Interim Advice Note 61/04

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)

Summary:
This document advises of additional work required to assess the air quality impact of a scheme on sensitive ecosystems. It supplements the advice given in and should be read in association with the Design Manual for Roads and Bridges, Volume 11, section 3, part 1.

1. Introduction

This guidance has been prepared as a supplement to the DMRB 11.3.1 (Air Quality) to assess the effect of air quality upon internationally designated nature conservation sites and Sites of Special Scientific Interest (SSSIs). These sites will henceforth be referred to as Designated Sites in this advice note. Air quality will be considered in terms of oxides of nitrogen (NO_x) concentrations, nitrogen deposition and construction dust. This note was prepared in collaboration with the Joint Nature Conservation Committee and English Nature.

This note discusses the potential effects of air pollution upon ecosystems, the legislative requirements for assessment and provides guidance on how the assessment should be carried out. In addition to the assessment that is already carried out as part of DMRB 11.3.1 for a road scheme, further work is required to assess NO_x concentrations and nitrogen deposition on sensitive ecosystems in Designated Sites if these could be affected by the scheme. Mitigation measures to reduce dust generated during construction should also be considered.

2. Background

Air pollution can affect ecosystems in a variety of ways on a local, regional and global scale. An ecosystem is defined as a biological community of interacting organisms and their physical environment. Concentrations in air and deposition of particles onto vegetation can damage the vegetation directly or affect plant health and productivity. Deposition of pollutants to the ground and vegetation can alter the characteristics of the soil, affecting the pH and nitrogen availability that can then affect plant health and productivity and species composition. Increased greenhouse gas emissions on a global scale can affect the global climate, such that the ability of existing species to tolerate local conditions can change.

2.1 Local Scale

Road transport emits a number of air pollutants including oxides of nitrogen, volatile organic compounds, ammonia, heavy metals and particulates. Increases in concentrations occur usually within 200m of a major road, though a small contribution from vehicular emissions may be measurable at further distances. The pollutant of most concern for sensitive vegetation near roads, and perhaps the best understood, is NO_x. The EU has set limit values for the protection of vegetation for NO_x and sulphur dioxide (1999/30/EC) based on the work of the United Nations Economic Commission for Europe (UNECE) and World Health Organisation (WHO) and these limit values have been incorporated into the Air Quality Limit Value Regulations (SI 2001 no. 2315). The limit value for NO_x for the protection of vegetation is 30 $\mu g/m^3$ for the annual mean. This is the same as the Air Quality Strategy (AQS) objective. Sulphur dioxide is not of concern near roads as emissions from road transport are negligible. The limit values for the protection of vegetation apply to locations more than 20 km from towns with more than 250,000 inhabitants or more than 5 km from other built-up areas, industrial installations or motorways. As monitoring sites need to be representative of an area of 1000 km^2, the limit does not have a statutory basis in micro-scale environments such as those close to a road. However, as the UNECE and the WHO have set a critical level for NO_x for the protection of vegetation, the Statutory Nature Conservation Agencies' (in England, English Nature) policy is to apply the 30 $\mu g/m^3$ criterion, on a precautionary basis, as a benchmark, in internationally designated conservation sites and SSSIs.

Nitrogen dioxide (NO_2) is taken up by plants principally through their stomata. Concentrations of NO_2 are higher close to roads so vegetation in these areas is exposed to a larger source of nitrogen.

Critical loads, which represent the exposure below which there should be no significant harmful effects on sensitive elements of the ecosystem (according to current knowledge), have been established for a number of habitats dependent on low nitrogen levels. Critical loads are expressed in deposition units of kg/N/ha/yr.

Deposition of particles, ammonia, metals and salt will also be increased close to the road. This could affect vegetation in a number of ways:

i) Dust or particles falling onto plants can physically smother the leaves affecting photosynthesis, respiration and transpiration. The literature suggests that the most sensitive species appear to be affected by dust deposition at levels above 1000 $mg/m^2/day$ (Farmer 1993) which is five times greater than the level at which most dust deposition may start to cause a perceptible nuisance to humans. Most species appear to be unaffected until dust deposition rates are at levels considerably higher than this. Without mitigation, some construction activities can generate considerable levels of fugitive dust, although this is highly dependant on the nature of the ground and geology, time of year construction occurs in, length of time specific construction activity (eg boring) occurs for and prevailing meteorology during this activity.

ii) An increase in the saltiness of roadside soils due to winter maintenance activities could lead to an accumulation of chloride ions in the plant.

iii) Ammonia emissions from road vehicles (from petrol-driven vehicles fitted with catalytic converters), although small in a national context, can lead to significant additional deposition of nitrogen to vegetation in immediate vicinity of roads (typically within 10m).

iv) Small quantities of heavy metals released during combustion and from vehicle wear and tear, may accumulate in soils near the road. However, such emissions cannot be reliably quantified or the negative ecological effects determined.

2.2 Regional Scale

Some of the pollutants emitted by vehicles will react over time to form secondary pollutants such as ozone and particles, which can also affect vegetation. The increases in concentrations at a national level from an individual road will be miniscule but the contributions from all of the roads in England do contribute towards a sizable background concentration.

Ozone is toxic to plants but concentrations tend to be lower close to a road as it is destroyed by nitric oxide emitted by vehicles. As emissions of NO_x decrease in the future, ozone concentrations are expected to increase in urban areas and adjacent to roads and may pose an increased threat to vegetation in these areas.

The oxidation products of NO_x, SO_2 and NH_3 (ie sulphate, nitrate and ammonium) have the potential to acidify the soil unless mineral weathering, chemical or microbial processes within the soil or liming can neutralise the acid. The nitrogen that is deposited in the UK is derived from oxides of nitrogen (oxidised nitrogen) and ammonia (reduced nitrogen) in roughly equal proportions. About 50% of the UK's emissions of oxides of nitrogen are released by road transport with the mass of emissions gradually declining due to increasingly stringent emission control technology. Only 6% of the UK's ammonia emissions are produced by road transport (from petrol-driven vehicles fitted with catalytic converters) with the majority originating from animal farming. Nitrogen is eventually deposited onto surfaces through wet and dry deposition. The components of and mechanisms for nitrogen deposition are summarised in equation form below.

$$\text{N deposition} = \underbrace{NO_2 \text{ dry} + NO_y \text{ wet}}_{\text{Oxidised nitrogen}} + \underbrace{NH_3 \text{ dry} + NH_x \text{ wet}}_{\text{reduced nitrogen}}$$

The mean residence time in the atmosphere of reduced nitrogen is 5 hours, while that of oxidised nitrogen is approximately 30 hours, and mean travel distances for reduced and oxidised nitrogen are 150 km and 1000 km respectively before it is deposited. In the cases of reduced nitrogen, with a relatively short atmospheric lifetime, the effects of UK emissions occur largely within the UK, whereas for oxidised nitrogen, 70% of which is exported from the UK, the effects primarily occur

IAN Contents

outside the UK. Similarly, some of the nitrogen deposited in the UK is produced by continental sources. Nitrogen deposition in terms of acidification and wet deposition is therefore a regional issue.

The change in primary emissions as a result of a scheme are already assessed in DMRB 11.3.1. This guidance will therefore address local impacts only.

3. Assessment Procedure

3.1 Sites to be Considered

European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the Habitats Directive) requires an Appropriate Assessment to be made of any plans or projects that are likely to have a significant effect upon the features for which the European protected site was designated. The Directive's purpose is to safeguard and maintain the most valuable nature conservation sites and threatened habitats and species in the European Union. The requirements of this Directive have been implemented into UK legislation through the Conservation (Natural Habitats, & c.) Regulations 1994 (as amended). These European protected sites are Special Protection Areas (SPAs) as classified under the Birds Directive and Special Areas of Conservation (SAC), Sites of Community Importance (SCIs) or candidate Special Areas of Conservation (cSAC) designated under the Habitats Directive. In England, Government policy in the form of Planning Policy Guidance 9 extends the definition to include proposed Special Protection Areas (pSPAs) and Ramsar (designated under the Ramsar Convention on Wetlands) sites. An Appropriate Assessment is defined as the consideration of the impact of the project on the integrity of the site, with respect to the site's structure and function and its conservation objectives. The Highways Agency requires that an Appropriate Assessment is carried out for all of its schemes where there is an internationally designated site within 2 km of the route corridor or within 10 km of a SAC (SCI or cSAC) for which bats have been included as one of the qualifying interests.

European Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment requires an Environmental Impact Assessment to be carried out for highway improvements that are situated in a sensitive area. The Highways (Assessment of Environmental Effects) Regulations (SI 1999 no 369) identify sensitive areas as including Sites of Special Scientific Interest (SSSIs) and European designated conservation sites. The latter includes SPA, SAC, proposed SPA and candidate SAC.

The sites that should be considered for this assessment are those for which the designated features are sensitive to air pollution, either directly or indirectly, and which could be adversely affected by the effect of local air pollution on vegetation within the following nature conservation sites SAC (SCI or cSAC), SPA, pSPA, SSSIs and Ramsar sites.

3.2 Approach

The assessment should consider the potential localised impacts of emissions. Since little is known about the interactive effects of the different pollutants emitted from road transport the primary focus of the assessment is on reactive nitrogen compounds. However, impacts are likely to be as a result of the suite of emitted pollutants. Emissions of NO_x and CO_2 are already calculated for their contribution to regional effects and global warming respectively, as part of the air quality scheme assessment at DMRB Stage 3 and so do not need to be considered further here.

The assessment should involve estimating NO_x concentrations and nitrogen deposition within the designated site. The results of the assessment should be included in the intermediate assessment reports, the Environmental Statement (DMRB Stage 3), Appropriate Assessment if required, and be used in all the ecological impact assessments where appropriate.

DMRB Stage 1- Identification of sites

1 **Identify sensitive sites**: Identify any SAC (SCI or cSAC), SPA, cSPA, Ramsar or SSSI sites within 200m of all roads, including side roads, that could be affected by the proposals either during operation or construction. Affected roads are those that are likely to have at least a 10% change in emissions for non-motorway roads or 5% for motorways or where the road centre has moved by at least 5 m. The change in emissions is determined by the change in traffic flow, speed and proportion of heavy duty vehicles (HDV) with a 10% change in flows resulting in a 10% change in emissions (however, the relationship with speed and HDV proportion is not so straightforward). If there are no Designated Sites within 200m of an affected road, there is no need to proceed any further with this air quality assessment.

If there is a Designated Site within 2 km of a scheme so that an Appropriate Assessment is required, but there is no significant change in emissions from roads within 200m of the site, then the scheme will not result in a significant change in air quality and the effects of a change in air quality can be assumed to be negligible.

2. **Identify the site's characteristics**: Identify the reason for the designation (from the site citation), the locations of the potentially sensitive interest features e.g. habitats and species, the proportion of the Designated Site over which that species or habitat can be found and particularly the habitats and species located in the area of potential impact. The conservation objectives for and the current condition of the site should be obtained from English Nature. Sites declared for geological reasons or for fauna that are not dependant on habitats that are sensitive to air pollution can be ignored for the rest of the local air quality assessment.

Details of the sensitivity of different habitats and species to air pollutants are provided on the Air Pollution Information System website (www.apis.ac.uk).

DMRB Stage 2-A) NO_x concentrations

3. **Calculate NO_x concentrations**: Calculate the NO_x concentration in a transect up to 200 m away from each of the affected roads within or near the designated sites. Receptors should be placed at the edge of the designated site and then at increasing intervals away from the road. The calculations should be carried out for the opening year both with and without the scheme and the base year. The DMRB air quality screening method (DMRB 11.3.1) should be used to carry out the calculations unless this method is not appropriate for the scheme being assessed.

4. **Compare with EU limit value / AQS objective**: The NO_x concentration should be compared with the EU limit value / AQS objective of 30 $\mu g/m^3$ at the locations of the designated habitats and species and the change in concentration due to the scheme determined. If the scheme is expected to cause an increase in concentrations of at least 2 $\mu g/m^3$ and the predicted concentrations (including background) are very close to or exceed the limit value / objective, then the sensitivity of that species to NO_x should be commented upon. Advice from an ecologist or English Nature should be sought at this stage. The results of this assessment should also be passed to an ecologist for inclusion in the ecological impact assessment (environmental impact assessment and / or Appropriate Assessment). The ecologist should consider the potential cumulative effects of all of the various impacts such as air pollution, water pollution and habitat loss and comment upon the effect of the scheme on the integrity of the Designated Site.

5. **Consider mitigation**: If the designated features are at risk of being adversely affected by the scheme, mitigation measures should be considered to minimise the scale of impact.

DMRB Stage 2-B) N deposition

6. **Identify sensitive sites**: Examine the site features identified at DMRB stage 1 to determine if any of these are sensitive to increases in nitrogen deposition. These include various types of woodland, heathland, grassland, bog and sand dune listed in Table 1. If there are no Designated Sites that are sensitive to nitrogen deposition, then there is no need to proceed any further with the nitrogen deposition assessment.

7. **Obtain total average N deposition for 5 km square:** The average deposition rate from all sources of nitrogen (including the road of interest) should be obtained for the area of interest. Maps of total deposition rates can be found in the Air Pollution Information System (APIS) at www.apis.ac.uk. These are mapped on a 5 km square basis so the area covered by each 5 km square should be noted. The data currently available on the system is for 1999-2001 which should be taken to be equivalent to those in 2000. [1]The total average deposition rates obtained from the Air Pollution Information System for 2000 should be reduced by 2% per year to estimate deposition rates for the assessment years.

8. **Obtain background NO_2 and NO_x concentrations.** These should be obtained from the Air Quality Archive at http://www.airquality.co.uk/archive/laqm/tools.php. Concentrations in the assessment years should be estimated using the year adjustment calculator provided in the Archive. The usual procedures should be followed when obtaining background rates for NO_2 predictions near a road, ie background concentrations should be obtained for 1 km squares up to 4 km away from the road so that the road contribution is not double counted (guidance is given in DMRB 11.3.1 para 3.27). The average NO_2 concentration in the 5 km APIS square (ie average of the 25 1 km^2 squares) should also be calculated as this is included in the APIS deposition rate.

9. **Calculate NO_2 concentrations in a transect near the road**: Calculate the annual mean NO_2 concentration in a transect up to 200 m away from each of the affected roads within or near the designated site. The calculations should be carried out for the opening year both with and without the scheme and the base year and should include the background concentration in the usual way. The DMRB air quality screening method should be used to carry out the calculations unless the method is not appropriate for the scheme being assessed.

10. **Estimate dry deposition of NO_2 in the transect near the road:** The nitrogen deposition due to dry deposition of NO_2 at each of the receptor sites should be estimated using the equation given below. The deposition rate in the 5 km APIS square should also be calculated. Dry NO_2 deposition rates should be estimated using the following scaling factor which is based on a deposition velocity for NO_2 of 0.001 m/s (taken from EMEP Eularian photochemistry model).

$$1\ \mu g/m^3 \text{ of } NO_2 = 0.1 \text{ kg N ha}^{-1} \text{ yr}^{-1}$$

11. **Determine the road increment to NO_2 dry deposition**: The APIS 5 km square dry NO_2 deposition rate should be deducted from the receptor dry NO_2 deposition rate to give the increase in deposition rate at each receptor in the road corridor. This road increment should be added to the APIS average total deposition rate to give the total deposition rate at each receptor.

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[1] Reduced nitrogen generally contributed about 45% of the total nitrogen deposited in Britain in 1997 with oxidised nitrogen contributing the remainder, although the proportion will vary depending on the location of the site and sources. Based on the results of transboundary deposition modelling for 1997 and 2010, deposition of reduced and oxidised nitrogen is expected to decrease on average across Britain by 1.5% and 2.6% per annum respectively due to increasingly stringent emission limits (NEGTAP, 2001). As the deposition of oxidised nitrogen is expected to decrease faster than that of reduced nitrogen, the proportion of the total nitrogen deposited from reduced nitrogen will increase in the future. It is expected to have reached 60% by 2010. If reduced and oxidised nitrogen are assumed to contribute to total deposition in equal proportions, then the annual decrease in nitrogen deposition can be assumed to be 2% (estimated in a non cumulative manner, ie decrease over 5 years is 5 x 2% = 10%) However, the deposition changes will not be linear across the country but 2% should be indicative of the typical change.

12. **Compare with critical loads**: The total deposition rate at each receptor should then be compared with the empirical critical loads for nitrogen set by the UNECE in 2003 that are shown in Appendix A Table 1. Further information is given in Appendix A Table 2 on critical loads for forest habitats. Local factors such as phosphorus availability, site management (eg grazing) and rainfall will also affect the responsiveness of a site to altered nitrogen availability. Information on how these are likely to affect the critical load for selected ecosystems are given in the footnote to the table. The Status of UK Critical Loads report contains information on the applicability of the UNECE critical loads to sensitive UK habitats.

13. The change in deposition due to the scheme should be noted and discussed in relation to the critical load relevant to the interest features of the site, the background deposition and the extent of any exceedance. The results of this assessment should also be passed to an ecologist for inclusion in the ecological impact assessment (environmental impact assessment and / or Appropriate Assessment). The ecologist should consider the potential cumulative effects of all of the various impacts such as air pollution, water pollution and habitat loss and comment upon the effect of the scheme on the integrity of the Designated Site.

DMRB Stage 3- Construction Dust

The locations of any designated species or habitats within a Designated Site within 200 m of a construction site should be clearly identified so that mitigation measures to reduce dust emissions can be rigorously applied. Appropriate measures should reflect the nature of the construction activity (type, dust source points, construction operation periods and calendar dates) as well as ameliorating conditions (such as prevailing wind directions and speeds, typical precipitation and the dampening effect of retained soil moisture). Mitigation measures specifically in relation to a Designated Site should be incorporated into the Construction Environmental Management Plan (CEMP), reflecting the requirements of best practicable means (BPM).

4. Bibliography and Further Reading

Bell, J.N.B. 2002. Air Pollution and Plant Life. John Wiley & Sons Ltd. Chichester.

English Nature. 2004. The Ecological Effects of Diffuse Air Pollution from Road Transport. Report 580.

Farmer, AM. 1993 The effects of dust on vegetation – a review. Environmental Pollution 79, 63-75

NEGTAP, 2001. National Expert Group on Transboundary Air Pollution on behalf of Defra and the devolved administrations. Transboundary Air Pollution: Acidification, eutrophication and ground level ozone in the UK. ISBN 1 870393 61 9.

UNECE , 2003. Empirical Critical Loads for Nitrogen - Expert Workshop, Berne 2002, Eds. Acherman and Bobbink. Environmental Documentation No. 164, SAEFL

UK National Focal Centre, CEH Monks Wood. Status of UK Critical Loads. Critical Loads Methods, Data and Maps. http://www.airquality.co.uk/archive/reports/cat11/maintext_7may.pdf.

IAN Contents

Appendix A.
Table 1 UNECE Critical Loads for Nitrogen

Ecosystem type	Kg N $ha^{-1}yr^{-1}$	Reliability and Indication of exceedance effects
Forest habitats		
Temperate and boreal forests	10-20	# Changes in soil processes, ground vegetation, mycorrhiza, increased risk of nutrient imbalances and susceptibility to parasites
Heathland, scrub and tundra habitats		
Tundra	5-10[a]	# Changes in biomass, physiological effects, changes in species composition in moss layer, decrease in lichens
Arctic, alpine and subalpine scrub habitats	5-15[a]	(#) Decline in lichens, mosses and evergreen shrubs
Northern wet heath • 'U' *Calluna* dominated wet heath (upland moorland) • 'L' *Erica tetralix* dominated wet heath	 10-20 10-25 [a,b]	 (#) Decreased heather dominance, decline in lichens and mosses (#) Transition heather to grass
Dry heaths	10-20[a,b]	## Transition heather to grass, decline in lichens
Grassland and tall forb habitats		
Sub-Atlantic semi-dry calcareous grassland	15-25	## Increase tall grasses, decline in diversity, increased mineralization, N leaching
Non-Mediterranean dry acid and neutral closed grassland	10-20	# Increase in graminoids, decline typical species
Inland dune pioneer grasslands	10-20	(#) Decrease in lichens, increase biomass
Inland dune siliceous grasslands	10-20	(#) Decrease in lichens, increase biomass, increased succession
Low and medium altitude hay meadows	20-30	(#) Increase in tall grasses, decrease in diversity
Mountain hay meadows	10-20	(#) Increase in nitrophilous graminoids, changes in diversity
Moist and wet oligotrophic grasslands • *Molinia caerulea* meadows • Heath (*Juncus*) meadows and humid (*Nardus stricta*) swards	 15-25 10-20	 (#) Increase in tall graminoids, decreased diversity, decrease of bryophytes # Increase in tall graminoids, decreased diversity, decrease of bryophytes
Alpine and subalpine grasslands	10-15	(#) Increase in nitrophilous graminoids, biodiversity change
Moss and lichen dominated mountain summits	5-10	# Effects upon bryophytes or lichens
Mire, bog and fen habitats		
Raised and blanket bogs	5-10[a,c]	## Change in species composition, N saturation of *Sphagnum*
Poor fens	10-20	# Increase sedges and vascular plants, negative effects on peat mosses
Rich fens	15-35	(#) Increase tall graminoids, decrease diversity, decrease of characteristic mosses
Mountain rich fens	15-25	(#) Increase vascular plants, decrease bryophytes

Ecosystem type	Kg N ha^{-1}yr^{-1}	Reliability and Indication of exceedance effects
Inland and surface water habitats		
Permanent oligotrophic waters • Softwater lakes • Dune slack pools	 5-10 10-20	 ## Isoetid species negatively affected (#) Increased biomass and rate of succession
Coastal habitat		
Shifting coastal dunes	10-20	(#) Biomass increase, increase N leaching
Coastal stable dune grassland	10-20	# Increase tall grasses, decrease prostrate plants, increased N leaching
Coastal dune heaths	10-20	(#) Increased plant production, increase N leaching, accelerated succession
Moist to wet dune slacks	10-25	(#) Increased biomass, tall graminoids
Marine habitats		
Pioneer and low-mid salt marshes	30-40	(#) Increased late-successional species, increase productivity

Reliability key: ## reliable, # quite reliable, (#) expert judgement

a. Use towards high end of range at phosphorus limitation, and towards lower end if phosphorus is not limiting
b. Use towards high end of range when sod cutting has been practiced, use towards lower end of range with low intensity management
c. Use towards high end of range with high precipitation and towards low end of range with low precipitation

Appendix A
Table 2: Detailed Information on the UNECE Critical Loads for Forest Habitats

Forest Habitats	Kg N $ha^{-1}yr^{-1}$	Reliability and Indication of exceedance effects
Soil processes		
Deciduous and coniferous	10-15	# Increased N mineralization, nitrification
Coniferous forests	10-15	## Increased nitrate leaching
Deciduous forests	10-15	(#) Increased nitrate leaching
Trees		
Deciduous and coniferous	15-20	# Changed N/macro nutrients ratios, decreased P, K, Mg and increased N concentrations in foliar tissue
Temperate forests	15-20	(#) Increased susceptibility to pathogens and pests, change in fungistatic phenolics
Mycorrhiza		
Temperate and boreal forest	10-20	(#) Reduced sporocarp production, changed/ reduced below-ground species composition
Ground vegetation		
Temperate and boreal forests	10-15	# Changed species composition, increase of nitrophilous species, increased susceptibility to parasites
Lichens and algae		
Temperate and boreal forests	10-15	(#) Increase of algae, decrease of lichens