

AQTAG06

Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air



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1 Purpose of document

The purpose of this document is to assist in carrying out a Stage 3 appropriate assessment of air quality impacts under the Habitats Regulations¹.

2 Related documents

Environment Agency Operational Instruction 182_01: [Applying the Habitats Regulations to Environment Agency permissions, plans and projects](#) (issued 10/08/2010).

Environment Agency Operational Instruction 183_01: [Habitats Directive: taking a new permission, plan or project through the regulations](#) (issued 10/08/2010).

Environment Agency Operational Instruction: 254_06: [Assessment of new or revised COMAH safety reports for their impact on nature conservation](#) (issued 16/10/2012).

Environment Agency Operational Instruction 84_07: [Assessing the impact of ammonia releases from new and expanding intensive farms on nature conservation sites](#) (issued 20/01/2012).

Environment Agency Operational Instruction 66_12: [Simple assessment of the impact of aerial emissions from new or varying IPPC regulated industry for impacts on nature conservation](#) (issued 08/05/2012).

Environment Agency Operational Instruction 67_12: [Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation](#) (issued 08/05/2012).

DEFRA, 2002. [Ammonia in the UK](#).

UKCLAG, 1996. [Critical levels of air pollutants for the United Kingdom](#). UK Critical Loads Advisory Group, Institute of Terrestrial Ecology, Edinburgh.

3 Background

Applications for authorisation under the Environmental Permitting Regulations (EPR) need to be assessed in relation to the requirements of the EU Habitats Directive and Birds Directive and the UK regulations (Conservation of Habitats and Species Regulations, 2010). A four-stage risk assessment process has been developed:

- Stage 1 – identification of relevant permissions.
- Stage 2 – assessment of likely significant effect for '*relevant*' permissions.
- Stage 3 – appropriate assessment for '*significant*' permissions.
- Stage 4 – determination of the application.

¹ The modelling assessment principles described here are also applicable to SSSIs and local nature sites (NNR, LNR, LWS and ancient woodland).

Once an application has gone through Stages 1 and 2 of the assessment procedure it may be necessary to carry out a Stage 3 appropriate assessment. This guidance describes modelling approaches for an appropriate assessment.

4 Introduction

This document provides guidance on how to carry out a quantitative assessment (Stage 3 appropriate assessment) using short range modelling for emissions to air arising from a EPR process in order to fulfil the requirements of the Habitats Regulations.

The purpose of the appropriate assessment is to ascertain, in view of the site's conservation objectives², whether the proposal would or would not have an adverse effect on the integrity of the European Site.

This guidance mainly considers sulphur dioxide (SO₂), nitrogen oxides (NO_x) and ammonia (NH₃). However other pollutants are discussed in Section 14.

In order to determine whether a Stage 3 appropriate assessment is required to be carried out the following sources can be used:

- Environment Agency Operational Instruction 66_12: [Simple assessment of the impact of aerial emissions from new or varying IPPC regulated industry for impacts on nature conservation](#).
- Environment Agency Operational Instruction 84_07: [Assessing the impact of ammonia releases from new and expanding intensive farms on nature conservation sites](#).

5 Source information

Modelling is to be carried out for all processes that have been deemed as requiring an appropriate assessment as a result of performing Stages 1 and 2 of the four-stage assessment procedure. This procedure is carried out for all process within 10 km of the European site, unless the process is a power station for which the range is 15 km. A process that is outside this range may still be included in the assessment procedure if it is thought that it may have an impact on a European site.

Emission characteristics given in operator EPR applications require double-checking for errors, such as inconsistency between volume flow rates, gas concentrations and emission rates. Emission characteristics can be checked using the 'AQMAU source check spreadsheet'. A copy of the spreadsheet can be obtained from AQMAU in England and AQMRAT in Wales for internal use.

The source data that is required for modelling purposes comprises of:

- stack height
- stack internal diameter
- exit temperature
- volume flow rate, or exit velocity (care should be taken in distinguishing between values given at actual or reference conditions)
- emission rate

The authorised limit emission rate (or maximum emission rate for new applications) should be used as the basis for the Stage 3 appropriate assessment. If it cannot be shown that the

² The interest (or qualifying) features are identified in the citations for each European site. There will be a conservation objective for each site, covering each feature. These can be obtained from the relevant Fisheries and Biodiversity team, or from the Natural England website.

proposal under these conditions will not have an adverse effect on the integrity of the European site then alternative options for control should be considered as part of Stage 4 of the assessment process.

Buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building. The maximum projected width is the maximum observable width of the building if seen in silhouette and rotated around its centre).
- Taller than 40 % of the stack height.

Building information that is required for modelling includes:

- height, width, and length
- the angle between the length and north
- the coordinates of the centre or south west corner of the building

If the source being assessed is a large existing source, which was also included in the background estimation, then care should be taken in ensuring that it is not included twice in any total deposition flux and PEC concentration that is calculated.

6 Receptor information

Each European site is digitised as a set of individual polygons that taken together represent the individual SAC (Special Area of Conservation), SPA (Special Protection Area) or Ramsar site.

The minimum approach to modelling is to represent each polygon by a single point.

The X,Y co-ordinates for all the polygons that make up a European site need to be obtained from the Environment Agency or Natural England. These X,Y coordinates can be entered into the dispersion model as discrete receptors.

Generally, polygons within 10 km (15 km for power stations) of the sources should be included in the assessment. For some European sites there are a large number of individual polygons, in this situation please contact AQMAU in England and AQMRAT in Wales for help.

A fine grid can be placed over those polygons that are considered sufficiently near to a source such that the annual average ground level concentration across the domain of the polygon may vary significantly. Alternatively the polygon can be represented by a set of discrete receptors.

A polygon is considered near a source if the following criteria is met:

- The distance r between the source and the edge of the polygon is less than the $1.5 \times$ the largest width W of the polygon.

If a polygon is considered near a source then the polygon can be represented by a set of receptor points. This set of receptor points can either be obtained via:

- The use of a modelling grid. However not all points in the modelling grid will be located within the individual polygons.
- The placing by hand of a set of individual receptors within the individual polygons with a view to cover the area of worst impact.

The predicted maximum ground level concentration within the set of points used to represent a polygon is then used in the assessment process.

7 Meteorological data and terrain data

The modelling assessment should be repeated for a set of five different years of meteorological (met) data if possible, with a minimum of three years.

In the first instance, modelling results obtained for the worst met year for each polygon should be used in the assessment process, i.e. the comparison between modelled results and the critical loads and levels. However as outlined in Appendix 7, a range of scenarios should be considered before any decisions are taken to require modifications to or refuse any consent (see Section 12 for further details).

Note that it is important to correct the met data for differences in surrounding land use and surface roughness between the met site and process site.

For guidance on how to create met data for dispersion modelling please contact the helpdesk of AQMAU in England and AQMRAT in Wales.

A wind rose can be generated for each year of met data. AERMOD and ADMS both contain the capability to generate a wind rose for the user. These wind roses can be used to determine the principal wind directions and the subsequent choice of receptors. If complex terrain is present (gradients greater than 1 in 10) then the effects of complex terrain should be represented within the dispersion model via the appropriate method. For guidance on how to create terrain data for dispersion modelling please contact the AQMAU or AQMRAT helpdesk for more information.

8 Calculation of deposition fluxes

Dry deposition flux

The maximum annual average ground level concentration at any point in a European site polygon can be obtained from modelling.

The annual dry deposition flux can be obtained from the modelled annual average ground level concentration via use of the formula:

Dry deposition flux = ground level concentration × deposition velocity.

$(\mu\text{g m}^{-2} \text{ s}^{-1})$ $(\mu\text{g m}^{-3})$ (m s^{-1})

where μg refers to μg of the chemical species under consideration.

The deposition velocities for various chemical species recommended for use are shown below in Table 8.1. The dry deposition velocity for ammonia is concentration dependent and can be significantly reduced at high concentrations, see Table 1 in "[Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming](#)", for more details.

Table 8.1 Recommended dry deposition velocities.

Chemical species	Recommended deposition velocity, m s^{-1}	
NO_2^*	Grassland	0.0015
	Forest	0.003
SO_2	Grassland	0.012
	Forest	0.024
NH_3	Grassland	0.020

	Forest	0.030
HCl	Grassland	0.025
	Forest	0.060
HNO ₃	0.040	
Sulphate aerosol, SO ₄ ²⁻	0.010	

* The majority of NO_x emitted from a combustion source is in the form of NO. Please see the Environment Agency's guidance for the conversion ratio from NO to NO₂ at:

http://www.environment-agency.gov.uk/static/documents/Business/noxno2conv2005_1233043.pdf

For modelling concentration and deposition of ammonia from intensive farming, please also refer to the most recent version of the Environment Agency's "Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming", available from: <http://www.environment-agency.gov.uk/business/sectors/40071.aspx>.

It is believed that the contribution of HNO₃ and SO₄²⁻ deposition arising from atmospheric chemistry of SO₂ or NO_x can be neglected in the short-range dispersion field.

However where HNO₃ and sulphate aerosol are emitted directly the deposition should be accounted for.

Note that for nutrient nitrogen deposition the appropriate units are kgN ha⁻¹ yr⁻¹. However, for acid deposition the units are keq ha⁻¹ yr⁻¹ where keq refers to the kilo H⁺ equivalent of acidification. The same unit is used for acid deposition from N and S species, and HCl.

Conversion factors

To convert the dry deposition flux from units of µg m⁻² s⁻¹ (where µg refers to µg of the chemical species) to units of kg N ha⁻¹ year⁻¹ (where kg refers to kg of nitrogen) multiply the dry deposition flux by the conversion factors shown in table 8.2. To convert dry deposition flux to acid deposition multiply by factors shown in table 8.3

Table 8.2 Dry deposition flux conversion factors for nutrient nitrogen deposition

µg m ⁻² s ⁻¹ of species	Conversion factor to kg N ha ⁻¹ year ⁻¹
NO ₂	95.9
NH ₃	260
HNO ₃	70.0

Table 8.3 Dry deposition flux conversion factors for acidification

$\mu\text{g m}^{-2} \text{ s}^{-1}$ of species	Conversion factor to keq $\text{ha}^{-1} \text{ year}^{-1}$
NO ₂	6.84
NH ₃	18.5
HNO ₃	5.00
SO ₂	9.84
HCl	8.63

1 hectare is 10000 m²

Wet deposition flux

It is considered that the wet deposition of SO₂, NO₂ and NH₃ is not significant within a short range.

However, wet deposition for HCl and HNO₃ should be considered where a process emits these species.

For more information about wet deposition calculations please contact AQMAU in England and AQMRAT in Wales for assistance.

9 Background Contribution

Background data can be obtained from the following sources:

- verified local background monitoring
- UK National Air Quality Information Archive (www.airquality.co.uk)
- local authority websites
- Air Pollution Information System (APIS, www.apis.ac.uk)
- ammonia and deposition estimates (<http://www.uk-pollutantdeposition.ceh.ac.uk/>)

Local monitoring data is not always available. When available it can be used for assessment purposes. Note that the monitored values may also already contain a contribution from the existing process under consideration, see below.

Information on the concentration of ammonia in air, acid deposition and deposition of nitrogen can be found on the UK pollutant deposition website (<http://www.uk-pollutantdeposition.ceh.ac.uk/>). A map of UK ammonia concentrations is also available from the website (<http://www.uk-pollutantdeposition.ceh.ac.uk/image/tid/30>).

For the purposes of comparing the process + background ground level atmospheric concentrations against the critical levels of SO₂ and NO_x, the background concentrations can be obtained from the UK National Air Quality Information Archive at www.airquality.co.uk

For the purposes of comparing the process + background deposition fluxes against the critical loads, the background fluxes for eutrophication and acidification can be obtained from the APIS website (<http://www.apis.ac.uk/>) or the UK pollutant deposition website

(<http://www.uk-pollutantdeposition.ceh.ac.uk/>). These websites may have different update dates. Generally, the data from the most recently updated site should be used in the assessment (the date the information was obtained should be noted).

The chosen background values may already contain a contribution from the process under consideration. This can at first be ignored (a conservative and practical approach) for the assessment process. If however the assessment concludes that the process is having an adverse effect on the European site when considered in combination with the background then the possible double counting of contributions should be considered.

A method for removing the contribution of the process under consideration from the background is as follows:

- Place a modelling domain containing the wildlife site, centred on the process source, with a grid resolution of 1 km for SO₂ and NO₂ and 5 km for NH₃. Run the model for the met year of interest.
- Obtain the annual average atmospheric concentrations modelled at the grid nodes and average them. This average can be taken as an estimate of the contribution already contained within the background figure.
- Subtract this figure from the background figure (after conversion to a deposition flux if working with deposition fluxes).

Ideally these would be incorporated into the assessment, although the resources and data required may be considerable. Hence for the purposes of permitting a process the additional effort required to improve the estimate of the background value is only warranted where doing so might influence the outcome of the assessment process.

The improved representation of background sources via their inclusion in the local modelling is unlikely to lead to much lower values for the background contribution, but may lead to much higher values.

Where the PEC (Predicted Environmental Concentration) is within +/- 30 % of the critical load or level, a more detailed consideration of the representation of background sources may be warranted.

When the PC (Process Contribution) is a very large percentage of the critical load or level (or a very small percentage) it may be unlikely that obtaining a more accurate background value would influence the final assessment for permitting purposes, and hence a more detailed consideration of the background representation would not be required.

If the modelling of “background” sources is to be done in more detail then:

- Major local sources within the boundary of the European site should be considered separately via inclusion in the local modelling.
- If it is thought that a particular existing source may be having a significant impact upon the European site in combination with the source being assessed then it should be considered separately via inclusion in the local modelling, for example, other IPPC processes located close to the site boundary.
- Emissions from major roads are included in the background estimation. However if there are major roads (greater than ~ 50,000 vehicles a day) within 2 – 3 km of a European site, then it would be better to model the roads as separate line sources due to the strong local NO_x gradients they can produce. In this case contact AQMAU in England and AQMRAT in Wales for assistance.

10 Critical levels

The term “critical level” refers to the concentrations of a pollutant in the atmosphere above which direct adverse effects on receptors, such as plants, ecosystems or materials, may occur according to present knowledge. They refer to the direct effects of atmospheric pollutants on vegetation.

The Air Pollution Information System (www.apis.ac.uk) has a searchable database for critical levels. To obtain the critical level for a pollutant and habitat type or species select “Search by Pollutant” under the “Search the Database” section.

Tables 10.1, 10.2 and 10.3 show the critical levels for SO₂, NO_x and NH₃ respectively. They represent the best scientific understanding of the concentrations to be achieved for the protection of vegetation.

Table 10.1 Critical levels for SO₂ for the protection of vegetation

Receptor	Averaging time	Concentration $\mu\text{g}/\text{m}^3$
Agricultural Crops	Annual and winter* means	30 ^a
Forests and natural vegetation	Annual and winter* means	20 ^{a,b}
	Annual and winter* means where accumulated temperature sum above 5°C is <1000 degrees days per year	15 ^a
Lichens	Annual mean	10 ^a

* October - March inclusive; ^a WHO, 2000; ^b Defra, 2007, also see H1 annex F

Table 10.2 Critical levels for NO_x for the protection of vegetation

Averaging time	Concentration $\mu\text{g}/\text{m}^3$
1 day	75 ^a
1 year	30 ^{a,b}

^a WHO, 2000; ^b Defra, 2007, also see H1 annex F

Table 10.3 Critical levels for ammonia for the protection of vegetation

Receptor	Averaging time	Concentration $\mu\text{g}/\text{m}^3$
Lichens and bryophytes (including ecosystems where lichens and bryophytes are a key part of ecosystem integrity)	Annual mean	1 ^a
Higher plants (including heathland, grassland and forest ground flora)	Annual mean	3 ^{a, b}

^a UNECE, 2007; ^b an explicit uncertainty range of 2 - 4 $\mu\text{g m}^{-3}$ was set for higher plants (including heathland, semi-natural grassland and forest ground flora). The uncertainty range is intended to be useful when applying the critical level in different assessment contexts (e.g.

precautionary approach or balance of evidence.) ICP Modelling and Mapping
<http://icpmapping.org/cms/zeigeBereich/11/manual-english.html>

In the past, the critical level was defined for nitrogen dioxide (NO_2). Because of new knowledge of the important phytotoxic effects of nitric oxide (NO), the present critical level is a combined value for NO plus NO_2 (termed NO_x , i.e. $\text{NO}_x = \text{NO} + \text{NO}_2$). The short term NO_x critical level should be included in the impact assessment because it may be more stringent than the annual level.

11 Critical Loads

There are critical loads for eutrophication and critical loads for acidification. Critical loads are a quantitative estimate of an 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.

Site specific critical loads for eutrophication and acidification can be found on APIS, <http://www.apis.ac.uk/>

Eutrophication critical loads, which have recently been revised, are given as a range and have units of $\text{kg N ha}^{-1} \text{ year}^{-1}$. A table indicating which part of the range should be used in an assessment is provided on APIS (<http://www.apis.ac.uk/indicative-critical-load-values>).

The critical loads for acidification are more complicated in that both the nitrogen and sulphur deposition fluxes must be considered at the same time. Therefore a critical load function is specified for acidification, via the use of three critical load parameters:

- CL_{maxS} – the maximum critical load of sulphur, above which the deposition of sulphur alone would be considered to lead to an exceedance.
- CL_{minN} – this is a measure of the ability of a system to “consume” deposited nitrogen (e.g. via immobilisation and uptake of the deposited nitrogen).
- CL_{maxN} – the maximum critical load of acidifying nitrogen, above which the deposition of nitrogen alone would be considered to lead to an exceedance.

These three quantities define the so-called critical load function shown in Figure 11.1.

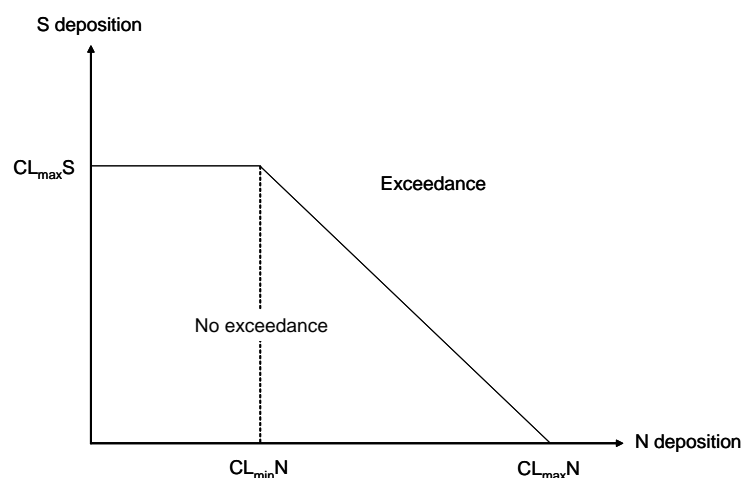


Figure 11.1 Critical load function of sulphur and nitrogen defined by the three quantities CL_{maxS} , CL_{minN} and CL_{maxN} .

When the S and N deposition fluxes arising from the process are plotted on the graph they specify a specific point. If the critical load function for the European feature being assessed is also plotted it is possible to judge by the location of the point in relation to the function whether the critical load for acidification has been exceeded.

The units of the critical load parameters for acidification are $\text{keq ha}^{-1} \text{ year}^{-1}$.

Calculating exceedance of an acidity critical load function, or the significance of a contribution from a source, is complex. A tool to calculate exceedance is available on APIS (<http://www.apis.ac.uk/critical-load-function-tool>).

For a proposed installation with a HCl emission, the process contribution of HCl, in addition to S and N, also needs to be considered in the acidity critical load assessment. The acid contribution from HCl should be added to the S contribution and treated as S in the APIS tool.

12 Assessment

The location of the designated feature within a given polygons/European sites can be confirmed with Natural England to inform the appropriate assessment. Information should also be obtained on the influence of any local factors such as altitude or nutrient status of the Habitat site (i.e. whether a feature is P-limited or not) which may modify the impact of the pollutants concerned.

The process contribution (PC) added to the background should be compared against the relevant critical levels or loads.

Critical loads³

Calculation of total deposition flux:

total deposition flux = deposition flux_{process contribution} + deposition flux_{background}

Critical levels³

Calculation of total or predicted environmental concentration (PEC):

PEC = atmospheric concentration_{process contribution} (PC) + atmospheric concentration_{background}

The overall assessment is a judgement taking into account whether the site is exceeded as a result of contributions from all sources including the process contribution and the presence of any modifying factors. A range of assessment scenarios as suggested in Habitats Directive Work Instruction Appendix 7 need to be considered together with various sources of uncertainty.

For a specific EPR site assessment, the large sources regulated by the Environment Agency are treated as part of the background contribution on APIS. However, when one of these large sources is close to the investigated European site (e.g., the distance to the European site is smaller than 10 – 15 km as appropriate) then this source should be modelled locally. The method described in Section 9 dealing with double counting for large sources should be used.

Sources of uncertainty and the reliability of data should be taken into account before a decision can be made.

³ For modelling concentration and deposition of ammonia from intensive farming, please refer to the Environment Agency's "[Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming](#)".

13 Uncertainty

This guidance is developed for an appropriate assessment. The issue of model uncertainty needs to be addressed in the assessment. It is also recognised that there is uncertainty in the critical loads or critical levels used in the assessment. At present this cannot be quantified but needs to be borne in mind in making the final judgement as to whether the proposal does or does not have an adverse effect on the integrity of the European site.

For local modelling, model uncertainty can arise from various sources, i.e., from the model algorithm, atmospheric turbulence and model input parameters. Sensitivity testing is a useful tool to address uncertainty in model input parameters.

A sensitivity assessment of this type will give rise to a range of possible outcomes which can be set out as suggested in Appendix 7 of the Habitats guidance. At this stage further information on the influence of modifying factors such as P limitation or humidity can be brought into consideration before arriving at the final judgement.

Please contact AQMAU for more information if required.

14 Other Pollutants

For an assessment of the impact arising from pollutants other than HCL, SO₂, NO_x and NH₃ (e.g., HF) the problem can be broken down into:

- Modelling the atmospheric concentrations and fluxes incident on the European site.
- Assessing the type of impact and possible effects the pollutant may have on the integrity of the European site.
- Obtaining an environmental assessment level against which to assess whether the pollutant is having an adverse effect on the European site or not.

Information on the type of impact and appropriate assessment levels (where available) can be found on the Air Pollution Information System (www.apis.ac.uk).

Provided adequate information can be obtained concerning the emission rates and source characteristics, then essentially there is no difference between modelling atmospheric concentrations for other pollutants than for modelling SO₂ for instance.

However with regard to calculating deposition fluxes of a pollutant the situation is more complicated. The appropriate deposition velocities must be obtained for the pollutant in order to calculate a dry deposition flux, and consideration given to how to model wet deposition. *In such cases contact AQMAU in England and AQMRAT in Wales for advice on how to model deposition fluxes for other pollutants.*

15 Examples

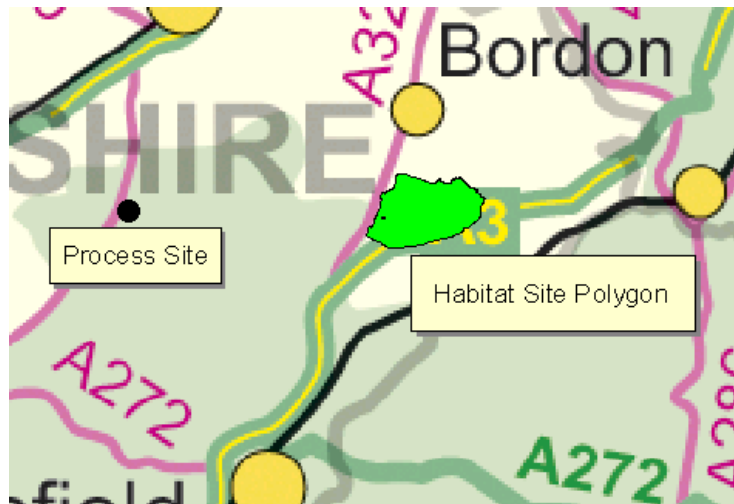
15.1 Example 1 - local modelling for a process, $r > 1.5 W$

Local modelling for a process $r > 1.5 \times W$, where:

r = distance from source to polygon

W = largest width of the polygon

A hypothetical process emitting SO₂ and NO₂ applies for an EPR permit and an appropriate assessment is required under the Habitats Regulations.



The ground level concentration at the European site, arising from the process is modelled using a short-range air dispersion model.

The process is less than 10 km from a European site, Woolmer Forest SAC (UK ID: UK0030304). The Woolmer Forest SAC consists of only one polygon which is approximately 4.1 km wide at its widest part.

The process source is situated more than 9.8 km away from the X,Y coordinates of the polygon, hence a single receptor can be used to represent the polygon.

The emission characteristics of the process stack are given in the table below.

Parameter	Value	Units
Emission rate: NO ₂	800	g s ⁻¹
Emission rate: SO ₂	329	g s ⁻¹
Stack Height	65	m
Stack Diameter	5.8	m
Exit Temp	137	°C
Exit Velocity	24.5	m s ⁻¹
X-Coordinate	470466	m
Y-Coordinate	132413	m

The nearest met data site suitable for use in dispersion modelling is Odiham RAF station, for which there are four years worth of met data.

There are gradients greater than 1 in 10 present and hence it is necessary to represent the presence of complex terrain in the dispersion model.

In this case the X,Y co-ordinates, 480349, 132463 are used to represent the European site (GIS system, e.g. Arcview software can be used to identify the X,Y co-ordinates).

The predicted maximum annual average NO₂ ground level concentration over the European site polygon under investigation was 1.5 µg m⁻³ (only 1995 met data was used in this example).

The predicted maximum annual average SO₂ ground level concentration over the European site polygon under investigation was 0.6 µg m⁻³ (only 1995 met data was used in this example).

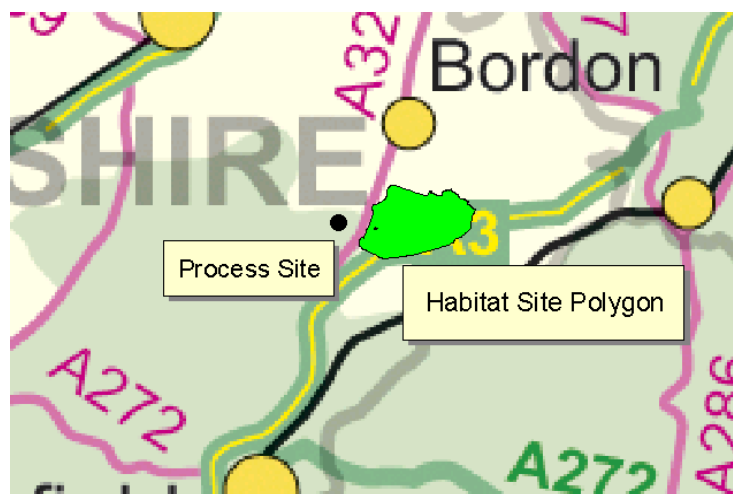
15.2 Example 2 - local modelling, $r < 1.5 W$

Local modelling for a process $r < 1.5 \times W$, where:

r = distance from source to polygon

W = largest width of the polygon

A hypothetical process emitting SO₂ and NO₂ applies for an EPR permit and an appropriate assessment is required under the Habitats Regulations.



The ground level concentration at the European site, arising from the process is modelled using a short-range air dispersion model.

The process is less than 10 km from a European site, Woolmer Forest SAC (UK ID: UK0030304). The Woolmer Forest SAC consists of solely one polygon which is approximately 4.1 km wide at its widest part.

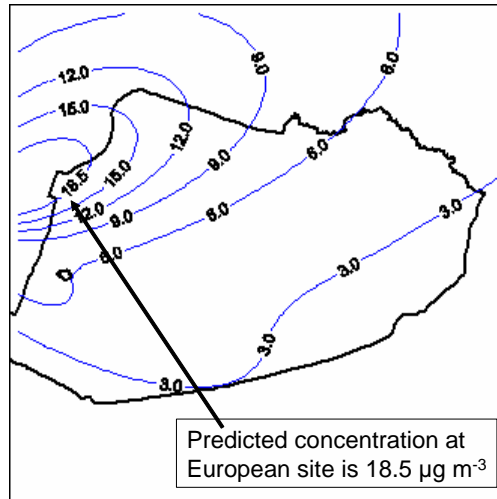
The process source is situated 2.6 km away from the X,Y coordinates of the polygon, hence a single receptor is insufficient to represent the polygon.

The emission characteristics of the process stack are given in the table below.

Parameter	Value	Units
Emission rate: NO ₂	800	g s ⁻¹
Emission rate: SO ₂	329	g s ⁻¹
Stack Height	65	m
Stack Diameter	5.8	m
Exit Temp	137	°C
Exit Velocity	24.5	m s ⁻¹
X-Coordinate	477700	m
Y-Coordinate	132413	m

It is necessary to represent the polygon with more than one discrete receptor point. A fine receptor grid can be placed over the polygons, and the maximum concentration modelled within the polygon is used for assessment purposes.

Sometimes it might be necessary to overlay the contour plots on an OS Map.



The predicted annual average NO₂ ground level concentration over the European site polygon under investigation, when using 1995 met data, was 18.5 µg m⁻³.

The predicted annual average SO₂ ground level concentration over the European site polygon under investigation, when using 1995 met data, was 7.6 µg m⁻³.

15.3 Example 3 - calculation of acid load arising from sulphur deposition flux

Calculation of acid load arising from sulphur deposition flux from example 1:

The maximum annual average ground level SO₂ concentration over a specific European site polygon due to the process is modelled as 0.6 µg m⁻³.

The dry deposition velocity of SO₂ is taken as 0.012 m s⁻¹

$$\begin{aligned} \text{The dry deposition flux in } \mu\text{g SO}_2 \text{ m}^{-2} \text{ s}^{-1} &= 0.6 * 0.012 \\ &= 0.0072 \mu\text{g SO}_2 \text{ m}^{-2} \text{ s}^{-1} \end{aligned}$$

The conversion factor to go from µg SO₂ m⁻² s⁻¹ to keq ha⁻¹ yr⁻¹ in table 8.3 is 9.84.

$$\begin{aligned} \text{Therefore the acid load arising from S deposition is } &0.0072 * 9.84 \text{ keq ha}^{-1} \text{ yr}^{-1} \\ &= 0.07 \text{ keq ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

The process does not have an emission of HCl, therefore the wet deposition flux is considered not significant and is not calculated.

Hence the total acid load arising from the deposition flux of S at the polygon due to the process is 0.07 keq ha⁻¹ year⁻¹.

This process contribution load then needs to be compared with relevant critical loads.

15.4 Example 4 - calculation of nitrogen deposition flux

Calculation of nitrogen deposition flux from example 1:

The maximum annual average ground level NO₂ concentration over a specific European site polygon due to the process is modelled as 1.5 µg m⁻³.

The dry deposition velocity of NO₂ is taken as 0.0015 m s⁻¹

$$\begin{aligned} \text{The dry deposition flux in } \mu\text{g NO}_2 \text{ m}^{-2} \text{ s}^{-1} &= 1.5 * 0.0015 \\ &= 0.00225 \mu\text{g NO}_2 \text{ m}^{-2} \text{ s}^{-1} \end{aligned}$$

The conversion factor to go from µg NO₂ m⁻² s⁻¹ to kg N ha⁻¹ year⁻¹ is 95.9

$$\text{The dry deposition flux in kg N ha}^{-1} \text{ year}^{-1} = 0.00225 * 95.9$$

$$= 0.216 \text{ kg N ha}^{-1} \text{ year}^{-1}$$

As there is no HCl emission the wet deposition flux is considered to be insignificant. Therefore the total deposition flux is $0.216 \text{ kgN ha}^{-1}\text{yr}^{-1}$.

For acid deposition, the conversion factor from $\mu\text{g m}^{-2} \text{ s}^{-1}$ to $\text{keq ha}^{-1} \text{ year}^{-1}$ is 6.84.

Therefore, as wet deposition is not significant, the acid load arising from N deposition from NO_2 in $\text{keq ha}^{-1} \text{ year}^{-1} = 0.00225 * 6.84$

$$= 0.0154 \text{ keq ha}^{-1} \text{ year}^{-1}$$

For eutrophication the predicted deposition flux from the process of $0.216 \text{ kgN ha}^{-1}\text{yr}^{-1}$ needs to be compared with relevant critical loads. For example, if the eutrophication critical load is $10 \text{ kgN ha}^{-1}\text{yr}^{-1}$, then the PC is $0.216/10 = 2.2 \%$ of the critical load.

15.5 Example 5 - critical levels assessment

Assessment of SO_2 and NO_x levels against critical levels, from example 1:

Sulphur dioxide

The National Air Quality Strategy critical level for the protection of vegetation and ecosystems for SO_2 is $20 \mu\text{g m}^{-3}$.

The WHO guideline critical level for protection of Lichen is $10 \mu\text{g m}^{-3}$.

The 2001 background air concentration taken from the UK National Air Quality Information Archive is $2.6 \mu\text{g m}^{-3}$.

This was obtained by going to www.airquality.co.uk and selecting "LAQM Tools", then selecting "Background maps", then selecting the appropriate local authority.

The modelled Process Contribution to atmospheric ground level concentrations is $0.6 \mu\text{g m}^{-3}$.

Hence the Predicted Environmental Concentration is $0.6 + 2.6 = 3.2 \mu\text{g m}^{-3}$.

The PEC is 16 % of the critical level.

The PC is 3 % of the critical level.

Hence the critical level for SO_2 is not exceeded.

Nitrogen oxides

The National Air Quality Strategy critical level (objective) for the protection of vegetation and ecosystems for NO_x is $30 \mu\text{g m}^{-3}$ as an annual mean (expressed as NO_2).

The 2001 background air concentration of NO_x taken from the UK National Air Quality Information Archive is $24.2 \mu\text{g m}^{-3}$ (expressed as NO_2).

The modelled Process Contribution to atmospheric ground level annual average NO_2 concentrations is $1.5 \mu\text{g m}^{-3}$.

Hence the Predicted Environmental Concentration is $24.2 + 1.5 = 25.7 \mu\text{g m}^{-3}$.

The PEC is 86 % of the critical level.

The PC is 5 % of the critical level.

Hence the critical level for NO_x is not exceeded.

The emissions from the process have already been expressed as NO_2 , so any NO component has already been included.

16 References

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