14 Air Quality

This chapter describes the local air quality impacts within 500m of the Northern Leg. Within this area, the impacts of the proposed scheme are expected to range from Moderate adverse to Moderate beneficial. Most of the adverse impacts would be caused by emissions from vehicles using the new road. The beneficial impacts would be due to reduced traffic on existing roads and to realignments of existing roads. Most locations within 500m of the Northern Leg would experience adverse impacts, but air quality will remain good with or without the proposed scheme.

This assessment has not identified any requirement to mitigate the air quality impacts, other than those measures that are already built into the scheme design.

14.1 Introduction

14.1.1 Air pollutants emitted from road vehicles can worsen local air quality, which may lead to health effects or damage to particularly sensitive vegetation. A new road scheme will alter driving patterns and thus change the numbers of vehicles on particular roads, as well as potentially reducing congestion and changing driving speeds, and as such can influence local air quality not only close to the new road, but also across a much wider road network. 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.

14.1.2 Nationally there are two local air pollutants of greatest concern in terms of road traffic; nitrogen dioxide and fine particles (normally measured as PM_{10} - particulate matter less than 10 micrometres diameter). 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 AWPR DMRB Stage 2 Assessment (Mouchel Consulting, 2002, 2003) have confirmed that these are the only two road traffic pollutants of potential concern 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.

14.1.3 Existing (2005) concentrations of these pollutants close to the proposed scheme are described. Concentrations are also predicted for the year 2011 both with and without the proposed scheme. For the purposes of this air quality assessment, 2011 has been assumed to be the opening year for the scheme, even though opening is actually expected to be 2012. Due to national and international measures that have been established to reduce emissions from road transport and many other sectors, current projections assume that concentrations of both nitrogen dioxide and PM_{10} will fall in the future. Thus, assessing 2011 is a worst-case approach.

14.2 Approach and Methods

Study Area

14.2.1 This chapter describes the local air quality impacts that are expected within 500m of the Northern Leg during its operation. This 'Northern Leg corridor' is shown in Figures 14.1a-d. As is explained in Appendix A14.1, this is only a small part of the overall study area for the air quality assessment, which extends 10km from the proposed scheme. Local air quality impacts outwith the route corridor, as well as total emissions and greenhouse gas emissions, are all addressed in Chapter 55 (Air Quality Cumulative Impact Assessment). Air quality impacts within 500m of the Southern Leg and Fastlink are addressed in Chapters 29 and 44 respectively. Air quality impacts during the construction phase are addressed in Chapter 18 (Disruption due to Construction).

14.2.2 The recommended approach to Stage 1 and 2 DMRB assessments is to assess air quality within 200m of all roads with significantly affected traffic flows (not just within 200m of the proposed scheme itself). This requirement does not apply to a Stage 3 assessment, and in this case a detailed dispersion model has been used that encompasses a wider study area that extends 10km from the proposed scheme. Results from the model are presented separately for the Northern Leg, Southern Leg and Fastlink corridors, so as to highlight the impacts that the proposed scheme will have on residents living close to the proposed route. To retain consistency with other sections of this ES, these corridors extend 500m to either side of the scheme. Impacts across the whole study area are presented in Chapter 55 (Air Quality Cumulative Impact Assessment).

Policy Context

14.2.3 The air quality 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; and
- The Air Quality (Scotland) Amendment Regulations 2002.

14.2.4 In 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 assessment reported in this chapter was carried out prior to May 2007 and thus references the previous publication. However, it is considered that if this assessment were to be carried out following the May 2007 guidance, the conclusions would be unaltered. Reference has also been made to Interim Advice Note 61/05 (Highways Agency, 2005), which has been issued as a supplement to DMRB Volume 11.3 (IAN 61/05 is now incorporated within Advice Note 207/07 (Highways Agency, 2007)). The implications of the above documents in terms of this air quality assessment are outlined below.

<u>Local Air Quality</u>

14.2.5 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, and 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 14.1. 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 in this assessment if the annual mean concentration is likely to be above this level.

14.2.6 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 14.1, provides the most stringent approach.

Table 14.1 – 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

14.2.7 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.

14.2.8 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 review of the Northern Leg corridor also included a search for any sensitive non-residential receptors such as schools.

Air Quality Impacts on Vegetation

14.2.9 There is evidence that elevated concentrations of NOx can damage particularly sensitive vegetation, and 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'*.

14.2.10 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 20km 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.

Assessment Criteria

14.2.11 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.

14.2.12 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).

Sensitivity

14.2.13 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 because in terms of ecosystem effects, the UK statutory nature conservation agencies treat all relevant SSSIs and other officially designated as sensitive.

Impact Magnitude

14.2.14 The definition of impact magnitude is solely related to the degree of change in pollutant concentrations. The impact magnitude criteria are provided in Table 14.2.

Table 14.2 - 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

14.2.15 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 14.3 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 14.3 - 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

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

14.2.17 Information on the existing levels of nitrogen dioxide within the overall air quality study area (as defined in paragraph 14.2.1) 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. Three of these monitoring sites were within Northern Leg corridor; the locations of which are shown in Figure 14.1a-d. 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.

14.2.18 The results of the passive diffusion tube monitoring have been supplemented with results of measurements made by Aberdeen City Council and Aberdeenshire Council, as part of on-going monitoring programmes. All of these measurements were made outwith the Northern Leg corridor. As explained in Appendix A14.1, the monitoring data provided by the Councils were the most recent available at the time this assessment was undertaken.

14.2.19 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 described in Chapter 4 (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.

14.2.20 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 overall 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.

14.2.21 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.

14.2.22 All of the roads within the MVA traffic model and within 10km of the proposed scheme have been entered into every run of the dispersion model. Thus, emissions outwith the Northern Leg corridor are taken into account when predicting concentrations. MVA advised that some of the baseline traffic flows on roads in Aberdeenshire may have been under predicted, but this will not have occurred within the Northern Leg corridor and is not significant.

14.2.23 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. The measurements provided by Aberdeenshire Council have not been used to verify the model because of the potential for under prediction of baseline flows in Aberdeenshire, as discussed above in paragraph 14.2.22.

14.2.24 In order to describe the most significant impacts of the proposed scheme within the Northern Leg corridor, 133 sensitive receptors were chosen. This selection was based on professional judgement and, as shown in Figures 14.1a-d, they represent the full range of scheme-related impacts. Receptors are positioned on the roadside façade of each property. Since air quality has been assessed at such a large number of receptors, numerical results are only presented for a selection of 19 receptors, which are labelled as NR1 to NR19 in Figures 14.1a-d. The labelled receptors were chosen to aid description of the results. They include the locations with the 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 because the 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.

14.2.25 The model requires information on background conditions within the study area. Since almost all road traffic in the region has been modelled explicitly (i.e. emissions from each road have been calculated individually), 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.

Air Quality Impacts on Vegetation

14.2.26 In accordance with Interim Advice Note (IAN) 61/05 to DMRB (Highways Agency, 2005), an assessment of potential impacts on vegetation was carried out. Any officially designated sites (i.e. SACs, SPAs, cSPAs, Ramsar sites or SSSIs) were identified; the only relevant site is Corby, Lily and Bishops Lochs SSSI. It should be noted that this site is split into two sections, one of which (the eastern section) is within 200m of the proposed scheme, while the other (the western section) is close to one of the roads addressed in Chapter 55 (Air Quality Cumulative Impact Assessment). Only the eastern section is included here.

14.2.27 There is no requirement in the DMRB to assess impacts of air quality on farming activities. Furthermore, there is no reason for air quality impacts to contravene the organic status of any farmland (See Chapter 7: Land Use). It is, however, recognised that land-owners might be concerned about the potential for traffic-related air pollution to affect farmland. Since there is no set methodology for assessing the potential for such impacts, the pragmatic approach has been taken of treating any organic and biodynamic farmland within the Northern Leg corridor as if it were a SSSI, SAC, SPA or Ramsar site. This additional assessment is presented in Appendix A14.1.

14.2.28 NOx and nitrogen dioxide concentrations for the base year (2005) and the year of opening, both with and without the proposed scheme, were calculated using unadjusted background concentration maps (Defra and the DAs 2006a) and using the DMRB Screening Model which is recommended in IAN 61/05. For the purposes of the IAN 61/05 method, the DMRB model is sufficiently robust and it is not necessary to use the AAQuIRE model. The DMRB model results have been treated following the latest guidance from Defra and the DAs regarding the relationship between NOx and NO_2 (Laxen et al., 2007). 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 nitrogen dioxide 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).

Limitations to Assessment

14.2.29 All values presented here are the best possible estimates, but uncertainties in the results might cause over-predictions or under-predictions. All of the measurements presented in this chapter and Appendix A14.1 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. There will be additional uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example: it has been assumed that during each year, the vehicle fleet 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 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 Appendix A14.1 (Figures A14.7 and A14.9 and Tables A14.1.4 and A14.5.1). 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.

14.2.30 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.

14.2.31 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.

14.2.32 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 will be treated as such in the discussion.

14.3 Baseline Conditions

Local Air Quality

14.3.1 Aberdeen City Council and Aberdeenshire Council have both carried out reviews and assessments of air quality over a number of years. They have not, to date, identified any likely exceedences of the air quality objectives within the Northern Leg corridor and thus no AQMAs have been declared within the Northern Leg corridor.

Nitrogen Dioxide

14.3.2 Table 14.4 sets out the measured nitrogen dioxide concentrations at each of the three diffusion tube monitoring sites labelled in Figures 14.1a-d as DT1, DT 2 and DT6. Diffusion Tube 1 was positioned near to a minor road north of Dyce Airport, and the concentrations measured were very low, reflecting the rural setting. Diffusion Tube 2 was located near to the A96 at Chapel of Stoneywood. Levels recorded here were also very low, but clearly influenced by emissions from the A96. Diffusion Tube 6 was positioned next to the A90 at Blackdog, and levels recorded were more than double those measured at Diffusion Tube 1, although still well below the objective level.

Table 14.4 – Summary of Measured Annual Mean Nitrogen Dioxide Concentrations within the Northern Leg Corridor (June 2005 to June 2006) (µg/m^3)

Location	2005
Diffusion Tube 1	10
Diffusion Tube 2	16
Diffusion Tube 6	26
Objective	**40**

Note: Data are adjusted for bias as described in Appendix A14.1.

14.3.3 Figures 14.1a-d also show the annual mean nitrogen dioxide concentrations predicted by the model for each of the 133 sensitive receptors within 500m of the Northern Leg in 2005; which is taken to represent the current baseline situation. The results for selected receptors are set out in Table 14.5. At most receptors within the Northern Leg corridor, existing annual mean nitrogen dioxide concentrations are expected to be less than 10 µg/m^3. In some locations, particularly close to roads, concentrations are between 10 µg/m^3 and 20 µg/m^3. The only receptor at which existing concentrations are expected to be greater than 20 µg/m^3 (half the level of the objective) is adjacent to the A90 (Receptor NR18). Thus, all of the predicted concentrations are well below the objective.

14.3.4 Figures 14.2a-d show the predicted annual mean nitrogen dioxide concentrations at all of the receptors in 2011 without the proposed scheme. The results for the 19 selected receptors are set out in Table 14.5. As noted in paragraph 14.1.3, ambient concentrations of nitrogen dioxide are expected to fall between 2005 and 2011 because of reduced emissions from road transport and other sectors, and as a result even fewer of the predicted concentrations are greater than 10 µg/m^3 in 2011 without the proposed scheme than is the case for 2005. None of the predicted concentrations are greater than 20 µg/m^3 (half of the objective level) in 2011 without the proposed scheme, even close to busy roads. Concentrations greater than 10 µg/m^3 are predicted even well away from busy roads in an area near to Chapel of Stoneywood. These concentrations reflect locally-increased background concentrations, probably as a result of the proximity to Dyce airport.

Table 14.5 – Summary of Predicted Annual Mean Nitrogen Dioxide Concentrations within the Northern Leg Corridor without the Proposed Scheme (µg/m^3)

Location	2005	2011
Receptor NR1	8	6
Receptor NR2	9	7
Receptor NR3	5	3
Receptor NR4	12	10
Receptor NR5	19	16
Receptor NR6	18	15
Receptor NR7	12	7
Receptor NR8	8	6
Receptor NR9	5	4
Receptor NR10	7	5
Receptor NR11	5	3
Receptor NR12	17	11
Receptor NR13	6	4
Receptor NR14	9	6

Location	2005	2011
Receptor NR15	9	6
Receptor NR16	5	3
Receptor NR17	4	3
Receptor NR18	23	17
Receptor NR19	16	11
Objective	**40**	**40**

Particulate Matter PM_{10}

14.3.5 The annual mean is the more stringent of the two PM_{10} averaging periods in terms of road traffic emissions. The PM_{10} Figures therefore present only the annual mean data and not the 24-hour data, as this represents the worst-case scenario or precautionary approach in terms of objective exceedences. The 24-hour data are discussed in the text and presented in the Tables, and it should be noted that the spatial patterns of both data sets will be similar, because the 24-hour data are calculated directly from the annual mean.

14.3.6 Figures 14.3a-d show the predicted annual mean PM_{10} concentrations at all 133 sensitive receptors within the Northern Leg corridor in 2005. The results for the 19 selected receptors are set out in Table 14.6, together with the predicted number of exceedences 50 µg/m^3 as a 24-hour PM_{10} concentration.

14.3.7 Predicted existing annual mean PM_{10} concentrations range from 10 µg/m^3 to 20 µg/m^3. Thus, all of the predicted concentrations are well below the level of the 2004 objective. The spatial distribution of this range of concentrations, as shown in Figures 14.3a-d, is influenced by local roads, but also appears to reflect the influence of other sources included in the predicted background concentrations. A clear example of this is the band of marginally elevated concentrations which extends both northeast and southwest from Dyce airport. The only predicted concentrations that are greater than 18 µg/m^3 in the existing situation are adjacent to the B997 and the B977 northeast of the airport.

14.3.8 Figures 14.4a-d show the predicted annual mean PM_{10} concentrations at all of the receptors in 2011 without the proposed scheme. The results for the 19 selected receptors are set out in Table 14.6. As noted in paragraph 14.1.3, concentrations of PM_{10} are expected to fall nationally between 2005 and 2011 because of reduced emissions from road transport and other sectors. However, where large local increases in traffic flows or other emissions are predicted, these reductions are cancelled out and so in some locations, concentrations are not expected to fall appreciably between 2005 and 2011.

14.3.9 The main differences between annual mean PM_{10} concentrations in 2005 (Figures 14.3a-d) and 2011 (Figures 14.4a-d) are that thirteen of the 133 receptors move from the 13 to 18 µg/m^3 range in 2005 into the 8 to 13 µg/m^3 range in 2011, while five receptors move from the 18 to 23 µg/m^3 range in 2005 to the 13 to 18 µg/m^3 range in 2011. The more stringent annual mean PM_{10} objectives that will be in place by 2011 will not be exceeded within the Northern Leg corridor. Predicted concentrations for 2011, at roughly half of the receptors (63 of the 133 receptors shown in Figures 14.4a-d, and eight of the 19 receptors short listed in Table 14.6), are considered to be close to the objective level (i.e. are more than 75% of the annual mean objective level).

14.3.10 No exceedences of 50 µg/m^3 as a 24-hour PM_{10} concentration are predicted at most of the receptors within the Northern Leg corridor in either 2005 or 2011. The maximum predicted number of 24-hour exceedences is at Receptor NR12, where in 2005, only three exceedences are expected; this falling to one exceedence by 2011. This is well below the objective level of no more than seven exceedences.

Table 14.6 – Summary of Predicted PM_{10} Concentrations within the Northern Leg Corridor without the Proposed Scheme

Location	Annual Mean Concentration (µg/m³)		No Days > 50 µg/m³	
	2005	2011	2005	2011
Receptor NR1	12	12	0	0
Receptor NR2	12	12	0	0
Receptor NR3	11	10	0	0
Receptor NR4	14	13	0	0
Receptor NR5	15	15	0	0
Receptor NR6	15	15	0	0
Receptor NR7	13	12	0	0
Receptor NR8	13	12	0	0
Receptor NR9	12	11	0	0
Receptor NR10	14	13	0	0
Receptor NR11	15	14	0	0
Receptor NR12	20	18	3	1
Receptor NR13	17	16	1	0
Receptor NR14	17	17	1	1
Receptor NR15	16	15	0	0
Receptor NR16	15	14	0	0
Receptor NR17	10	10	0	0
Receptor NR18	14	13	0	0
Receptor NR19	12	12	0	0
Objective	**40**	**18**	**35**	**7**

Note: All results gravimetric equivalent

Air Quality in Areas with Potentially Sensitive Vegetation

14.3.11 There are no SPAs, SACs or Ramsar sites within 500m of the Northern Leg. Corby, Lily and Bishops Lochs SSSI does, however, lie within the Northern Leg corridor. This SSSI is made up of two separate areas, which are approximately 400m apart. The edge of the eastern area is approximately 190m from the centreline of the proposed scheme, and the predicted baseline NOx concentrations in this area are set out in Table 14.7. Existing concentrations are likely to be well below the critical level. Concentrations are expected to fall between 2005 and 2011 for reasons explained previously. The western part of this SSSI is predominantly outwith the Northern Leg corridor and is thus assessed in Chapter 55 (Air Quality Cumulative Impact Assessment).

Table 14.7 – Predicted NOx Concentrations Near to Potentially Sensitive Ecological Sites

Site	Distance from Road Centre (m)	Annual Mean NOx Concentration (µg/m³)	
		2005	2011 Without Scheme
Corby, Lily and Bishops Lochs (Eastern Section)	190	5	4
	200	5	4
Critical Level		**30**	**30**

14.3.12 Table 14.8 sets out the predicted baseline rates of nitrogen deposition to the SSSI. Also shown are the site-specific critical loads. Critical loads are usually given as ranges and this range has been 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 the upper value). Rates of deposition are expected to reduce between 2005 and 2011 but the predicted 2011 baseline levels remain just above the lower range of critical loads for these habitats.

Table 14.8 – 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 (Eastern Section)	190	12	11	10 - 25
	200	12	11	

14.4 Potential Impacts

Local Air Quality

Nitrogen Dioxide

14.4.1 Table 14.9 provides the annual mean concentrations for 2011 without and with the proposed scheme for the 19 selected receptors, with the 2005 baseline results repeated for ease of comparison. Also shown is the impact magnitude and significance for these 19 receptors; defined according to the criteria set out in Section 14.2 (Approach and Methods). Figures 14.5a-d show the predicted annual mean nitrogen dioxide concentration in 2011 at each of the 133 sensitive receptors in the Northern Leg corridor with the proposed scheme. Figures 14.6a-d illustrate the expected change in annual mean nitrogen dioxide concentrations at each receptor attributable to the proposed scheme.

Table 14.9 – Predicted Annual Mean Nitrogen Dioxide Concentrations at Selected Receptors within the Northern Leg Corridor (μg/m^3)

Receptor	2005	2011		Impact Magnitude	Impact Significance
		No Scheme	With Proposed Scheme		
NR1	8	6	9	very large increase	Moderate adverse
NR2	9	7	6	medium decrease	Slight beneficial
NR3	5	3	9	very large increase	Moderate adverse
NR4	12	10	15	very large increase	Moderate adverse
NR5	19	16	20	very large increase	Moderate adverse
NR6	18	15	15	very small decrease	Negligible beneficial
NR7	12	7	11	very large increase	Moderate adverse
NR8	8	6	9	very large increase	Moderate adverse
NR9	5	4	10	very large increase	Moderate adverse
NR10	7	5	9	very large increase	Moderate adverse
NR11	5	3	6	very large increase	Moderate adverse
NR12	17	11	9	large decrease	Slight beneficial
NR13	6	4	8	very large increase	Moderate adverse

Receptor	2005	2011		Impact Magnitude	Impact Significance
		No Scheme	With Proposed Scheme		
NR14	9	6	6	small increase	Slight adverse
NR15	9	6	4	very large decrease	Moderate beneficial
NR16	5	3	8	very large increase	Moderate adverse
NR17	4	3	5	very large increase	Moderate adverse
NR18	23	17	14	large decrease	Slight beneficial
NR19	16	11	13	medium increase	Slight adverse
Objective	**40**	**40**	**40**	**-**	**-**

Note: Impact magnitude descriptors based on unrounded numbers, for example, the predicted concentration at Receptor NR14 in 2011 with no scheme is 5.88 µg/m^3, while the predicted concentration in 2011 with the proposed scheme is 6.35 µg/m^3. Both numbers round to 6 µg/m^3, even though the model predicts an 8% 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 NR14, since the prediction is of an 8% increase in concentrations, the receptor is assigned a "small increase" based on the criteria set out in Table 14.2.

14.4.2 Figures 14.5a-d show that with the proposed scheme, most of the predicted annual mean nitrogen dioxide concentrations within the Northern Leg corridor would remain below 10 µg/m^3 in 2011, even very close to the Northern Leg. Annual mean nitrogen dioxide concentrations between 10 µg/m^3 and 20 µg/m^3 are predicted at some receptors close to the A90, around Craibstone and Chapel of Stoneywood, and at the far southern end of the Northern Leg corridor. Figures 14.5a-d show that only one receptor would experience an annual mean nitrogen dioxide concentration greater than 20 µg/m^3 (i.e. half of the objective level) in 2011 with the proposed scheme. This is Receptor NR5, which is very close to the A96 at Chapel of Stoneywood at approximately ch317400. Generally, annual mean nitrogen dioxide concentrations are expected to be very low, even close to the proposed scheme. This is highlighted by the examples of Receptors NR9 and NR16. Receptor NR9 would be approximately 20m from the edge of the northbound carriageway, while Receptor NR16 would be approximately 40m from the edge of the southbound carriageway. The results in Table 14.9 show that these receptors would experience annual mean nitrogen dioxide concentrations of 10 µg/m^3 and 8 µg/m^3 respectively with the proposed scheme. In a national context, such concentrations are considered to be exceptionally low.

14.4.3 Figures 14.6a-d show the impact the proposed scheme would have on annual mean nitrogen dioxide concentrations at the 133 sensitive receptors within the Northern Leg corridor. The significance of impacts ranges from Moderate adverse to Moderate beneficial. The predicted adverse impacts are near to the proposed scheme and to roads on which traffic flows would increase as a result of the proposed scheme. The predicted beneficial impacts are near to those roads on which traffic flows would fall as a result of the proposed scheme and also near to roads that would be realigned away from sensitive receptors. Beneficial impacts are expected near to the B977; the B999; the A90 south of the proposed scheme; and near to minor roads south of the A96. Elsewhere within the Northern Leg corridor, annual mean nitrogen dioxide concentrations would be expected to increase due to the scheme. Thus, overall within the Northern Leg corridor, more adverse impacts are expected than beneficial impacts. A comparison of the number of properties at which improvements and deteriorations in air quality are expected across the entire study area is presented in Chapter 55 (Air Quality Cumulative Impact Assessment).

<u>Particulate Matter PM_{10}</u>

14.4.4 Figures 14.7a-d show the predicted annual mean PM_{10} concentration in 2011 at the 133 sensitive receptors within the Northern Leg corridor with the proposed scheme. Figures 14.8a-d illustrate the changes in annual mean PM_{10} concentrations at each receptor that are attributable to the proposed scheme. These changes are defined according to the significance criteria set out in Section 14.2 (Approach and Methods). The results for the 19 selected receptors are set out in Table 14.10, with the baseline results repeated for ease of comparison.

Table 14.10 – Predicted Annual Mean PM_{10} Concentrations at Selected Receptors within the Northern Leg Corridor ($\mu g/m^3$)

Receptor	2005	2011		Impact Magnitude	Impact Significance
		No Scheme	With Proposed Scheme		
NR1	12	12	13	small increase	Slight adverse
NR2	12	12	11	small decrease	Slight beneficial
NR3	11	10	12	large increase	Slight adverse
NR4	14	13	15	small increase	Slight adverse
NR5	15	15	16	small increase	Slight adverse
NR6	15	15	14	small decrease	Slight beneficial
NR7	13	12	13	small increase	Slight adverse
NR8	13	12	13	small increase	Slight adverse
NR9	12	11	12	medium increase	Slight adverse
NR10	14	13	14	small increase	Slight adverse
NR11	15	14	15	very small increase	Slight adverse
NR12	20	18	17	very small decrease	Slight beneficial
NR13	17	16	17	small increase	Slight adverse
NR14	17	17	17	very small increase	Slight adverse
NR15	16	15	15	very small decrease	Slight beneficial
NR16	15	14	15	small increase	Slight adverse
NR17	10	10	10	small increase	Slight adverse
NR18	14	13	13	very small decrease	Negligible beneficial
NR19	12	12	12	small increase	Slight adverse
Objective	**40**	**18**	**18**	-	-

Note: All results gravimetric equivalent. Impact magnitude descriptors based on unrounded numbers (see footnote to Table 14.9)

14.4.5 With the proposed scheme in 2011 there would be no exceedences of the annual mean PM_{10} objective within the Northern Leg corridor. As in 2011 without the proposed scheme, all of the predicted concentrations in 2011 with the proposed scheme are between 8 and 18 $\mu g/m^3$ (illustrated by comparison of Figures 14.7a-d with Figures 14.4a-d).

14.4.6 Figures 14.8a-d show that the proposed scheme is expected to result in annual mean PM_{10} impacts ranging from Slight beneficial to Slight adverse within the Northern Leg corridor. The predicted adverse impacts are near to the proposed scheme, and near to roads on which traffic flows would increase as a result of the proposed scheme. The predicted beneficial impacts are near to those roads on which traffic flows would fall as a result of the proposed scheme, and near to roads that would be realigned further away from receptors. As with nitrogen dioxide, the beneficial impacts are expected near to the A947; the B977; the B999; the A90 south of the proposed scheme; and near to minor roads south of the A96. Elsewhere within the Northern Leg corridor, the impacts are expected to be adverse, and overall more adverse impacts are expected than beneficial impacts. A comparison of the number of properties at which improvements and deteriorations in air quality are expected across the entire study area is presented in Chapter 55 (Air Quality Cumulative Impact Assessment).

14.4.7 Table 14.11 sets out the predicted number of exceedences of 50 $\mu g/m^3$ as a 24-hour mean PM_{10} concentration at the 19 selected receptors. A change in the number of 24-hour exceedences is only expected at one of these receptors (Receptor NR13). Even here, the change is considered to be Negligible adverse. No exceedences of the 2010 24-hour PM_{10} objective are expected at any of the receptors shown in Figures 14.1 to 14.8.

Table 14.11 – Predicted Number of Exceedences of 50 μg/m³ as a 24-hour PM_{10} Concentration at Selected Receptors within the Northern Leg Corridor (days)

Receptor	2005	2011		Impact Magnitude	Impact Significance
		No Scheme	With Proposed Scheme		
NR1	0	0	0	no change	No Change
NR2	0	0	0	no change	No Change
NR3	0	0	0	no change	No Change
NR4	0	0	0	no change	No Change
NR5	0	0	0	no change	No Change
NR6	0	0	0	no change	No Change
NR7	0	0	0	no change	No Change
NR8	0	0	0	no change	No Change
NR9	0	0	0	no change	No Change
NR10	0	0	0	no change	No Change
NR11	0	0	0	no change	No Change
NR12	3	1	1	no change	No Change
NR13	1	0	1	extremely small increase	Negligible adverse
NR14	1	1	1	no change	No Change
NR15	0	0	0	no change	No Change
NR16	0	0	0	no change	No Change
NR17	0	0	0	no change	No Change
NR18	0	0	0	no change	No Change
NR19	0	0	0	no change	No Change
Objective	**35**	**7**	**7**	**-**	**-**

Air Quality Impacts on Vegetation

14.4.8 Table 14.12 sets out the predicted change in ambient NOx concentrations expected in the eastern part of Corby Lily and Bishops Lochs SSSI. Baseline levels are repeated for ease of comparison. According to the descriptive criteria defined in Table 14.3, the proposed scheme would cause a medium (11%) increase in NOx concentrations at the very edge of the SSSI. This would amount to a Slight adverse impact. Predicted concentrations would, however, remain less than 1/6th of the critical level representing exceptionally clean air. Predicted concentrations with the proposed scheme are also less than those predicted in 2005.

Table 14.12 – Predicted NOx Concentrations Near to Potentially Sensitive Ecological Sites

Site	Distance from Road Centre (m)	Annual Mean NOx (µg/m³)			Sign of Change	> 2 µg/m³ change close to critical levels
		2005	2011 Without Scheme	2011 With Scheme		
Corby, Lily and Bishops Lochs (Eastern Section)	190	5	4	5	increase	No
	200	5	4	4	increase	No
Critical Level		**30**	**30**	**30**	-	-

Note: the 2µg/m³ criterion is prescribed in IAN 61/05. Sign of change calculated from unrounded numbers (see footnote to Table 14.9).

14.4.9 Table 14.13 sets out the predicted rates of nitrogen deposition to the SSSI without and with the proposed scheme. The proposed scheme would cause an extremely small (less than 0.5%) increase in nitrogen deposition. The lower bound critical load would be exceeded with or without the scheme, and this change is considered to be Slight adverse in terms of the criteria set out in Table 14.3.

14.4.10 The results of this assessment have been discussed with the authors of Chapter 10 (Ecology and Nature Conservation) and they are not considered to be significant in terms of ecological impacts on the habitats protected by SSSI designation.

Table 14.13 – Nitrogen Deposition Fluxes Near to Potentially Sensitive Ecological Sites

Site	Distance from Road Centre (m)	Nitrogen Deposition (kg-N/ha/yr)				Sign of Change	Change as % of Critical Load [a]
		2005	2011 Without Scheme	2011 With Scheme	Site-Specific Critical Load		
Corby, Lily and Bishops Lochs (Eastern Section)	190	12	11	11	10 - 25	increase	< 1 %
	200	12	11	11		increase	< 1 %

Note: Sign of change calculated from unrounded numbers (see footnote to Table 14.9).

14.5 Mitigation

14.5.1 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.

14.6 Residual Impacts

14.6.1 Because the impacts set out above are not considered to require any specific mitigation, the residual impacts will be the same as those presented in the Potential Impacts section. These are summarised below.

Local Air Quality

Nitrogen Dioxide

14.6.2 The impacts of the proposed scheme are expected to range from Moderate adverse to Moderate beneficial in terms of annual mean nitrogen dioxide concentrations within 500m of the Northern Leg. The beneficial impacts would result from changes to existing roads associated with the proposed scheme. Most of the adverse impacts would result from the direct effects of emissions from vehicles on the proposed scheme. Annual mean nitrogen dioxide concentrations will be well below the level of the Government's health-based air quality objective with or without the proposed scheme. In most locations, even directly adjacent to the proposed route, predicted concentrations are expected to remain less than half of the objective level. In a national context, concentrations such as these are considered to represent very clean air.

14.6.3 More locations are expected to experience adverse air quality impacts than would experience beneficial air quality impacts within the Northern Leg corridor. The net impacts on local air quality across the entire study area are presented in Chapter 55 (Air Quality Cumulative Impact Assessment).

Particulate Matter (PM_{10})

14.6.4 The impacts of the proposed scheme are expected to range from Slight adverse to Slight beneficial in terms of annual mean PM_{10} concentrations within 500m of the Northern Leg. As with nitrogen dioxide, the beneficial impacts would result from changes to traffic flows on, and alignments of, existing roads associated with proposed scheme. Most of the adverse impacts would result from the direct effects of emissions from vehicles on the Northern Leg. No exceedences of the Government's health-based PM_{10} objectives are expected in 2011.

14.6.5 More locations are expected to experience adverse air quality impacts than would experience beneficial air quality impacts within the Northern Leg corridor. The net impacts on local air quality across the entire study area are presented in Chapter 55 (Air Quality Cumulative Impact Assessment).

Air Quality Impacts on Vegetation

14.6.6 The proposed scheme would cause an increase in NOx concentrations and nitrogen deposition at the northern edge of within Corby, Lily and Bishops Lochs SSSI but the predicted changes are so small that they are not considered to be significant.

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