A14.1: Air Quality Technical Information

1 Legislative and Policy Framework

1.1.1 The assessment considers the relevant Air Quality legislation and Local Air Quality Management Technical Guidance. Relevant planning policy is considered at the national, regional and local level.

Relevant Legislation

1.1.2 Table 1 below summarises key legislation and policy relevant to the protection of air quality.

Table 1: Key UK Air Quality Legislation and Policy

Applicable Law	Description
Environment Protection Act 1990 Part III	Provides statutory nuisance provisions for nuisance dust
Environment Act 1995, Part IV	Defines requirements for Local Air Quality Management
The Air Quality Standards Regulations (Scotland) 2010	Transpose formalised limit values set out in the EU ambient air quality directive 2008/50/EC to UK law
The National Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland, 2007	Updates the 2000 Air Quality Strategy, and sets out how local air quality is managed, through the application of Air Quality Objectives (AQO) based on the Air Quality (England) Regulations 2000 and 2002 Amendments

1.1.3 Directive 2008/50/EC was published to consolidate previous European Directives on ambient air quality. Although published in 2007, the Air Quality Strategy is consistent with the Air Quality Standards Regulations (England) 2010.

1.1.4 The UK government is responsible to the European Commission for ensuring that it complies with the provisions of the EU Directives. The UK government, and governments of other member states have agreed postponements with the EC to the achievement dates for fine particulate matter (PM_{10}) and nitrogen dioxide (NO_2). On the UK government's behalf, the Departments for Transport (DfT) and for Environment Food and Rural Affairs (Defra) have Public Service Agreements relating to EU limit values. The responsibilities of local authorities with respect to meeting Air Quality Objectives are not the same as the responsibilities of the UK Government to the EC. Local authorities do have statutory duties for Local Air Quality Management, but they are not obliged to ensure that Air Quality Standards are met.

Air Quality Strategy

1.1.5 The National Air Quality Strategy for England, Scotland, Wales and Northern Ireland (the AQS) establishes Air Quality Objectives (AQO) for a number of specific pollutants. The pollutants relevant to this assessment are nitrogen dioxide (NO_2) nitrogen oxides (NO_x), and PM_{10} (see Table 2).

Table 2: Air Quality Strategy Objectives

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times/yr (99.79th percentile)	1 hour mean	31-12-2005
	40 µg/m^3	Annual mean	31-12-2005
Nitrogen Oxides (NO_x)	30 µg/m^3	Annual mean	19-07-2001
PM_{10}	50 µg/m^3, not to be exceeded more than 7 times/yr	24 hour mean	31-12-2010
	18 µg/m^3	Annual mean	31-12-2010

1.1.6 For a full description of the terms used in relation to air quality, the science and the legislation, reference should be made to the AQS documents, and to the supporting Technical Guidance: Local Air Quality Management (TG(09)) referred to hereafter as LAQM TG(09) (Defra, 2009).

1.1.7 There are no assessment methods available which can produce robust predictions of short-term concentrations from road traffic. Therefore, compliance with the short-term AQOs is assessed by following the guidance presented in LAQM TG(09), which provides a relationship between the annual mean concentration and the number of periods per year where the short-term AQO is likely to be exceeded. These relationships have been derived from examination of monitoring data across the UK.

1.1.8 Receptors would not be expected to exceed the NO_2 1 hour mean AQO if predicted annual mean concentrations are less than 60 µg/m^3, or the PM_{10} 24 hour mean AQO, if predicted annual mean concentrations are less than 32 µg/m^3.

1.1.9 AQOs are health-based standards. They are set at a level to provide protection to the whole population.

1.1.10 NO_2 is a colourless, odourless gas which has been shown to have adverse health effects including causing respiratory irritation in asthmatics. There is believed to be a threshold at which it has an impact. It is formed principally from the oxidation of nitric oxide (NO) through the action of ozone in the atmosphere. Combustion in air forms mainly NO and with some NO_2, collectively termed oxides of nitrogen (NO_x), from the combination of atmospheric nitrogen and oxygen. NO_x emitted from internal combustion engines as well as other forms of combustion and formed from natural sources such as lightning. NO_x is a precursor to PM_{10}.

1.1.11 PM_{10} is the fraction of particulate matter (dust) in the air with an average aerodynamic diameter of less than 10 µm. This size range of particulate matter can penetrate deep into the lungs and has been shown to have a range of adverse health effects. These include a causal association with cardiovascular and respiratory illnesses. According to the AQS, 'it is not currently possible to discern a threshold concentration below which there are no effects on the whole population's health'. That is to say, scientific research cannot say whether any concentration of PM_{10} at all does no harm. There is no proven safe threshold. In terms of harm, economically PM_{10} is costed as being many times as harmful as NO_2. PM_{10} is formed from both man-made and natural sources. Primary PM_{10} is formed from the incomplete combustion of fuel (e.g. soot from diesel exhausts), sea-salt and wind-blown dust. Secondary PM_{10} is formed in the atmosphere from other pollutants such as NO_x and sulphur oxides, and in certain circumstances in photochemical smogs. PM_{10} has a residence time of several days in the atmosphere, so pollution events occur in southern England when polluted air is blown from the continent.

1.1.12 Responsibility for determining whether AQOs are complied with lies with Local Authorities within the system of Local Air Quality Management (LAQM). Local Authorities are required to review and assess air quality within their districts, against the AQOs. Where the AQOs are not being met at relevant locations, they must declare Air Quality Management Areas (AQMAs). Within eighteen months of doing so, they should publish an Air Quality Action Plan (AQAP) setting out measures to work towards reducing the concentrations of the relevant pollutants to below the relevant AQOs by given dates. The given dates for compliance have all now passed.

1.1.13 Pollutants such as benzene and 1,3 butadiene are associated with the use of fuels for road transport (petrol). The other pollutants are potentially associated with emissions from diesel combustion.

1.1.14 The majority of AQMAs have been declared for NO_2 concentrations, mostly as a result of road traffic. Where there are significant local sources of PM_{10} or SO_2, there have also been AQMAs declared for these pollutants. AQOs for the other pollutants are very unlikely to be exceeded and therefore the other pollutants have not been considered further.

1.1.15 The AQS introduces measures to control exposure to $PM_{2.5}$ (the fraction of particulate matter with an average aerodynamic diameter less than 2.5 µm). This is intended to be addressed at national level, so the control of $PM_{2.5}$ concentrations has not been incorporated into Local Air Quality Management, and authorities have no statutory obligation to review and assess against them. The objective value of 25 µg/m^3 is designed to deliver a minimum level of protection everywhere.

Dust Nuisance

1.1.16 One of the main concerns regarding the air quality impact during construction is the potential for dust annoyance. There are no nationally recognised criteria defining levels of dust that can cause an annoyance.

1.1.17 These impacts can be controlled under the Statutory Nuisance provisions of Part III of the Environmental Protection Act, 1990.

2 Methodology

2.1.1 This air quality assessment identifies the potential air quality impacts by predicting the changes in air quality which would result from the combination of background concentrations with the contributions from the roads in the study area, including the proposed scheme. This assessment conforms to the standard practice of environmental impact assessment, whereby the baseline is established, and then the situation with the proposed scheme in place (Do Something or DS) is compared with the situation without it (Do Minimum or DM). The air quality situation is developed from the national emissions inventory, which in turn is affected by year-on-year changes in the composition of, and the emissions from, the national vehicle fleet. The changes in emissions into the future are predicted on behalf of the government. For this reason, air quality for road schemes is normally assessed for a baseline year (in the recent past) and for the opening year with and without the proposed scheme in place.

2.1.2 The impact of the proposed scheme has been assessed using the Design Manual for Roads and Bridges HA207/07 air quality assessment methodology (DMRB) (HA, 2007), and LAQM TG(09) (DEFRA, 2009). DMRB allows for either a 'detailed' or 'simple' assessment. For this scheme, a detailed assessment has been carried out, which takes into account diurnal changes in traffic flows using a dispersion model.

Assessment Scenarios and Study Area

2.1.3 The outline assessment method is to quantify the ambient pollution concentrations for the road traffic scenarios below:

- Baseline Year 2012
- Opening Year 2019 – DM - (i.e. without the proposed scheme in place)
- Opening Year 2019 – DS - (i.e. with proposed scheme)

2.1.4 In addition, future scenarios 15 years after opening are considered for regional emissions for:

- Design Year 2034 - DM; and
- Design Year 2034 - DS

2.1.5 The assessment covers two different geographic scales, as follows:

- Local air quality, focusing only on the headline pollutants NO_2 and PM_{10} plus dust; and
- Regional air quality, focusing on NO_x, PM_{10}, carbon dioxide (CO_2) and total hydrocarbons (HC).

2.1.6 Traffic data for the modelling scenarios has been provided from the Saturn traffic models produced by Jacobs on behalf of the Highways Agency. The base year air quality modelling uses traffic data, pollution measurements and meteorological measurements from 2012.

Local Air Quality Modelling Methodology

2.1.7 The assessment of the potential air quality impacts of the proposed scheme has been undertaken using the ADMS-Roads Air Dispersion Modelling Software.

2.1.8 The ADMS-Roads modelling software has been developed by Cambridge Environmental Research Consultants Ltd (CERC) and is a version of an atmospheric modelling system that focuses on road traffic as a source of pollutant emissions. ADMS is based on a Gaussian model of plume dispersion and is known as a new generation model, as it includes complex descriptions of the atmospheric boundary layer.

2.1.9 ADMS Roads is a recognised tool for carrying out air quality impact assessments and has been comprehensively validated by both the manufacturers and independently. It is used both by regulatory authorities and commercially to assist in decisions related to air quality and traffic management, urban planning and public health in many countries around the world. Version 3.1 (released August 2011) was used for this study.

2.1.10 It should be noted that dispersion models provide an estimate of concentrations arising from input emissions and historical meteorological data. The predictions produced while appropriately representing the complex factors involved in atmospheric dispersion, are subject to uncertainty. Whilst the predictions provided by the models should not be regarded as definitive statements of concentrations that will arise in the future, they are the most reasonable, robust and representative available. The predictions are composed of calculations made at a single point on each residential property. Calculations at specific properties are more precise than those based on isopleths which require further interpolation of modelled point data.

Meteorological Data

2.1.11 The effect of meteorological conditions on dispersion is included within the model. The most significant factors in the dispersion of emitted pollutants are wind speed and direction. The meteorological data site considered to be most representative of conditions across the study area was Strathallan Airfield for 2012, which is 22km southwest of the study area. Cloud cover data was not available from Strathallan Airfield and the outstanding data was obtained from Leuchars meteorological data station.

Vehicle Emissions

2.1.12 The modelling system takes into account the emissions produced by Light Duty Vehicles (LDV, less than 3.5 tonnes) and Heavy Duty Vehicles (HDV) travelling at a certain speed along a section of road over an average hour and predicts the dispersion of these emissions.

2.1.13 Emissions for light and heavy duty vehicles are taken from the Defra Emissions Factor Toolkit Version 5.2c (Defra, 2013). The traffic data for each traffic period was used to calculate the emission rate for each road link. These emissions are vehicle-weighted averaged emissions for the national vehicle fleet. Emissions factors are defined by year to represent the predicted vehicle fleet, and the range of vehicle types and EURO emissions standards present across the fleet. The use of the traffic period data ensures that the emissions diurnal emissions profile is consistent with that predicted by the traffic model.

Receptors

2.1.14 The detailed assessment covers representative residential properties and other sensitive properties (e.g. nurseries, hospitals) predicted to be in exceedence of the AQOs in the opening year. Building usage was determined using the Ordnance Survey Address Layer dataset, and calculations are made at the nearest façade to the busiest road. A total of 24 receptors were included in the assessment and were selected using either professional judgement for being close to the affected roads and representative of the maximum impacts of the proposed scheme in that region (shown

as points on Figure 14.2 and listed in Appendix 14.5). Ladner Cottage (R19) will be acquired as part of the proposed scheme and therefore will not be a receptor in the DS scenario.

Designated Habitat Sites

2.1.15 The River Tay Special Area of Conservation (SAC) and Cairnleith Moss Site of Special Scientific (SSSI) are both within the air quality study area of the proposed scheme.

Background Concentrations

2.1.16 'Background' air quality is a concept used to enable assessments of the impacts of particular emissions sources, without the need for all sources in the area to be considered explicitly. For the purposes of this assessment, the background air quality is the boundary condition of the road emissions pollution model. The road derived pollution is added to the background pollution concentrations.

2.1.17 Defra provides empirically-derived national background maps, which provide estimates of background pollutant concentrations on a 1km x 1km grid square resolution. This model relates the National Atmospheric Emissions Inventory to the national network of pollution measurements.

2.1.18 This data is obtained through Defra (http://www.laqm.defra.gov.uk). The data for NO_x, NO_2 and PM_{10} have recently been updated, with a base year of 2010 from which future years mapping years are projected. Defra have stated that 2010 concentrations were generally elevated for NO_x and NO_2 compared to more recent years. A review of air quality monitoring in the vicinity of the proposed scheme indicates that 2010 did not demonstrate elevated concentrations. A comparison of measured background indicates that the background maps performed reasonably and there was no need for adjustment.

2.1.19 The 'in-grid square' contribution from trunk 'A' road, primary 'A' road and minor road sectors have been removed from the background annual mean NO_x and PM_{10} concentration estimates, and background annual mean NO_2 estimates have been corrected using the Defra's Background NO_2 Calculator. This process has been undertaken to avoid double counting of road traffic emissions. Where predicted concentrations for specific receptors are presented, the sector-removed background concentrations used are also presented. The predicted background pollutant concentrations in the study area are significantly below the AQOs.

Prediction of Environmental Concentrations including Adjustment for Long-term Trends in NO_x and NO_2

2.1.20 The model is used to predict the road traffic contributions to NO_x and PM_{10} concentrations at specified receptors. Adjustments are applied to the model predictions based on a comparison against measured air concentrations, in a process known as model verification and adjustment. The modelled road contributions of NO_x, NO_2 and PM_{10} were adjusted to correct them against measured road components derived from monitoring data, following an adjustment method set out in LAQM TG(09). NO_x and NO_2 concentrations were calculated using the NO_x from NO_2 calculator (version 3.2) available on the Defra website. The calculator was issued in conjunction with the LAQM TG(09) guidance. A total environmental concentration is then produced by addition of the adjusted road contribution to the background concentration. Further detail on the verification process is provided in Appendix 14.2.

2.1.21 For the opening year predictions, a further adjustment step is then undertaken, to account for the observed trends in ambient roadside NO_x and NO_2.

2.1.22 In July 2011 Defra published a report examining the long-term air quality trends in NO_x and NO_2 concentrations. This identified that there has been a clear decrease in NO_2 concentrations between 1996 and 2002. Thereafter NO_2 concentrations have stabilised with little to no reduction between 2004 and 2010. Defra's report presents a similar pattern for the change in NO_x concentrations over the same time period. The consequence of the conclusions of Defra's advice

on long-term trends is that there is now a gap between current projected vehicle emission reductions and projections on the annual rate of improvements in ambient air quality, which are built into the vehicle emission factors, the projected background maps and the NO_x to NO_2 calculator.

2.1.23 The HA has developed the Gap Analysis methodology (HA *et al.*, 2013a) to adjust model predictions based on the method in LAQM TG(09) to account for the long-term NO_x and NO_2 profiles. This uses the relationship between the Base year vehicle emission rates and the Opening year vehicle emission rates, and the measured trends in roadside air quality concentrations to uplift opening year predicted concentrations to align them better with the long-term trends of NO_x and NO_2.

2.1.24 The current trends in air quality are based on measurements of emissions from the existing vehicle fleet. New vehicles will need to comply with the more stringent Euro VI emissions standards from September 2014 onwards. Vehicles complying with the Euro VI emissions standard are not yet on the road network, and therefore the performance of these vehicles is not present in the long-term air quality monitoring trends. If the Euro VI fleet emissions perform as predicted, then this should lead to substantial reductions in predicted future roadside air quality concentrations.

2.1.25 However, because the likely impacts of Euro VI vehicles on air quality are yet to be fully understood, the HA's advice is that a long-term trend based on the existing fleet is assumed to be linear and continue at this projected rate of decrease into the future. Given the relatively low penetration of Euro VI into the fleet prior to 2016 and their contribution to total emission rates, the HA considers the Gap Analysis methodology to be reasonable. Beyond 2016, the long-term trends projections are expected to be conservative as the fleet penetration of Euro VI increases, and as more information becomes available the long-term trend projections will be reviewed and the Interim Advice Note updated accordingly.

2.1.26 When forming a judgement on the significance of the impacts, both the LAQM TG(09) results and the results adjusted using the Gap Analysis method (to reflect Long-term Trends) should be provided and a justification statement, setting out the reasons for selecting the results used to inform the judgement on significance. After 2015, actual future year concentrations would be expected to fall somewhere between the calculated results for the two methods. For this project, the Opening Year 2019 is five years after the start of Euro VI uptake and it is likely that the roadside NO_x and NO_2 concentrations will be reduced compared to the current measured trends due to Euro VI vehicles. A precautionary approach is applied here, where the Gap Analysis method to represent Long-term Trends provides the predicted NO_2 concentrations in 2019, and thus the basis for judgements. Predictions for NO_2 using the LAQM TG(09) method (which are lower) are also used in the final assessment to provide context for the uncertainty in model predictions.

2.1.27 The Gap Analysis method is not applied to PM_{10} predictions, and the results based on the LAQM TG(09) method are the final predicted concentrations throughout the assessment.

2.1.28 The DMRB regional air quality assessment methodology is completed for the study area. This is an estimate of the change in total emissions of PM_{10}, NO_x, carbon dioxide (CO_2) and hydrocarbons (HC) per year from all vehicles on the affected roads.

3 Impact Assessment and Significance

3.1.1 In order to convey the level of impact of the proposed scheme, it is necessary to determine its significance. The ‘significance’ of an environmental impact is a function of the ‘sensitivity’ of the receptor and the ‘scale’ of the impact.

Construction

3.1.2 The DMRB methodology for assessing the impact of construction on air quality is followed to determine the potential impacts, and best practice dust control measures are proposed.

Operation

3.1.3 The model results are used to assess whether there any significant impacts as a result of the proposed scheme. The approach to evaluating significant air quality impacts, is set out in two Interim Advice Notes (IANs) published in June 2013 (HA *et al.*, 2013b) (HA *et al.*, 2013c).

3.1.4 The EU Directive on Ambient Air Quality sets limit values for a range of pollutants. The purpose of the Directive is to protect human health, and the environment as a whole. Defra reports annually, on behalf of the UK government, on the status of air quality to the European Commission. The compliance risk assessment test detailed in IAN 175/13 (HA *et al.*, 2013c) has been developed to enable decision makers to judge a proposed scheme's likelihood of non-compliance with the EU Directive.

3.1.5 The approach to air quality assessment identifies and assesses sensitive receptors near roads where air quality might be affected. Consequently, areas where national AQOs might be expected to be exceeded are considered, which includes Air Quality Management Areas (AQMAs). The model results are used to identify those receptors which are in exceedence of AQOs in either the DM or DS scenario. These are the only receptors which are considered in the judgement of significance. The change in predicted concentration is then calculated as the difference between DS and DM model results at these receptors.

3.1.6 Where the difference in concentrations are less than 1% of the AQO e.g. less than 0.4 µg/m³ for annual average NO_2, then the change at these receptors is considered to be imperceptible and they can be scoped out of the judgement on significance.

3.1.7 The HA *et al.* has developed a framework to provide guidance on the number of receptors for each of the magnitude of change categories that might result in a significant effect. These are guideline values only, and are to be used to inform professional judgement on significant impacts of the proposed scheme. The guideline bands are based on the HA's considered opinion and are intended to help provide consistency across all major road schemes. The significance categories for NO_2 and guideline property numbers are summarised in Table 3.

Table 3: Guideline to Number of Properties Constituting a Significant Effect

Magnitude of Change in NO_2 (µg/m³)	Number of Receptors with:	
	Worsening of AQO already above objective or creation of a new exceedance	Improvement of an AQO already above objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2 to 4)	10 to 30	10 to 30
Small (>0.4 to 2)	30 to 60	30 to 60

3.1.8 The significance of the change is greater, the higher above the air quality thresholds the changes are predicted to occur. Where it is predicted that the short-term NO_2 and / or PM_{10} thresholds are exceeded, then more significance should be attributed to these impacts.

3.1.9 The upper and lower bands presented are guidelines and not absolutes. On occasions when the number of properties affected is above the upper guideline band, then consideration should be given to all the evidence that may support or detract from a conclusion of a significant effect when coming to a concluding view. The further above the upper guideline band the more likely it is that local air quality impacts would be significant.

3.1.10 Where the results reside between the lower and upper guideline bands for any of the magnitude criteria then scheme impacts could be significant and a judgement is required taking into account the results for all six categories. This judgement will be based on the technical knowledge and experience of the air quality professional. To assist this judgement consideration should be given (but not limited) to the following:

3.1.11 Scheme impacts are more likely to be significant where:

- there are no / few receptors with any improvements;
- PM_{10} annual averages are also affected by small, medium or large deteriorations; and
- short-term exceedances may be caused or worsened by the scheme for either NO_2 or PM_{10}.

3.1.12 Scheme impacts are more likely to be not significant where:

- there are receptors with small, medium or large improvements;
- PM_{10} annual averages are not affected by small, medium or large deteriorations; and
- short-term exceedances are not caused or worsened by the Scheme for either NO_2 or PM_{10}.

3.1.13 The establishment of overall air quality significance for the scheme should also consider whether the scheme detracts or supports measures set out in relevant local authority Air Quality Action Plans, if the scheme represents a low or high compliance risk with the EU directive on air quality, the impacts on any designated site(s) affected, and potential effective mitigation.