Natural England Commissioned Report NECR200

Potential risk of impacts of nitrogen oxides from road traffic on designated nature conservation sites

First published 18 February 2016

www.gov.uk/natural-england

Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Biodiversity 2020 identifies air pollution as a direct threat to biodiversity in England. Many habitats of nature conservation importance in the UK are adapted to low nutrient conditions and/or are vulnerable to acidification, and are sensitive to additional airborne nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3), as well as to nitrogen deposition and acid deposition.

Pollutants come from a range of different sources, but transport is known to be the single largest source of NO_x emissions. Natural England commissioned a study to assess what risk air pollution from roads poses to designated sites in England. There are two reports:

- NECR199: A literature review looking at the ecological effects of air pollution from road transport.
- NECR200: A mapping and site analysis report that classifies designated sites – Sites of Special Scientific Interest (SSSIs) and Special Areas of Conservation (SACs) – in terms of their exposure to NO_x from road traffic, taking into account other background sources of NO_x. It goes on to consider potential risk of impacts of NO_x from road transport in relation to SACs.

This mapping and site analysis report will be useful to a range of organisations in the transport and environment sectors. It provides a national overview of exposure to NO_x from road traffic (for SSSIs and SACs) and the potential risk of impacts to SACs posed by air pollution from road traffic.

The results will help Natural England to:

- Advise on interventions at specific sites.
- View new proposals with implications for road traffic in the context of the potential risk of impacts to designated sites posed by air pollution from existing road traffic.
- Inform Biodiversity 2020 delivery and the Improvement Programme for England's Natura 2000 sites (IPENS).
- Facilitate the targeting of mitigation/remediation measures that will contribute to Site Improvement Plans (SIPs)/Site Nitrogen Action Plans (SNAPs).

We recommend that the mapping and site analysis report is read in conjunction with the literature review.

Natural England Project Manager - Clare Warburton, Senior Environmental Specialist (Transport), Natural England, Mail Hub Block B, Whittington Road, Worcester WR5 2LQ **clare.warburton@naturalengland.org.uk**

Contractor - Ricardo-AEA Ltd

Keywords - Air quality, air pollution, roads, biodiversity, designated sites, Sites of Special Scientific Interest, Special Areas of Conservation, Nitrogen oxides, nitrogen deposition, acid deposition, road traffic emissions, road traffic pollution, critical loads, critical levels, diffuse pollution

Further information
This report can be downloaded from the Natural England website: **www.gov.uk/government/organisations/natural-england**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**.

ISBN 978-1-78354-292-5

Potential risk of impacts of nitrogen oxides from road traffic on designated nature conservation sites




Report for Natural England

Ricardo-AEA/R/ED59134

Customer:

Natural England

Customer reference:

ITT672 FST19-04-099

Confidentiality, copyright & reproduction:

Contact:

Richard Smithers
Ricardo-AEA Ltd
Gemini Building, Harwell, Didcot, OX11 0QR

t: 01235 75 3615

e: richard.smithers@ricardo-aea.com

Ricardo-AEA is certificated to ISO9001 and ISO14001

Author:

Richard Smithers, Shaun Brace, Daniel Brookes, Ioannis Tsagatakis and Mark Broomfield

Approved By:

Mark Broomfield

Date:

[Publish Date]

Ricardo-AEA reference:

Ref: ED59134 [Status]

Acknowledgements

This study was commissioned by Natural England and undertaken by Ricardo-AEA. We would particularly like to thank Natural England's Project Officer, Clare Warburton, for her steadfast support. We are also grateful for input and comments provided by other members of Natural England's steering group: Alastair Burn, Kathleen Covill, Zoe Russell (née Masters) and Gordon Wyatt.

Executive summary

There are over 4,100 Sites of Special Scientific Interest (SSSIs) in England, covering around 8% of the country's land area. More than 70% of these sites (by area) are internationally important for their wildlife (the Natura 2000 sites) and designated as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) or Ramsar sites. Whilst many SSSIs and European designated sites are in favourable condition, some are not. The targets/outcomes in the England Biodiversity Strategy ("Biodiversity 2020") are for 90% of priority habitats to be in favourable or recovering condition and at least 50% of SSSIs to be in favourable condition, with a minimum of 95% in favourable or recovering condition.

Biodiversity 2020 identifies air pollution as a direct threat to biodiversity in England. Many habitats of nature conservation importance in the UK are adapted to low nutrient conditions and/or are vulnerable to acidification. They are, therefore, sensitive to additional airborne nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3), as well as to nitrogen deposition and acid deposition. The Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2011 identify that transportation is the single largest source of NO_x emissions and is emitted by road traffic in much larger quantities than SO_2 and NH_3.

A comprehensive review of the ecological effects of diffuse air pollution from road transport on semi-natural habitats (Bignal and others, 2004) concluded that:

- Knowledge of the impacts of road traffic pollution on vegetation was limited and that there were gaps in many aspects of lab-based and field-based research;
- Few studies had looked at differences in impacts along transects away from roads, which are critical to determining a road's 'edge effect' (due to traffic pollutants);
- Although there were many gaps in knowledge, the literature provided evidence that vegetation was being impacted by exposure to motor vehicle pollution at distances of up to 200m from roads and that there was potential for this distance to be greater;
- Although there was some evidence to suggest that wooded shelterbelts act as a physical barrier to nitrogen dioxide transport, buffer zones may be better regarded as providing physical distance between the road and protected sites, rather than an area of vegetation able to remove pollutants from the atmosphere.

The Improvement Programme for England's Natura 2000 Sites (IPENS) will review all Natura 2000 sites. By 2015, there will be an improvement plan for each site and a directory of measures and funding options to deliver favourable condition. Natural England is a statutory consultee on many transport development proposals. Advising on air quality assessments undertaken by developers forms a significant part of its pre-application and statutory advice in relation to transport proposals. Understanding where potential risks to designated sites from traffic-related air pollution are greatest would assist Natural England in relation to IPENS and in responding to casework.

This study's objectives were to:

1. Update Natural England's evidence base on the local effects of air pollution from roads on semi-natural habitats and designated sites;
2. Develop and apply a matrix for screening and assessing the potential risk to SSSIs and SACs of impacts from road traffic emissions;
3. Provide national summary statistics to demonstrate the number and proportion of SSSIs and SACs in England at potential risk from air pollution from roads and the associated condition of these sites;
4. Discuss the implications for England's biodiversity commitments and IPENS work.

Delivery of the first of these objectives is the subject of a separate report (Smithers and others, in press). It concludes that:

- Critical Loads for nitrogen are set empirically, using evidence from long-term field experiments, field surveys and, to a lesser degree, broad ecological surveillance datasets. Nevertheless, Critical Loads for some habitats rely to a large extent on expert judgment. Furthermore, a recent study (Emmett and others 2011) has detected that nitrogen deposition below Critical Loads may be associated with changes in some species and ecosystem function indices, indicating that Critical Loads may not protect all species or ecosystem functions, with possible implications for current conservation commitments and biodiversity targets. Emmett and others 2011 has also identified that changes in species and ecosystem function indices continue above Critical Loads;
- Recent transect studies provide further evidence of the impacts on individual species from exposure to NO_x and nitrogen dioxide (NO_2) associated with vehicle emissions. These impacts are greatest within the first 50-100m from roads but may be discernible at greater distances;
- The findings of many studies, undertaken since 2004, of the effect of nitrogen emissions from road traffic on habitats suggest that NO_2, rather than other forms of nitrogen deposition, is the likely driver of changes in roadside plant communities. All of the studies reinforce that differential effects may lead to changes in competitive advantage between species affecting the composition of vegetation, management of roadside sites and nature conservation.

Whilst delivery of this study's last three objectives (above) focuses on road traffic as the principal source of NO_x in the UK, this should neither be taken to mean that other sources of NO_x are insignificant nor to suggest that the contribution from NO_x to atmospheric nitrogen deposition and acid deposition is any more important than that derived from NH_3 nor, with regard to the latter, from SO_2. Hence, when evaluating the impacts of air pollution from roads, it is important to take into account that their contribution combines with other sources of pollutants that may already approach or exceed Critical Levels or Critical Loads.

In order to categorise the number and proportion of designated sites in England at potential risk of impacts from road traffic emissions, sites were first classified in terms of their exposure to NO_x from road traffic, taking into account other background sources of NO_x. The next step was to classify sites in terms of their sensitivity to NO_x from road traffic. It is not possible to classify sites in terms of their sensitivity to road traffic emissions on the basis of exposure to NO_x, because the air quality standards for NO_x concentrations apply equally to all habitats. However, NO_x makes a substantial contribution to nitrogen deposition and acid deposition for which site-specific Critical Loads were available nationally for SACs. As such, SAC's site sensitivity to NO_x was evaluated on the basis of sensitivity to atmospheric nitrogen deposition and acid deposition. The potential risk of impact to SACs was then categorised by inter-relating exposure and sensitivity through development of a matrix. The method allowed whole sites and specific areas of sites to be classified in terms of their exposure and potential risk of impact; and enabled the collation of national statistics. Site-specific Critical Loads were not available nationally for SSSIs, so assessment of the potential risk of impact to SSSIs was not pursued.

National summary statistics of exposure to NO_x from road traffic were produced separately for SACs and SSSIs with and without major roads within 50m for 2011 and 2020 with regard to High, Medium and Low categories of exposure. National maps of exposure to NO_x from road traffic were produced for SACs and SSSIs for both 2011 and 2020. National summary statistics of potential risk of impacts from NO_x were produced for SACs in each potential risk category with regard to nitrogen deposition and acid deposition for 2011 and 2020. National maps of potential risk of impacts to SACs from NO_x were produced separately for nitrogen deposition and acid deposition with regard to sites with High and Medium and Low sensitivity for 2011 and 2020. Site-level statistics of potential risk of impacts to SACs from NO_x were produced separately for nitrogen deposition and acid deposition for 2011 and 2020. All statistics have been supplied to Natural England as Excel files and are also appended to this report. All maps have been supplied to Natural England, as ESRI Shape Files and as jpegs.

This study has provided Natural England with a valuable analysis of SSSIs and SACs in terms of their exposure to NO_x from road traffic, taking into account other background sources of NO_x, and the potential risk of impacts of NO_x from road traffic on SACs in England. The national statistics provide evidence of the potential significance of road traffic impacts on designated sites, which Natural England can use to develop its thinking and communicate the issue to others, in the context of other sources of emissions to air and other sources of impacts on designated sites.

The results identify that a substantial reduction in the extent of the specific areas and number of sites affected by High or Medium exposure to NO_x from road traffic in combination with other sources by 2020 is projected. However, the projections indicate that in 2020 the level of exposure to NO_x from road traffic, in combination with other sources, will continue to be:

- High across a total of 3822.3ha within 300 SSSIs and 1171.5ha within 80 SACs;
- Medium across a total of 6019.1ha within 103 SSSIs and 2132.5ha within 13 SACs.

This suggests that there is a need for further consideration of the potential risk of impacts at such sites. Although the study finds that there is a substantial projected decline in the potential risk of impacts to SACs from NO_x due to road traffic in combination with other sources between 2011 and 2020, in relation to sites where baseline deposition exceeds Critical Loads for:

- Nitrogen deposition, an area of 539.0ha of 19 sites with High sensitivity and an area of 2159.9ha of 37 sites with Medium sensitivity will continue to have High or Medium exposure to NO_x from road traffic in combination with other sources;
- Acid deposition, an area of 375.9ha of 18 sites with High sensitivity and an area of 600.3ha of 12 sites with Medium sensitivity will continue to have High or Medium exposure to NO_x from road traffic in combination with other sources.

The site-specific statistics provide useful information for Natural England to investigate and prioritise the potential risk of impacts from road traffic on individual SACs. These datasets enhance Natural England's ability to target investigation and potential intervention at specific sites, and to view new proposals with implications for road traffic in the context of the potential risk of impacts posed by air pollution from existing road traffic, subject to uncertainties relating to:

- Impacts of road traffic pollution on habitats and species (Bignal and others 2004; Smithers and others, in press);
- Modelled NO_x concentrations (Section 2.2);
- Critical Loads (Section 2.3);
- Modelled baseline nitrogen deposition and acid deposition (Section 2.3);
- The efficacy of mitigation measures (Bignal and others 2004; Smithers and others, in press).

The maps provide a visual representation of SACs in each category of potential risk. The maps may be imported into a GIS by Natural England, overlaid with other layers and presented for use in a range of forms. The jpegs have been produced at a sufficient resolution to allow users to zoom in on screen to particular areas of interest and identify SSSIs and SACs that may be of particular concern. The maps enable Natural England to gain an overview of potential issues that may extend across multiple sites, and also to identify areas where road traffic pollution may pose a lesser risk to designated sites.

At Natural England's request, the categorisation of risk is not intended to imply any prioritisation because of the uncertainties listed above, because site-specific factors may override other reasons for prioritising action, and in order to allow Natural England greatest freedom in how the information produced is used in the development of its policies and practices. It is recommended that Natural England gives further consideration to prioritising the risk categories and some options are discussed in this report.

It was not possible to inter-relate the condition of SSSI units with the potential risk of impact of NO_x from road traffic in conjunction with other background sources, as the potential risk to SSSIs was not assessed due to lack of a national dataset of site-specific Critical Loads. Natural England also advised that to inter-relate SSSI condition with the potential risk to SACs would have been spurious. The analysis for SSSIs could be undertaken if a national dataset of site-specific Critical Loads is produced in future. However, the results in isolation would be neither likely to demonstrate any clear linkages due to the number of confounding variables nor allow the area of sites in unfavourable condition in whatever is deemed the 'highest' class of potential risk from NO_x due to road traffic to be attributed to air pollution from roads.

Supporting evidence is not currently available from Common Standards Monitoring (CSM), as the link between air pollution and its effect can take many years to manifest itself, and multiple causes can generate very similar looking effects (Hall and others 2006). However, the interagency Chief Scientists' Group is currently testing the feasibility of using CSM criteria in attributing site condition to air pollution, which may be aided by this study's identification of potential risk of impact to designated sites from NO_x due to road traffic. In the meantime, we note that even if NO_x from road traffic is not the reason for the specific areas of sites being in whatever is deemed the 'highest' risk category, it seems reasonable to assume that the exposure of these areas to such air pollution and their sensitivity may compound the challenge of achieving favourable or recovering condition. As such, we would recommend that IPENS uses this study to assist in the identification of those SACs where potential risk of impact from NO_x due to road traffic is a key issue. It could then consider this study's review of mitigation measures (Smithers and others, in press), in conjunction with Bignal and others (2004) and the RAPIDS (Remedies for Air Pollution Impacts on Designated Sites) project, to determine how potential risks of impact from NO_x due to road traffic might be addressed on a site-by-site basis.

Table of contents

1 Background

1.1 SSSIs and European designated sites

There are over 4,100 Sites of Special Scientific Interest (SSSIs) in England, covering around 8% of the country's land area. More than 70% of these sites (by area) are internationally important for their wildlife (the Natura 2000 sites) and designated as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) or Ramsar sites. There are 337 Natura 2000 sites. Many SSSIs are also National Nature Reserves (NNRs) or Local Nature Reserves (LNRs). They are essential to conserving our remaining natural heritage for future generations. Wildlife and geological features are under pressure from development, pollution, climate change and unsustainable land management. SSSIs are important as they support plants and animals that find it more difficult to survive in the wider countryside. Protecting and managing SSSIs is a shared responsibility, and an investment for the benefit of future generations.

SSSI's are legally protected under the Wildlife and Countryside Act 1981, as amended by the Countryside and Rights of Way (CROW) Act 2000 and the Natural Environment and Rural Communities (NERC) Act 2006. Natura 2000 sites are protected under the European Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora), which has been transposed into UK domestic legislation through the Conservation of Habitats and Species Regulations 2010 (as amended), (the "Habitats Regulations 2010"). This legislation gives Natural England powers to ensure better protection and management of SSSIs and Natura 2000 sites and safeguard their future existence.

1.2 Biodiversity 2020 and IPENS

Whilst many SSSIs and European designated sites are in favourable condition, some are not. The targets/outcomes in the England Biodiversity Strategy ("Biodiversity 2020") are for 90% of priority habitats to be in favourable or recovering condition and at least 50% of SSSIs to be in favourable condition, with a minimum of 95% in favourable or recovering condition. Biodiversity 2020 identifies air pollution as a direct threat to biodiversity in England. It includes a Priority Action to reduce air pollution impacts on biodiversity through approaches at national, UK, EU and international levels targeted at the sectors that are sources of relevant pollutants: nitrogen oxides (nitric oxide, NO, and nitrogen dioxide, NO_2, collectively known as NO_x), ozone, sulphur dioxide (SO_2), and ammonia (NH_3).

The Improvement Programme for England's Natura 2000 Sites (IPENS) will review all Natura 2000 sites to:

- Understand the key issues that are affecting their condition;
- Consider how these issues will be addressed;
- Identify how much it will cost and where the money could come from.

By 2015, there will be an improvement plan for each site and a directory of measures and funding options to deliver favourable condition.

1.3 Risk to designated sites from air pollution

Many habitats of nature conservation importance in the UK are adapted to low nutrient conditions and/or are vulnerable to acidification. They are, therefore, sensitive to additional airborne NO_x, SO_2 and NH_3, as well as to nitrogen deposition and acid deposition, with effects on both ecosystem structure and function. Nitrogen deposition and acid deposition are described by the Air Pollution Information System (APIS), as detailed in Box 1 (below).

Box 1 Description of atmospheric nitrogen and acid deposition

Nitrogen deposition

"N deposition is the term used to describe the input of reactive nitrogen species from the atmosphere to the biosphere. Most concern has addressed the impacts of N deposition to terrestrial ecosystems, but impacts may also occur in the marine environment. The pollutants that contribute to N deposition derive mainly from nitrogen oxides (NO_x) and ammonia (NH_3) emissions. In the atmosphere NO_x is transformed to a range of secondary pollutants, including nitric acid (HNO_3), nitrates (NO_3^-) and organic compounds, such as peroxyacetyle nitrate (PAN), while NH_3 is transformed to ammonium (NH_4^+). Both the primary and secondary pollutants may be removed by wet deposition (scavenging of gases and aerosols by precipitation) and by dry deposition (direct turbulent deposition of gases and aerosols) (Fowler and others 1989, Hornung and others 1995)."

Acid deposition

"Acid deposition represents the mix of air pollutants that together lead to the acidification of soils and freshwaters. The term encompasses the popular idea of "acid rain", but also includes the direct uptake of pollutants by the ground in the absence of rain. This direct uptake is referred to as "dry deposition", while precipitation inputs are referred to as "wet deposition". In addition, the direct impaction of cloudwater on hills is sometimes referred to as "occult deposition". Today the contribution of SO_2 has fallen dramatically though with some more linearity since levels have fallen closer to source than over the mountains (Fowler and others 1989). The pollutants that contribute to acid deposition include:

- ***sulphur dioxide (SO_2) and its reaction product sulphate (SO_4^{2-});***
- ***nitrogen oxides (NO_x) and the various reaction products which include nitric acid (HNO_3), nitrate (NO_3^-) and peroxyacetyle nitrate (PAN);***
- ***ammonia (NH_3) and its reaction product ammonium (NH_4^+)".***

http://www.apis.ac.uk **[Accessed April 2014]**

Atmospheric nitrogen deposition and acid deposition are not unique to the UK and are recognised as serious pressures on biodiversity across Europe. The (total) UK deposition of atmospheric nitrogen is currently approximately equally derived from NO_x (46%, 2005) and NH_3 (54%, 2005), not all arising from UK sources (RoTAP 2012). Acid deposition in 2005 was due to airborne SO_2 (30%), NO_x (32%) and NH_3 (37%); equivalent figures for 2020 are SO_2 (25%), NO_x (31%) and NH_3 (44%) (RoTAP 2012). Nitrogen emissions can impact at a highly localised level, as well as contributing to effects from long-range pollutant transport.

Critical Loads and Critical Levels are set by scientists under the auspices of the Convention on Long-Range Transboundary Air Pollution. They are derived from empirical evidence from experiments and field studies across Europe. Critical Levels are defined as *"concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge"*[1]. Critical Loads are defined as: *"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*[1]. Thus, a Critical Level is the gaseous concentration of a pollutant in the air, whereas a Critical Load relates to the quantity of pollutant deposited from the air. Critical Loads for nitrogen deposition and acid deposition are currently exceeded across more than 50% of all broad habitats (RoTAP 2012) and a

[1] http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm

large number/area of Sites of Special Scientific Interest (SSSIs) and SACs (http://www.apis.ac.uk accessed April 2014).

APIS identifies a range of common biological effects caused by an exceedance of the Critical Level for NO_x and Critical Loads for nitrogen deposition and acid deposition (http://www.apis.ac.uk accessed April 2014), as follows:

NO_x

- Visible symptoms for example, leaf discoloration;
- Direct damage to mosses, liverworts and lichens, which receive their nutrients largely from the atmosphere;
- Changes in species composition.

Nitrogen deposition

- Terrestrial impacts:
    - Changes in species composition especially in nutrient poor ecosystems with a shift towards species associated with Higher nitrogen availability (e.g. dominance of tall grasses);
    - Reduction in species richness;
    - Increases in plant production;
    - Decrease or loss of sensitive lichens and bryophytes;
    - Increases in nitrate leaching.
- Freshwater impacts:
    - Potential in N-limited systems to change algal productivity and nutrient regimes in upland lakes;
    - Increase rate of succession.

Acid deposition

- Terrestrial impacts:
    - A decrease in soil base saturation, increasing the availability of aluminium (Al_{3+}) ions, which may cause toxicity to plants and mycorrhiza, and have a direct effect on Lower plants (bryophytes and lichens);
- Freshwater impacts:
    - An increase in Al_{3+} concentrations, impacts on invertebrate populations, and toxicity to fish.

1.4 Air pollution from traffic

Road vehicles emit a cocktail of pollutants including NO_x, volatile organic compounds (VOCs), heavy metals, particulates and NH_3; dust may also be an issue during the road construction phase. The Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2011 identify that transportation is the single largest source of NO_x emissions, accounting for 45.5% of NO_x emissions from England in 2011 with 36% of NO_x emissions being from road traffic (http://uk-air.defra.gov.uk accessed April 2014). The UK map of NO_2 concentrations clearly shows the major transport network (ROTAP, 2012). The UK National Atmospheric Emissions Inventory contains data on emissions of SO_2, NO_x and NH_3 from road traffic up to 2011. In 2011, road traffic resulted in emissions to air of 0.87kT of SO_2, 339kT of NO_x and 9.1kT of NH_3 (http//:naei.defra.gov.uk accessed April 2014). Notably, NO_x is emitted in much larger quantities than the other substances.

A comprehensive review of the ecological effects of diffuse air pollution from road transport on semi-natural habitats (Bignal and others 2004) concluded that:

- Knowledge of the impacts of diffuse pollution from road transport on vegetation was limited and that there were gaps in many aspects of both lab-based and field-based research;

- Few studies had looked at differences in impacts along transects away from roads, which are critical if the ‘edge effect’ of a road (due to motor vehicle pollutants) is to be determined;
- Although there were many gaps in knowledge, the literature provided evidence that vegetation was being impacted by exposure to motor vehicle pollution at distances of up to 200m from roads and that there was potential for this distance to be greater;
- Although there was some evidence to suggest that wooded shelterbelts act as a physical barrier to NO_2 transport, buffer zones may be better regarded as providing physical distance between the road and protected sites, rather than an area of vegetation able to remove pollutants from the atmosphere.

1.5 Natural England’s role as a statutory consultee

Natural England is a statutory consultee on many transport development proposals, including:

- Nationally Significant Infrastructure Projects and other major transport schemes (roads, rail, port and airport expansion);
- Environmental Impact Assessments of transport schemes;
- Strategic Environmental Assessment/Sustainability Appraisal in relation to Local Transport Plans and Local Plans;
- Habitats Regulations Assessment in relation to transport plans and projects.

Advising on air quality assessments undertaken by developers forms a significant part of Natural England’s pre-application and statutory advice in relation to transport proposals. Understanding where potential risks to designated sites from traffic-related air pollution are greatest would assist advisers in responding to casework.

1.6 Purpose of this study

The purpose of this study was to assess the potential risk that air pollution from roads poses to the SSSI and Natura 2000 network in England. Natural England sought development of a methodology for assessing the risk at the local/regional scale to enable its assessment of the implications for its biodiversity commitments, particularly when providing air quality advice to developers on transport schemes.

In developing an approach/guidance to local/regional casework, Natural England needs a clear national picture of the potential risks and to be sure how it fits with its broader strategy. This study was intended to help inform Natural England’s strategy in relation to designated sites adjacent to roads, including the development of an approach to assessing increases in traffic emissions from new road schemes.

Whilst the study focuses on road traffic as the principal source of NO_x in the UK, this should neither be taken to mean that other sources of NO_x are insignificant nor to suggest that the contribution from NO_x to atmospheric nitrogen deposition and acid deposition is any more important than that derived from NH_3 nor, with regard to the latter, from SO_2. Hence, when evaluating the impacts of air pollution from roads, it is important to take into account that their contribution combines with other sources of pollutants that may already approach or exceed Critical Levels or Critical Loads .

1.7 Aims of the study:

- To quantify the potential risk to designated sites (SSSIs and SACs) from short-range air pollution from roads;
- To help advance understanding of the effect it is having on site condition;
- To produce summary statistics (evidence) that can be used to communicate the potential risk within Natural England, with the Department for Environment, Food and Rural Affairs (Defra) and with Natural England’s stakeholders and customers;

- To develop a more detailed, robust method/tool for illustrating and quantifying the potential risk at the local/county level.

1.8 Objectives

The study's objectives were to:

1. Update Natural England's evidence base on the local effects of air pollution from roads on semi-natural habitats and designated sites;
2. Develop and apply a matrix for screening and assessing the potential risk to SSSIs and SACs of impacts from road traffic emissions;
3. Provide national summary statistics to demonstrate the number and proportion of SSSIs and SACs in England at potential risk from air pollution from roads and the associated condition of these sites;
4. Discuss the implications for England's biodiversity commitments and IPENS work.

Delivery of the first of these objectives is the subject of a separate report (Smithers and others, in press).

1.9 Update to evidence base

The separate report on Objective 1 (Smithers and others, in press) provides an update to Bignal and others (2004), and:

- Summarises the findings of peer-reviewed or grey literature that has been published subsequently;
- Incorporates conclusions from research looking at the impacts of, and remedies for, road traffic air pollution in relation to Natura 2000 sites, specifically those features of interest that are sensitive to air pollution;
- Updates recommendations on remedies for tackling air pollution (including case studies).

Key conclusions of Smithers and others (in press) relevant to delivery of Objectives 2, 3 and 4 are that:

- Critical Loads for nitrogen are set empirically, using evidence from long-term field experiments, field surveys and, to a lesser degree, broad ecological surveillance datasets. Nevertheless, Critical Loads for some habitats rely to a large extent on expert judgment. Furthermore, a recent study (Emmett and others 2011) has detected that nitrogen deposition below Critical Loads may be associated with changes in some species and ecosystem function indices, indicating that Critical Loads may not protect all species or ecosystem functions, with possible implications for current conservation commitments and biodiversity targets. Emmett and others 2011 has also identified that changes in species and ecosystem function indices continue above Critical Loads;
- Recent transect studies provide further evidence of the impacts on individual species from exposure to nitrogen oxides (NO_x) and nitrogen dioxide (NO_2) associated with vehicle emissions. These impacts are greatest within the first 50-100m from roads but may be discernible at greater distances;
- The findings of many studies, undertaken since 2004, of the effect of nitrogen emissions from road traffic on habitats suggest that NO_2, rather than other forms of nitrogen deposition, is the likely driver of changes in roadside plant communities. All of the studies reinforce that differential effects may lead to changes in competitive advantage between species affecting the composition of vegetation, management of roadside sites and nature conservation.

2 Methodology

2.1 Summary

In order to categorise the number and proportion of designated sites in England at potential risk of impacts from road traffic emissions, SSSIs and SACs were first classified in terms of their **exposure** to NO_x from road traffic, taking into account other background sources of NO_x.

The next step was to classify sites in terms of their **sensitivity** to NO_x from road traffic. It is not possible to classify sites in terms of their sensitivity to road traffic emissions on the basis of exposure to NO_x, because the air quality standards for NO_x concentrations apply equally to all habitats. However, NO_x makes a substantial contribution to nitrogen deposition and acid deposition for which site-specific Critical Loads were available nationally for SACs. As such, SAC's site sensitivity to NO_x was evaluated on the basis of sensitivity to atmospheric nitrogen deposition and acid deposition.

The **potential risk of impact** to SACs was then categorised by inter-relating exposure and sensitivity through development of a matrix. The method allowed whole sites and specific areas of sites to be classified in terms of their exposure and potential risk of impact; and enabled the collation of national statistics.

Site-specific Critical Loads were not available nationally for SSSIs, so their assessment was not pursued. This also meant that it was not possible to inter-relate the condition of SSSI units with the potential risk of impact of NO_x from road traffic in conjunction with other background sources, as Natural England advised that to have done so for SACs would have been spurious.

Figure 1 (below) provides an outline schematic of the methodology and further details are provided below.

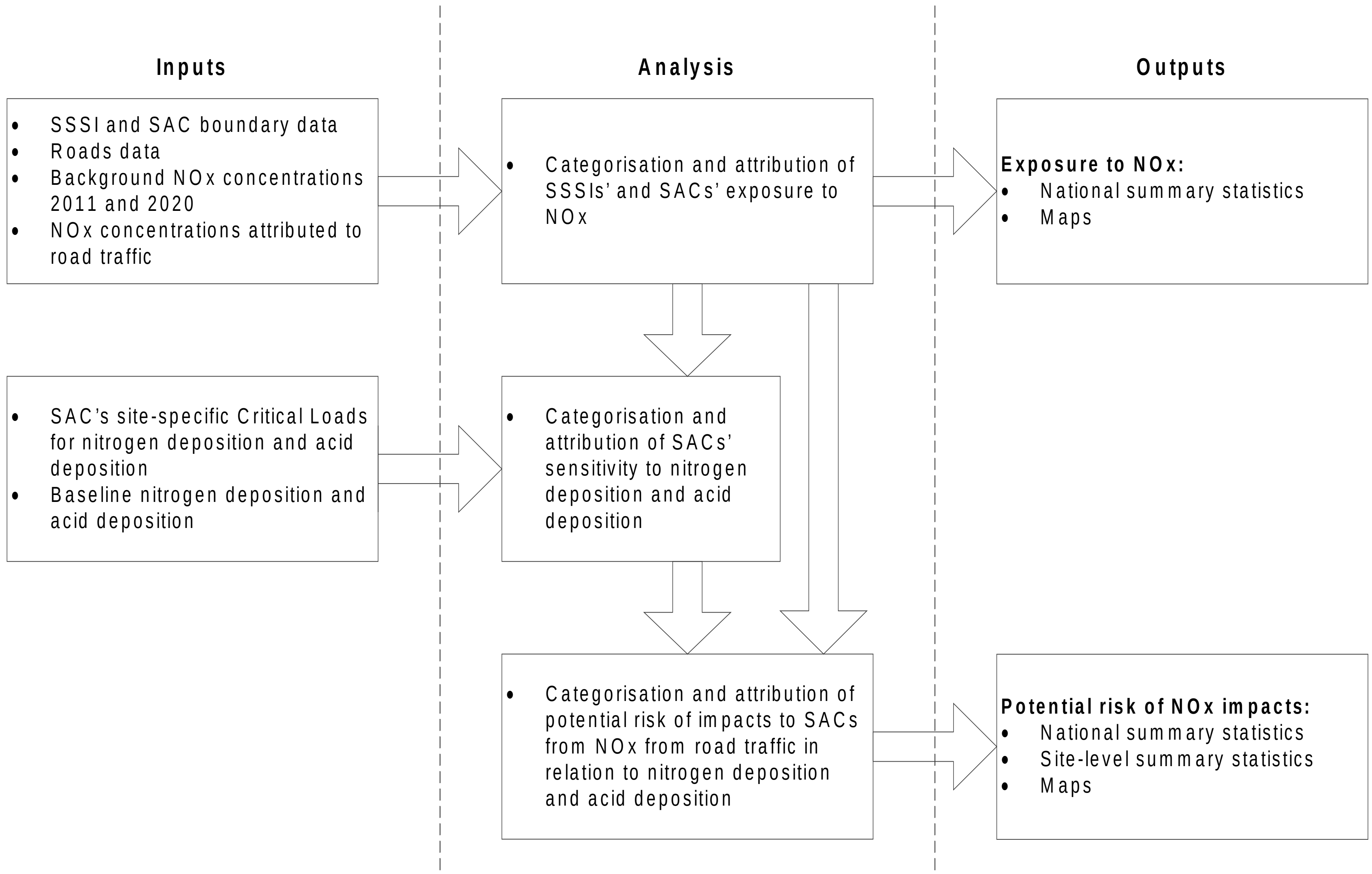


Figure 1 Outline schematic of the methodology, identifying inputs, analysis, and outputs

2.2 Determining exposure to NO_x from road traffic

Careful consideration was given to two possible metrics that could be used for evaluating the level of exposure of designated sites to NO_x from road traffic:

1. The rate of NO_x emissions from road traffic per kilometre of road, together with the distance of the road from the designated site. This was a potentially an attractive option because of the robustness of traffic-emissions data, which has been subject to extensive verification and is widely used by Government departments and agencies; and
2. NO_x concentrations at the designated site due to road traffic. This was a potentially attractive option, as it provides data of direct relevance to the assessment of impacts on designated sites and is also used in support of national policies, such as Local Air Quality Management (LAQM).

The sources of these datasets are set out below.

Emissions data

National total hot-exhaust emissions from road transport and related estimates of fuel consumption are calculated as part of the NAEI (http://naei.defra.gov.uk/ accessed April 2014), which covers a wide range of pollutants, including NO_x. Fuel consumption and emissions factors are used for each vehicle type in the UK vehicle fleet. The vehicle fleet age profiles, Euro standard and fuel mix are derived using Regional Vehicle Licensing Statistics (DVLA) and the Department for Transport's (DfT) Automatic Number Plate Recognition (ANPR) database. As the fleet mix varies by location, different emissions factors are applied to different road types in the Devolved Administrations. This dataset is described by Passant and others (2013).

Emissions are also mapped within a Geographical Information System (GIS) throughout the UK. The Ordnance Survey (OS) Meridian 2 base map of the UK road network is used to provide locations of all roads (motorways, A-roads, B-roads and minor roads) in Great Britain. Traffic flow data from DfT are used to attribute the road network with vehicle flows for major roads. Emissions and fuel consumption factors are then applied to derive emissions estimates taking into account factors, such as regional fleet characteristics, road type, and vehicle speeds (Tsagatakis and others 2013).

For minor roads, an alternative approach is used to provide emissions data, as availability of data is more limited. Minor road lengths are calculated within a GIS from the OS Meridian 2 road network on a 1 x 1km grid covering the UK. These are then combined with average traffic flows by vehicle type and minor road type at a regional level to derive vehicle kilometres (vkm) by vehicle type. Emissions and fuel consumption factors are then applied to derive emissions estimates on a 1 x 1km grid. Further details of the emissions estimates are given in the UK Emissions Mapping Methodology (Tsagatakis and others 2013).

For this study, consideration was given to use of detailed road transport emissions data from the NAEI 2010 and for 2020 based on the Department of Energy and Climate Change's Updated Energy and Emissions Projections (UEP45; DECC, 2012).

Concentrations data

Annual mean NO_x concentrations at background and roadside locations have been derived for the UK using the NAEI emissions maps, produced by Ricardo-AEA and predecessors on behalf of Defra since the late 1990s (see e.g. Brookes and others 2012). Maps of concentrations for 2011 and 2020 were made available for this study by Defra. The NO_x modelling was underpinned by the NAEI 2010 NO_x emissions estimates (Passant and others 2012) and projections of emissions were based on DECC's UEP45 energy and emissions projections (DECC 2012).

NO_x concentrations at those areas of designated sites up to 50m from major roads were estimated with specific regard to individual road links, whilst concentrations at greater distances were based on the proportion of area source emissions[2] attributed to road traffic. Further details are provided below. Given that transect studies provide evidence of the effects of road traffic pollution on species and habitats up to and beyond 200m from roads (Bignal and others 2004; Smithers and others in press), it would have been preferable to link NO_x concentrations to specific major roads at distances greater than 50m but this was not supported by established modelling methods.

For those areas of designated sites up to 50m from major roads, NO_x concentrations at any given distance from a particular road link were estimated by extending the Pollution Climate Mapping (PCM) roadside increment modelling method (described most recently in Brookes and others 2012). The PCM model is calibrated using measured concentrations at roadside Automatic Urban and Rural Network (AURN) monitoring sites in urban areas at an average distance of 4m from the kerb. To extend the predicted NO_x concentrations to distances in the range up to 50m from the kerb, the empirical approach of Laxen and Marner (2008) and Defra (2009) was followed. This approach describes the fall-off in NO_2 concentrations at different distances from the road. Concentrations derived using this approach for all major roads should be considered as estimates, because the PCM model is calibrated using AURN monitoring sites in urban areas, whereas the majority of designated habitat sites are in rural areas.

For those areas of designated sites beyond 50m from a major road, NO_x concentrations attributed to local road traffic were derived from the NAEI's 1km x 1km background emissions maps. The PCM methodology used to produce these maps (again most recently described in Brookes and others 2012) determines background concentrations on a 1km x 1km basis by using a unitary inverse dispersion kernel to calculate the contribution of emissions from area sources attributed to road traffic within a 33km x 33km square surrounding each 1km x 1km square. The impact of sources of NO_x within 50 metres of the receptor location in that square is excluded by the PCM methodology on the basis that background sites are not located very close to specific sources such as major roads. As the areas of designated sites for this part of the analysis were more than 50m from a major road, the PCM approach to removing the impact of sources of NO_x within 50m of the receptor location is appropriate as a basis for evaluating concentrations in such locations.

The PCM background model is specifically designed to represent concentration levels away from the influence of particular local sources. Hence, it does not pick up steep local gradients in concentrations at a resolution less than the 1km x 1km grid except where specifically represented for major roads. In some cases the concentrations will, therefore, be under-estimated where an area of a designated site is more than 50m from a major road but close to another significant source of NO_x from road traffic. This is unavoidable, since information on the spatial distribution of emissions at the sub-grid level is only available for major roads.

Selection of concentrations vs emissions data

The emissions datasets described above are robust and based on extensive vehicle emissions estimates, albeit subject to ongoing refinement and updating. However, they do not enable assessment of NO_x levels at specific locations and, hence, are a less sensitive means of evaluating exposure at designated sites than the concentrations datasets. By providing NO_x concentrations associated with road traffic, the modelled data described above enable exposure to be evaluated with reference to the air quality standard for annual mean NO_x concentrations of $30\mu g/m^3$, which has been established for protection of vegetation.

One disadvantage of the concentration dataset is that additional uncertainty is introduced through the modelling process used to calculate NO_x concentrations due to road traffic emissions. Nevertheless, the dataset does allow concentrations to be estimated specifically at designated sites, and is widely used elsewhere to support policy and regulation in relation to the impact of road traffic emissions on air quality (e.g. in LAQM, and in support of the land-use planning process for traffic-generating development). Given the need to adopt a

[2] Area source emissions are defined as 'diffuse emissions' from many unspecified locations

precautionary approach, it was concluded with Natural England that the concentration dataset was the most appropriate to use to evaluate the exposure of designated sites to NO_x from road traffic.

Key uncertainties in the modelled projections include:

- The weather can impact on the magnitude of emissions from domestic and commercial heating and the dispersion of air pollutants. The weather may not be the same as in the reference year for the projections, which is 2011;
- The economic and energy forecasts used to derive emission projections;
- The expected levels of future traffic activity;
- The expected rates of turnover in vehicle fleets;
- The assumption regarding the emission factors for road traffic. The projections are particularly sensitive to the assumptions for the emissions performance of Euro 6 diesel cars and vans. Note that the impact of any reduction in emissions from a second stage of Euro 6 emission limits for cars and vans has not been included in the baseline projections.

Classification of exposure

As described in 'Emissions data' above, Ricardo-AEA has developed a dataset for Defra that establishes total background NO_x concentrations on a 1km x 1 km grid square basis from which the contributions from road traffic were extracted.

An important factor in determining the significance of designated sites' exposure to NO_x from roads is the background concentration of NO_x not attributable to the relevant traffic. In particular, when this is taken into account, it may make a substantial difference to an assessment of exposure to NO_x from traffic if the relevant road increment does or does not result in an exceedance of the air quality standard, or exacerbates a pre-existing exceedance of the standard. For example, the situation where the road contribution is 10µg/m^3 and the background level not attributable to relevant traffic is:

- 15µg/m^3 would not lead to an exceedance of the air quality standard of 30µg/m$^{3;}$
- 25µg/m^3 would result in an exceedance of the air quality standard;
- 35µg/m^3 would not itself result in a new exceedance of the standard, but would result in a substantial worsening of an existing exceedance.

Background concentrations of NO_x in rural areas away from significant road traffic sources were evaluated from measurements reported from all rural and suburban background sites within the AURN during 2010 to 2013 (see Table 1 below). This indicated that rural background levels of NO_x are typically in the range 15 – 20µg/m^3. Hence, a major road concentration increment of 10 – 15µg/m^3 at a designated site would typically be expected to result in the exceedance of the air quality standard, even if the standard would not have been exceeded in the absence of the road.

A precautionary approach was adopted to development of a system for classifying designated sites in terms of their exposure to NO_x from local road traffic in combination with baseline levels.

Table 1 Measured levels of NO_x at rural and suburban background sites

Year	Number of sites	Average NO_x concentration ($\mu g/m^3$)	25th percentile NO_x concentration ($\mu g/m^3$)	50th percentile NO_x concentration ($\mu g/m^3$)	75th percentile NO_x concentration ($\mu g/m^3$)	Range of NO_x concentration ($\mu g/m^3$)
2010	10	16.3	11.4	14.4	20.6	6.0 – 34.8
2011	12	14.5	8.9	12.2	20.0	4.7 – 26.5
2012	11	16.7	10.6	13.0	24.5	5.1 – 32.7
2013	10	13.6	10.5	13.5	17.7	6.1 – 21.9

Note: Data recorded at: Charlton Mackrell, Glazebury, Harwell, High Muffles, Ladybower, Leominster, Lullington Heath, Market Harborough, Rochester Stoke, St Osyth, Wicken Fen, Yarner Wood

The classification system defined the NO_x contribution from roads, as follows:

- Large > 10µg/m^3;
- Medium 5 to 10µg/m^3;
- Small < 5µg/m^3.

The background concentration of NO_x was defined in the context of the air quality standard of 30µg/m^3, as follows:

- High > 25µg/m^3;
- Medium 20 to 25µg/m^3;
- Low < 20µg/m^3.

The classes of exposure of designated sites to NO_x from relevant road traffic in combination with other sources were then defined, as detailed in Table 2.

Table 2 Classes of exposure of designated sites to NO_x from road traffic in combination with other sources

Exposure	Qualifying scenarios
High (background concentration + road contribution >30µg/m^3 in all cases)	• High or Medium background + Large contribution; • High background + Large or Medium contribution; • Low background + Large contribution (where total >30µg/m^3).
Medium (background concentration + road contribution > 25µg/m^3 but may or may not exceed 30µg/m^3)	• High background + Small contribution; • Medium background + Medium contribution; • Low background + Large or Medium contribution (where total >25µg/m^3 and <30µg/m^3).
Low (background concentration + road contribution <25µg/m^3 in all cases)	• Low background + Small contribution; • Low background + Large or Medium contribution (where total <25µg/m^3).

National summary statistics of exposure to NO_x from road traffic

The system for classifying exposure was applied in a GIS in relation to all SACs and terrestrial SSSIs that are sensitive to NO_x (as defined by Natural England, i.e. excluding geological SSSIs) by overlaying the following data:

- SAC and SSSI boundaries supplied by Natural England (Note: SACs included coastal/marine sites that were not included in the SSSI dataset; Figure 2);
- The concentrations data described in Section 2.2;
- Ordnance Survey Meridian 2 (2014) roads data.

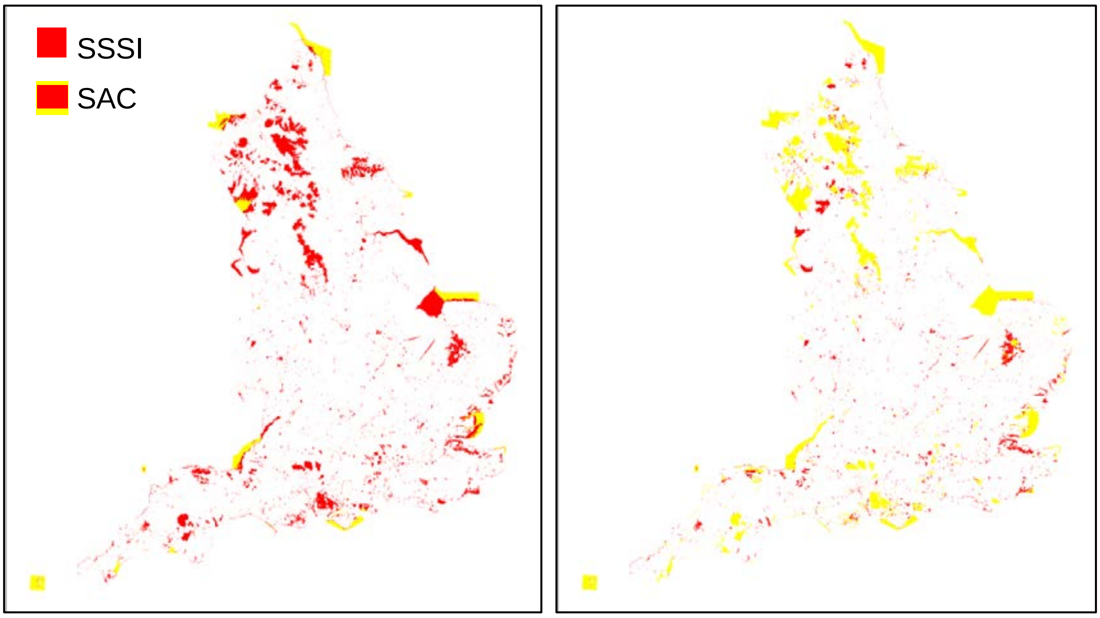


Figure 2 SSSI data and SAC data used in the analyses overlaid on one another

In order to classify areas of SACs and SSSIs within 50m of a major road using the qualifying scenarios, the contribution from roads was defined as the NO_x concentrations attributed to the major road and the background concentration was defined as the total background NO_x. For areas of SACs and SSSIs not within 50m of a major road, the contribution from roads was defined as the NO_x concentrations from road traffic attributed to the 1km x 1km square and the background concentration was defined as the total background NO_x minus the NO_x concentrations from road traffic attributed to the 1km x 1km square.

Statistics were produced separately for SACs and SSSIs with and without major roads within 50m for 2011 and 2020 in regard to:

- Total area of sites in the High, Medium and Low categories of exposure (with each site classified as a whole according to the specific area with the highest exposure) or that could not be classified (non-terrestrial areas for which no NO_x concentrations data was available to allow calculation of exposure) or that was not sensitive. The total area of sites in each category was also expressed as a percentage of the total area of all sites;
- Total area of specific areas of sites in the High, Medium and Low categories of exposure or unclassified or not sensitive, also expressed as a percentage of the total area of all sites;
- Total number of sites and SSSI units in the High, Medium and Low categories of exposure, also expressed as a percentage of the total number of all sites or SSSI units.

National maps of exposure to NO_x from road traffic

Two versions of maps were produced for both 2011 and 2020 in which either:

- The whole of each site was shaded according to the specific area of the site that was attributed the highest class of exposure; or
- The specific areas of each site were shaded according to their exposure class (i.e. areas within 50m of major roads or by individual 1km x 1km square).

2.3 Defining site sensitivity to NO_x from road traffic

Means of determining site sensitivity to NO_x

NO_x can have a direct impact on species and habitats and an indirect impact on them by contributing to atmospheric nitrogen deposition and acid deposition (see Section 1.3).

APIS specifies annual mean and 24-hour mean Critical Levels for NO_x. These Critical Levels apply equally to all habitat types and, therefore, do not differentiate sensitivity to airborne NO_x between sites. In contrast, impacts due to nitrogen deposition and acid deposition at designated sites are assessed by reference to Critical Loads. Lower (i.e. more demanding) Critical Loads are applied to more sensitive habitats and species.

NO_x makes an important contribution to both nitrogen deposition and acid deposition, but is not the sole contributor. Airborne NH_3 makes a significant contribution to nitrogen deposition and airborne SO_2 and NH_3 make significant contributions to acid deposition (Section 1.3). Sensitivities to nitrogen deposition and acid deposition are, therefore, associated with wider issues than NO_x concentrations. However, exposure to NO_x concentrations is the principal route by which road traffic contributes to nitrogen deposition and acid deposition (Section 1.4). Consequently, the evaluation of site sensitivity to NO_x was based on the site-specific Critical Loads for nitrogen deposition and acid deposition available nationally for SACs. Further information on the derivation of these Critical Loads is provided on APIS (http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm accessed April 2014). Site-specific Critical Loads are not available nationally for SSSIs, so their further assessment was not pursued.

Site sensitivity to nitrogen deposition

Data on SAC's site-specific Critical Loads for nitrogen deposition were supplied by Natural England. The Critical Loads are assigned by 1km x 1km grid square on the assumption that all designated features (habitats and/or species) for an SAC occur across the entire site. The sensitivity of habitats/species to nitrogen deposition at each designated site is defined on APIS using a range of Critical Load values (e.g. 5 – 10 kgN/ha/year). The lower value is referred to as the "minimum Critical Load for nitrogen deposition" and is more protective than the higher value. Minimum Critical Load values for nitrogen deposition can take the following values: 5, 8, 10, 15 or 20 kgN/ha/year. Site sensitivity to nitrogen deposition was defined in relation to the habitat/species at each designated site with the lowest minimum Critical Load. The sensitivity of individual sites was then classified in relation to the range of values for all sites as follows:

- High sensitivity to nitrogen deposition: 5 or 8kgN/ha/year;
- Medium sensitivity to nitrogen deposition: 10 or 15kgN/ha/year;
- Low sensitivity to nitrogen deposition: 20kgN/ha/year.

APIS does not define a Critical Load for some SACs, either because the site is not sensitive to nitrogen deposition or because there is insufficient data to allocate a Critical Load.

Site sensitivity to acid deposition

Data on SAC's site-specific Critical Loads for acid deposition were supplied by the Centre for Ecology & Hydrology (CEH) and had been derived using (a) national soils data (National Soil Resources Institute, Macaulay, Department of Agriculture and Rural Development – Northern

Ireland; data obtained under licence agreements) and (b) other national datasets from CEH. Further details are available (http://cldm.defra.gov.uk accessed April 2014). Again, the Critical Loads are assigned by 1km x 1km grid square on the assumption that all designated feature habitats/species for an SAC occur across the entire site

The sensitivity of designated sites to acid deposition is defined on APIS in terms of three Critical Load values, referred to as “CLminN”, “CLmaxN” and “CLmaxS”. These values define the Critical Load function for a site, and are specified in units of kEq/ha/year (the term “Eq” means an “equivalent”: that is, one mole of hydrogen ions with a mass of one gram). Again, minimum and maximum values are defined where appropriate, with the minimum values being more protective.

APIS notes that in the majority of cases, baseline deposition is above the CLminN value (http://www.apis.ac.uk/clf-guidance accessed April 2014). In this case, the contribution of a particular source to acid deposition should be expressed as a percentage of the CLmaxN value. Consequently, the CLmaxN value was used to classify SACs in terms of their sensitivity to acid deposition. Site sensitivity to acid deposition was defined in relation to the habitat/species at each SAC with the lowest CLmaxN. The full range of minimum CLmaxN values for all designated sites in England were reviewed, and divided into three groups, such that approximately one third of all values were in each sensitivity class, as follows:

- High sensitivity to acid deposition: minCLmaxN 0.3 to <1.0kEq/ha/year;
- Medium sensitivity to acid deposition: minCLmaxN 1.0 to <2.0kEq/ha/year;
- Low sensitivity to acid deposition: minCLmaxN 2.0 to 14.0kEq/ha/year.

For some SACs, no Critical Load is defined because the site is not sensitive to acid deposition, or because there is insufficient data to allocate a Critical Load.

Baseline deposition

Baseline deposition is an important factor in determining site sensitivity. A site where nitrogen deposition or acid deposition is already close to or above the Critical Load is likely to be more sensitive to further deposition than a site where deposition is well below the Critical Load. Baseline levels of deposition relative to the site-specific Critical Loads were, therefore, used in classifying site sensitivity. As a result of ongoing research into dose-response relationships for application of Critical Load models, Natural England was particularly concerned that the situation where baseline deposition was approaching the Critical Load should be specifically identified. Due to a lack of specific evidence, an arbitrary threshold of within 10% of the Critical Load was set. Thus, there were three secondary classes of site sensitivity, where baseline deposition was:

- Above (>100%) the Critical Load;
- Approaching (90% – 100%) the Critical Load;
- Not approaching (<90%) the Critical Load.

Data on baseline nitrogen deposition and acid deposition for 2009–2011 (using the Concentration Based Estimated Deposition – CBED model), hereafter referred to as ‘2011’, and 2020 (using the Fine Resolution Atmospheric Multi-pollutant Exchange – FRAME – model) were supplied by CEH. Two caveats relating to the 2020 data are that they were:

- Calibrated to CBED 2006–08 data (rather than the 2011 data used here);
- Based on DECC’s UEP43 emissions scenarios (DECC 2011); more recent scenarios may give different projections.

These data are assigned to a 5km x 5km grid, and so are at a lower resolution than data in relation to NO_x concentrations attributed to road traffic and background levels of NO_x. Nevertheless, these data provide a useful indication of whether nitrogen deposition and acid deposition at an individual site are above, close to, or below the relevant Critical Loads. The data supplied by CEH provide background deposition rates that account for the different deposition velocities of different land-cover types and assume:

- Moorland everywhere – these values are intended for use in relation to all grass/heath/bog/montane or other low-growing natural or semi-natural vegetation/habitats and were used in this study as the default values;
- Woodland everywhere – these values were applied in this study to all sites containing woodland habitats.

2.4 Establishing potential risk of impacts from NO_x due to road traffic

Exposure to NO_x from road traffic and sensitivity to nitrogen deposition and acid deposition were inter-related in separate matrices for nitrogen deposition (Figure 3, page 17) and acid deposition (Figure 4, page 17) in order to categorise the potential risk of impacts from NO_x at each SAC. These matrices enabled SACs to be classified on an individual and nationally consistent basis.

The potential risk of impacts from NO_x at SACs due to road traffic was classified on the basis of:

- Exposure to NO_x from road traffic (taking background concentrations into account), classified as High, Medium or Low, as described in Section 2.2;
- The site sensitivity to nitrogen deposition and acid deposition, classified as High, Medium or Low, as described in Section 2.3;
- Baseline levels of nitrogen deposition or acid deposition relative to the Critical Load, as described in Section 2.3.

The matrices for nitrogen deposition (Figure 3, page 17) and acid deposition (Figure 4, page 17) were each applied separately in a GIS in relation to all SACs. A colour-coding scheme was used to enable the various classes of potential risk to be mapped, as shown in Figures 3 and 4 (page 17). At Natural England's request, colours were chosen that do not imply any prioritisation. This was because of the uncertainties listed in Section 4.1, because site-specific factors may override other reasons for prioritising action, and in order to allow Natural England greatest freedom in how the information produced is used in the development of its policies and practices

National summary statistics of potential risk of impacts from NO_x

National summary statistics were produced for SACs with regard to:

- Nitrogen deposition and acid deposition;
- 2011 and 2020.

All figures were laid out in accordance with the format of the matrices (Figures 3 and 4, page 17). Individual matrices were completed with the following sets of figures:

- Total area of SACs in each potential risk category or with no Critical Load (with each site classified as a whole according to the specific area with the highest code number, ordered firstly by sensitivity, secondly by baseline deposition versus Critical Load and thirdly by exposure; Table 3), also expressed as a percentage of the total area of all SACs;
- Total area of specific areas (ie the sum total of specific areas) of SACs in each potential risk category or with no Critical Load, also expressed as a percentage of the total area of all SACs but excluding that area that was unclassified (ie non-terrestrial areas for which no NO_x concentrations data was available to allow calculation of exposure);
- Total number of SACs in the High, Medium and Low categories of exposure, also expressed as a percentage of the total number of all SACs.

Table 3 Classification of SACs in order of decreasing code number

(eg High Above High = 'High' sensitivity + Baseline deposition 'Above' CL + 'High' exposure)

Classification	Code	Classification	Code
High Above High	333	Medium Approaching Low	221
High Above Medium	332	Medium Below High	213
High Above Low	331	Medium Below Medium	212
High Approaching High	323	Medium Below Low	211
High Approaching Medium	322	Low Above High	133
High Approaching Low	321	Low Above Medium	132
High Below High	313	Low Above Low	131
High Below Medium	312	Low Approaching High	123
High Below Low	311	Low Approaching Medium	122
Medium Above High	233	Low Approaching Low	121
Medium Above Medium	232	Low Below High	113
Medium Above Low	231	Low Below Medium	112
Medium Approaching High	223	Low Below Low	111
Medium Approaching Medium	222		

National maps of potential risk of impacts from NO_x

Maps were produced separately for nitrogen deposition and acid deposition with regard to:

- SACs with High and Medium and Low sensitivity;
- 2011 and 2020;
- Whole SACs (with each SAC shaded as a whole according to the specific area with the highest code number; Table 3) and specific areas of SACs shaded according to their potential risk of impacts from NO_x.

The colour coding schemes in the matrices (Figures 3 and 4, page 17) were used.

Site-level statistics

Site-level statistics were produced separately for nitrogen deposition and acid deposition with regard to:

- 2011 and 2020;
- Whole SACs (with each SAC classified as a whole according to the specific area with the highest code number; Table 3) and specific areas of SACs.

The statistics provide:

- The total area in each potential risk category (i.e. relating to each possible combination of classes of sensitivity, baseline deposition as compared to the Critical Load, and exposure, as defined in Figures 3 and 4, page 17).

2.5 Inter-relating potential risk of impacts with condition

The resultant classification of SACs in relation to potential risk of impact of NO_x from road traffic in conjunction with other background sources was not inter-related in a GIS with the current condition of SSSI units, as Natural England advised that to have done so for SACs would have been spurious.

Site sensitivity to N deposition / **Exposure to NO_x from traffic taking account of background concentrations**	High (min. CL 5 or 8 kgN/ha/year)			Medium (min. CL 10 or 15 kgN/ha/year)			Low (min. CL 20 kgN/ha/year)			No CL
	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	
High										
Medium										
Low										

Figure 3 Potential risk of impacts matrix for nitrogen deposition

Site sensitivity to acid deposition / **Exposure to NOx from traffic taking account of background concentrations**	High (minCLmaxN 0.3 to <1.0 kEq/ha/year)			Medium (minCLmaxN 1.0 to <2.0 kEq/ha/year)			Low (minCLmaxN 2.0 to 14.0 kEq/ha/year)			No CL
	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	
High										
Medium										
Low										

Figure 4 Potential risk of impacts matrix for acid deposition

3 Results

3.1 Exposure to NO_x from road traffic

National summary statistics

As described in Section 2.2, national summary statistics on the exposure of SSSIs and SACs to NO_x from road traffic can be found for 2011 in Appendix 1 and for 2020 in Appendix 2. Whole site statistics and maps were prepared for visualisation purposes at Natural England's request in order to aid easy identification of sites with High exposure. However, whole site statistics are not analysed here, instead focus is given to the more accurate statistics assembled for specific areas of sites.

We would recommend readers look at the full set of results in Appendices 1 and 2 covering High, Medium and Low exposure to NO_x from road traffic. The findings in relation to the specific areas of sites in the highest categories of exposure to NO_x from road traffic in combination with other sources, i.e. High or Medium, (Table 4) are that a substantial reduction in their total area by 2020 is projected. However, the projections indicate that in 2020 the level of exposure to NO_x from road traffic in combination with other sources will continue to be:

- High across a total of 3822.3ha within 300 SSSIs and 1171.5ha within 80 SACs;
- Medium across a total of 6019.1ha within 103 SSSIs and 2132.5ha within 13 SACs.

Sites categorised as having Low exposure to NO_x from road traffic in combination with other sources should not be overlooked. Low exposure to NO_x from road traffic could exacerbate risks to species and ecosystem functions at sites where baseline nitrogen or acid deposition is already above the Critical Load or could lead to the Critical Load being exceeded at sites where baseline nitrogen or acid deposition is approaching the Critical Load. The results of the assessment of potential risk of impacts of NO_x from road traffic are presented in Section 3.2.

Table 4 Specific areas of sites (SSSIs and SACs) with High or Medium exposure to NO_x from road traffic

Exposure to NO_x from traffic taking account of background concentrations	2011				2020			
	SSSIs		SACs		SSSIs		SACs	
	Total area (ha)	Total number of sites	Total area (ha)	Total number of Sites	Total area (ha)	Total number of sites	Total area (ha)	Total number of sites
High	41,559.3	664	15,434.3	88	3822.3	300	1171.5	60
Medium	24,827.3	211	11,432.5	12	6019.1	103	2132.5	13

National maps

All maps detailed in Section 2.2 have been supplied to Natural England, as ESRI Shape Files and as jpegs.

Figures 5 and 6 (below) are excerpts from the national maps of SSSIs that are sensitive to air pollution categorised according to their exposure to NO_x from background concentrations plus contributions from road traffic for 2011, which illustrate the two versions of maps produced for each year, as detailed in Section 2.2.

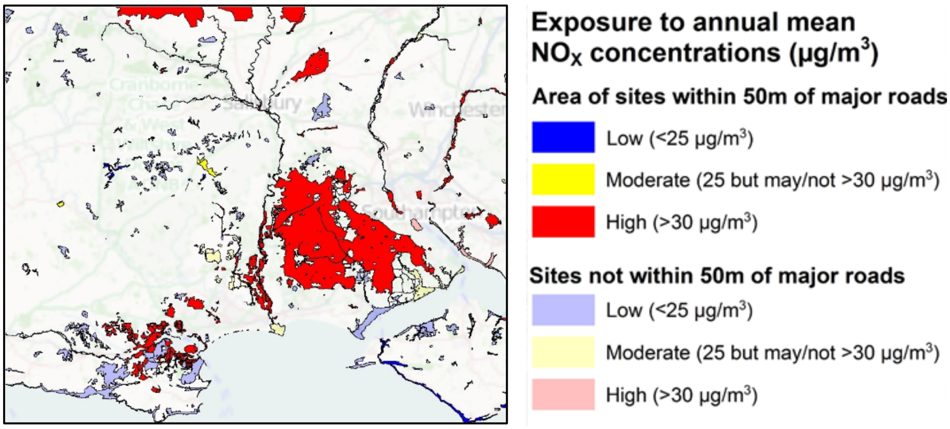


Figure 5 The whole of each SSSI shaded according to the specific area of the site that was attributed the highest class of exposure[3]

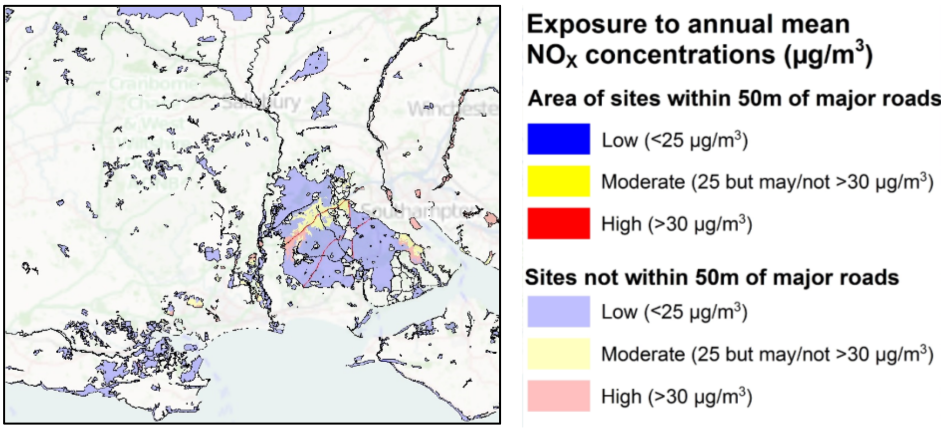


Figure 6 Specific areas of each SSSI shaded according to their exposure class (i.e. areas within 50m of major roads or by individual 1km x 1km square)[3]

3.2 Potential risk of impacts from NO_x due to road traffic

National summary statistics

As detailed in Section 2.4, national summary statistics in relation to the potential risk of impacts of NO_x from road traffic on SACs can be found for 2011 in Appendices 3 (nitrogen deposition) and 4 (acid deposition), and for 2020 in Appendices 5 (nitrogen deposition) and 6 (acid deposition). Whole site statistics and maps were prepared for visualisation purposes at Natural England's request in order to aid easy identification of sites at 'high' risk. Whole site statistics are not analysed here, instead focus is given to the more accurate statistics assembled for specific areas of sites.

We would recommend readers look at the full set of results in Appendices 3-6 covering:

- High, Medium and Low sensitivity sites;
- Sites where baseline deposition is above, approaching, and not approaching Critical Load;
- Sites with High, Medium and Low exposure to NO_x from road traffic in combination with other sources.

The findings in relation to SACs in the highest categories of sensitivity (i.e. High or Medium) where baseline deposition exceeds Critical Loads and exposure to NOx from road traffic in combination with other sources is highest (i.e. High or Medium) are summarised in Table 5 (for nitrogen deposition) and in Table 6 (for acid deposition). Although there is a substantial projected decline in the area of SACs at these levels of risk by 2020, in relation to sites where baseline deposition exceeds Critical Loads for:

- Nitrogen deposition, an area of 539.0ha of 19 sites with High sensitivity and an area of 2159.9ha of 37 sites with Medium sensitivity will continue to have High or Medium exposure to NO_x from road traffic in combination with other sources;
- Acid deposition, an area of 375.9ha of 18 sites with High sensitivity and an area of 600.3ha of 12 sites with Medium sensitivity will continue to have High or Medium exposure to NO_x from road traffic in combination with other sources.

Details of findings for other sites (i.e. where Critical Loads for nitrogen deposition or acid deposition are not exceeded or that have Low sensitivity or Low exposure to NO_x from road traffic in combination with other sources) can be found in Appendices 3-6. The fact that they are not summarised here does not mean they should be overlooked as the findings for these sites may also have important implications for mitigation.

Table 5 Specific areas of SACs with High or Medium sensitivity where baseline nitrogen deposition exceeds Critical Loads and exposure to NO_x from road traffic in combination with other sources is High or Medium

Exposure to NO_x from traffic taking account of background concentrations	**2011**				**2020**			
	High sensitivity, baseline deposition > Critical Load		**Medium sensitivity, baseline deposition > Critical Load**		**High sensitivity, baseline deposition > Critical Load**		**Medium sensitivity, baseline deposition > Critical Load**	
	Area (ha)	**Number of sites**	**Area (ha)**	**Number of Sites**	**Area (ha)**	**Number of sites**	**Area (ha)**	**Number of sites**
High	3027.8	23	11194.0	48	279.3	16	694.1	28
Medium	5944.5	3	4385.8	5	259.7	3	1465.8	9

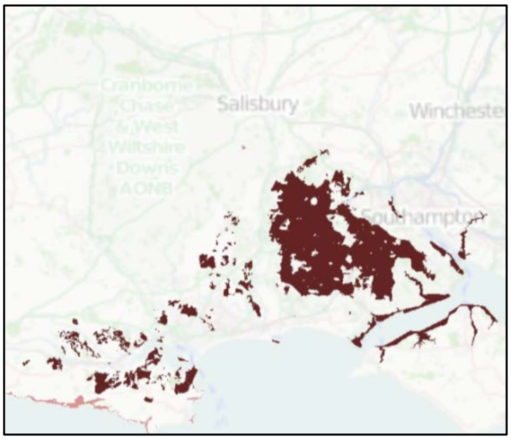
Table 6 Specific areas of SACs with High or Medium sensitivity where baseline acid deposition exceeds Critical Loads and exposure to NO_x from road traffic in combination with other sources is High or Medium

Exposure to NO_x from traffic taking account of background concentrations	**2011**				**2020**			
	High sensitivity, baseline deposition > Critical Load		**Medium sensitivity, baseline deposition > Critical Load**		**High sensitivity, baseline deposition > Critical Load**		**Medium sensitivity, baseline deposition > Critical Load**	
	Area (ha)	**Number of sites**	**Area (ha)**	**Number of Sites**	**Area (ha)**	**Number of sites**	**Area (ha)**	**Number of sites**
High	4273.1	21	5205.0	20	293.4	13	185.4	9
Medium	5542.7	4	2435.8	3	82.5	5	414.9	3

National maps

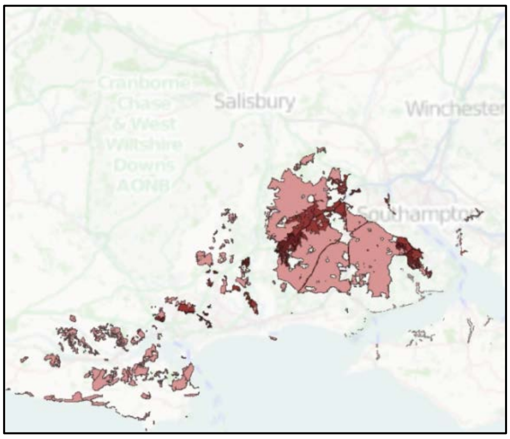
All maps detailed in Section 2.4 have been supplied to Natural England, as ESRI Shape Files and as jpegs.

Below are excerpts from the national maps of SACs that are classified as having High sensitivity to nitrogen deposition, which illustrate the maps produced for whole SACs (Figure 7) and specific areas of SACs (Figure 8) in relation to potential risk of impacts from NO_x due to road traffic for 2011, as detailed in Section 2.4.



Site sensitivity to nutrient N deposition / Exposure to NOx from traffic taking account of background concentrations	High (min. CL 5 or 8 kgN/ha/year)			No CL
	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	
High				
Medium				
Low				

Figure 7 The whole of each SAC shaded according to the specific area of the site that was attributed the highest class of potential risk[4]



Site sensitivity to nutrient N deposition / Exposure to NOx from traffic taking account of background concentrations	High (min. CL 5 or 8 kgN/ha/year)			No CL
	Baseline deposition above CL	Baseline deposition approaching CL (within 10%)	Baseline deposition not approaching CL	
High				
Medium				
Low				

Figure 8 Specific areas of each SAC shaded according to their potential risk of impacts (i.e. areas within 50m of major roads or by individual 1km x 1km square)[4]

Site-level statistics

An example excerpt from site-level statistics for the potential risk of impacts of NO_x from road traffic with regard to nitrogen deposition in 2011 for whole SACs can be found at Appendix 7. All site-level statistics detailed in Section 2.4 have been supplied to Natural England, as Excel files tabulated in the same form as this excerpt.

---

[4] Restricted commercial, internal use only. Not for external circulation.

4 Discussion and conclusions

4.1 Uncertainties

This study has provided Natural England with a valuable analysis of SSSIs and SACs in terms of their exposure to NO_x from road traffic, taking into account other background sources of NO_x, and the potential risk of impacts of NO_x from road traffic on SACs in England, subject to uncertainties relating to:

- Impacts of road traffic pollution on habitats and species (Bignal and others 2004; Smithers and others, in press);
    - While transect studies provide evidence that the impacts on individual species from exposure to NO_x associated with vehicle emissions is greatest within the first 50-100m from roads and may be discernible at greater distances, there remains substantial scope to increase understanding through further such studies in order to address the full range of habitats, traffic flows and meteorological conditions;
    - Critical Loads for some habitats rely to a large extent on expert judgment. Furthermore, a recent study (Emmett and others 2011) has detected that nitrogen deposition below Critical Loads may be associated with changes in some species and ecosystem function indices, indicating that Critical Loads may not protect all species or ecosystem functions, with possible implications for current conservation commitments and biodiversity targets. Emmett and others 2011 has also identified that changes in species and ecosystem function indices continue above Critical Loads;
- Modelled baseline NO_x concentrations (Section 2.2);
    - NO_x concentrations were only linked to specific major roads at distances up to 50m, as established modelling methods did not support such linkage at greater distances;
    - For those areas of designated sites up to 50m from major roads, modelled NO_x concentrations were calibrated using AURN monitoring sites in urban areas, whereas the majority of designated habitat sites are in rural areas;
    - For those areas of designated sites beyond 50m from a major road, NO_x concentrations attributed to local road traffic were derived from the NAEI's 1km x 1km background emissions maps. In some cases, these will under-estimate NO_x concentrations where an area of a designated site is more than 50m from a major road but close to another significant source of NO_x from road traffic. This is unavoidable, since information on the spatial distribution of emissions at the sub-grid level is only available for major roads;
- Modelled future NO_x concentrations (Section 2.2);
    - The weather can impact on the magnitude of emissions from domestic and commercial heating and the dispersion of air pollutants. The weather may not be the same as in the reference year for the projections, which is 2011;
    - The economic and energy forecasts used to derive emission projections;
    - The expected levels of future traffic activity;
    - The expected rates of turnover in vehicle fleets;
    - The assumption regarding the emission factors for road traffic. The projections are particularly sensitive to the assumptions for the emissions performance of Euro 6 diesel cars and vans. Note that the impact of any reduction in emissions from a second stage of Euro 6 emission limits for cars and vans has not been included in the baseline projections;
- Site-specific Critical Loads (Section 2.3);
    - Critical Loads are assigned by 1km x 1km grid square on the assumption that all designated features (habitats and/or species) for an SAC occur across the entire site;

    - For some SACs, no Critical Loads are defined because the site is not sensitive to nitrogen deposition or acid deposition, or because there is insufficient data to allocate a Critical Load;
- Modelled baseline nitrogen deposition and acid deposition (Section 2.3)
    - Projected 2020 data are;
        - Calibrated to CBED 2006–08 data (rather than the 2009–2011 data used for the baseline);
        - Based on DECC's UEP43 emissions scenarios (DECC 2011); more recent scenarios may give different projections;
    - These data are assigned to a 5km x 5km grid, and so are at a lower resolution than data in relation to NO_x concentrations attributed to road traffic and background levels of NO_x. Nevertheless, these data provide a useful indication of whether nitrogen deposition and acid deposition at an individual site are above, close to, or below the relevant Critical Loads;
    - The data supplied by CEH provide background deposition rates that account for the different deposition velocities of different land-cover types and assume;
        - Moorland everywhere – these values are intended for use in relation to all grass/heath/bog/montane or other low-growing natural or semi-natural vegetation/habitats and were used in this study as the default values;
        - Woodland everywhere – these values were applied in this study to all sites containing woodland habitats.

4.2 National statistics

The national statistics provide evidence of the potential significance of NO_x from road traffic for designated sites, which Natural England can use to develop its thinking and communicate the issue to others, in the context of other sources of emissions to air and other sources of impacts on designated sites.

Site exposure to NO_x from road traffic

The national statistics for SSSIs and SACs of their exposure to NO_x from road traffic, taking into account other background sources of NO_x, help to highlight its potential significance in relation to the Critical Level of 30µg/m^3. While this Critical Level applies equally to all habitat types and, therefore, does not differentiate sensitivity to airborne NO_x between sites, nevertheless, the national statistics do highlight the scope for concern, given that Critical Levels are defined as *"concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge"*[5].

The results in Section 3.1 (and Appendices 1 and 2) identify that a substantial reduction in the extent of the specific areas and number of sites affected by High or Medium exposure to NO_x from road traffic in combination with other sources by 2020 is projected. This is due to implementation of cleaner technologies. <u>However, the projections indicate that in 2020 the level of exposure to NO_x from road traffic in combination with other sources will continue to be:</u>

- <u>High across a total of 3822.3ha within 300 SSSIs and 1171.5ha within 80 SACs;</u>
- <u>Medium across a total of 6019.1ha within 103 SSSIs and 2132.5ha within 13 SACs.</u>

This suggests that there is a need for further consideration of the potential risk of impacts at such sites (see below) in order to prioritise localised mitigation.

[5] http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm

Potential risk of impacts to SACs from NO_x due to road traffic

NO_x can have a direct impact on species and habitats and an indirect impact on them by contributing to atmospheric nitrogen deposition and acid deposition. So, the national statistics of the potential risk of impacts from NO_x due to road traffic differentiate between sites by not only taking account of the level of exposure but also their sensitivity in relation to nitrogen deposition and acid deposition, as determined from site-specific Critical Loads, and whether baseline deposition is above, approaching (within 10%) or below the Critical Load (Sections 2.3 and 2.4). As site-specific Critical Loads are only available nationally for SACs, further assessment of SSSIs was not pursued.

The results in Section 3.2 highlight that, although there is a substantial projected decline in the potential risk of impacts to SACs from NO_x due to road traffic in combination with other sources between 2011 and 2020, in relation to sites where baseline deposition exceeds Critical Loads for:

- Nitrogen deposition, an area of 539.0ha of 19 sites with High sensitivity and an area of 2159.9ha of 37 sites with Medium sensitivity will continue to have High or Medium exposure to NO_x from road traffic in combination with other sources;
- Acid deposition, an area of 375.9ha of 18 sites with High sensitivity and an area of 600.3ha of 12 sites with Medium sensitivity will continue to have High or Medium exposure to NO_x from road traffic in combination with other sources.

Future assessment of potential risk of impacts to SSSIs from NO_x due to road traffic

If a national dataset of site-specific Critical Loads was developed for SSSIs then their potential risk of impacts from NO_x due to road traffic could be assessed by employing the methods set out in Sections 2.3 and 2.4. Currently, the interest features of SSSIs are defined at a very broad level in a national database, for example, “broad-leaved, mixed and yew woodland” or “supralittoral sediment”. These ‘reporting categories’ may contain habitats with a range of sensitivity to nitrogen deposition (and/or acidity). As such, all possible ‘matches’ are currently assigned in APIS and the user then has to go through a series of selection screens to refine the selection of the habitat type; for further information see http://www.apis.ac.uk/assigning-critical-loads [accessed August 2014]. This is not possible at the national level, as it requires local knowledge.

4.3 Individual site-level statistics

SACs

The site-level statistics for individual SACs provide useful information for Natural England to further investigate and prioritise the potential risk of impacts from NO_x due to road traffic on individual sites and develop targeted mitigation measures, subject to the uncertainties listed at the start of this section and those relating to the efficacy of mitigation measures (Bignal and others 2004; Smithers and others, in press).

SSSIs

The potential risk to individual SSSIs has not been assessed due to the lack of site specific critical load data for SSSIs. Potential risk to individual SSSIs could be assessed by employing the methods set out in Sections 2.3 and 2.4 on a site-by-site basis. However, this would be labour intensive, so could not practically be undertaken on anything other than a targeted basis (e.g. sites categorised as having High exposure to NO_x from road traffic, taking into account other background sources of NO_x). If implemented in this way on a site-by-site basis, the methodology could be enhanced to take account of more detailed local knowledge (e.g. inter-relating the level of exposure to NO_x with the specific locations of individual habitats). In the meantime, Natural England could further investigate and prioritise the potential risk of impacts from road traffic on individual SSSIs and develop targeted mitigation measures based solely on their exposure to NO_x from road traffic, taking into account other background sources of NO_x. This would be justifiable, given the links between

NO_x and atmospheric nitrogen deposition and acid deposition and recent findings (Emmett and others 2011) that changes in some species and ecosystem function indices occur below Critical Loads (i.e. irrespective of site sensitivity).

Impact assessments or Habitats Regulations Assessments

While Natural England can broadly view new proposals for road traffic in the context of site-level statistics for potential risk to individual SACs, or any site-level statistics subsequently developed for SSSIs using the methods set out in Sections 2.3 and 2.4, it would not be appropriate to use the statistics to inform detailed impact assessments or Habitat Regulations Assessments of development schemes or development plans. This is because:

- The assessment of potential risk of impacts from NO_x due to road traffic was based on national-scale traffic modelling. There would be no prospect of this modelling being repeated for a new development. Any traffic modelling for a new development would have significant methodological differences, such that if the assessment associated with the new development sought to take account of its projected emissions, changes in the potential risk of impacts from NO_x due to road traffic are likely to arise not only from the effects of the development but also from the methodological differences in local-scale vs national-scale traffic modelling;
- The assessment of potential risk to SACs necessarily introduced a range of simplifying assumptions in order to carry out the assessment at a national scale, e.g. site sensitivity was defined in relation to the habitat/species at each designated site with the lowest minimum Critical Load (Section 2.3). Such assumptions would not be appropriate for an impact assessment or Habitats Regulations Assessment, where a site-specific understanding of the habitat should be used.

4.4 Maps

The maps provide a visual representation of:

- Whole SSSIs and SACs and specific areas of all such sites in each class of exposure.
- Whole SACs and specific areas of SACs in each category of potential risk.

The maps have been supplied as ESRI Shape Files, in order that they may be imported into a GIS by Natural England, overlaid with other layers and presented for use in a range of forms. The jpegs have been produced at a sufficient resolution to allow users to zoom in on screen to particular areas of interest and individual sites. The maps can be consulted in conjunction with the national statistics and site-level statistics and enable Natural England to:

- Gain an overview of potential issues which may extend across multiple sites;
- Develop its thinking in the context of other sources of emissions to air and other sources of impacts on designated sites;
- Identify SSSIs and SACs where exposure to NOx from road traffic, taking into account other background sources of NOx, and the potential risk of impacts of NOx from road traffic (SACs only) may be of particular concern and, hence, help prioritise where consideration needs to be given to any further development that would increase traffic flows;
- Inform further investigation and prioritisation of individual SSSIs based on their exposure to NOx and of individual SACs in relation to potential risk of impacts from road traffic and develop targeted mitigation measures;
- Communicate issues to others.

Direct, simple comparison of maps of each whole site shaded according to the specific area of the site that was attributed the highest class of exposure, or potential risk, with maps of the specific areas of each site in each exposure class or potential risk category is not recommended. Small specific areas of sites that are easily overlooked may determine how whole sites are classified even when the maps are overlain with site boundary data.

4.5 Prioritisation of potential risk

At Natural England's request, colours were chosen for the colour-coding scheme used to enable the various classes of potential risk to be mapped that are not intended to imply any prioritisation (Figures 3 and 4). This was because of the uncertainties listed in Section 4.1, because site-specific factors may override other reasons for prioritising action, and in order to allow Natural England greatest freedom in how the information produced is used in the development of its policies and practices. However, priorities are inevitably implied by any categorisation and it is important to acknowledge that in order to attribute risk to each SAC as a whole, the methodology (Section 2, Table 3) systematically placed an emphasis firstly on sensitivity, secondly on baseline deposition versus Critical Load and thirdly on exposure. This is one of the reasons why whole site statistics are not analysed in Section 3.2 and focus instead is given to the statistics assembled for specific areas of sites. However, at Natural England's request, highlighting in Sections 3.2 and 4.2 SACs in the highest categories of sensitivity (i.e. High or Medium) where baseline deposition exceeds Critical Loads and exposure to NO_x from road traffic in combination with other sources is highest (i.e. High or Medium) in itself implies it is these sites that are considered to be at highest risk.

Further work could be done to prioritise the risk categories, as discussed below. We would note that in general terms, impact assessment relies upon the principle that the potential risk of impact increases as the level of exposure of receptors and their sensitivity increases (Figure 9).

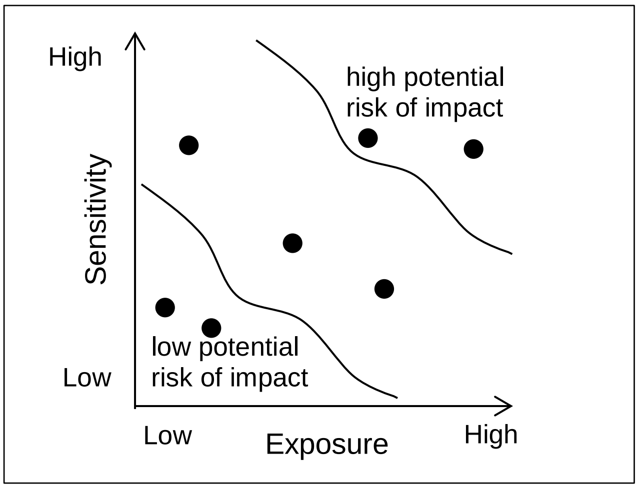


Figure 9 Conceptual model of potential risk of impact

Thus, in accordance with this principle the potential risk of impact of a specific increase in exposure from nitrogen or acid deposition on a site that has a low Critical Load (i.e. high sensitivity) is proportionately far greater than for a site with a high Critical Load (i.e. low sensitivity) irrespective of whether baseline deposition is above, approaching or below the Critical Load. Indeed, although the Critical Load is defined as: *"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*[6], there is growing evidence that changes in some species and ecosystem functions may occur at lower levels of exposure and continue above Critical Loads (e.g. Emmett and others 2011). With this in mind, Figure 10 (nitrogen deposition) and Figure 11 (acid deposition) depict matrices that could be used to prioritise potential risk of impacts from NO_x on a precautionary basis where risk is classified as:

[6] http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm

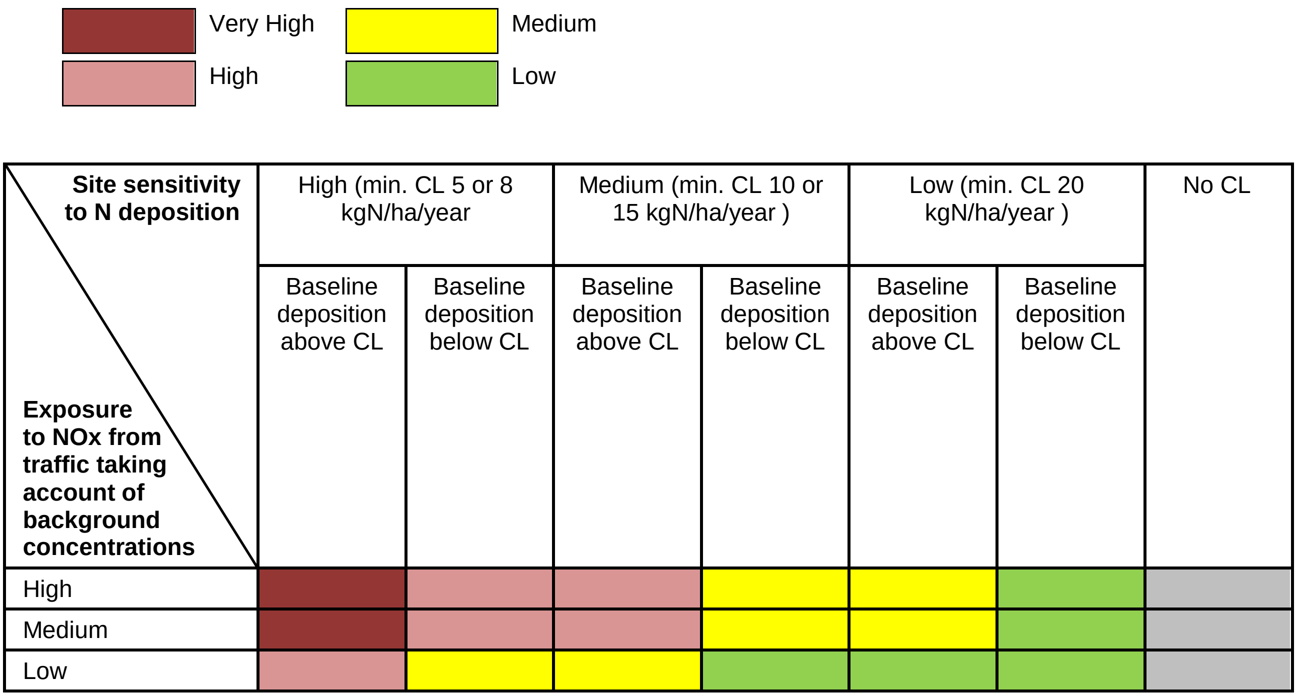


Figure 10 Alternative matrix of potential risk of impacts from nitrogen deposition

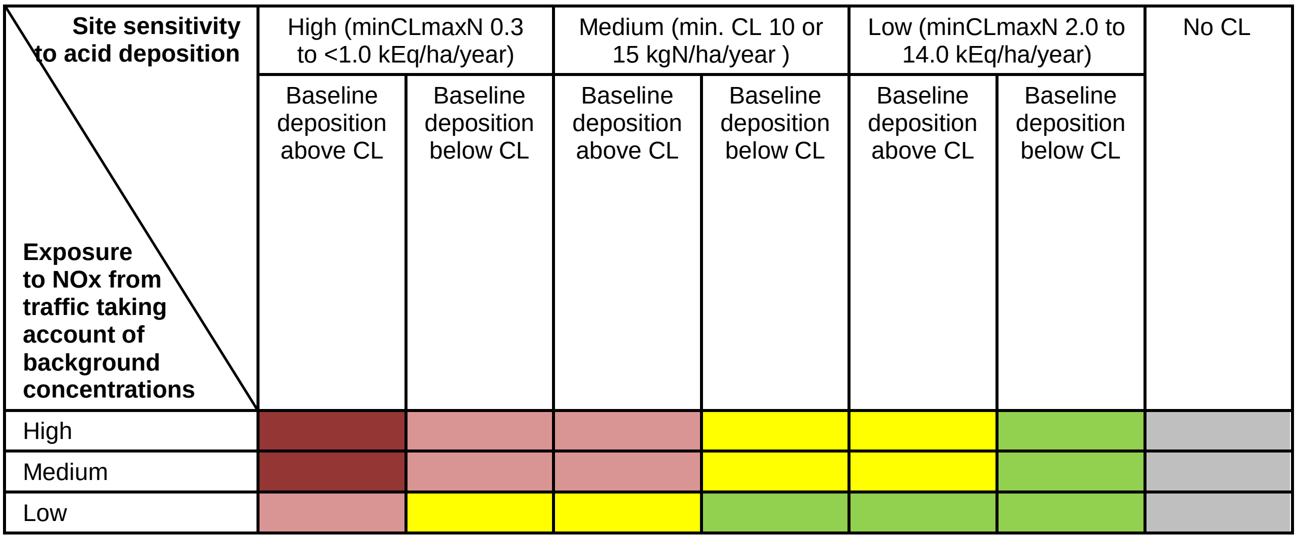


Figure 11 Alternative matrix of potential risk of impacts from acid deposition

There may also be other ways of prioritising the risk categories. For example, it might be argued that all sites with High exposure to NO_x from road traffic where baseline deposition exceeds the Critical Load across all site sensitivities should be assigned to the highest risk category. It is, therefore, recommended that Natural England gives further consideration to prioritising the risk categories.

4.6 Site condition

It was not possible to inter-relate the condition of SSSI units with the potential risk of impact of NO_x from road traffic in conjunction with other background sources, as the potential risk to SSSIs was not assessed due to lack of a national dataset of site-specific critical loads and Natural England advised that to inter-relate SSSI condition with the potential risk to SACs would have been spurious. The analysis for SSSIs could be undertaken if a national dataset of site-specific Critical Loads is produced in future. However, the results in isolation would be neither likely to demonstrate any clear linkages due to the number of confounding variables nor allow the area of sites in unfavourable condition in whatever is deemed the ‘highest’ class of potential risk from NO_x due to road traffic to be attributed to air pollution from roads.

Supporting evidence is not currently available from Common Standards Monitoring (CSM), as the link between air pollution and its effect can take many years to manifest itself, and multiple causes can generate very similar looking effects (Hall and others 2006). However, following a request by the interagency Chief Scientists’ Group, JNCC is currently testing the feasibility of using CSM criteria in attributing site condition to air pollution. The JNCC study may be informed by this study’s identification of potential risk of impact to designated sites from NO_x due to road traffic. In the meantime, we note that even if NO_x from road traffic is not the reason for the specific areas of sites being in whatever is deemed the ‘highest’ risk category, it seems reasonable to assume that the exposure of these areas to such air pollution and their sensitivity may compound the challenge of achieving favourable or recovering condition. As such, we would recommend that IPENS uses this study to assist in identification of those SACs where potential risk of impact from NO_x due to road traffic is a key issue. It could then consider this study’s review of mitigation measures (Smithers and others, in press), in conjunction with Bignal and others (2004) to determine how potential risks of impact from NO_x due to road traffic might be addressed on a site-by-site basis.

5 References

BIGNAL, K., ASHMORE, A. & POWER, S. 2004. The ecological effects of diffuse air pollution from road transport. English Nature Research Report Number 480.

BROOKES, D., STEDMAN, J., KENT, A., KING, R., VENFIELD, H., COOKE, S., LINGARD, J., VINCENT, K., BUSH, A. & ABBOTT, J. 2013. Technical report on UK supplementary assessment under the Air Quality Directive (2008/50/EC), the Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2011. AEAT/ENV/R/3316. URL: http://uk-air.defra.gov.uk/library/reports?report_id=768 [Accessed April 2014].

DEPARTMENT OF ENERGY & CLIMATE CHANGE (DECC). 2012. Updated Energy and Emissions Projections: 2011. URL: http://webarchive.nationalarchives.gov.uk/20130106105028/http://decc.gov.uk/assets/decc/11/about-us/economics-social-research/3134-updated-energy-and-emissions-projections-october.pdf [Accessed April 2014].

DEPARTMENT OF ENERGY & CLIMATE CHANGE (DECC). 2012. Updated Energy and Emissions Projections: 2012. URL: http://webarchive.nationalarchives.gov.uk/20130106105028/http://decc.gov.uk/assets/decc/11/about-us/economics-social-research/6660-updated-emissions-projections-october-2012.pdf [Accessed April 2014].

DEPARTMENT FOR ENVIRONMENT, FOOD & RURAL AFFAIRS (DEFRA). 2009. Part IV of the Environment Act 1995 Environment (Northern Ireland) Order 2002 Part III Local Air Quality Management. Technical Guidance LAQM.TG(09). URL: http://laqm.defra.gov.uk/technical-guidance/index.html [Accessed April 2014].

EMMETT, B., ROWE, E., STEVENS, C.J., GOWING, D.J., HENRYS, P., MASKELL, L. & SMART, S. 2011. Interpretation of evidence of nitrogen impacts on vegetation in relation to UK biodiversity objectives. Joint Nature Conservation Committee Report No. 449. URL: http://jncc.defra.gov.uk/pdf/jncc449_web.pdf [Accessed April 2014].

HALL, J., BEALEY, B. & WADSWORTH, R. 2006. Assessing the risks of air pollution impacts to the condition of Areas/Sites of Special Scientific Interest in the UK. JNCC Report No. 387. URL: http://jncc.defra.gov.uk/pdf/387_web.pdf [Accessed April 2014].

LAXEN, D. & MARNER, B. 2008. NO_2 concentrations and distance from roads. Report reference - 504/1/F1. A report prepared by Air Quality Consultants Ltd. for Defra. URL: http://www.aqconsultants.co.uk/getattachment/e46f839d-e74f-4cb4-8419-5bf2028565ab/Fall-Off-With-Distance-Rept-July-08.aspx [Accessed April 2014].

PASSANT, N.R., MURRELLS, T.P., MISRA, A., PANG, Y., WALKER, H.L., WHITING, R., WALKER, C., WEBB, N.C.J. & MACCARTHY, J. 2012. UK Informative Inventory Report (1980 to 2010). National Atmospheric Emissions Inventory, AEA. URL: http://uk-air.defra.gov.uk/reports/cat07/1203221052_UK_IIR_2012_final.pdf [Accessed April 2014].

PASSANT, N.R., MURRELLS, T.P., PANG, Y., THISTLETHWAITE, G., VENFIELD, H.L., WHITING, R., WALKER, C, MACCARTHY, J, WATTERSON, J., HOBSON, M. & MISSELBROOK, T. 2013. UK Informative Inventory Report (1980 to 2011). URL: http://uk-air.defra.gov.uk/reports/cat07/1303261254_UK_IIR_2013_Final.pdf [Accessed April 2014].

ROTAP. 2012. Review of Transboundary Air Pollution: Acidification, Eutrophication, Ground Level Ozone and Heavy Metals in the UK. Summary for Policy Makers. Contract Report to the Department for Environment, Food and Rural Affairs. Centre for Ecology & Hydrology. URL: http://www.rotap.ceh.ac.uk/sites/rotap.ceh.ac.uk/files/RoTAP%20Summary%20report.pdf [Accessed April 2014].

SMITHERS, R.J., HARRIS, R., & HITCHCOCK, G. In press. Air pollution from roads and designated nature conservation sites: literature review. Natural England.

STEVENS, C.J., SMART, S.M., HENRYS, P., MASKELL, L.C., WALKER, K.J., PRESTON, C.D., CROWE, A., ROWE, E., GOWING, D.J. & EMMETT, B.A. 2011. Collation of evidence of nitrogen impacts on vegetation in relation to UK biodiversity objectives. JNCC Report 447. URL: http://jncc.defra.gov.uk/page-5894 [Accessed April 2014].

TSAGATAKIS, I., BRACE, S., PASSANT, N. & COOKE, S. 2013. UK Emission Mapping Methodology 2011. A report of the National Atmospheric Emissions Inventory. URL: http://naei.defra.gov.uk/reports/reports?report_id=787 [Accessed August 2014].

Appendices

Appendix 1 Exposure to NO_x 2011 – summary statistics

Table A1.1 Whole SSSI area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	396,589.9	36.6%	18,607.6	1.7%	415,197.4	38.3%
Medium	12,116.7	1.1%	14,463.1	1.3%	26,579.8	2.5%
Low	91,202.6	8.4%	399,013.5	36.8%	490,216.0	45.2%
Unclassified	0	0.0%	0	0.0%	0	0.0%
Non-sensitive	51,496.2	4.8%	99,886.0	9.2%	151,382.2	14.0%
Total	551,405.3	50.9%	531,970.1	49.1%	1,083,375.4	100.0%

Table A1.2 Whole SAC area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	497,965.0	48.9%	51,371.8	5.0%	549,336.8	54.0%
Medium	2,103.3	0.2%	2,900.1	0.3%	5,003.5	0.5%
Low	127,292.9	12.5%	330,550.1	32.5%	457,843.1	45.0%
Unclassified	0	0.0%	5,481.6	0.5%	5,481.6	0.5%
Non-sensitive	0	0.0%	0	0.0%	0	0.0%
Total	627,361.2	61.6%	390,303.7	38.4%	1,017,665.0	100.0%

Table A1.3 Specific SSSI area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites
High	2,890.7	0.3%	38,668.7	3.6%	41,559.3	3.8%
Medium	431.3	0.0%	24,396.0	2.3%	24,827.3	2.3%
Low	961.6	0.1%	709,671.2	65.5%	710,632.8	65.6%
Unclassified	0	0.0%	154,973.8	14.3%	154,973.8	14.3%
Non-sensitive	453.5	0.0%	151,382.2	14.0%	151,835.7	14.0%
Total	4,737.0	0.4%	1,079,091.9	99.6%	1,083,829.0	100.0%

Table A1.4 Specific SAC area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites
High	1,452.4	0.1%	13,981.9	1.4%	15,434.3	1.5%
Medium	319.2	0.0%	11,113.3	1.1%	11,432.5	1.1%
Low	648.9	0.1%	495,547.2	48.7%	496,196.1	48.8%
Unclassified	83.9	0.0%	494,518.3	48.6%	494,602.2	48.6%
Non-sensitive	0	0.0%	0	0.0%	0	0.0%
Total	2,504.3	0.2%	1,015,160.7	99.8%	1,017,665.0	100.0%

Table A1.5 Number of SSSIs

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites
High	429	10%	235	6%	664	16%
Medium	48	1%	163	4%	211	5%
Low	120	3%	2,094	49%	2,214	52%
Unclassified	0	0%	0	0%	0	0%
Non-sensitive	154	4%	1,019	24%	1,173	28%
Total	751	18%	3,511	82%	4,262	100%

Table A1.6 Number of SACs

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites
High	79	32%	9	4%	88	36%
Medium	3	1%	9	4%	12	5%
Low	23	9%	108	44%	131	53%
Unclassified	2	1%	12	5%	14	6%
Non-sensitive	0	0%	0	0%	0	0%
Total	107	44%	138	56%	245	100%

Table A1.7 Number of SSSI units

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total number of units	% total number of all units	Total number of units	% total number of all units	Total number of units	% total number of all units
High	1,478	5%	1,246	4%	2,724	9%
Medium	206	1%	1,143	4%	1,349	4%
Low	467	2%	18,684	62%	19,151	63%
Unclassified	0	0%	4,232	14%	4,232	14%
Non-sensitive	302	1%	2,438	8%	2,740	9%
Total	2,453	8%	27,743	92%	30,196	100%

Appendix 2 Exposure to NO_x 2020 – summary statistics

Table A2.1 Whole SSSI area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	287,766.9	26.6%	877.5	0.1%	288,644.5	26.6%
Medium	69,891.3	6.5%	5,794.9	0.5%	75,686.2	7.0%
Low	142,250.9	13.1%	425,411.6	39.3%	567,662.5	52.4%
Unclassified	0	0.0%	0	0.0%	0	0.0%
Non-sensitive	51,496.2	4.8%	99,886.0	9.2%	151,382.2	14.0%
Total	551,405.3	50.9%	531,970.1	49.1%	1,083,375.4	100.0%

Table A2.2 Whole SAC area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	376,190.2	37.0%	37.9	0.0%	376,228.1	37.0%
Medium	9,147.4	0.9%	4,776.1	0.5%	13,923.6	1.4%
Low	242,023.6	23.8%	380,008.1	37.3%	622,031.6	61.1%
Unclassified	0	0.0%	5,481.6	0.5%	5,481.6	0.5%
Non-sensitive	0	0.0%	0	0.0%	0	0.0%
Total	627,361.2	61.6%	390,303.7	38.4%	1,017,665.0	100.0%

Table A2.3 Specific SSSI area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites
High	1,541.2	0.1%	2,281.1	0.2%	3,822.3	0.4%
Medium	441.2	0.0%	5,577.9	0.5%	6,019.1	0.6%
Low	2,301.2	0.2%	764,876.8	70.6%	767,178.0	70.8%
Unclassified	0	0.0%	154,973.8	14.3%	154,973.8	14.3%
Non-sensitive	453.5	0.0%	151,382.2	14.0%	151,835.7	14.0%
Total	4,737.0	0.4%	1,079,091.9	99.6%	1,083,829.0	100.0%

Table A2.4 Specific SAC area

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites	Total area of specific areas of sites (ha)	% total area of all sites
High	620.5	0.1%	551.0	0.1%	1,171.5	0.1%
Medium	231.4	0.0%	1,901.2	0.2%	2,132.5	0.2%
Low	1,568.6	0.2%	518,190.2	50.9%	519,758.8	51.1%
Unclassified	83.9	0.0%	494,518.3	48.6%	494,602.2	48.6%
Non-sensitive	0	0.0%	0	0.0%	0	0.0%
Total	2,504.3	0.2%	1,015,160.7	99.8%	1,017,665.0	100.0%

Table A2.5 Number of SSSIs

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites
High	291	7%	9	0%	300	7%
Medium	69	2%	34	1%	103	2%
Low	237	6%	2,449	57%	2,686	63%
Unclassified	0	0%	0	0%	0	0%
Non-sensitive	154	4%	1,019	24%	1,173	28%
Total	751	18%	3,511	82%	4,262	100%

Table A2.6 Number of SACs

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites	Total number of sites	% total number of all sites
High	59	24%	1	0%	60	24%
Medium	11	4%	2	1%	3	5%
Low	35	14%	123	50%	158	64%
Unclassified	0	0%	0	0%	0	0%
Non-sensitive	2	1%	12	5%	14	6%
Total	107	44%	138	56%	245	100%

Table A2.7 Number of SSSI units

Exposure to NO_x from traffic taking account of background concentrations	Major road within 50m		No major road within 50m		Total	
	Total number of units	% total number of all units	Total number of units	% total number of all units	Total number of units	% total number of all units
High	658	2%	78	0%	736	2%
Medium	237	1%	231	1%	468	2%
Low	1,256	4%	20,764	69%	22,020	73%
Unclassified	0	0%	4,232	14%	4,232	14%
Non-sensitive	302	1%	2,438	8%	2,740	9%
Total	2,453	8%	27,743	92%	30,196	100%

Appendix 3 Potential risk of impact from NO_x due to road traffic (nitrogen deposition) 2011 – summary statistics

Table A3.1 Whole SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from traffic taking	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
account of background concentrations	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	248,941.7	24.6%	0.0	0.0%	0.0	0.0%	296,116.7	29.3%	0.0	0.0%	0.0	0.0%	0.0	0.0%	359.3	0.0%	37.9	0.0%	4,114.4	0.4%	549,570.1	54.3%
Medium	4,553.1	0.4%	0.0	0.0%	0.0	0.0%	0.0	0.0%	2,479.5	0.2%	0.0	0.0%	105.2	0.0%	0.0	0.0%	0.0	0.0%	84.1	0.0%	7,221.9	0.7%
Low	89,765.0	8.9%	0.0	0.0%	0.0	0.0%	151,639.1	15.0%	0.0	0.0%	26,848.6	2.7%	108,842.4	10.8%	1,632.6	0.2%	65,542.9	6.5%	11,120.8	1.1%	455,391.4	45.0%
Total	343,259.8	33.9%	0.0	0.0%	0.0	0.0%	447,755.7	44.2%	2,479.5	0.2%	26,848.6	2.7%	108,947.6	10.8%	1,992.0	0.2%	65,580.9	6.5%	15,319.3	1.5%	1,012,183.3	100.0%

Table A3.2 Specific SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
traffic taking account of background concentrations	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified
High	3,027.8	0.6%	0.0	0.0%	0.0	0.0%	11,194.0	2.2%	33.4	0.0%	1.5	0.0%	0.0	0.0%	106.9	0.0%	245.7	0.0%	605.4	0.1%	15,214.6	2.9%
Medium	5,944.5	1.1%	0.0	0.0%	0.0	0.0%	4,385.8	0.8%	160.8	0.0%	28.3	0.0%	45.7	0.0%	0.0	0.0%	10.8	0.0%	584.0	0.1%	11,159.9	2.2%
Low	120,948.5	23.4%	46.7	0.0%	0.0	0.0%	351,772.8	68.0%	59.7	0.0%	424.4	0.1%	822.8	0.2%	322.9	0.1%	681.3	0.1%	15,955.3	3.1%	491,034.4	94.9%
Total	129,920.8	25.1%	46.7	0.0%	0.0	0.0%	367,352.6	71.0%	254.0	0.0%	454.2	0.1%	868.5	0.2%	429.8	0.1%	937.7	0.2%	17,144.7	3.3%	517,408.9	100.0%

Table A3.3 Number of SACs

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from traffic taking	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
account of background concentrations	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites
High	23	12%	0	0%	0	0%	48	24%	0	0%	0	0%	0	0%	2	1%	1	1%	0	0%	74	37%
Medium	3	2%	0	0%	0	0%	5	3%	0	0%	0	0%	1	1%	0	0%	0	0%	0	0%	9	5%
Low	33	17%	0	0%	0	0%	74	37%	0	0%	1	1%	4	2%	1	1%	2	1%	0	0%	115	58%
Total	59	30%	0	0%	0	0%	127	64%	0	0%	1	1%	5	3%	3	2%	3	2%	0	0%	198	100%

Appendix 4 Potential risk of impact from NO_x due to road traffic (acid deposition) 2011 – summary statistics

Table A4.1 Whole SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from traffic taking account of background concentrations	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	339,172.0	33.5%	0.0	0.0%	0.0	0.0%	57,905.2	5.7%	0.0	0.0%	0.0	0.0%	636.8	0.1%	0.0	0.0%	1,030.8	0.1%	64,652.5	6.4%	463,397.4	45.8%
Medium	13,810.6	1.4%	0.0	0.0%	0.0	0.0%	1,548.1	0.2%	0.0	0.0%	0.0	0.0%	0.0	0.0%	589.4	0.1%	109.3	0.0%	84.1	0.0%	16,141.4	1.6%
Low	235,170.3	23.2%	0.0	0.0%	1,134.3	0.1%	47,108.5	4.7%	133.8	0.0%	23,785.2	2.3%	3,923.7	0.4%	576.6	0.1%	7,148.8	0.7%	213,663.2	21.1%	532,644.5	52.6%
Total	588,153.0	58.1%	0.0	0.0%	1,134.3	0.1%	106,561.8	10.5%	133.8	0.0%	23,785.2	2.3%	4,560.5	0.5%	1,166.0	0.1%	8,288.8	0.8%	278,399.8	27.5%	1,012,183.3	100.0%

Table A4.2 Specific SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total (excluding unclassified)	
Exposure to NO_x from traffic taking account of background concentrations	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified
High	4,273.1	0.8%	0.0	0.0%	0.0	0.0%	5,205.0	1.0%	159.6	0.0%	148.9	0.0%	1,525.9	0.3%	113.6	0.0%	3,052.3	0.6%	955.9	0.2%	15,434.3	3.0%
Medium	5,542.7	1.1%	0.0	0.0%	0.0	0.0%	2,435.8	0.5%	13.7	0.0%	11.3	0.0%	300.7	0.1%	92.5	0.0%	2,098.9	0.4%	937.0	0.2%	11,432.5	2.2%
Low	181,882.4	34.8%	47.2	0.0%	161.3	0.0%	166,711.1	31.9%	1,281.3	0.2%	8,031.6	1.5%	36,863.0	7.0%	4,577.9	0.9%	72,082.5	13.8%	24,557.7	4.7%	496,196.1	94.9%
Total	191,698.2	36.6%	47.2	0.0%	161.3	0.0%	174,351.9	33.3%	1,454.5	0.3%	8,191.8	1.6%	38,689.5	7.4%	4,784.0	0.9%	77,233.7	14.8%	26,450.6	5.1%	523,062.8	100.0%

Table A4.3 Number of SACs

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from traffic taking account of background concentrations	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites
High	21	12%	0	0%	0	0%	20	11%	0	0%	0	0%	3	2%	0	0%	7	4%	0	0%	51	28%
Medium	4	2%	0	0%	0	0%	3	2%	0	0%	0	0%	0	0%	1	1%	1	1%	0	0%	9	5%
Low	46	26%	0	0%	1	1%	29	16%	2	1%	7	4%	9	5%	2	1%	24	13%	0	0%	120	67%
Total	71	39%	0	0%	1	1%	52	29%	2	1%	7	4%	12	7%	3	2%	32	18%	0	0%	180	100%

Appendix 5 Potential risk of impact from NO_x due to road traffic (nitrogen deposition) 2020 – summary statistics

Table A5.1 Whole SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
traffic taking account of background concentrations	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	133,470.7	13.2%	0.0	0.0%	0.0	0.0%	176,486.2	17.4%	187.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	267.4	0.0%	4,084.4	0.4%	314,495.7	31.1%
Medium	6,843.1	0.7%	0.0	0.0%	0.0	0.0%	6,895.9	0.7%	184.5	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	13,923.6	1.4%
Low	202,946.0	20.1%	0.0	0.0%	0.0	0.0%	266,353.5	26.3%	0.0	0.0%	26,976.7	2.7%	966.0	0.1%	105.2	0.0%	175,181.8	17.3%	11,234.9	1.1%	683,764.1	67.6%
Total	343,259.8	33.9%	0.0	0.0%	0.0	0.0%	449,735.6	44.4%	371.6	0.0%	26,976.7	2.7%	966.0	0.1%	105.2	0.0%	175,449.2	17.3%	15,319.3	1.5%	1,012,183.3	100.0%

Table A5.2 Specific SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total (excluding unclassified)	
Exposure to NO_x from	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
traffic taking account of background concentrations	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified	Total area of specific areas of sites (ha)	% total area of all sites excluding unclassified
High	279.3	0.1%	0.0	0.0%	0.0	0.0%	694.1	0.1%	6.5	0.0%	2.8	0.0%	0.0	0.0%	0.0	0.0%	6.0	0.0%	129.9	0.0%	1,118.7	0.2%
Medium	258.7	0.0%	1.4	0.0%	0.0	0.0%	1,465.8	0.3%	44.0	0.0%	12.8	0.0%	0.0	0.0%	0.0	0.0%	3.9	0.0%	297.8	0.1%	2,084.5	0.4%
Low	129,339.9	25.0%	145.2	0.0%	199.0	0.0%	364,202.9	70.4%	767.6	0.1%	616.1	0.1%	463.9	0.1%	254.7	0.0%	1,499.7	0.3%	16,716.9	3.2%	514,205.8	99.4%
Total	129,877.9	25.1%	146.6	0.0%	199.0	0.0%	366,362.9	70.8%	818.1	0.2%	631.7	0.1%	463.9	0.1%	254.7	0.0%	1,509.6	0.3%	17,144.7	3.3%	517,408.9	100.0%

Table A5.3 Number of SACs

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
traffic taking account of background	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites
High	16	8%	0	0%	0	0%	28	14%	1	1%	0	0%	0	0%	0	0%	1	1%	0	0%	46	23%
Medium	3	2%	0	0%	0	0%	9	5%	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	13	7%
Low	40	20%	0	0%	0	0%	86	43%	0	0%	3	2%	2	1%	1	1%	7	4%	0	0%	139	70%
Total	59	30%	0	0%	0	0%	123	62%	2	1%	3	2%	2	1%	1	1%	8	4%	0	0%	198	100%

Appendix 6 Potential risk of impact from NO_x due to road traffic (acid deposition) 2020 – summary statistics

Table A6.1 Whole SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from traffic taking account of background concentrations	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites	Total area of whole sites (ha)	% total area of all sites
High	160,279.3	15.8%	0.0	0.0%	0.0	0.0%	7,086.1	0.7%	1,136.7	0.1%	0.0	0.0%	0.0	0.0%	0.0	0.0%	603.1	0.1%	58,235.5	5.8%	227,340.7	22.5%
Medium	81,294.9	8.0%	0.0	0.0%	0.0	0.0%	1,671.7	0.2%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	942.4	0.1%	0.0	0.0%	83,908.9	8.3%
Low	345,681.2	34.2%	897.5	0.1%	1,134.3	0.1%	94,839.2	9.4%	994.4	0.1%	24,752.9	2.4%	3,777.9	0.4%	398.1	0.0%	8,293.9	0.8%	220,164.3	21.8%	700,933.7	69.2%
Total	587,255.4	58.0%	897.5	0.1%	1,134.3	0.1%	103,596.9	10.2%	2,131.1	0.2%	24,752.9	2.4%	3,777.9	0.4%	398.1	0.0%	9,839.4	1.0%	278,399.8	27.5%	1,012,183.3	100.0%

Table A6.2 Specific SAC area

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total (excluding unclassified)	
Exposure to NO_x from traffic taking account of background concentrations	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding	Total area of specific areas of sites (ha)	% total area of all sites excluding
High	293.4	0.1%	0.0	0.0%	0.0	0.0%	185.4	0.0%	0.5	0.0%	123.5	0.0%	61.9	0.0%	9.1	0.0%	307.3	0.1%	190.3	0.0%	1,171.5	0.2%
Medium	82.5	0.0%	0.0	0.0%	0.0	0.0%	414.9	0.1%	0.8	0.0%	497.4	0.1%	5.1	0.0%	56.5	0.0%	677.8	0.1%	397.6	0.1%	2,132.5	0.4%
Low	190,264.7	36.4%	1,057.7	0.2%	208.5	0.0%	169,996.8	32.5%	2,353.2	0.4%	10,425.8	2.0%	25,401.3	4.9%	11,873.6	2.3%	82,314.6	15.7%	25,862.7	4.9%	519,758.8	99.4%
Total	190,640.5	36.4%	1,057.7	0.2%	208.5	0.0%	170,597.1	32.6%	2,354.5	0.5%	11,046.7	2.1%	25,468.3	4.9%	11,939.2	2.3%	83,299.7	15.9%	26,450.6	5.1%	523,062.8	100.0%

Table A6.3 Number of SACs

	Site sensitivity: High						Site sensitivity: Medium						Site sensitivity: Low						No CL		Total	
Exposure to NO_x from traffic taking account of background concentrations	Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL		Baseline deposition >100% CL		Baseline deposition 90% - 100% CL		Baseline deposition <90% CL					
	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites	Total number sites	% total number of all sites
High	13	7%	0	0%	0	0%	9	5%	1	1%	0	0%	0	0%	0	0%	4	2%	0	0%	27	15%
Medium	5	3%	0	0%	0	0%	3	2%	0	0%	0	0%	0	0%	0	0%	3	2%	0	0%	11	6%
Low	52	29%	1	1%	1	1%	36	20%	4	2%	8	4%	7	4%	2	1%	31	17%	0	0%	142	79%
Total	70	39%	1	1%	1	1%	48	27%	5	3%	8	4%	7	4%	2	1%	38	21%	0	0%	180	100%

Appendix 7 Potential risk of impact from NO_x due to road traffic (nitrogen deposition) 2011 – example excerpt from site-level statistics for the specific areas (ha) of SACs

Site sensitivity	H	H	H	H	H	H	H	H	H	M	M	M	M	M	M	M	M	M	L	L	L	L	L	L	L	L	L
Baseline deposition cf. CL	**>100%**	**>100%**	**>100%**	**90% - 100%**	**90% - 100%**	**90% - 100%**	**<90%**	**<90%**	**<90%**	**>100%**	**>100%**	**>100%**	**90% - 100%**	**90% - 100%**	**90% - 100%**	**<90%**	**<90%**	**<90%**	**>100%**	**>100%**	**>100%**	**90% - 100%**	**90% - 100%**	**90% - 100%**	**<90%**	**<90%**	**<90%**
Exposure to NOx from traffic taking account of background concentrations	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**
Alde-Ore & Butley Estuaries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	117.6	0.0	0.0	155.3
Arnecliff & Park Hole Woods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asby Complex	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.6	0.0	3090.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ashdown Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.9	0.0	2682.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aston Rowant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	126.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Avon Gorge Woodlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	106.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barnack Hills & Holes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bath & Bradford on Avon Bats	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bees Nest & Green Clay Pits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Benacre to Easton Bavents Lagoons	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	303.2
Berwickshire & North Northumberland Coast	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.7
Birklands & Bilhaugh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	269.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blean Complex	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	522.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolton Fell Moss	0.0	0.0	229.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Border Mires, Kielder-Butterburn	0.0	0.0	10528.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Borrowdale Woodland Complex	0.0	0.0	605.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bracket's Coppice	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Braunton Burrows	0.0	0.0	661.0	0.0	0.0	25.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Breckland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147.0	29.7	7354.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bredon Hill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	360.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Breney Common and Goss & Tregoss Moors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	815.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Briddlesford Copses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	166.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brown Moss	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burnham Beeches	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	383.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Butser Hill	65.8	51.4	102.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calf Hill & Cragg Woods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cannock Chase	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.2	218.1	999.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cannock Extension Canal	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carrine Common	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Castle Eden Dene	0.9	77.2	96.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Castle Hill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cerne & Sydling Downs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	370.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chesil & The Fleet	3.3	0.0	219.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chilmark Quarries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chilterns Beechwoods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	121.1	238.8	909.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cothill Fen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cotswold Beechwoods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	579.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RICARDO-AEA

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR

Tel: 01235 75 3000
Web: www.ricardo-aea.com