or improvement (negative) in air quality as a result of the proposed scheme. This information is also set out in Table 55.20. The results show that while 19 thousand properties would experience deteriorated air quality as a result of the proposed scheme, 76 thousand properties would experience improved air quality. This calculation includes all predicted changes, however small they might be. For this reason, the table also sets out the number of properties for which concentrations of nitrogen dioxide or PM_{10} are expected to change by 0.5 $\mu g/m^3$ or more. After applying this screening, the pattern shows an even stronger net benefit, with up to 25 times more properties experiencing an improvement than deterioration. The STAG assessment only takes account of the influence of roads within 200m of each property, however, because the proposed scheme is likely to reduce background levels across the city, these results are likely, on balance, to under-estimate the benefits of the proposed scheme and to over-estimate the negative effects.

Table 55.20 – Results of STAG Assessment

	Nitrogen Dioxide	PM_{10}
Overall STAG Assessment Score	-21,048	-5,883
Number of Properties included in the STAG Assessment	97,636	97,636
Average Change in Concentration	0.2 μg/m^3 reduction	0.1 μg/m^3 reduction
Number of Properties to Experience Improved Air Quality	75,814	76,084
Number of Properties to Experience Deteriorated Air Quality	19,280	19,010
Number of Properties to Experience No Predicted Change	2,542	2,542
Number of Properties to Experience an Improvement of at least 0.5µg/m^3	6,973	380
Number of Properties to Experience an Deterioration of at least 0.5µg/m^3	284	47

Note: The count includes all residential properties (including farms) and educational establishments within 200m of any road that is included in the traffic model and that is within 10km of the proposed scheme. The count does not include commercial/industrial premises or churches. The overall STAG score includes double-counts (i.e. if a property is within 200m of two roads, it is included twice); the number of properties as reported in the table removes these double counts (so each property is only counted once) based on the road to which it is closest. The calculation of the average change in concentrations is not required by STAG, but assists understanding of what the STAG score represents. It is calculated simply as the STAG score divided by the total number of properties (without double-counts) included in the assessment.

The number of properties with a change of at least 0.5 µg/m^3 has been calculated for each distance band separately – so that properties in the 0-50m distance band are more likely to be counted than properties in the 150-200m distance band.

Air Quality Impacts on Vegetation

55.4.12 Table 55.21 sets out the predicted change in ambient NOx concentrations at each site. Baseline levels are repeated for ease of comparison. The proposed scheme is likely to increase NOx concentrations at some locations and to reduce them at others, but most of the changes are too small to show up once values are rounded for presentation. Concentrations would remain well below the critical level at all sites.

55.4.13 Table 55.22 sets out the predicted rates of nitrogen deposition to each site. Baseline levels are, again, repeated for ease of comparison. At all sites except for Red Moss of Netherley, the predicted changes are less than 1% of the lower bound critical load. At Red Moss of Netherley, the proposed scheme would increase rates of nitrogen deposition by up to 2% of the lower bound critical load. However, it should be noted that rates of nitrogen deposition to this site in 2011 with the proposed scheme in place would be smaller than those that are currently experienced. This is due to a range of national and international measures that have already been set in place to reduce emissions of the relevant pollutants. The specialists involved in preparing Chapters 10, 25 and 40 (Ecology and Nature Conservation chapters) have advised that these predicted impacts are not significant.

Table 55.21 – Predicted NOx Concentrations Near to Potentially Sensitive Ecological Sites

Site	Distance from Road Centre	Annual Mean NOx Concentration (µg/m^3)			> 2 µg/m^3 change close to critical levels
		2005	2011 Without Scheme	2011 With Scheme	
Corby, Lily and Bishops Lochs West	29	9	7	7	No
	50	8	6	6	No
	100	6	5	5	No
	200	5	4	4	No
Sands of Forvie (including Ythan Estuary and Meikle	22	5	4	4	No
	50	4	3	3	No
	100	3	3	3	No

Site	Distance from Road Centre	Annual Mean NOx Concentration ($\mu g/m^3$)			> 2 $\mu g/m^3$ change close to critical levels
		2005	2011 Without Scheme	2011 With Scheme	
Loch)	200	3	2	2	No
Scotstown Moor	4	23	16	17	No
	50	17	13	13	No
	100	16	12	12	No
	200	15	12	12	No
Garron Point	130	7	5	5	No
	150	7	5	5	No
	200	7	5	5	No
Red Moss of Netherley	Northern edge of site	5	3	3	No
	Western edge of site	4	3	3	No
	Eastern edge of site	4	3	3	No
	Southern edge of site	5	3	3	No
Critical Level		**30**	**30**	**30**	**-**

Note: the 2ug/m^3 criterion is prescribed in IAN 61/05

Table 55.22 – Nitrogen Deposition Fluxes Near to Potentially Sensitive Ecological Sites

Site	Distance from Road Centre	Nitrogen Deposition (kg-N/ha/yr)				Change as % of Critical Load
		2005	2010 Without Scheme	2010 With Scheme	Site-Specific Critical Load	
Corby, Lily and Bishops Lochs West	29	12	11	11	10-25	< 1 %
	50	12	11	11		< 1 %
	100	12	11	11		< 1 %
	200	12	11	11		< 1 %
Sands of Forvie (including Ythan Estuary and Meikle Loch)	22	10	9	9	10-20	< 1 %
	50	10	9	9		< 1 %
	100	10	8	8		< 1 %
	200	10	8	8		< 1 %
Scotstown Moor	4	13	11	11	10-20	< 1 %
	50	13	11	11		< 1 %
	100	13	11	11		< 1 %
	200	13	11	11		< 1 %
Garron Point	130	12	10	10	10-20	< 1 %
	150	12	10	10		< 1 %
	200	11	10	10		< 1 %
Red Moss of Netherley	Northern edge of site	14	13	13	5-10	< 1 %
	Western edge of site	14	13	13		< 1 – 1%
	Eastern edge of site	14	13	13		1 – 2 %
	Southern edge of site	15	13	13		<1 %

Wider-Scale Impacts

55.4.14 Table 55.23 sets out the total emissions of carbon monoxide, total hydrocarbons, NOx and PM_{10} from all of the roads in the traffic model within 10km of the proposed scheme. Baseline values are repeated for ease of comparison.

55.4.15 In its opening year, the proposed scheme is likely to cause an extremely small increase in emissions from the modelled road network of hydrocarbons, a very small increase in emissions of carbon monoxide a small increase in emissions of NOx, and a medium increase in emissions of PM_{10}. In 2027, the proposed scheme is expected to give rise to an extremely small increase in emissions of hydrocarbons, a very small increase in emissions of carbon monoxide, a medium increase in emissions of NOx, and a large increase in emissions of PM_{10}.

Table 55.23 – Total Emissions from the Entire Modelled Road Network within 10km of the Proposed Scheme. All values are in tonnes per year.

Year	Scenario	Carbon Monoxide	Total Hydrocarbons	Nitrogen Oxides	PM_{10}
2005	Baseline	1,942	266	1,436	50
2011	Without Scheme	1,590	212	1,025	32
	With Scheme	1,607	212	1,103	36
	Absolute Change	17	0	78	4
	Percentage Change	1	<1	8	12
2027	Without Scheme	1,622	215	792	26
	With Scheme	1,651	217	880	31
	Absolute Change	30	2	88	5
	Percentage Change	2	<1	11	17

55.4.16 Describing these changes in percentage terms has limitations as the percentage change is very sensitive to the size of the study area (a smaller study area would give a larger percentage change and vice versa). It is thus useful to compare the scheme-related impacts with more robust baseline estimates. Pertinent data taken from the National Atmospheric Emissions Inventory (Defra and the DAs, 2007c) are set out in Table 55.24. At the time that this report was prepared, comparison data were only available for 2003 and 2004 and thus direct comparisons should be treated with caution. However, a comparison between the numbers in Tables 55.23 and 55.24 (which are all expressed in the same units), shows that none of the absolute increases in emissions with the proposed scheme, in either 2011 or 2027, would amount to more than 2.2% of the total emissions from road vehicles in Aberdeen and Aberdeenshire during 2004. Thus, in a local context the relative change would be very small. In a national context, the change would be Negligible.

Table 55.24 – Reference Emissions Data for 2004. All values are in tonnes per year.

	Carbon Monoxide	Total Hydro-carbons	Nitrogen Oxides	PM_{10}
2004 Total UK emissions (UNECE)	2,930,000	1,024,000	1,621,000	154,000
2003 Total UK emissions (IPCC)	2,757,000	1,087,000	1,569,000	-
2003 UK Transport emissions (IPCC)	1,402,000	164,000	709,000	-
2004 Emissions from Aberdeen and Aberdeenshire	23,040	10,220	12,479	1,802
2004 Emissions from road transport in Aberdeen and Aberdeenshire	9,964	982	4,024	244

Note: All data taken from Defra and the DAs (2007c) The most recent year available for UNECE data is 2004; the most recent year for IPPC data is 2003. Both datasets are likely to be revised by Defra in the future.

Statistics on a United Nations Economic Commission for Europe (UNECE) basis are used to report progress against international targets for sulphur dioxide, nitrogen oxides, ammonia and volatile organic compounds. UNECE excludes land use change and also shipping in UK ports, but includes aviation emissions below 1000 metres to cover take-off and landing cycles.

IPCC emission formats are reported to the United Nations Framework on Climate Change. IPCC includes land use and all emissions from domestic aviation and shipping, but excludes international marine and aviation bunker fuels.

Aberdeenshire data taken from Defra and the DAs (2006c)

Greenhouse Gases

55.4.17 Total emissions of carbon dioxide from all roads included in the traffic model within 10km of the proposed scheme are shown in Table 55.25. Baseline values are repeated for ease of comparison.

55.4.18 The proposed scheme is expected to give rise to a small (7% - 9%) increase in emissions. Describing these changes in percentage terms has limitations as the percentage change is very sensitive to the size of the study area (a smaller study area would give a larger percentage change and vice versa). It is thus useful to compare the scheme-related impacts with more robust baseline estimates. Table 55.26 sets out a range of different estimates of total carbon dioxide emissions from different areas and sectors. A comparison between the scheme-related changes and the emissions shown in Table 55.26 shows that, for example, the proposed scheme is likely to cause a 0.02% increase in the UK's total transport emissions in 2010 (i.e. comparing the 2011 scheme opening year directly with projected emissions for 2010).

55.4.19 The UK Climate Change Programme (2006) predicts that total carbon dioxide emissions are falling nationally and are expected to continue to fall, even though emissions from the transport sector have been rising and are expected to continue to rise. In its Climate Change Programme (UKCCP, 2006), the UK Government acknowledges that reductions in emissions from other sectors will have to offset the increases in carbon dioxide emissions from road traffic. Table 55.27 summarises the reductions in total greenhouse gas emissions that have already been achieved in Scotland. The table also sets out some anticipated reductions associated with policy measures that are in place to provide reductions by 2010. It should be reiterated that Table 55.27 describes total greenhouse gases, while Tables 55.25 and 55.26 describe just carbon dioxide. SCCP (2006) shows that in 1990 carbon dioxide made up 82% of total greenhouse gases. In 2003, this fraction had risen to 84% (SCCP, 2006). Thus, within the context of this assessment, comparing carbon dioxide emissions associated with total greenhouse gas savings listed in SCCP (2006) is not unreasonable. All of the reductions in total greenhouse gases shown in Table 55.27 are several orders of magnitude greater than the increase in carbon dioxide that would be associated with the proposed scheme. For example, the increase in carbon dioxide emissions in 2027 due to the proposed scheme would amount to less than 0.3% of the expected greenhouse gas savings in Scotland associated with policies contained in UKCCP (2006) and SCCP (2006) that have been introduced since the UKCCP and SCCP were first published in 2000. The proposed scheme is thus not inconsistent with the approach set out in SCCP (2006), which shows how reductions in emissions from non-transport sectors can offset the increases associated with road vehicles.

Table 55.25 – Total Emissions of Carbon Dioxide from the Entire Modelled Road Network within 10km of the Proposed Scheme.

Year		Kilotonnes of Carbon Dioxide (as Carbon) per year
2005	Baseline	104
2011	Without Proposed Scheme	109
	With Proposed Scheme	117
	Absolute Change	8
	Percentage Change	7%
2027	Without Proposed Scheme	110
	With Proposed Scheme	120
	Absolute Change	10
	Percentage Change	9%

Note: UNECE, UKCCP (2006) SCCP (2006) and Highways Agency (2007) report carbon dioxide emissions in units of carbon. A tonne of carbon is equal to 3.7 tonnes of carbon dioxide (the full mass of the gas molecule is made up of the carbon atom and the two oxygen atoms).

Table 55.26 – Reference Data on Carbon Dioxide Emissions.

Description of Emission Estimate	Kilotonnes of Carbon Dioxide (as Carbon) per year
2004 Total UK emissions (UNECE) (Defra and the DAs 2007c)	153,643
2003 Total UK emissions (IPCC) (Defra and the DAs 2007c)	156,053
2003 UK Transport emissions (IPCC) (Defra and the DAs 2007c)	34,357
2002 Scotland total emissions (IPCC) (Defra and the DAs 2007c)	16,600
2010 Total UK emissions (UKCCP, 2006)	144,000
2020 Total UK emissions (UKCCP, 2006)	147,000
2010 UK transport emissions (UKCCP, 2006)	37,000
2020 UK transport emissions (UKCCP, 2006)	38,800
2004 Emissions from Aberdeen and Aberdeenshire (Defra and the DAs 2007c)	1954
2004 Emissions from road transport in Aberdeen and Aberdeenshire (Defra and the DAs 2007c)	218

Note: UNECE, UKCCP (2006) SCCP (2006) and Highways Agency (2007) report carbon dioxide emissions in units of carbon. A tonne of carbon is equal to 3.7 tonnes of carbon dioxide (the full mass of the gas molecule is made up of the carbon atom and the two oxygen atoms). The years presented are the most recent year available from Defra and the DAs (2007c).

Statistics on a United Nations Economic Commission for Europe (UNECE) basis are used to report progress against international targets for sulphur dioxide, nitrogen oxides, ammonia and volatile organic compounds. UNECE excludes land use change and also shipping in UK ports, but includes aviation emissions below 1000 metres to cover take-off and landing cycles.

IPCC emission formats are reported to the United Nations Framework on Climate Change. IPCC includes land use and all emissions from domestic aviation and shipping, but excludes international marine and aviation bunker fuels.

UKCCP data include total emissions from reported sources minus removals by reported sinks.

Table 55.27 – Estimates of Greenhouse Gas Savings Published in Scotland's Climate Change Programme (2006). Data presented as carbon equivalents.

Description of Emission-Reduction Estimate		Kilotonnes of Carbon per year
Reductions Already Achieved	Reductions in Scotland's total Carbon Dioxide Emissions between 1990 and 2003	1300
	Increase in Scotland's carbon dioxide removals (i.e. emissions removed from the atmosphere by forests and soils) between 1990 and 2003	400
Expected reductions from measures in the UKCCP (2006) and the SCCP (2006)	Total savings in 2010 from reserved policy measures in the UKCCP	13800
	Scottish share of savings in 2010 from reserved policy measures in the UKCCP	1100
	Total savings in 2010 from devolved policy measures in the UKCCP	20700
	Scottish share of savings in 2010 from devolved policy measures in the UKCCP	1700
	Total savings in 2010 from devolved policy measures in the SCCP	2600
	Sum of savings in Scotland associated with devolved and reserved policies introduced since the UKCCP and SCCP were first published in 2000 (SCCP, 2006)	3700

Note: Data taken from SCCP (2006) (data from the UKCCP are those reported in SCCP, 2006). It is important to note that these data include all greenhouse gases expressed in units of carbon. On average, carbon dioxide is likely to make up more than 80% of these totals. Devolved policies are those where the Executive has policy levers. Reserved policies are those where the Executive does not have policy levers.

55.5 Mitigation

55.5.1 This assessment has not identified any requirement to mitigate either local air quality impacts or the impacts of air quality on vegetation other than those measures that are already built into the scheme design, such as ensuring the proposed scheme and realigned side roads are as far from sensitive locations as practicable. Similarly, the assessment has not identified any requirement to mitigate wider-scale impacts, including those associated with greenhouse gas emissions. There would, however, be a considerable amount of planting associated with the proposed scheme, which would provide some carbon dioxide removal.

55.6 Residual Impacts

55.6.1 As the impacts set out above are not considered to require any specific mitigation, the residual impacts will be the same as those presented in section 55.4. These impacts are summarised below.

Local Air Quality

55.6.2 The predicted impacts of the proposed scheme on local air quality range from Moderate adverse to Substantial beneficial. The majority of beneficial impacts are expected within the densely-populated areas of the city and within Aberdeen City Council's AQMA, while the adverse impacts would mostly occur close to the proposed scheme, where fewer people would be exposed. The scheme would not cause any of the air quality objectives or EU limit values to be exceeded. It would, however, reduce the number of exceedences of the air quality objectives and EU limit values. More than 75,000 properties are likely to experience improved air quality as a result of the proposed scheme, compared with fewer than 20,000 properties that would experience a deterioration in air quality.

Air Quality Impacts on Vegetation

55.6.3 No changes in annual mean NOx concentrations of more than 2 $\mu g/m^3$ are expected in locations where concentrations are close to the critical levels. Any change in the rates of nitrogen deposition would be less than 1% of the critical load at most locations. At Red Moss of Netherley SAC, nitrogen deposition rates are likely to increase by up to 2% of the critical load. This critical load would be exceeded with or without the proposed scheme in place. However, the increase caused by the proposed scheme would be less than the reductions that are expected to take place between 2005 and 2011. Thus, when the scheme is operational, rates of nitrogen deposition would be lower than those currently experienced. The specialists involved in preparing Chapters 10, 25 and 40 (Ecology and Nature Conservation chapters) have advised that these predicted impacts are not significant.

Wider-Scale Impacts

55.6.4 The proposed scheme is expected to bring about an extremely small increase in emissions of hydrocarbons (< 1%), a small increase in emissions of carbon monoxide (2%), a medium increase in emissions for oxides of nitrogen (11%), and a large increase in emissions of PM_{10} (17%) in 2027. In the context of total emissions from road vehicles in Aberdeen and Aberdeenshire, these changes would be very small, while in a national context, the changes would be Negligible. Even with these increases, emissions with the proposed scheme would remain below current (2005) values.

Greenhouse Gases

55.6.5 The proposed scheme is expected to bring about a small (9%) increase in emissions of carbon dioxide in 2027. However, the increase would amount to less than 0.3% of the expected greenhouse gas savings in Scotland associated with policies contained in UKCCP (2006) and SCCP (2006) that have been introduced since the UKCCP and SCCP were first published in 2000 (SCCP, 2006). The increase in carbon dioxide emissions would not, therefore, run counter to the assumptions made in Scotland's Climate Change Programme (2006), which shows how reductions in emissions from non-transport sectors can offset the increases associated with road-vehicles.

55.7 References

Aberdeen City Council. 2003a. Updating and Screening Assessment of Air Quality in Aberdeen.

Aberdeen City Council. 2003b. 4th Stage Air Quality Review and Assessment.

Aberdeen City Council. 2005. Aberdeen Air Quality Action Plan. Results of ADMS-Roads Modelling (2002 and 2010).

Aberdeenshire Council. 2005. Local Air Quality Management Progress Report.

Air Quality Expert Group. 2006. Trends in Primary Nitrogen Dioxide in the UK. Draft report for comment. August 2006.

Apis 2006. Air Pollution Information System. www.apis.ac.uk. Accessed September 2006.

Defra and the DAs. 2001. National Expert Group on Transboundary Air Pollution (NEGTAP): Acidification, Eutrophication and Ground-Level Ozone in the UK.

Defra and the DAs. 2003a. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum. February 2003.

Defra and the DAs. 2003b. Review & Assessment: Technical Guidance LAQM.TG(03).

Defra and the DAs. 2006a. Air Quality Archive. www.airquality.co.uk Accessed May to September 2006.

Defra and the DAs. 2006b. Air Quality Review and Assessment Helpdesk. www.uwe.ac.uk/aqm/review/index.html. Accessed May to September 2006.

Defra and the DAs. 2006c. The National Atmospheric Emissions Inventory. www.naei.org.uk Accessed May to September 2006.

Defra and the DAs, 2007a, 2007b, and 2007c – as 2006a, 2006b, and 2006c, accessed April to May 2007

DETR. 2000. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, January 2000.

Highways Agency, 2003. Design Manual for Roads and Bridges (DMRB) Vol. 11, Section 3, Part 1 Air Quality, and the air quality screening model issued to accompany this document.

Highways Agency, 2004. Interim Advice Note 54/04. Revision to "GOMMMS" Local Air Quality Assessment Procedure in DMRB 11.3.1.

Highways Agency, 2005. Interim Advice Note 61/05. Guidance for Undertaking Environmental Assessment of Air Quality for Sensitive Ecosystems in Internationally Designated Nature Conservation Sites and SSSIs (Supplement to DMRB 11.3.1).

Highways Agency, 2007. Advice Note HA207/07. Design Manual for Roads and Bridges (DMRB) Vol. 11, Section 3, Part 1 Air Quality.

Laxen, D. and Marner, B. 2003. Analysis of the Relationship Between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites. Available from Defra, 2006a and Defra 2006b.

Laxen, D. and Marner, B. 2004. Was 2003 an Exceptional Pollution Year? UK Trends in Nitrogen Dioxide, Nitrogen Oxides and PM_{10} Concentrations. Available from Defra and the DAs 2006b.

Laxen, D., Marner, B. and Donovan, S. 2007. Deriving NO_2 from NOx for Air Quality Assessments of Roads – Updated to 2006. Available from Defra and the DAs 2007a and 2007b.

Marner, B. and Harrison, R.M. 2004. A spatially refined monitoring based study of atmospheric nitrogen deposition. Atmospheric Environment 38. 5045-5056.

Mouchel 2002. Aberdeen Western Peripheral Route (Western Leg), Stage 2 Addendum Environmental Assessment. Mouchel Consulting Ltd.

Mouchel 2003. Aberdeen Western Peripheral Route (Northern Leg), Stage 2 Environmental Assessment. Mouchel Consulting Ltd.

NRA, 2006. National Roads Authority. Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes. Available at www.nra.ie. Accessed May 2007.

NSCA, 2006. National Society for Clean Air and Environmental Protection. Development Control: Planning for Air Quality.Scottish Executive. 2006a. Scottish Transport Appraisal Guidance (STAG) 2006. http://www.scot-tag.org.uk. Accessed early 2006.

Scottish Executive. 2006b. Scotland's National Transport Strategy – a Consultation. Astron, Edinburgh, April 2006. Available on the Scottish Executive website: www.scotland.gov.uk. Accessed September 2006.

Scottish Executive. 2006c. Changing Our Ways – Scotland's Climate Change Programme.

Stationery Office. 2000. Air Quality (Scotland) Regulations, 2000 (Scottish Statutory Instrument 2000 No. 97)

Stationery Office, 2002. The Air Quality (Scotland) Amendment Regulations 2002 (Scottish Statutory Instrument 2002 No. 297).

Stationery Office, 2006. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. A consultation document.

Stedman, J., Bush, T., Vincent, K., Kent, A., Grice, S. and Abbott, J. 2005a. UK air quality modelling for annual reporting 2003 on abmbien air quality assessment under Council Directives 96/62/EC, 1999/30/EC and 2000/69/EC. AEAT/ENV/R/1790 Issue 1 January 2005.

Stedman, J., Bush, T., Grice, S., Kent, A., Vincent, K., Abbott, J. and Derwent, D. 2005b. UK air quality modelling for annual reporting 2004 on ambient air quality assessment under Council Directives 96/62/EC, 1999/30/EC and 2000/69/EC. AEAT/ENV/R/2052 Issue 1 November 2005.

The Environment Act 1995. Available at:
http://www.hmso.gov.uk/acts/acts1995/Ukpga_19950025_en_1.htm. Accessed September 2006.