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CHAPTER 1: Introduction – Local Air Quality Management (LAQM)

1.01 This technical guidance (LAQM.TG16)[1] supersedes all previous versions, the most recent being LAQM.TG09. It is designed to support local authorities in carrying out their duties under the Environment Act 1995, the Environment (Northern Ireland) Order 2002, and subsequent regulations. LAQM is the statutory process by which local authorities monitor, assess and take action to improve local air quality. Where a local authority identifies areas of non-compliance with air quality objectives, and there is relevant public exposure, there remains a statutory need to declare the geographic extent[2] of non-compliance as an Air Quality Management Area (AQMA) and to draw up an action plan detailing remedial measures to address the problem. A general introduction to the system is provided in the Policy Guidance documents[3].

Who Should Read this Document?

1.02 The primary users will be technical officers within local authorities charged with air quality duties under the regulations cited above in England, Scotland, Wales and Northern Ireland. Secondary users will include transport, planning and policy officials. London has its own system of LAQM and local authorities in Greater London should refer to separate guidance prepared by the Mayor of London, which may refer to this document.

What has Changed?

1.03 The LAQM system across the UK has changed. England and Scotland have adopted a new streamlined approach which places greater emphasis on action planning to bring forward improvements in air quality and to include local measures as part of EU reporting requirements. It also sees the introduction of an air quality Annual Status Report (ASR) for England and Annual Progress Report (APR) for Scotland to reduce the burden of the cycle of Updating and Screening Assessments, Progress Reports, Detailed Assessments, Further Assessments[4] and Action Plan Progress Reports.

1.04 Authorities will continue to appraise air quality, with the main emphasis on those pollutants shown to be challenging in respect of compliance – Nitrogen Dioxide (NO_2), Particulate Matter (PM_{10}) and Sulphur Dioxide (SO_2), whilst introducing a new role for local authorities to work towards reducing levels of $PM_{2.5}$.

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[1] LAQM.TG16 refers to LAQM Technical Guidance (England) 2016

[2] Authorities should declare the area of exceedance as a minimum but can declare an area that is wider if they wish.

[3] Separate Policy Guidance exists for England, Scotland, Northern Ireland, Wales and London.

[4] Further Assessments have already been removed via statute in England, Wales and Scotland. Whilst Further Assessments are still a formal requirement under Part III of the Environment (Northern Ireland) Order 2002, in practice, NI Policy Guidance recommends that Further Assessments not be submitted as separate documents but taken forward in parallel with the development of Air Quality Action Plans.

1.05 Wales and Northern Ireland are still to consider changes to LAQM and continue to work according to the previous regimes.

Structure

1.06 The structure of this revised technical guidance allows for updates to be applied on an on-going basis and is ordered in such a way that ensures the focus is on measures and public reporting.

1.07 This Technical Guidance supports the wider central government shift towards evidence-based action planning for the benefit of public health and wellbeing. To aid local authorities in this, existing air quality tools and measures have been updated where necessary, outdated technical or policy guidance has been removed, and new products and supporting material have been added to help local authorities assess the impact of measures.

NO_2, PM_{10} and SO_2

1.08 At the core of LAQM delivery are three pollutant objectives; these are: Nitrogen Dioxide (NO_2), Particulate Matter (PM_{10}) and Sulphur Dioxide (SO_2)[5]. All current Air Quality Management Areas (AQMAs) across the UK are declared for one or more of these pollutants, with NO_2 accounting for the majority. It is a statutory requirement for local authorities to regularly review and assess air quality in their area and take action to improve air quality when objectives set out in regulation cannot be met.

$PM_{2.5}$

1.09 Local authorities in England have a new flexible role in working towards reducing emissions and concentrations of $PM_{2.5}$ - Chapter 7 of LAQM.PG16 provides more examples on the interpretation of this role. In Scotland, local authorities have a statutory obligation to achieve the 10µg/m^3 annual mean objective for $PM_{2.5}$.

1.10 This guidance therefore provides support to local authorities with regards to some of the approaches available for considering $PM_{2.5}$ within the LAQM system. For Scotland, this should be aligned to the methods currently employed for the Review and Assessment of other pollutants for which there are statutory objectives, i.e. apply a combination of monitoring and predictive modelling based methods.

1.11 For local authorities in England, this technical guidance does not prescribe what the local authority approach should be; it is for the local authority in consultation with its public health officials to consider how it wishes to define this role and what approach to take, based upon the local circumstances and public health priorities. This flexibility of approach is intended to allow authorities to steer towards focussing upon clear actions with attainable targets to tackle $PM_{2.5}$ alongside other air pollutants. Further details are provided in Chapter 2.

Benzene, 1,3-Butadiene, Carbon Monoxide and Lead

1.12 Reflecting feedback under the LAQM review process the UK Government has decided to retain Benzene, 1,3-Butadiene, Carbon Monoxide and Lead in regulations for England. However, in recognition of the fact that all of the objectives for these pollutants have been met for several years and are well below limit values, local authorities in England do not have to report on these pollutants unless local circumstances indicate otherwise. These pollutants remain a statutory reporting requirement in Scotland, Wales and Northern Ireland.

Table 1.1 – UK Air Quality Objectives and Pollutants - LAQM

Pollutant	Objective	Averaging Period	Obligation
Nitrogen dioxide (NO_2)	200µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	All local authorities
	40µg/m^3	Annual mean	All local authorities
Particulate Matter (PM_{10})	50µg/m^3 not to be exceeded more than 35 times a year	24-hour mean	All local authorities
	50µg/m^3 not to be exceeded more than 7 times a year	24-hour mean	Scotland only
	40µg/m^3	Annual mean	All local authorities
	18µg/m^3	Annual mean	Scotland only
Particulate Matter ($PM_{2.5}$)	Work towards reducing emissions/concentrations of fine particulate matter ($PM_{2.5}$)	Annual mean	England only
	10µg/m^3	Annual mean	Scotland only
Sulphur dioxide (SO_2)	266µg/m^3 not to be exceeded more than 35 times a year	15-minute mean	All local authorities
	350µg/m^3 not to be exceeded more than 24 times a year	1-hour mean	All local authorities
	125µg/m^3 not to be exceeded more than 3 times a year	24-hour mean	All local authorities
Benzene (C_6H_6)	16.25µg/m^3	Running annual mean	All local authorities
	5µg/m^3	Annual mean	England and Wales only
	3.25µg/m^3	Running annual mean	Scotland and Northern Ireland only
1,3-Butadiene (C_4H_6)	2.25µg/m^3	Running annual mean	All local authorities
Carbon Monoxide (CO)	10mg/m^3	Maximum daily running 8-hour mean	England, Wales and Northern Ireland only
	10mg/m^3	Running 8-hour mean	Scotland only
Lead (Pb)	0.5µg/m^3	Annual mean	All local authorities
	0.25µg/m^3	Annual mean	All local authorities

LAQM Systems Across the United Kingdom

1.13 Currently different Review and Assessment methodologies exist across the UK. It is important for those using LAQM.TG(16) to refer to the section relevant to their country.

Phased Approach: Wales and Northern Ireland

1.14 The LAQM system is still to be reviewed in Wales and Northern Ireland. Until then, the previous system based on phased reporting remains. Round 6 of this process started in 2015. This is summarised in Table 1.2.

Table 1.2 – Phased Approach – Cycle of Reporting for Wales and Northern Ireland

Year	Updating and Screening Assessments	Progress Reports	Detailed Assessments
Round 6 – Completion Dates			
2015	30 April 2015	-	Whenever necessary[6]
2016	-	30 April 2016	Whenever necessary
2017	-	30 April 2017	Whenever necessary
Round 7 – Completion Dates			
2018	30 April 2018	-	Whenever necessary
2019	-	30 April 2019	Whenever necessary
2020	-	30 April 2020	Whenever necessary

Streamlined Approach: England and Scotland

1.15 Following separate consultations, England (including London) and Scotland have adopted a streamlined approach in order to review and assess air quality, with all three utilising the submission of a single ASR/APR in place of the phased approach previously used. Each region has its own template and requirements specific to local circumstances.

1.16 Air quality in the capital is devolved to the Mayor of London, who has a supervisory role, with powers to intervene and direct local authorities in Greater London under Part IV of the Environment Act 1995. In support of these devolved powers, the Mayor has established a London LAQM system for the effective and coordinated discharge of their respective responsibilities under Part IV of the Act.

1.17 The Secretary of State expects local authorities in Greater London to participate in the Mayor of London's LAQM system and to have regard to any advice or guidance issued by the Mayor as to the performance of their LAQM functions.

[6] Detailed Assessments are due within 12 months of the date they are initiated, which can be at any time.

Overview: England LAQM

Reporting:

1.18 Submission of a single Annual Status Report (ASR). This report (in the format of a template) replaces all other reports which previously had to be submitted as part of the LAQM system including Review and Assessment and Action Plan Progress Reports, Updating and Screening Assessments (USAs) and Detailed Assessments. Action Plans remain as separate.

1.19 Local authorities are required to submit the ASR by 30 April each year. However, in the first year of operation the submission date will be 30 June 2016.

1.20 The ASR includes a new public-facing executive summary, which local authorities are mandated to complete and make available on their website to help promote air quality locally.

Pollutant Focus:

1.21 Statutory reporting of NO_2, PM_{10} and SO_2: Authorities in England are not required to report on Benzene, 1,3-Butadiene, Carbon Monoxide and Lead, but may do so if there is an issue that needs to be addressed.

1.22 Local authorities in England have a new role to work towards reducing emissions and concentrations of $PM_{2.5}$, which is a very important area of focus due to the well-documented health impacts.

1.23 The $PM_{2.5}$ role has not been defined in detail so as to allow each local authority the flexibility to set its own approach in contributing towards $PM_{2.5}$ reductions. Local authorities should define in the ASR how they are working towards reducing levels of $PM_{2.5}$, with a clear explanation as to the reasoning. Guidance is provided on measures known to be especially effective in reducing $PM_{2.5,}$ including how local authorities can make best use of national monitoring and modelling. Reference should also be made to the Public Health England document on estimating local mortality burdens associated with particulate air pollution.[7]

Air Quality Management Areas (AQMAs):

1.24 The ASR is designed to allow sufficient understanding in the analysis of pollutant occurrence to support the identification of new non-compliant areas (i.e. 'hot spots') and to report on progress within existing AQMAs. The template approach does not preclude the flexibility to provide detailed or extra analysis where this has taken place. For instance, annexes may be adjoined to the ASR.

Fast Track AQMA Declaration Option:

1.25 LAQM has been in operation for over a decade now and we know from historical records that once a pollutant is identified as exceeding the national objective or is at risk of doing so, the Detailed Assessment (which often took at least 12 months to complete) more often than not confirmed the initial risk assessment, leading to the declaration of an AQMA or appropriate remedial measures. Bearing this in mind, a

[7] https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution

new Fast Track AQMA Option has been introduced, which local authorities may use if deemed appropriate.

1.26 The Fast Track Option works on the assumption that most local authorities have a much better understanding of air quality in their areas than when they first started implementing LAQM. Where annual monitoring and local intelligence shows a persistent exceedance the local authority is encouraged to consider moving immediately to declaring and establishing an AQMA and hence to the development of action plan measures to remediate the problem. It is suggested that only local authorities who, until now, have had few air quality problems, or have sufficient doubts, should consider the necessity of obtaining further information/data, with the process briefly set out in the ASR.

Overview: Scotland LAQM

Reporting:

1.27 Submission of a single Annual Progress Report (APR).

1.28 This report (in the format of a template) replaces all other reports which previously had to be submitted as part of the LAQM system including Review and Assessment and Action Plan Progress Reports, Updated Screening Assessments (USAs) and Detailed Assessments. Action Plans remain as separate.

1.29 Local authorities are required to submit the APR by 30 June each year.

Pollutant focus:

1.30 Statutory reporting of existing pollutant objectives, NO_2, PM_{10} and SO_2 including Benzene, 1,3-Butadiene, Carbon Monoxide and Lead.

1.31 The second-stage annual mean PM_{10} objective currently remains at 18µg/m^3. This may be updated at a future date to 20µg/m^3 to align with the WHO[8] guideline value.

1.32 Inclusion of a new $PM_{2.5}$ annual mean objective of 10µg/m^3, also to align with the WHO guideline value.

Public Exposure

1.33 For the purposes of LAQM, regulations state that exceedances of the objectives should be assessed in relation to “the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present”.

1.34 For the purpose of assisting local authorities, some examples of where the objectives should, and should not apply, are summarised in Box 1.1. These examples are not intended to be comprehensive, and it is expected that local knowledge will often be

[8] World Health Organisation (WHO) – guidelines and rationale for PM limit values - http://apps.who.int/iris/bitstream/10665/69477/1/WHO_SDE_PHE_OEH_06.02_eng.pdf

required. If in doubt, further guidance may be obtained from the LAQM Support Helpdesk (see Box 1.2).

Box 1.1 – Examples of Where the Air Quality Objectives Should Apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour mean and 8-hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties[9].	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets) Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-min mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes	

Further information

1.35 Supplementary or revised technical guidance will be issued periodically to reflect any new information as it arises. Local authorities should register for updates at the LAQM Support Helpdesk operated on behalf of Defra and the Devolved Administrations (see

[9] Such locations should represent parts of the garden where relevant public exposure is likely, for example where there are seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied

Box 1.2), which will ensure they are automatically notified of new guidance as soon as it is issued.

Box 1.2 – LAQM Support Helpdesk for Local Authorities

Helpdesk	Operated by	Details
LAQM Support Helpdesk	Bureau Veritas	Email: laqmhelpdesk@uk.bureauveritas.com Website: http://laqm.defra.gov.uk/ **0800 032 7953**

Air Quality Management Areas Declared Across the UK

1.36 To date, there are more than 700 AQMAs currently declared across the UK (nearly 600 of which are in England). Of these, the vast majority (over 90%) are related to road traffic emissions, where attainment of the annual mean objective for nitrogen dioxide (NO_2) is considered unlikely, sometimes in association with exceedances of the 24-hour mean PM_{10} objective, or in Scotland the annual mean PM_{10} objective.

1.37 By comparison, there are very few AQMAs associated with domestic, industrial or other transport-related emissions, although in Northern Ireland a number of AQMAs have been declared as a consequence of pollution associated with the residential heating sector. Additional information about AQMAs is available on the AQMA website[10]

[10] Air Quality Management Areas website available at http://uk-air.defra.gov.uk/aqma/

CHAPTER 2: Air Quality Action Plans

Introduction

2.01 Every local authority that has an active AQMA, is required under Part IV of the Environment Act 1995 and Part III of the Environment (NI) Order 2002 to provide an Air Quality Action Plan (AQAP) as a means to address the areas of poor air quality that have been identified within the AQMA. The emphasis within AQAPs should be two-fold:

- to develop measures that will provide the necessary emissions reductions to achieve the air quality objectives within specified timescales; and
- act as a live document which is continually reviewed and developed, to ensure current measures are progressing and new measures are brought forward.

2.02 Policy Guidance LAQM.PG16 and LAQM.PG(S)16[11] states that an AQAP should ideally be prepared within **12 months**[12] of an AQMA being declared.

2.03 The process of developing AQAPs has been described in detail within previous Policy Guidance[3] and Technical Guidance documents. Further support is also available via the LAQM Support website[13] to assist in this process.

2.04 Whilst the core fundamentals behind developing AQAPs have not changed, it is important to ensure that the process continues to focus on the effective implementation and delivery of measures developed to address the specific local air quality issues. Defra has published an AQAP template to assist local authorities in England with the development of their AQAPs and ensure a consistent format for AQAP reporting. It is recommended that local authorities in England make use of this template for new or substantial revisions to their AQAP. The template is available on the LAQM Support website.

2.05 Furthermore, the ASR for England and the APR for Scotland now also provide a consistent format for local authorities to report on the progress of their AQAP and other supporting measures developed to reduce emissions towards achieving the air quality objectives.

What Makes an Effective AQAP?

2.06 A number of mechanisms and approaches improve the focus of AQAPs and assist with their effective development through to the final stage, where a set of measures tailored to the local situation have been developed and adopted by key stakeholders.

2.07 It is recognised that there is not a 'one size fits all' approach to developing AQAPs. They should be adapted to every local situation and most importantly are seen as part of an integrated package of measures, particularly in relation to linking with other key

[11] LAQM.PG(S)16 refers to LAQM Policy Guidance (Scotland) 2016

[12] Northern Ireland policy guidance suggests 12 months.

[13] http://laqm.defra.gov.uk/

policy areas, notably:

- Transport Planning, promoting sustainable transport, local transport management, integration with local transport plans;
- Climate change policies in relation to carbon management and reduction of greenhouse gas emissions; environmental assessments should consider impacts on air quality and climate change issues; and
- Low Emission Strategies. Many local authorities are moving towards developing Low Emission Strategies that can be used as an integrated approach to promoting emissions reductions measures across a wide policy spectrum, benefiting both air quality and climate change.
- Public Health Outcomes (PHO) policy areas which seek to promote health and wellbeing within the population with direct links to the promotion of physical exercise through walking and cycling initiatives (which reduce reliance on private vehicle use);
- Education programmes which again seek to promote health and wellbeing through walking and cycling, but also the principles of sustainability.

2.08 However, there are some key common requirements for the development of an effective AQAP:

1) Develop the AQAP in stages;
2) Undertake appropriate local monitoring and assessment (source apportionment);
3) Decide what level of actions are required;
4) Establish links to other key policy areas / strategies;
5) Establish a Steering Group with key stakeholder groups at an early stage;
6) Undertake measures selection and impact assessment;
7) Agree monitoring and evaluation of success; and
8) Undertake consultation.

2.09 These are discussed further below.

1 - Develop the AQAP in Stages

2.10 Effective AQAPs are rarely established within a single step or developed by taking 'off the shelf solutions' with little local assessment. The development of an effective AQAP should be seen as an iterative process to identify the best solutions, rather than an attempt to develop short term, single step solutions.

2.11 Steps to developing an effective AQAP include:

- Engagement of key officers and stakeholders at an early stage to capture measures already in place and to develop shared ownership for local solutions;
- Collation of detailed knowledge of the contributory sources, to determine the range and extent of the problem;

- An approach to consider suitable measures to reduce air pollutant emissions across a range of policy areas;
- Development of appropriate targets and indicators across key programme areas to monitor progress; and
- Evaluation and detailed consideration of further measures.

2 - Undertake Appropriate Local Monitoring and Assessment (Source Apportionment) for Development Phase

2.12 The overall expectation at the outset of the Review and Assessment process is for the local authority to identify all areas where the air quality objectives are being or are likely to be exceeded.

2.13 This should mean that sufficient monitoring and/or assessment be carried out, so that the required reduction in pollutant emissions to attain the objectives can be estimated and to allow the authority to confidently judge the scale of effort required within the AQAP.

2.14 Within the early stages of the process, the local authority should determine the nature of the local pollution problem as accurately as possible to enable an effective plan to be developed.

2.15 Local monitoring and/or assessment should provide a detailed picture of the local pollution problem. To achieve this, detailed dispersion modelling may be required, and appropriate monitoring should also be considered. The available monitoring and modelling evidence should be sufficient to enable:

- Key sources to be identified and allow the source apportionment exercise to be carried out;
- The nature and extent of the exceedance to be fully understood;
- The number and location of relevant receptors to be clearly identified; and
- The degree of population exposure to be considered.

2.16 Work carried out should allow authorities to identify the extent to which different key sources contribute to the air quality exceedances that have been identified, i.e. by means of baseline ‘source apportionment’. This will assist authorities to correctly target the most important sources, and to focus the principal measures within the AQAP.

2.17 The greater the level of detail in data and information gathered through screening assessments, detailed dispersion modelling and monitoring, the more confident the authority can be that the proposed measures identified during the development stage of the AQAP will be successful and will achieve the desired outcome.

2.18 Further information on source apportionment, including methodology and a worked example, are provided in Chapter 7 (para 7.81). Where alternative methods for source apportionment become available in due course these will be done so through the LAQM Helpdesk and users alerted as appropriate.

3 - Decide what Level of Actions are Required

2.19 To determine the scale of effort required in the AQAP to tackle air pollution within AQMAs, the local authority should also identify the reduction in pollutant emissions that is required to attain the objectives.

2.20 In theory, this should be a simple calculation that can be derived by comparison of the objective with the maximum predicted pollutant concentration. Within the study, authorities should confirm that the earlier assessment work had identified the locations at which the highest pollutant concentrations would occur (taking into account relevant exposure). It is also helpful to set out the reductions that would be required across several locations, so that the appropriate context is set.

2.21 Quantifying the emission reduction required for the area of concern will allow a range or combination of measures that have the potential to deliver the emissions reductions identified, within specific timescales for delivery.

2.22 Further information on the calculation of reduction in emissions, including a worked example, is provided in Chapter 7 (para 7.91).

2.23 The emphasis should be on developing measures that can deliver the required level of emissions reductions to meet air quality objectives within acceptable timescales.

4 - Establish Links to Other Key Policy Areas / Strategies

2.24 Once the nature and extent of the problem and the level of emissions reductions required by source are established, a range of measures can be considered.

2.25 In most cases, measures across a wide range of Government policy areas (which may already be in operation) may contribute to improving local air quality, including:

- National Air Quality Plans;
- Climate Change and Carbon reduction programmes;
- Sustainability Strategies;
- Low Emission Strategies;
- Transport Policy;
- Noise Action Plans;
- Procurement Policies;
- Planning Policies;
- Public Health; and
- Education.

2.26 It is important to identify and assess existing measures within the above areas that are likely to affect air quality and the development of the AQAP. Early consideration of this will provide a strong foundation for the development of the AQAP whilst also helping to minimise potential conflicts with other policy areas.

5 - Establish a Steering Group with Key Stakeholder Groups at an Early Stage

2.27 A local steering group of lead officers (and members) may be appropriate to develop a range of measures for further consideration, across relevant policy areas, and to ensure that there is sufficient political engagement.

2.28 Unless local situations present straightforward solutions, an assessment is likely to be required to determine a set of preferred options that have the potential to deliver the required levels of emissions reductions.

2.29 The AQAP should only be considered in detail once the source and extent of the problem are clearly understood. The Steering Group should collaborate to identify:

- If there are existing programmes in other areas that will contribute to emissions reductions (or increases) that should be accounted for within the AQAP.
- What may influence the local pollution situation in the near future (i.e. 5 to 10 years);
- The future trends that are likely to contribute (regional emissions trends as well as local factors);
- If there is sufficient information to clearly define effective measures;
- If an assessment may be required, before proceeding to developing the AQAP;
- If emissions will reduce sufficiently to achieve air quality objectives in the next 5 years, as a result of measures already in place;
- Whether it is appropriate to develop a generic set of measures, or whether locally derived measures targeting local hotspots is a preferred emissions management option – or a combination of both; and
- If traffic management interventions are required.

2.30 Early engagement with appropriate stakeholders at the outset and throughout the AQAP development process at appropriate times is likely to be key to integrating the AQAP with other relevant policies and programmes at the local and/or regional level.

2.31 It will also be beneficial to commence stakeholder discussion at the earliest opportunity in order to identify, apply and secure sources of funding for the AQAP measures.

2.32 Of particular importance is ensuring that transport planners are engaged in the process of developing the AQAP, to ensure that it is integrated with Local Transport Plans or equivalent documents in a successful manner.

2.33 Where relevant, it is important to ensure that dialogue is established with neighbouring authorities who may share responsibilities for some preferred actions. National bodies, e.g. Highways England and/or the Environment Agency (or equivalent bodies for the Devolved Administrations), should also be consulted as key stakeholders where they may have an influence on local air quality.

6 - Undertake Measures Selection and Impact Assessment

2.34 Once further assessment has been carried out, the local authority should consider

which options to take forward to a draft AQAP for consultation and subsequent adoption by the Council.

2.35 In most cases local authorities will be considering a package of measures to provide the required levels of emissions reductions to achieve the objectives as quickly as possible. The package of adopted measures should be subject to an impact assessment that provides a clear estimate of the emissions reductions these measures may be expected to deliver within an agreed timescale.

2.36 Some measures within the package of measures lend themselves to detailed quantifiable analysis in terms of emissions reductions more than others. Focus should be on the top 3 to 5 measures that provide the most significant impact on emissions and rank high on the cost benefit analysis of the measures package. Local authorities will need to ensure that they remain focused on the implementation of measures that are most targeted on the emissions source(s) leading to the exceedance of the relevant pollutant objective(s).

2.37 The assessment should also provide an estimate of when the objectives are likely to be achieved following implementation of the AQAP, or whether further measures are likely to be required to meet the objectives within specified timescales.

2.38 The AQAP should identify which measures have secured approval and funding, including those already in place via LEPs. These measures should have estimates of the emission reductions expected to be realised, and clear timescales for their delivery.

2.39 The AQAP should also identify those measures that remain as options for further consideration but don't have approval or funding associated. These measures should also have estimates of the emission reductions expected to be realised and should be accompanied by a clear timetable for their development.

2.40 The two sets of measures (realised and proposed) can then be reviewed on an annual basis, which should help maintain the AQAP as a live document.

7 - Agree Monitoring and Evaluation of Success

2.41 Once the final package of measures has been agreed and validated by all stakeholders, the AQAP should include details on the way their success will be measured, which will help determine whether additional measures may be required at a later stage.

2.42 Where possible, each measure within AQAPs should include details of the key indicators to use within further reports to track their delivery within agreed timescales.

2.43 Progress on implementing individual measures within AQAPs will need to be reported in the relevant annual LAQM report[14] with reference to the AQAP that has been developed.

[14] ASR in England, APR in Scotland, and Review and Assessment Progress Report (or AQAP Progress Report in years when USAs are required) for Wales and Northern Ireland

8 - Undertake Consultation

2.44 Local authorities will need to consider the extent and degree of consultation required during the formulation of their AQAP. For example, local authorities should undertake consultations with interested local organisations and bodies (e.g. residents and local businesses affected by the AQAP measures) and also consult with statutory consultees (such as Defra, Environment Agency, the relevant strategic transport bodies, etc). Such consultation may be done jointly, or could be done locally prior to the undertaking of consultation with statutory bodies.

Local Consultation

2.45 The previous sections on links to key policy areas and establishing local steering groups outlined a process that should facilitate local consultation. In many cases local consultation can be planned into the development of the AQAP, so that all relevant stakeholder groups are engaged as appropriate.

2.46 Local consultation may be required in order to consolidate measures that have been identified in the early stages of AQAP development. Draft AQAPs may be subject to engagement with key stakeholder groups, prior to final statutory consultation and adoption by the local authority.

2.47 An effective AQAP will have been subject to appropriate local consultation and approved by appropriate Local Council Committees before the process of adoption by the local authority following statutory consultation.

Statutory Consultation

2.48 The process for statutory consultation is outlined in Chapter 6 of Policy Guidance LAQM.PG16 and LAQM.PG(S)16. This makes clear that local authorities are required to undertake statutory consultation when either preparing or revising their AQAP.

$PM_{2.5}$ and Action Planning

2.49 This section provides guidance to local authorities in England and Scotland on integrating measures that will help to reduce $PM_{2.5}$ concentrations into their AQAPs.

2.50 Even for those authorities that do not have a requirement for developing an AQAP, the ASR/APR provides the basis for authorities to report upon their commitments to, and actions being undertaken to, reduce $PM_{2.5}$ at the local level. Any evidence that may be used to benchmark local authority progress on reducing $PM_{2.5}$ emissions, concentrations, or associated health effects, should also be detailed in the ASR/APR (in section 2 – Actions to Improve Air Quality).

Linkages between Air Quality and Public Health

2.51 The $PM_{2.5}$ indicator in the Public Health Outcomes Framework (England) provides further impetus to join up action between the various different local authority departments which impact on the delivery of air quality improvements.

2.52 To help facilitate this, Defra commissioned research to develop a toolkit to help local

authorities and public health professionals tackle air pollution in their area with a particular focus on $PM_{2.5}$[15]. The toolkit provides a one-stop guide to the latest evidence on air pollution; guiding local authorities to use existing tools to appraise the scale of the air pollution issue in its area. It also advises local authorities how to appropriately prioritise air quality alongside other public health priorities to ensure it is on the local agenda.

2.53 Integral to a successful process is the development of communication methods for localised air quality and health impact information. Communication guides were developed through a series of workshops and interviews. Participants included Directors of Public Health, public health professionals, local authority air quality managers and members of the public.

2.54 The toolkit comprises the following key guides:

- Getting to grips with air pollution – the latest evidence and techniques;
- Understanding air pollution in your area;
- Engaging local decision-makers about air pollution;
- Communicating with the public on air pollution; and
- Air Pollution: an emerging public health issue: Briefing for elected members.

Identifying Areas for $PM_{2.5}$ Action

2.55 Due to its extremely small size, $PM_{2.5}$ can travel for long distances in the air and it is estimated that as much as 40% to 50% of the levels found in any given area can be from sources outside a local authority's direct boundary[16]. Nevertheless, this means that the contribution of local sources to total $PM_{2.5}$ levels is significant (typically 50% or more), and therefore local actions to reduce $PM_{2.5}$ emissions will have a significant beneficial impact with regard to overall $PM_{2.5}$ concentrations.

2.56 Local authorities are encouraged to make use of all available sources of information to aid the identification of any 'hot-spot' areas of elevated $PM_{2.5}$ concentrations within the local authority area. Such information will aid the direction of actions to specific priority areas that are most in need of reductions in $PM_{2.5}$ levels, and allow measures to be targeted to the identified $PM_{2.5}$ issues. It will also allow progress in reducing $PM_{2.5}$ levels due to local authority action to be benchmarked.

2.57 Increased frequency of $PM_{2.5}$ monitoring and/or modelling is encouraged where possible, particularly where it has been identified as a priority. Those authorities not already undertaking $PM_{2.5}$ monitoring and/or modelling should make use of other existing sources of information to aid identification of any $PM_{2.5}$ 'hot-spots' in order to focus on action.

2.58 Methods available to local authorities that may assist in the identification of the key

[15] http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=18580

[16] Fine Particulate Matter ($PM_{2.5}$) in the United Kingdom. Air Quality Expert Group (AQEG) Report. 2012. https://www.gov.uk/government/publications/fine-particulate-matter-pm2-5-in-the-uk

areas for, and the required degree of, $PM_{2.5}$ focus are discussed below. Whichever approach or degree of action is taken by local authorities with regards to $PM_{2.5}$, a clear rationale should be provided in the ASR/APR.

Monitoring

2.59 It is acknowledged that many local authorities do not presently monitor $PM_{2.5}$ concentrations within their local authority area; as - except now in Scotland - $PM_{2.5}$ is still not incorporated into LAQM Regulations, there is no statutory requirement to review and assess $PM_{2.5}$ for LAQM purposes. Whilst an increase in $PM_{2.5}$ monitoring across the UK is desirable given the links to the Public Health Outcomes Framework, it is also recognised that the costs involved[17] can be prohibitive.

2.60 Further discussion on suitable methods for monitoring $PM_{2.5}$ is provided in Chapter 7 (para 7.120).

Modelling

2.61 In some circumstances, where there is considered to be sufficient cause to warrant the detailed study of a local $PM_{2.5}$ issue associated with a specific process or activity (e.g. fugitive releases from industrial sites), local authorities may wish to undertake detailed modelling of the $PM_{2.5}$ emissions source. This will allow the significance of the $PM_{2.5}$ issue to be accurately quantified at locations of relevant exposure, relative to the background $PM_{2.5}$ concentrations, therefore determining the degree and nature of any required action to reduce $PM_{2.5}$ levels.

2.62 Further discussion on estimating emissions from - and undertaking subsequent detailed modelling of - PM sources is provided in Chapter 7 (section 3 and section 4).

Other Supporting Information

2.63 Where no local $PM_{2.5}$ monitoring or modelling data is available, there are several sources of existing information that may assist local authorities in evaluating $PM_{2.5}$ at the local level. This includes, but is not limited to:

- ***National $PM_{2.5}$ Monitoring.*** There are approximately eighty $PM_{2.5}$ monitoring stations within the AURN[18]. These can be found on the UK Air website[19]. Monitoring data from sites located either close to, or within the local authority area, will provide a good indicator as to likely $PM_{2.5}$ concentrations within the Council area. It will be important to understand the implications of the monitoring site classification which is being used as a surrogate for local $PM_{2.5}$ concentrations, e.g. whether background, roadside or other. This is discussed further in Chapter 7

[17] http://uk-air.defra.gov.uk/networks/monitoring-methods?view=mcerts-scheme

[18] http://uk-air.defra.gov.uk/networks/network-info?view=aurn

[19] http://uk-air.defra.gov.uk/networks/find-sites?view=advanced

(section 2);

- ***National $PM_{2.5}$ Modelling*.** As discussed in Chapter 7 Section 1 (para 7.48), Defra maintains national background maps, which are provided for each 1km × 1km grid square across the UK. By plotting the $PM_{2.5}$ mapped data for the appropriate base year, $PM_{2.5}$ concentrations can be identified within the local authority area. Although considered quite coarse resolution, such information may prove useful to local authorities in directing actions to areas that are most in need of reductions in $PM_{2.5}$ levels. Source apportionment data contained in the background maps will also aid in understanding the relative contributions of the mapped emissions sources[20].
- ***Ratio of PM_{10} to $PM_{2.5}$*.** In the absence of any $PM_{2.5}$ monitoring data, local authorities can use one of the methodologies provided in Chapter 7 Section 1 (paras 7.94 to 7.97) to provide an indication of $PM_{2.5}$ concentrations.
- ***$PM_{2.5}$ Assessment in Planning and Environmental Permitting*.** Where necessary, air quality impact assessments submitted in support of a planning application may include quantitative assessment of $PM_{2.5}$ emissions associated with the proposed development. Applications for environmental permits either submitted to the Environment Agency (for Part A1 regulated processes) or directly to local authorities (Part A2 or Part B regulated processes) may also provide similar information. This could provide further evidence in the form of additional monitoring data and/or model predicted $PM_{2.5}$ concentrations at specific locations within the local authority area.
- ***Public Health Indicators for $PM_{2.5}$*.** These will provide a useful indication as to the burden associated with concentrations of $PM_{2.5}$ within the local authority area. For example, population-weighted annual average concentrations of anthropogenic $PM_{2.5}$ are provided for all lower tier and unitary local authorities within England[21]. These are combined to produce figures at upper tier, regional and national level so that attributable fractions of annual all-cause adult mortality associated with long-term exposure to current levels of anthropogenic $PM_{2.5}$ can be calculated at those scales also.

  The above approaches are provided for reference purposes only. They are intended to provide an illustration of the various approaches available to local authorities to help ensure actions to reduce $PM_{2.5}$ concentrations are targeted to the key areas of concern, and that measures are developed commensurate with the scale and nature of the $PM_{2.5}$ issues within the local authority area. Scottish local authorities may follow comparable approaches, but should also pay due regard to the statutory regulations for $PM_{2.5}$ and the need to undertake more formal Review and Assessment of $PM_{2.5}$ concentrations.

Local Action to Reduce $PM_{2.5}$

2.64 For the effective targeting of local action to help reduce $PM_{2.5}$ concentrations, it is important to first understand the source apportionment to total $PM_{2.5}$. Although this will vary by location, and it is acknowledged that there will be limited local $PM_{2.5}$ source

[20] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

[21] The Department for the Environment and Rural Affairs (Defra) intends to make these figures available on its website in future years.

apportionment studies (if any), consideration should be given to taking action that will address $PM_{2.5}$ associated with the following:

- **Primary $PM_{2.5}$ Sources (approximately 19% of UK total[22]).** Comprising anthropogenic emissions from combustion (industrial processes and road traffic exhausts) and non-combustion processes (e.g. fugitive emissions from agricultural and industrial material handling; non-exhaust emissions from vehicles - tyre and brake wear, and road abrasion); and
- **Secondary $PM_{2.5}$ Sources (approximately 13-20% of UK total[22]).** Not all of the particulate matter found in the atmosphere has been directly emitted into the atmosphere by primary sources. Secondary $PM_{2.5}$ is formed in the atmosphere by chemical reactions involving primary emitted precursor species, with each secondary PM component thus having its own primary PM precursor or precursors. In general, the most important secondary inorganic aerosols are sulphate (formed by oxidation of gaseous SO_2), nitrate (formed by oxidation of gaseous NO_2), and ammonium (formed by oxidation of gaseous ammonia – NH_3). Secondary organic aerosols are dominated by the oxidation of certain volatile organic compounds (VOCs).

  Measures to tackle $PM_{2.5}$ can be broadly separated along mobile, stationary sources and area or fugitive sources. Table 2.1 provides examples of the some of the measures that can be implemented to specifically reduce $PM_{2.5}$ emissions. These are measures that LAs may already be taking to address other pollutants such as PM_{10} and NO_x. Local authorities should therefore review any existing measures already currently being implemented to determine whether they are already taking positive action to reduce $PM_{2.5}$ emissions; such benefits should be reported in the ASR/APR.

Table 2.1 – Example of Measures to Tackle $PM_{2.5}$

Source Type	Measure
Mobile Source Measures	• On-road diesel engine retrofits for public service and heavy goods vehicles using Euro standards, e.g. implemented as a Low Emission Zone; • Non-road mobile machinery diesel engine retrofit, rebuild/replace with diesel particulate filter (DPF); • Diesel idling programmes for HGV, locomotive, and other mobile sources; • Transportation control measures including transportation demand management and transportation systems management strategies; • Programmes to reduce emissions or accelerate retirement of high emitting vehicles; • Emissions testing and repair/maintenance programs for on-road vehicles; • Emissions testing and repair/maintenance programs for non-road heavy duty vehicles and equipment; • Programmes to expand use of cleaner burning fuels - use of sulphur-free diesel, biofuels and alternative fuels such as compressed natural gas.
Stationary Source Measures	• Process change measures (modification to raw materials, process technologies and operations, and the use of cleaner fuels) • Process management (improvement to operations such as cleaning up dust spillages,

[22] Mitigation of United Kingdom $PM_{2.5}$ Concentrations. Air Quality Expert Group (AQEG) Report. 2013. http://uk-air.defra.gov.uk/library/aqeg/publications

	preventing dust escaping to ambient air and introducing more efficient combustion) - measures to reduce fugitive dust from industrial sites; • Stationary diesel engine retrofit, rebuild or replacement, with particle filter; • New or upgraded emission control requirements for direct $PM_{2.5}$ emissions at stationary sources (e.g. electrostatic precipitators, fabric filters, scrubbers and cyclones; improved monitoring methods); • New or upgraded emission controls for $PM_{2.5}$ precursors at stationary sources (e.g. wet/dry scrubbers); • Energy efficiency measures to reduce fuel consumption.
Area Source Measures	• Smoke management programmes to reduce domestic coal use; • Reduce emissions from woodstoves and fireplaces; • Regulate commercial cooking operations; • Further reduce solvent usage or solvent substitution.

2.65 To assist local authorities further, the Action Tool Box of AQAP measures provided in Annex A indicates the measures that will likely be beneficial to reducing $PM_{2.5}$ levels (in addition to other pollutants). Local authorities should be mindful of the potential co-benefits of action plan measures upon multiple pollutants of concern when developing their AQAPs.

The Format and Content of Air Quality Action Plans

2.66 As a minimum, AQAPs should include the following:

- **Quantification of source contributions (e.g. HGVs, buses, taxis, other transport**, industrial or domestic sources etc.) responsible for the exceedance of the relevant objective; knowing the source of the problem will allow the AQAP measures to be effectively targeted;
- **Quantification of impacts of proposed measures** including, where feasible, expected emission and concentration reductions (either locally obtained and/or via national monitoring/modelling statistics). It is important that the local authority shows how it intends to monitor and evaluate the effectiveness of the plan;
- **Clear timescales**, including milestones and expected outcomes, which the authority and other delivery partners propose to implement the measures within the AQAP; and
- **Defined roles and responsibilities** that detail how the local authority and other delivery partners, including transport, planning and health departments, will take ownership of the problem and in what capacity they will work together to implement the AQAP.

2.67 Although local authorities are free to determine the format of their AQAP, in England, they are encouraged to make use of the updated AQAP template that is now included within Policy Guidance.

2.68 The AQAP should follow the structure below:

- **Introduction**, explaining the requirement and rationale for its development;
- **Summary of current air quality in the local authority area**. This should include information on any exceedances of the air quality objectives. Details of any AQMAs (current or proposed) should also be provided.

- **Local authority air quality priorities**. This should describe the Council's priorities and drivers for pursuing some actions to improve air quality. This may include a description of the health context in the local authority's administrative area, major sources of pollutants such as roads, airports and industry, the planning context (upcoming developments) and other Council policies, such as health and wellbeing, sustainability, economic development, transport, climate change or education.

  Source apportionment dispersion modelling studies may assist in identifying priorities. For example, in an AQMA declared for NO_2 primarily due to emissions from road traffic and, e.g. if bus emissions are identified to contribute a high proportion of the total road-NO_x, AQAP measures that specifically target this source group should be prioritised.

  If there are other documents or strategies that set out information on the local authority's approach to air quality, information (and any links) pertaining to them should be provided with details of how they have been accounted for within the AQAP.

  This is an opportunity to lay out the Council's rationale and prioritisation.

- **Development and implementation of the AQAP**. This should include details of consultation undertaken during the development of the AQAP and feedback with regards to stakeholder engagement.

  Details of the Steering Group should also be provided. This should include composition, the group's activity (e.g. number of meetings) and in what ways the Steering Group has pushed forward the implementation of the AQAP.

  The members of the Steering Group should include local authority officers across the different Council's departments, including at county level (in two-tier authorities) and may also include officers from neighbouring local authorities. The Steering Group would decide on engaging support from other outside bodies, businesses and local community groups to take the process forward.

  Other local authority departments and external bodies should be constructively engaged in agreeing actions to improve air quality and meet the legal requirement to work towards air quality objectives.

  The following, in particular, should engage constructively in improving air quality:

    - Transport planners;
    - local and national highway authorities;
    - land use planners and town centre managers;
    - environmental protection and energy management officers;
    - waste managers;
    - economic development, regeneration and tourism departments;
    - corporate policy and resources; and
    - Environment Agencies.

- **AQAP measures**. A table of the measures being pursued by the local authority as part of the AQAP should be provided, with each measure assigned one of the specified categories (as per the AQAP template).

  Where relevant, the Council should add further detail with regards to the measures adopted in their AQAP, beyond the summary level information provided in the

table. In particular if there are measures that are considered a priority or drawing out where local public support or action may be required.

Local authorities should also link their AQAP measures to existing National Plans[23] to improve air quality and wider-scale Low Emission Partnership (LEP) schemes where contributions to reductions in background concentrations of pollutants may arise, or focus within the plans may lead to benefits in air quality for specific AQMAs that coincide with National Plan or LEP schemes.

- **Additional supporting appendices**. The Council should add additional supporting appendices as required. For example, where the selection of AQAP measures has been supported by further studies, e.g. quantitative appraisal of AQAP measures through dispersion modelling, or other feasibility studies, this work should be included.

On-going Assessment of Progress – Keeping the AQAP Live

2.69 The success of the AQAP is dependent upon the on-going assessment and reporting of progress in the implementation of measures and the evidence acquired from on-going evaluation of the impacts of measures that are reported through the annual LAQM report[14]. The use of monitoring to show the decline in pollutant concentrations attributed to the implementation of measures is an obvious basis on which local authorities should provide evidence to show progress. However, for some measures alternative indicators, such as use of cycle schemes and passenger numbers on buses, can be used to report progress.

2.70 Local authorities should ensure that the AQAP Steering Group continues to meet on an annual basis after the adoption and implementation of measures contained within their AQAPs in order that a review of the AQAP and its progress is undertaken. Where, in undertaking their review, evidence shows that unforeseen barriers to progress have arisen, or measures are no longer suitable, the AQAP should be updated to reflect the local authority's position. The AQAP should be maintained as a "live" strategy. Where necessary, updates to source apportionment should be made to ensure that the measures remain targeted and focused within the AQAP.

[23] http://uk-air.defra.gov.uk/library/no2-consultation-documents-2015

CHAPTER 3: Annual Status Report (England) and Annual Progress Report (Scotland)

Introduction

3.01 This chapter provides guidance to local authorities in England and Scotland in the preparation of air quality Annual Status Reports (ASR) (or Annual Progress Reports (APR) in Scotland). The ASR/APR replaces the need for these local authorities to produce separate air quality Updating and Screening Assessments or Progress Reports. It may also contain any additional technical information required to support the decision to declare / amend or revoke AQMAs (such as detailed dispersion modelling), which was previously required as part of separate Detailed Assessments.

3.02 The ASR/APR is not addressed to local authorities in Wales or Northern Ireland, for which Updating and Screening Assessments (Chapter 4), Progress Reports (Chapter 5) and Detailed Assessments (Chapter 6) still need to be prepared and submitted separately.

3.03 The aim of the ASR/APR is to simplify and streamline the LAQM system by combining the requirements of the Updating and Screening Assessment and Progress Report and, when required, additional supporting evidence. An ASR/APR needs to be prepared by local authorities every year.

3.04 If local authorities have declared AQMAs and produced an Action Plan, the ASR/APR should also include a section discussing progress on Action Plan measures.

3.05 The ASR should be filed electronically using the LAQM Report Submission Website (RSW)[24]. Local authorities should download the ASR/APR template available on the RSW or the LAQM Support website[25], complete offline, and upload back on the RSW once completed.

The Format and Content of Annual Status / Progress Reports

3.06 The ASR/APR should follow the structure below:

- Overview of air quality and actions being taken in the local authority's administrative area – this should be aimed at the members of the public and relevant stakeholders.
- A brief presentation of the Air Quality Strategy objectives.
- Actions to improve air quality – this section should include the following subtopics:
- A description of currently declared AQMAs.
- A section discussing the progress, and impact of Action Plan measures. For local

[24] http://laqm.defra.gov.uk/1rsw/

[25] http://laqm.defra.gov.uk/review-and-assessment/report-templates.html

authorities who have not declared any AQMA, this section should be used to provide an update on any other measure or policy that is part of other documents, such as Local Transport Plans, Air Quality Strategy or Climate Change Strategy.

- A section presenting the local authority's approach to reducing $PM_{2.5}$ emissions and/or concentrations.
- A summary of air quality monitoring data collated over the past 5 years, and comparison of the latest available results with the Air Quality Strategy objectives. This section should present NO_2, PM and SO_2 monitoring data as a minimum.
- If necessary, additional supporting information, such as screening assessments of new or changes in sources of pollution over the past year, or detailed dispersion modelling of emissions to support the declaration / amendment or revocation of AQMAs, should be provided in Appendix. Further information is provided in Chapter 7 Section 1 – Screening Tools and Methodology.

3.07 Further guidance on the minimum requirements for the ASR/APR is provided below.

Overview of Air Quality

3.08 This section is intended to be the public facing section of the ASR/APR. Therefore, it should aim at summarising, in simple terms, the following:

- What are the key air quality issues within the local authority's area, based on the findings of new information, such as monitoring data, screening of new/changed sources of pollution, or detailed dispersion modelling work? Is there a need to declare new AQMAs or amend existing AQMAs?
- What are the key actions that the local authority has / intends to put in place to tackle these issues?

Air Quality Objectives

3.09 This section should briefly introduce the relevant air quality objectives applicable to LAQM:

- For England, these include the objectives associated to NO_2, PM_{10} and SO_2;
- The objectives applicable in Scotland are the same as those applicable in England, but also include the Scotland-specific PM_{10} and $PM_{2.5}$ objectives.

Actions to Improve Air Quality

3.10 This should be the core section of the ASR/APR, focusing on the actions already implemented and/or actions that the local authority plans to implement to work towards compliance with the air quality objectives.

3.11 If the local authority has declared AQMAs in previous stages of the Review and Assessment process, a brief description of each AQMA should be provided, including:

- The name of the AQMA;

- The pollutant(s) and air quality objective(s) declared;
- A geographical description of the AQMA (city/town and description of the extent – i.e. roads/junctions etc.); and
- A link to the associated AQAP (if published), which should be available for download on the local authority's website.

3.12 This section should be brief, with key information presented in a summary table. The focus should be on currently declared AQMAs only. The ASR/APR should link to Defra's AQMA website[10] for further information, which already includes maps of the AQMAs, dates of declaration, a list of revoked AQMAs and other useful information.

3.13 If an AQAP has been produced and measures implemented, this section should provide information on how the local authority has progressed / is progressing with the measures since last year. It should inform the reader on all measures completed, on-going, and planned. For measures completed or on-going, the ASR/APR should summarise the impact on air quality, clearly highlighting successes and difficulties. For measures not yet implemented, the ASR/APR should summarise the expected benefits on air quality, and link to the AQAP for further information.

3.14 The ASR/APR template includes a summary table, which should help local authorities report on action plan progress.

3.15 If the local authority has not declared any AQMA so far, this section should present, if relevant, the status of any other strategy or policy document likely to have a beneficial impact on air quality. This may include:

- Air Quality Strategies
- Local Transport Plans
- Planning Policy documents – (i.e. Supplementary Planning Guidance)
- Climate Change Strategies

3.16 The ASR/APR should provide the following information about the above documents:

- How is the strategy/plan/guidance progressing?
- If completed, how implementation is progressing?
- When will the strategy/plan/guidance be reviewed/updated

3.17 Finally, this section of the ASR/APR should include how the local authority is working towards reducing $PM_{2.5}$ emissions and concentrations. For local authorities in England, this should allow the ASR/APR to link with the Public Health Outcomes Framework (as discussed in Chapter 2). In particular, the local authority should link to local $PM_{2.5}$ monitoring data, if currently in place across the area.

3.18 Additional information about how local authorities may report on $PM_{2.5}$ is available in Policy Guidance.

Air Quality Monitoring Data

3.19 The ASR/APR[26] should summarise local monitoring data collated by the local authority over the past 5 years, and particularly focus on the last year's results, comparing these against the air quality objectives. The focus should be on NO_2, PM_{10}, $PM_{2.5}$ (where appropriate) and SO_2. Both long-term (i.e. annual means) and short-term (i.e. daily, hourly, or 15-min means) data should be reported and compared against the relevant objective.

3.20 The monitoring data should include both automatic monitoring analysers and (for NO_2) passive diffusion tubes. The ASR/APR should only include a brief summary of monitoring data in the body of the report, with all technical information, including tabular results, presented in Appendix, as per the template. Supporting technical information should include:

- Quality Assurance / Quality Control (QA/QC) information, such as data capture;
- Bias adjustment factors;
- Annualisation factors (to estimate annual means based on short-term monitoring results); and
- Other data corrections, such as Volatile Correction Model for PM_{10} monitoring or fall-off with distance for NO_2 (see Chapter 7 for further information).

3.21 The summary results of monitoring data should answer the following questions:

- Has there been any changes in the local authority's air pollution monitoring network (new/closed/relocated sites, change in monitoring methodology) over the past year – and if so, for which reason(s)?
- Are there any new exceedances of the air quality objectives outside currently declared AQMAs?

3.22 If such exceedances have been found, the local authority should conclude on the need to declare an AQMA or not at this stage. Further information about the potential actions is provided below.

Additional Supporting Technical Information

3.23 As part of the ASR/APR, the local authority should also review and assess the main sources of pollution within the area. Prior to the implementation of the ASR/APR, this was done as follows:

- The Review and Assessment Progress Report contained a list of changes/new sources of air pollution identified since the previous year. The Progress Report only needed to flag these up without any further action, so that these could be assessed in the following Updating and Screening Assessment report
- The Updating and Screening Assessment required the local authority to screen any new or changed sources, to determine whether a Detailed Assessment was

[26] Scotland intends for local authorities to monitor $PM_{2.5}$.

needed or not, before deciding whether a new AQMA was necessary or not. The screening assessment for each source was based on screening tools, such as the DMRB air quality screening tool for road traffic sources, or nomograms for industrial sources.

3.24 The ASR/APR still requires such changes in air pollution to be identified, and if deemed necessary, screened to determine whether their impact on air quality is deemed significant.

3.25 Over the past few years, the vast majority of local authorities have not identified any significant changes in sources of air pollution, as most air quality hotspots across the UK have now been identified and well documented. As a result, the importance of screening assessments of new/changed sources has progressively reduced, and the focus has switched to air pollution monitoring data. It is therefore expected that this trend will continue. Therefore, screening assessments, if required, should only be presented in Appendix. The local authority should be able to identify the need for a screening assessment using the information provided in Chapter 7, Section 1 – Screening Tools and Methodology.

3.26 If necessary, detailed dispersion modelling of emissions to support the declaration / amendment or revocation of AQMAs, should be provided as an additional supporting technical information Appendix to the ASR/APR.

Declaration of AQMAs Based on the ASR/APR[27] Findings

3.27 Based on the information collated and reported in the ASR/APR, the local authority should identify whether there is a risk of exceeding an air quality objective outside existing AQMAs. If this is the case, the local authority may choose to:

- Option 1 - Proceed to the declaration of an AQMA without delay. This should be possible if the monitoring data and/or screening assessment results are deemed sufficient to conclude on the risk of exceedance and the area likely to be affected. It should also be the case if more detailed information collated over the past 12 months (such as detailed dispersion modelling of road traffic or industrial emissions) is now available and can be appended to the ASR/APR to support the decision to declare.
- Option 2 - Decide to collate additional technical information before deciding whether an AQMA is required or not. This could involve, for example, detailed dispersion modelling work, or an additional specific monitoring campaign focusing on the area of concern. In this case, this information can be collated by the local authority in the next 12 months, so that results can be appended to the next ASR/APR, to support the decision to declare an AQMA or not. In collecting additional information, it is not necessary for the local authority to wait until the next ASR/APR to move to declaration.

3.28 The reason for Option 1 is because most local authorities who have declared AQMAs are now unlikely to face declaring new areas, since most hotspots have been progressively identified over the years, either based on monitoring, screening or

[27] Refer to Scottish Policy Guidance for further details.

detailed dispersion modelling results. Therefore, it is expected that, in many cases, the focus is likely to be on extending or reducing the size of currently declared AQMAs. Moreover, even if areas not identified in the previous Rounds of Review and Assessment are now likely to exceed the air quality objectives, it is expected that many local authorities will be able to determine a suitable AQMA boundary with "reasonable certainty" based on their previous experience, if they already have declared other AQMAs, even without any detailed dispersion modelling. Moreover many local authorities can achieve greater flexibility by declaring broad AQMAs – enabling them to respond more quickly to air quality issues as they arise within their areas.

3.29 For local authorities without any / with little experience of the AQMA declaration process, guidance to determine the likely extent of AQMAs based on available technical information (such as traffic data) is available in Chapter 7, as well as on the LAQM Support Website, based on feedback on AQMAs.

Amendment and Revocation of AQMAs

3.30 The decision to amend or revoke an AQMA should only be taken following a detailed study, to be appended to the ASR/APR as additional supporting technical information. This should set out in detail all the available information used to reach the decision, with the same degree of confidence as was provided for the original declaration.

3.31 In some instances if compelling evidence exists, detailed modelling to support the decision to amend/revoke an AQMA may not be necessary and an AQMA may be amended or revoked following a screening assessment or on the basis of robust monitoring evidence.

3.32 However, pollutant concentrations may vary significantly from one year to the next, due to the influence of meteorological conditions, and it is important that authorities avoid cycling between declaring, revoking and declaring again, due simply to these variations. Therefore, before revoking an AQMA on the basis of measured pollutant concentrations, the authority therefore needs to be reasonably certain that any future exceedances (that might occur in more adverse meteorological conditions) are unlikely. For this reason, it is expected that authorities will need to consider measurements carried out over several years or more, national trends in emissions, as well as local factors that may affect the AQMA, including measures introduced as part of the Air Quality Action Plan, together with information from national monitoring on high and low pollution years.

CHAPTER 4: Progress Report – Wales and Northern Ireland

Introduction

4.01 This chapter provides guidance to local authorities in Wales and Northern Ireland in the preparation of air quality Progress Reports. It is not addressed to local authorities in England or Scotland, for which Progress Reports have been replaced by the Annual Status Report (England) / Annual Progress Report (Scotland) (see Chapter 3).

Role of Progress Reports

4.02 Progress Reports were introduced into the LAQM system following a detailed evaluation of the Review and Assessment process at the end of the first round. This evaluation identified a need to maintain continuity in the LAQM system, which in turn would make the periodic Review and Assessments easier to carry out.

4.03 Progress Reports are not intended to represent a further Updating and Screening Assessment, although authorities are reminded that if at any time they identify a risk of exceedance of an air quality objective, then they should proceed immediately to a Detailed Assessment and not delay until the next round of Review and Assessment.

When are Progress Reports Required?

4.04 Progress Reports are intended to provide continuity in the LAQM system. They fill the gaps between the three-yearly requirement to undertake an Updating and Screening Assessment. The timetable for Progress Reports is illustrated in Chapter 1, Table 1.2. They are only required in years when the authority is not undertaking an Updating and Screening Assessment.

The Format and Content of Progress Reports

4.05 Progress Reports should be filed electronically using the LAQM Report Submission Website (RSW)[28].

4.06 Local authorities should download the Progress Report template available on the RSW or the LAQM Support website[29], complete offline, and upload back on the RSW once completed.

[28] http://laqm.defra.gov.uk/1rsw/

[29] http://laqm.defra.gov.uk/review-and-assessment/report-templates.html

4.07 The following sections set out the minimum reporting requirements and optional additional elements for Progress Reports. For those authorities implementing Air Quality Action Plans, the Progress Report also needs to include a section reporting progress on Action Plans.

4.08 When preparing their reports, authorities should bear in mind that the overall aim is to report progress on implementing the LAQM system, and in achieving / maintaining pollutant concentrations below the air quality objectives. Examples of standard Progress Reports are available on the LAQM support website[30].

Minimum Requirements for Progress Reports

4.09 The overall aims of the Progress Report should be to:

- report progress on implementing LAQM;
- report progress in achieving or maintaining concentrations below the air quality objectives.

4.10 It is considered these aims can best be achieved by addressing the following:

- new monitoring results;
- new local developments that might affect local air quality;
- update on current/planned/revoked AQMAs; and
- progress on Action Plans.

4.11 This section provides guidance on the minimum requirements for what is expected under each of these headings.

New Monitoring Results

4.12 Most local authorities are carrying out some form of air quality monitoring in their area, which supplements the data available from national network sites. The Progress Report should provide a summary of all available monitoring results (both automatic and non-automatic) and compare these with the relevant air quality objectives. The QA/QC and data verification procedures should also be reported. Further guidance is provided in Chapter 7.

4.13 When reporting the monitoring data the following should be included where possible:

- a table providing a description of all monitoring sites, including site name and ID number, location (OS grid coordinates), site type, pollutants monitored, distance from the kerb, whether it is in an AQMA, and whether it is representative of

[30] http://laqm.defra.gov.uk/review-and-assessment/good-practice/examples.html

relevant exposure

- a map showing the monitoring locations, or reference to a map in a previously published document, as long as it is readily available
- explanation of any change in the air quality monitoring network (new sites installed / old sites closed)
- summary tables of concentrations that allow ready comparison with the air quality objectives
- plots showing trends in concentrations

4.14 Care should be exercised in discussing trends, as changes in concentrations can occur from year to year due to weather conditions. It is normal practice to only consider a trend as being significant when five years' worth of data are available, although a longer timescale may be appropriate for some pollutants, for example, PM_{10}. When reporting PM_{10} trends, only data derived from the same method should be used. Thus for Tapered Element Oscillating Microbalance (TEOM) PM_{10} analysers, results corrected using the Volatile Correction Model (see Chapter 7 para 7.125) should not be mixed with previous results corrected using an older method.

New Local Developments

4.15 This section should deal with granted new developments that may affect air quality, with relevant exposure nearby, such as:

- industrial installations;
- biomass boilers;
- developments leading to a significant change in traffic flows;
- landfill sites, quarries, etc.

4.16 If available, the outcome of air quality assessments submitted as part of the planning application should be summarised and referenced, especially for large developments subject to Environmental Impact Assessment (EIA).

4.17 The Progress Report should list these developments so that they can be considered more thoroughly in the next Updating and Screening Assessment.

Implementation of Action Plans

4.18 If local authorities have produced an Action Plan, they are also required to report the progress made with regards to the Action Plan measures. Initially, local authorities were required to submit a separate Action Plan Progress Report. However, the Action Plan Progress Report should now be combined with the Review and

Assessment Progress Report[31]. The role of Action Plan Progress Reports is set out in the relevant Policy Guidance documents[3].

4.19 Local authorities should also include the following:

- comments detailing, where possible, the impact of implemented measures on air quality;
- progress made during the year;
- progress made over the lifetime of the action plan so far, and comparison with the original AQAP; and
- the original timescales for implementation of the measures, and dates on which the measures were actually implemented.

4.20 The report should also look forward to the next year: the original targets set in the Action Plan should be reviewed and revised if necessary, and an implementation plan for the forthcoming year should be included.

4.21 The reporting of action plan progress should follow the structure and format of the summary table included in the Progress Report template[29].

Recommended Additional Elements

4.22 The Progress Report also provides an ideal opportunity to report on other aspects of the authority's work on air quality. Possible elements include the following, and should be added to the Progress Report if available:

- reporting of additional monitoring data not covered by the LAQM system;
- progress on local air quality strategies;
- a list of on-going / upcoming planning applications that could affect air quality;
- progress on implementing Local Transport Plans (LTP) measures that should improve air quality;
- any relevant updates on planning policies that relate specifically to air quality; and
- any other areas of local interest that the authority also wishes to incorporate.

Additional Monitoring Data

4.23 Authorities may find it helpful to report on their monitoring for pollutants not covered by the regulations, for example, O_3, PAH, etc, as well as other air quality data, for example, odour complaints, dust deposition, radiation monitoring, etc. Authorities may already be reporting such data to members of the public, so it should be

[31] Note that for years when an Updating and Screening Assessment (USA) is due, the Action Plan Progress Report should still be submitted as a standalone report, rather than included within the USA report.

straightforward to include this information.

Local Air Quality Strategy

4.24 The relevant Policy Guidance documents recommend that all authorities, particularly those that have not declared / do not expect to declare AQMAs, but have identified areas close to the air quality objectives, should consider drawing up a local air quality strategy.

4.25 Progress Reports provide the opportunity for the authority to report on the development of its strategy, or (where a strategy is in place) on progress with implementation of any specific measures within the strategy. The following questions could be addressed:

- To what extent has the authority developed an air quality strategy?
- If completed, how far has it been implemented?
- How accessible is the strategy (for example, deposited in local libraries and/or published on the internet)?
- When will the strategy next be reviewed?

Planning Applications

4.26 The land-use planning system is recognised to play an integral part in improving air quality. This requires close co-operation between planners and environmental health officers. Some local authorities have developed procedures to help ensure planning applications that might have impacts on air quality are forwarded to the environmental health department for comment. This is considered to be an important first step and authorities are encouraged to ensure that suitable procedures are in place.

4.27 Progress Reports provide the opportunity to log planning applications for new developments under considerations to give a picture of areas where changes in air quality may take place and where combined impacts from several developments may become important.

4.28 The information provided in a planning section of the Progress Report could therefore include a list of the major developments under consideration that might affect air quality. Such a list could be based on those applications for which an air quality assessment was being provided or for which an air quality assessment had been requested.

Air Quality Planning Policies

4.29 The policies set out in local authority planning documents[32] determine the authority's approach to the relationship between planning and air quality. They are important as new developments are judged against these policies. The Progress Report provides an ideal place to list these policies and to record changes that are introduced from time to time. This should extend to providing a reference to any supplementary planning guidance that is occasionally developed to address air quality matters.

Implementation of Local Transport Plans and Strategies

4.30 The majority of air quality issues in the UK relate to emissions from the road transport sector (although in Northern Ireland, emissions from the residential sector are also significant).

4.31 Measures to improve air quality on a local scale are thus closely related to Local Transport Plans (LTP) as well as transport measures planned or put in place by central government. Local authorities could choose to make a reference within the Progress Report to those measures within the LTP that specifically relate to bringing about air quality improvements. It may be appropriate to use the same text in both reports. Repetition should not be an issue as the reports address different audiences.

[32] i.e. "Local Development Plans" in Wales, and "Development Plans" in Northern Ireland.

CHAPTER 5: Updating and Screening Assessment – Wales and Northern Ireland

Introduction

5.01 This chapter provides guidance to local authorities in Wales and Northern Ireland in the preparation of Updating and Screening Assessments. It is not addressed to local authorities in England or Scotland, for which Updating and Screening Assessments have been replaced by the Annual Status Report (England) / Annual Progress Report (Scotland) (see Chapter 3).

Role of Updating and Screening Assessments

5.02 The Updating and Screening Assessment is intended to identify any significant changes that may have occurred since the previous rounds of Review and Assessment were completed. This will include new monitoring data, new or changed emissions sources (either locally or in neighbouring authorities), or any other local changes that might affect air quality.

5.03 In completing the Updating and Screening Assessment, authorities are encouraged to maximise and draw upon the work completed during earlier rounds of Review and Assessment.

5.04 It is recognised that many local authorities, through their previous Review and Assessment work, may have established detailed emissions inventories and applied various dispersion models. The following sections of this chapter set out the screening approach to use to complete the Updating and Screening Assessment.

When are Updating and Screening Assessments Required?

5.05 Updating and Screening Assessments are required every 3 years, at the start of each round of Review and Assessment. The timetable for Updating and Screening Assessments is illustrated in Chapter 1, Table 1.2.

The Format and Content of Updating and Screening Assessments

5.06 Updating and Screening Assessment reports should be filed electronically using the LAQM Report Submission Website (RSW)[33] . Local authorities should download the Updating and Screening Assessment report template available on the RSW or the

[33] http://laqm.defra.gov.uk/1rsw/

LAQM Support website[34], complete offline, and upload back on the RSW once completed. The format of this template follows the checklist provided in the following sections

5.07 The Updating and Screening Assessment checklists follow a source-by-source approach. For each source, all pollutants covered by LAQM regulations need to be assessed. A summary of the emission source categories that need to be considered is provided in Box 5.1. In each case, these sources need only be considered if they are new, if they have not previously been considered, or if there have been significant changes since the last round of Review and Assessment. Guidance on how to collate monitoring data and compare against the AQS objectives is provided in Box 5.2. The focus is upon new monitoring data, but it is also useful to show longer-term trends wherever possible.

5.08 Detailed methodology and worked examples to screen pollution sources are provided in Chapter 7.

Box 5.1 – Summary of emission sources and relevant pollutants to be considered as part of the Updating and Screening Assessment

Source Reference	Emission sources to be assessed	Relevant Pollutants
A: Road Transport Sources		
A.1	Narrow congested streets with residential properties close to the kerb	NO_2
A.2	Busy streets where people may spend 1-hour or more close to traffic	NO_2
A.3	Roads with a high flow of buses and/or HGVs	NO_2, PM_{10}
A.4	Junctions	NO_2, PM_{10}
A.5	New roads constructed since the last round of Review and Assessment	NO_2, PM_{10}
A.6	Roads with significantly changed traffic flows	NO_2, PM_{10}
A.7	Bus and coach stations	NO_2
B: Other Transport Sources		
B.1	Airports	NO_2
B.2	Railway (diesel and steam trains)	SO_2, NO_2
B.3	Ports (shipping) [35]	SO_2
C: Industrial Sources		

[34] http://laqm.defra.gov.uk/review-and-assessment/report-templates.html

[35] Fugitive emissions from materials handling at docks and ports are dealt with in E.1.

Source Reference	Emission sources to be assessed	Relevant Pollutants
C.1	Industrial installations (new installations and those with significantly increased emissions)	Benzene, 1,3-butadiene, lead, NO_2, SO_2, PM_{10}
C.2	Major petrol storage depots	Benzene
C.3	Petrol Stations	Benzene
C.4	Poultry farms	PM_{10}
D: Commercial and Domestic Sources		
D.1	Biomass combustion (including domestic solid-fuel burning for PM_{10})	NO_2, PM_{10}
D.2	Domestic solid-fuel burning	SO_2, PM_{10}
E: Fugitive or Uncontrolled Sources		
E.1	Quarries, landfill sites, opencast coal mining, waste transfer sites, materials handling (i.e. ports, major construction sites)	PM_{10}

Box 5.2 – Updating and Screening Assessment Checklist – Comparison of Monitoring Data against the Air Quality Objectives

Steps	Notes
1 - Collate all monitoring data	Include data from: the local authority monitoring network, national networks and other organisations, and if relevant, neighbouring authorities. Include all relevant information onsite types, monitoring methods, quality assurance and quality control, etc.
2 - Ratify and adjust the monitoring data	Ideally, all monitoring data should be ratified before use. The key steps are to ensure that continuous monitoring data have been screened and scaled – see Chapter 7 for details of how to do this. Where data are provisional, they should be clearly indicated as such. NO_2 diffusion tube data must be corrected for bias, and the approach taken clearly set out. Details regarding the laboratory performance and precision of the tubes should be provided wherever possible. See Chapter 7 para 7.172 for further information. PM_{10} data should be measured by a method equivalent to the reference (i.e. gravimetric) method. Certain methods require adjustment, such as Tapered Element Oscillating Microbalance (TEOM) instruments, which needs to be corrected to provide gravimetric-equivalent concentrations (see Chapter 7). Check with the LAQM Support Helpdesk if any queries.

Steps	Notes
3 - Calculate all statistics relevant for comparison against the air quality objectives: • long-term concentrations (annual mean) • short-term concentrations (24-hour / 8-hour / 1-hour / 15-min mean)	Annual mean concentrations should represent a calendar year if possible. Where fewer than nine months (i.e. 75%) of data are available for a calendar year, adjust the result to estimate the annual mean using the procedure set out in Box 7.7 and Box 7.8 in Chapter 7. Short-term statistics (such as the number of 8-hour and 1-hour means above a threshold) can only be calculated from continuous monitoring data. Where data capture is less than 85%, it is more appropriate to calculate the equivalent percentiles – see para 7.63 and Table 7.7 for further information.
4 - Compare monitoring data against the relevant air quality objectives	Ensure that the monitoring site locations are representative of relevant public exposure (see para 7.99 in Chapter 7). For NO_2, if this is not the case and the site is roadside, calculate the concentration at the nearest relevant exposure using the NO_2 fall-off with distance calculator before comparing against the objective. For diffusion tube monitoring, it can be considered that exceedances of the NO_2 1-hour objective may occur at roadside sites if the annual mean is above 60µg/m^3 (see para 7.77).
4.1 - Outside AQMA If monitoring data show an exceedance of an AQS objective, and no AQMA has been declared for that objective, then proceed to a Detailed Assessment for the relevant pollutant at these locations	The Detailed Assessment will be with a view to determining whether or not to declare an AQMA for the relevant pollutant(s) and objective(s).
4.2 - Within AQMAs If results within AQMAs show compliance with the AQS objectives for which the AQMA has been declared, then proceed to a Detailed Assessment for the relevant pollutant at these locations	The Detailed Assessment will be performed to determine whether or not to revoke an AQMA. However, if the monitoring sites are not at worst-case locations then it may not be appropriate to consider revoking the AQMA. Take into account the results of previous modelling for the AQMA. The decision will also depend on the history of results. Concentrations should normally be below the objective for several years before considering revoking, to avoid cycling between revoking and declaring.

What Needs to be Considered Within the Updating and Screening Assessment?

5.09 The Updating and Screening Assessment is intended to identify changes that have occurred since the previous round of Review and Assessment. The focus is therefore upon:

- new sources (new roads, industrial installations, etc);
- existing sources that have changed significantly (changed traffic flows, changed industrial installations, etc); or

- existing sources that were not previously considered (for example, where there is now relevant exposure).

Monitoring Data

5.10 Monitoring data can be used to identify new locations where there is a risk of exceedance of the air quality objectives, or to provide evidence that a previously declared AQMA may be revoked. In both cases, this would lead to a requirement for a Detailed Assessment.

5.11 The focus should be upon reporting new monitoring data collected during the last calendar year. However, a summary of monitoring data collated over the past 5 years should be included to provide valuable information on longer-term trends.

Emission Source Categories to Consider

5.12 The following sections provide a summary of the source categories to consider in the Updating and Screening Assessment. These are divided in five categories, as follows:

- Road Traffic Sources;
- Non-Road Transport Sources (i.e. Airports, Railway and Ports);
- Industrial Sources;
- Commercial and Domestic Sources; and
- Fugitive or Uncontrolled Sources.

5.13 For each source category, detailed methodology, technical information, and worked examples to assist local authorities are provided in Chapter 7.

A. Road traffic sources

5.14 The focus of attention for road traffic sources should be on relevant locations close to busy roads, especially:

- in congested areas and near to junctions, where emissions will be higher; and
- in built up areas where the road is canyon-like, with the buildings either side of the road restricting dispersion and dilution of the emissions.

5.15 Where sufficient monitoring data are not available to assess potential exceedances at all relevant locations, a screening assessment for road traffic sources may be carried out. For that purpose, the local authority should use the Design Manual for Roads and Bridges (DMRB) model, or a more detailed dispersion model (if deemed more efficient, and if such a model has already been set up by the local authority in previous rounds of Review and Assessment), as detailed in Chapter 7 (para 7.66).

5.16 Assessments of road traffic sources will require information on traffic flows, fleet composition and vehicle speeds. Ways to obtain traffic data are set out in Chapter 7 (see para 7.212).

5.17 Where predicted concentrations at relevant locations exceed any of the objectives, then local authorities should proceed to a Detailed Assessment.

B. Non-Road Transport Sources

5.18 Non-road transport sources to consider should include:

- Airports (aircraft emissions);
- Railways (stationary emissions from idling locomotives in stations and depots, as well as mobile emissions on busy lines with a significant number of diesel locomotives, as these may contribute to high NO_2 concentrations); and
- Ports (shipping emissions).

C. Industrial Sources

5.19 Industrial sources are controlled by Natural Resources Wales (NRW), the Northern Ireland Environment Agency (NIEA), and by local authorities under the Pollution Prevention and Control regulations. Local authorities also have controls over smaller industrial and commercial sources, largely through the Clean Air Act, with its associated control of the stack heights. As a result of these controls, there are relatively few sources that may be relevant to local authorities under the LAQM system. Many of these sources will have been addressed during previous rounds of Review and Assessment. The focus should thus be on new installations and those with significantly changed emissions.

5.20 While the number of sources that may be significant is limited, there is a wider range of pollutants to be considered.

5.21 The checklist is broken into four sections:

- C1 Industrial installations;
- C2 Major fuel (petrol) storage depots;
- C3 Petrol stations; and
- C4 Poultry farms.

D. Commercial and Domestic Sources

5.22 This section covers emissions from the commercial and domestic sector, including the service sector (for example, commercial offices, education, government, health, hotel and catering, retail, sport and leisure, warehousing, etc).

5.23 Consideration is given to the use of biomass combustion in the commercial and

domestic sectors, and to other solid-fuel combustion in domestic use. In the majority of instances, the significance of domestic biomass combustion is relatively small, although there are concerns, particularly in urban areas, that a significant increase in biomass combustion generally, and in particular the use of wood fuel, could detrimentally affect local air quality.

5.24 Local authorities will be able to identify any biomass combustion plant in their area that is covered by the Clean Air Act / Clean Air (NI) Order 1981, e.g. small biomass units, and exempt appliances in Smoke Control Areas. Further information can then be obtained from the operator. Authorities will need to enforce the Clean Air Act / (NI) Order if the air quality impact of biomass combustion is to be effectively managed.

5.25 It should be noted that "domestic furnaces" are not covered by the Clean Air Act / (NI) Order. "Domestic furnaces" are defined in Section 64(1) of the Act (and in Article 11 of the NI Order) as any furnace which is:

- designed solely or mainly for domestic purposes; and
- used for heating a boiler with a maximum heating capacity of less than 16.12 kilowatts.

5.26 A small domestic wood burning stove is not a boiler and so would not require notification under the Act / (NI) Order. In the case of domestic wood-burning stoves, it will therefore be necessary for local authorities to use their judgment, and information on housing density, to decide whether domestic biomass combustion will require assessment. Guidance, and a worked example, is provided in "Technical Guidance: Screening assessment for biomass boilers[36]".

5.27 The use of biomass to generate energy has potentially significant benefits for the reduction of greenhouse gas emissions. 'Planning our electric future: a White Paper for secure, affordable and low-carbon electricity'[37], and the 'UK Bioenergy Strategy'[38], both recognise the potential role of biomass combustion in meeting the UK's renewable energy targets. However, there are concerns, particularly in urban areas, that a large increase in biomass combustion could lead to a significant increase in pollutant concentrations, in particular for PM and NO_2. Where concentrations of these pollutants are already near or exceeding objectives, this will be a particularly sensitive issue.

5.28 The Review and Assessment needs to consider both individual installations and the combined impact of many small biomass installations.

[36] Abbott, J "Technical Guidance: screening assessment for biomass boilers". AEA Report reference AEA/ED48673005/R2655- Issue 1, prepared for Defra and the Devolved Administrations, July 2008. Available from http://uk-air.defra.gov.uk/reports/cat18/0806261519_methods.pdf

[37] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48129/2176-emr-white-paper.pdf

[38] https://www.gov.uk/government/publications/uk-bioenergy-strategy

E. Fugitive or uncontrolled sources

5.29 Fugitive or uncontrolled sources relate to dust emissions, which can lead to elevated PM_{10} concentrations. These sources include, but are not limited to:

- Quarrying and mineral extraction sites;
- Landfill sites;
- Coal and material stockyards, or materials handling;
- Major construction works; and
- Waste management sites.

5.30 For example, studies have previously identified substantial increases in annual mean PM_{10} concentrations, up to 30µg/m^3, alongside public roads up to 50m from the entrances to waste management sites and construction sites[39].

5.31 Emissions from these sources are not well quantified, and it is therefore difficult to predict PM_{10} concentrations with any accuracy. The screening assessment is therefore largely based upon practical experience gained from studies in the vicinity of these sources, and the results of previous rounds of Review and Assessment. Short-lived construction sites will not normally need to be considered.

5.32 The first step in the assessment is to determine whether there have been any assessments carried out by others for the source in question, and if so whether the assessment is of sufficient quality for the purposes of Review and Assessment. If there is no existing assessment, then potential public exposure near the sources of dust emission should be identified. Wherever possible, the distance from sensitive receptors to the actual sources of emission (rather than to the site boundary) should be considered. On-site sources can be haul roads, crushers, stockpiles etc. Off-site sources can also be important, in particular the roads used by vehicles accessing the site. Dust and dirt can be tracked out by vehicles leaving the site, deposited on the public highway, and then raised by passing vehicles. Concentrations fall-off rapidly on moving away from the source.

[39] AQEG (2005) Particulate Matter in the United Kingdom, and Fuller G (2008) PM_{10} Source Apportionment at Bexley 4, Manor Road, Erith, Kings College, London.

CHAPTER 6: Detailed Assessments - Wales and Northern Ireland

Introduction

6.01 This chapter provides guidance to local authorities in Wales and Northern Ireland in the preparation of Detailed Assessments. It is not specifically addressed to local authorities in England or Scotland, for which Detailed Assessments are no longer specifically required. However, the guiding principles are still of relevance to local authorities in England or Scotland if detailed studies are required to support the decision to declare, amend or revoke an AQMA – to be appended to the ASR/APR as additional supporting technical information.

Role of Detailed Assessments

6.02 Where the Updating and Screening Assessment has indicated that there is a risk of the air quality objectives not being achieved, the authority will need to carry out a Detailed Assessment. A Detailed Assessment is also required in circumstances where an authority proposes to revoke or otherwise amend an existing AQMA.

6.03 The aim of the Detailed Assessment is to determine the likelihood of the objectives not being achieved and, where necessary, establish the magnitude and geographical extent of any exceedance. The Detailed Assessment should be as robust as possible to ensure that the authority has confidence in the decision to declare or revoke/amend an AQMA.

The Format and Content of Detailed Assessments

6.04 Because of the wide range of sources and local circumstances, it is not possible to set prescriptive guidance for the Detailed Assessment. However, to assist authorities, guidance related to monitoring, emissions data and dispersion modelling is provided in Chapter 7. Local authorities may also contact the LAQM Support Helpdesk as required.

6.05 In undertaking the Detailed Assessment, due consideration should be given to the points of maximum relevant public exposure, i.e. those 'hot spot' locations where the highest concentrations are expected.

6.06 Authorities are also strongly encouraged to have regard to all existing sources of relevant information, including:

- Assessments submitted in support of planning applications; and
- Assessments submitted for installations regulated by Natural Resources Wales (NRW), the Northern Ireland Environment Agency (NIEA), and by local authorities under the Pollution Prevention and Control regulations.

Monitoring

6.07 Monitoring data will play an important role within the Detailed Assessment. Whilst it may be used for the purposes of model verification (see Chapter 7), in some circumstances, for example where the emissions arise from an unquantifiable fugitive source, the Detailed Assessment will need to rely predominantly on available monitoring data.

6.08 As a minimum, when developing a monitoring programme, careful consideration should be given to:

- The siting of monitors in relation to the emission source, so that relevant locations where exposure to pollution is likely to be highest are captured (generally downwind from the source, based on the prevailing wind direction);
- Ideally, monitoring should be carried out for 12 months, or as a minimum over the period when emissions are likely to be highest; and
- Authorities are advised to compare the results of local monitoring programmes with data from national network sites, to assist with the interpretation of findings. This will focus on separating out regional episodes, to help identify the impacts from local source(s).

6.09 Detailed guidance on monitoring methods, monitoring strategies and suitable quality assurance and quality control (QA/QC) procedures, is set out in Chapter 7.

Modelling

6.10 Detailed Assessments may utilise dispersion modelling to identify where exceedances of the objectives are likely. Where exceedances are supported by measured concentrations, the modelling predictions will help determine the geographical extent of the exceedance area, and therefore the extent of the AQMA. It will also help estimate the population exposed to pollutant concentrations above the objectives.

6.11 Important aspects for consideration when undertaking dispersion modelling include:

- **Meteorological data.** If possible, meteorological, background pollution, and emissions data should all be derived from the same year. For point sources, multiple years of meteorological data (three or more) should be used. This is to ensure that the potential effects of fluctuating wind directions in different years are taken into account when defining exceedance areas. However, although results for all meteorological years should be reported, any decision should be based upon the worst-case result.
- **Receptor spacing.** Potential ‘hot spots’ should be duly considered by using a suitable resolution for receptor grid spacing, or including specific receptors (representing the locations of maximum public exposure). It is also important to ensure that the separation distance between source and receptor is accurately set up within the model to avoid erroneous concentration predictions.
- **Model verification and adjustment.** To ensure a robust Detailed Assessment

for road traffic sources, it is recommended that model verification is carried out (see worked example in Box 7.12 in Chapter 7). Verification involves a comparison between predicted and measured concentrations at one or more suitable local sites, and adjustment of the modelled concentrations if necessary. For point sources, verification of short-term concentrations (which are the main concern, as more likely to exceed the air quality objectives) may be more difficult to perform. In all cases where model verification has been carried out, the approach should be fully documented, and any adjustment factor applied explicitly stated.

- **Relationships between NO_x and NO_2.** Model concentration predictions are often made for NO_x, and thus suitable conversion from NO_x to NO_2 is likely to be necessary. An adequate description of the methodology should be included in the report.
- **Background concentrations.** Typically only the process contributions from local sources are represented within and output by the dispersion model. In these circumstances, it is necessary to add an appropriate background concentration(s) to the modelled source contributions to derive the total pollutant concentrations.

6.12 Detailed advice on the selection and use of an appropriate air pollution dispersion model, which includes further discussion of the above key areas, is provided in Chapter 7.

Estimating Population Exposure

6.13 Within their Detailed Assessments, local authorities are required to estimate the number of people exposed to pollutant concentrations above the objectives, and the maximum pollutant concentration (measured or modelled) at a relevant receptor location.

6.14 Where the authority has modelled the area of exceedance, then this task should be relatively straightforward using Geographical Information Systems (GIS). All authorities have access to population data in GIS format for their administrative areas.

6.15 Where the exceedance area has not been modelled (e.g. where reliance is placed solely upon monitoring data) then it should be possible to estimate the number of properties and hence the population exposed.

6.16 It should be noted that it is the population within the exceedance area that is of interest, and not the population within the AQMA. In many cases, authorities choose to designate the AQMA over a much wider area than the geographical extent of the exceedance.

6.17 Authorities should assume that the residential population is representative of exposure within the exceedance area.

Source Specific Considerations

6.18 Box 6.1 provides guidance to local authorities when undertaking Detailed Assessments for particular source groups.

6.19 Given the small number of AQMAs declared so far for non-road transport sources[40], it is not considered likely that many authorities will need to proceed to a Detailed Assessment for non-road transport sources (such as airports, ports and railways). Some general guidance is provided below, but where such Detailed Assessments are required, the authority is advised to contact the LAQM Support Helpdesk prior to commencing the study.

Box 6.1 – Source Specific Considerations for Detailed Assessments

Source	Focus
Road traffic	Focus is likely to be upon: • A compilation of detailed and accurate road traffic emissions data, including if necessary, carrying out new traffic counts to more precisely characterise traffic flows and speeds; • A more detailed assessment of the road traffic contribution to NO_X and PM_{10} concentrations. In the case of PM_{10}, this may require further consideration of the non-exhaust PM emissions (i.e. brake, tyre wear and abrasion); • A more accurate description of existing background levels; and • Additional roadside monitoring using automatic monitors and/or an array of diffusion tubes in the case of NO_2. For example, it may prove useful to split roads up into much smaller sections, which will then allow a more accurate definition of changing vehicle speeds close to junctions. It may also prove important to take account of areas where cold-start emissions are particularly important, such as in the vicinity of long-term car parks. Emissions are also known to be affected by engine loading, for example when vehicles are climbing steep hills, and specific speeds and emission factors for these types of areas may need to be considered. Detailed guidance on how to estimate emissions and model road traffic sources, and the types of input data required, is provided in Chapter 7.
Airports	Authorities should be able to use the conclusions of previous assessments undertaken on behalf of the airport operator, once the authority has satisfied itself that appropriate methods have been used to carry out the assessment.

[40] http://uk-air.defra.gov.uk/aqma/summary

Source	Focus
Shipping	Focus will be upon compiling an inventory of ship emissions. The method used to determine ship emissions to be input into a dispersion model will vary considerably according to the data available, but will require determination of activity and emissions factors for the port being assessed. The following steps should be required: • Determine the weight and type of cargo for each ship movement; • Calculate the fuel consumption for each ship (dependent on ship type, i.e. liquid bulk, solid bulk, general cargo, tugs, etc) assuming engines are running at full power; • Calculate the fuel consumption for each mode (i.e. cruising, manoeuvring, hotelling, tanker offloading) for each ship using the fraction of maximum fuel consumption figures; • Calculate the emissions from the auxiliary engines used during hotelling according to the power rating and percentage load; • Calculate the emissions (determined from engine type) in each mode, for each ship, from the emissions factors (per ton of fuel used); and • Determine the overall emissions by combining the above emission factors with information on the time each ship spends in each mode. Given the likely constraints surrounding the availability of the required data detailed above, it is likely that a combination of port-specific data and more generic information available in the published literature will be required to give an approximation of the emissions. Further details of available sources of emissions data for shipping are provided in Chapter 7.
Railways	Focus will be upon compiling an inventory of locomotive emissions. An estimate of efflux parameters is also required for dispersion modelling purposes. For coal-fired locomotives, information will be required on the sulphur content of coal and the amount used over a period of time. In the case of diesel locomotives, information is available on emissions for different categories: freight, intercity and regional, within the National Atmospheric Emissions Inventory (NAEI) under the 'Railways' category. It is based on the gas-oil consumption rates for moving locomotives.
Domestic solid-fuel use	Focus is likely to be upon: • An assessment of solid fuel use to characterise the different fuels and combustion methods used in the area so that emissions may be accurately quantified; • The application of detailed dispersion modelling performed on the basis of the calculated emissions, to predict concentrations across the area of interest; and • Local monitoring to confirm existing concentrations of SO_2 and/or PM_{10} in the area of concern. Ideally, monitoring should be carried out for a period of 12 months, although six winter months may also be suitable. As a minimum, the monitoring should cover the main solid fuel burning season, for example, November to February. Further guidance on emissions calculations for domestic solid-fuel use is given in Chapter 7.

Source	Focus
Industrial emissions and biomass	Focus is likely to be upon: • The accurate quantification of the emissions. Many installations operate well within their emissions limits, and actual emissions data should be used. For certain types of installation, both seasonal and daily variations in emissions are significant, and should be considered wherever possible; • The application of detailed dispersion modelling. Significantly elevated point sources will have little impact upon the annual mean concentration, and in such instances the assessment should focus upon an accurate prediction of the shorter-term concentrations. The modelling approach should therefore ideally seek to predict hour-by-hour or day-by-day ground-level concentrations arising from the stack(s), which will then be added to suitable sequential hourly or daily background concentrations. Where this is not possible or practicable, alternative approaches to adding industrial installation and background contributions are summarised in Box 7.9 in Chapter 7; and • The use of more detailed local monitoring to confirm existing concentrations; Further guidance on the selection and application of suitable dispersion models for stack modelling and developing monitoring programmes is given in Chapter 7.
Poultry farms	Detailed Assessments for poultry farms are likely to be based on both monitoring and modelling studies. In many cases a suitable monitoring programme will need to be established to determine the impact of the poultry sources. Quantifying the PM_{10} emissions arising from a poultry farm for input into a dispersion model is not straightforward. Where required, authorities should contact the LAQM Support Helpdesk for further advice. Further guidance on the selection and application of suitable dispersion models for poultry farm modelling and developing monitoring programmes is given in Chapter 7.
Uncontrolled and fugitive emissions	Emission factors for fugitive sources, e.g. those published within the *Compilation of Air Pollution Emission Factors (USEPA-42)*, are subject to a variable degree of uncertainty and frequently require default assumptions to be made. Their application is therefore more suited to allowing predictions of the impact of operations which are currently not in existence. Consequently, it is likely that the Detailed Assessment will need to focus upon a detailed monitoring programme. In many cases a suitable monitoring programme will need to be established. Where monitoring indicates that the objectives are likely to be exceeded, then it may be helpful to refine the monitoring strategy, in order to more clearly identify the source contributions. In such cases, authorities may find it useful to: • Undertake monitoring of wind speed and direction to assist with the interpretation of results and any reported exceedances; • Carry out monitoring at several locations, including an upwind site. This will allow a more accurate assessment of the contributions of the different sources to the measured values. Alternatively, “directional” monitoring equipment (which allows measurements to be collected only within a pre-defined wind direction) can be employed; and • Consider the use of various speciation and chemical analysis methods to assess the source contribution to the measured values.

CHAPTER 7: Technical Supporting Information

Introduction

7.01 This chapter brings together a series of tools and other supporting information to help local authorities carry out their Review and Assessment of air quality. Where appropriate, the general approach and methodology is described, and worked examples are provided, with reference to associated online tools available on the LAQM Support website. Local authorities should ensure that they use the latest version of tools and are strongly recommended to register for automatic updates with the LAQM Support Helpdesk[41].

7.02 This chapter is split into four main topics, as follows:

- Screening Tools and Methodology;
- Air Quality Monitoring;
- Emission Calculations; and
- Dispersion Modelling.

1 – Screening Tools and Methodology

7.03 This section provides the methodology and associated tools that local authorities should use to screen sources of pollution as part of the Annual Status Report (England) / Annual Progress Report (Scotland), or the Updating and Screening Assessment (Wales and Northern Ireland).

7.04 After over 15 years of LAQM, it is recognised that, from now on, screening assessments required for the purpose of Review and Assessment are unlikely to be as numerous as in the early stages of the LAQM system, for the following reasons:

- All local authorities have now completed 5 rounds of Updating and Screening Assessments since 2003. This means that most current sources likely to give rise to exceedances of the air quality objectives should have been screened at least once;
- All sources of concern identified in previous rounds should have been further assessed and conclusions reported in previous Detailed Assessments, generally based on detailed dispersion modelling of emissions or air quality monitoring campaigns;
- For those sources confirmed to lead to exceedances, AQMAs should have been declared, and AQAPs implemented to tackle air pollution and work towards meeting the objectives. It is unlikely that many local authorities will need to proceed to new screening assessments in the future for emissions sources within existing AQMAs; and

[41] http://laqm.defra.gov.uk/helpdesks.html

- Many local authorities have installed permanent air quality monitoring sites (such as continuous monitoring analysers or NO_2 diffusion tubes) near those sources of concern that were borderline (i.e. sources below but close to the relevant screening criteria, or for which a Detailed Assessment has been carried out, which concluded that an AQMA was not required). Therefore, in most cases, existing air pollution monitoring networks have replaced the need to screen these sources. This is particularly true for road-traffic sources.

7.05 New or modified sources of emissions will usually be assessed for air quality and appraised by the local authority as part of the planning application process. However, screening assessments may still be required for various reasons, including:

- Where new sources of pollution have been identified (in particular industrial sources, or new roads);
- Where emissions are likely to have increased significantly (for example, due to significant increases in traffic flows along major roads, or extensions of industrial facilities; or
- Where there is new exposure to air pollution (for example in case of new residential developments near busy roads).

7.06 The methodology that should be followed to screen air pollution sources is proposed in the section below, for each of the following categories:

- Road traffic sources;
- Non-Road Transport Sources (i.e. Airports, Railway and Ports);
- Industrial Sources;
- Commercial and Domestic Sources; and
- Fugitive or Uncontrolled Sources.

7.07 Annex C provides local authorities with a decision-making tree, aimed to facilitate the selection of the most appropriate screening method when assessing the impact of stack emissions on local air quality, either for planning purposes or local authority Review and Assessment.

Road Traffic Sources

7.08 It is expected that most roads of concern will already have been assessed (sometimes more than once) in previous rounds of Review and Assessment. The roads identified as likely to exceed the objectives have been through further assessment (based on detailed dispersion modelling) and, where exceedances have been confirmed, are all likely to be incorporated within existing AQMAs. As road traffic emissions represent the main issue faced by UK local authorities, as confirmed by the number of AQMAs declared solely for road traffic sources[42], most

[42] Up-to-date statistics are available on the AQMA website at http://uk-air.defra.gov.uk/aqma/summary

local authorities' monitoring networks are now mainly focused on monitoring concentrations along these roads of concern. It is therefore unlikely that local authorities would have missed any roads where the objectives are breached.

7.09 Nevertheless, local authorities may need to proceed with screening assessments in a number of cases, such as for newly built roads, roads where traffic flow conditions have changed significantly (i.e. increase in overall traffic flow, the flow of HDVs, or increase in congestion), where there is new exposure (i.e. newly built residential properties), or potentially if roads have not been properly screened for a number of years.

7.10 Attention only needs to be given to NO_2 and, in some case, PM_{10}. The assessment should consider roads that fall within any of the categories below:

- **Narrow congested streets with residential properties close to the kerb.** Concentrations are often higher in these areas, due to the combination of slow moving traffic with stop/start driving conditions, and street canyon effect due to buildings on either side of the road, preventing good dispersion of pollutants;
- **Busy streets where people may spend 1-hour or more close to traffic**. For example, streets with many shops and streets with outdoor cafes and bars;
- **Roads with high HDV flows**. Roads with unusually high proportion of buses and/or HGVs can lead to high concentrations, even if total traffic is not particularly high;
- **Junctions,** where concentrations are usually higher due to the contribution of multiple roads combined with increased emissions due to stop start driving conditions;
- **New roads constructed or proposed.** The approach to considering new roads will depend on whether or not an assessment was carried out in advance of building the new road;
- Roads with significantly changed traffic flows; and
- **Bus and coach stations.** If they are not enclosed, and there is relevant exposure nearby.

7.11 Details of the methodology to follow to screen all source categories as above are provided in Table 7.1. Note that a screening assessment should **not** be necessary for locations:

- within existing AQMAs declared for road traffic sources for the specific pollutant under consideration; or
- outside AQMAs where air quality monitoring data is already available, provided the monitoring site is representative of the worst-case exposure location, and data QA/QC is adequate.

Table 7.1 – Screening Assessment of Road Traffic Sources

Road Source Category	Pollutant of Concern	Objectives of Concern (1)	Criteria	What to Report	Action if Screening Confirms Potential Issue	Notes
1 -Narrow congested streets with residential properties close to the kerb.	NO_2	Long and Short-Term	5,000 vehicles/day- exposure within 2m from kerb - slow moving traffic with frequent stop/start	Roads matching criteria	Carry out NO_2 monitoring survey(2) - Use results in next yearly LAQM report to determine whether an AQMA needs to be declared	Monitoring is recommended, as screening models generally fail to identify actual exceedances in these areas
2 - Busy streets where people may spend 1 hour or more close to traffic	NO_2	Short-Term	10,000 vehicles/day - exposure within 5m from kerb >= 1-hour	Results of DMRB Screening Assessment(4) to identify annual mean concentrations > 60µg/m^3	Carry out monitoring survey(2) and/or detailed dispersion modelling - to identify annual mean concentrations > 60µg/m^3 (3)	If AQMA already declared for NO_2 annual mean, only amend AQMA and AQAP to include 1-hour mean
3 - Roads with a high flow of HDVs	NO_2 / PM_{10}	Long and Short-Term	2,500 HDVs/day - exposure within 10m from kerb (20m in conurbations > 2m inhabitants)	Results of DMRB Screening Assessment(4) to identify exceedances	Carry out monitoring survey(2) and/or dispersion modelling(3)	If AQMA already declared for one of the objectives, only amend AQMA and AQAP to include the additional objectives exceeded
4 - Junctions	NO_2 / PM_{10}	Long and Short-Term	10,000 vehicles/day - exposure within 10m from kerb (20m in conurbations > 2m inhabitants)	Results of DMRB Screening Assessment(4) to identify exceedances	Carry out monitoring survey(2) and/or dispersion modelling(3)	Where two or more roads intersect, the traffic flows from each arm of the junction should be summed to give a combined total, which should then be divided by two before comparison against the screening criteria.
5 - New roads constructed or proposed since the last round of	NO_2 / PM_{10}	Long and Short-Term	if no air quality assessment available from planning application - 10,000 vehicles/day - exposure within	air quality assessment available: exceedances predicted in submitted assessment	Declare AQMA / Carry out additional dispersion modelling beforehand if deemed necessary	

Road Source Category	Pollutant of Concern	Objectives of Concern [1]	Criteria	What to Report	Action if Screening Confirms Potential Issue	Notes
Review and Assessment			10m from kerb (20m in conurbations > 2m inhabitants)	No air quality assessment available: results of DMRB Screening Assessment[4] to identify exceedances	Carry out monitoring survey[2] and/or dispersion modelling[3]	If the new road has increased traffic flow on existing roads where concentrations are likely to be below but close to the objectives (typically within 10%), then these should also be assessed
6 - Roads with significantly changed traffic flows	NO_2 / PM_{10}	Long and Short-Term	25% traffic increase on roads > 10,000 vehicles/day - exposure within 10m from kerb (20m in conurbations > 2m inhabitants) - Roads previously identified at risk of exceeding (within 10% of objective)	Results of DMRB Screening Assessment[4] to identify exceedances	Carry out monitoring survey[2] and/or dispersion modelling[3]	
7 - Bus and coach stations	NO_2	Long and Short-Term	2,500 bus/coach movements/day [5] - exposure within 10m from kerb (20m in conurbations > 2m inhabitants)	Results of DMRB Screening Assessment[4] to identify exceedances	Carry out monitoring survey[2] and/or dispersion modelling[3]	If AQMA already declared for NO_2 annual mean, only amend AQMA and AQAP to include 1-hour mean.

[1] Long-term refers to annual mean - Short-term refers to 1-hour mean (for NO_2) or 24-hour mean (for PM_{10})

[2] Monitoring survey should be carried out for a minimum 6-month period

[3] Local authorities in England may decide to declare an AQMA straightaway at this stage. Other local authorities will need to proceed with monitoring and/or modelling and report findings in a Detailed Assessment before deciding whether an AQMA needs to be declared

[4] See para 7.66 for details on the DMRB air quality screening tool and methodology

[5] A bus movement considers a bus either arriving, or leaving the station. A bus arriving then leaving therefore counts for 2 movements

Non-Road Transport Sources

7.12 Non-road transport sources include airports, railways and shipping emissions. It is unlikely that many local authorities will have to proceed with a screening assessment of these sources, for the following reasons:

- These sources are limited in number, and therefore it is expected that existing sources will have been screened in previous rounds of Review and Assessment;
- Since the inception of the LAQM system, only a handful of these sources required further assessment, and even less led to the declaration of an AQMA[43].

7.13 However, a summary of the methodology that may still be applied to screen these sources, if necessary, is described below. It is however recommended that local authorities contact the LAQM Support Helpdesk before reporting the screening assessment.

7.14 This section is only likely to be relevant to a small number of local authorities. Most of these sources will have been assessed in previous rounds of Review and Assessment. Assessments will only be required where new sources arise, where significant changes have occurred or if there is new relevant exposure near existing sources.

Airports

7.15 Aircraft are potentially significant sources of NO_x emissions, especially during take-off, and therefore the main risk is related to potential exceedances of the NO_2 air quality objectives. It is likely that all airports have been subject to a screening assessment in previous rounds of Review and Assessment; however, in case of significant changes (such as increase in airport capacity, or new population exposure near the airport), the local authority should be able to screen aircraft emissions from airports based on the following:

- Determine relevant exposure within 1km of the airport boundary;
- If exposure has been identified, determine whether the airport total equivalent passenger throughput is more than 10 million passengers per annum (mppa). Freight should also be considered, and converted to equivalent mppa using 100,000 tonnes = 1 mppa;
- Identify whether the background annual mean NO_x concentration is above 25µg/m^3 in these areas.

7.16 If all of the above criteria are matched, then the local authority should conclude that

[43] The only AQMAs declared for non-mobile sources are the Great Central Railway AQMA declared by Charnwood Borough Council in 2004 for SO_2, and the Dover Docks AQMA declared in 2002 for the same pollutant due to shipping emissions. However the latter was revoked in 2014.

there is a risk of exceedance of the NO_2 annual mean objective, and carry out an NO_2 monitoring survey (6-month period minimum) at relevant receptors to determine whether an AQMA should be declared. It is not recommended that local authorities carry out dispersion modelling of airport emissions for their screening purpose, as this can be time consuming and resource intensive, and results are likely to be subject to significant uncertainties. If an air quality assessment has been submitted by the airport operators, this should be reviewed and conclusions summarised as supporting information.

Railway

7.17 Diesel or coal fired stationary locomotives can give rise to high short-term SO_2 concentrations near railway stations or depots. Additionally, moving diesel locomotives can contribute to elevated short-term NO_2 concentrations close to the track. It is likely that all sources of concern have been assessed in previous rounds of Review and Assessment, given the few number of railway lines not yet electrified. However, in case of new exposure near the lines of concern, local authorities may need to reassess these, based on the following:

Stationary diesel or steam locomotives:

- Identify locations where diesel or steam locomotives are regularly (at least 3 times a day) stationary for periods of 15 minutes or more;
- Determine relevant exposure within 15m of the locomotives;

Moving diesel locomotives:

- Determine relevant exposure within 30m of the relevant railway tracks (Table 7.2 provides information on which lines should be considered);
- Identify whether the background annual mean NO_2 concentration is above 25µg/m^3 in these areas.

7.18 If the above criteria are matched, then the local authority should conclude that there is a risk of exceedance of the SO_2 15-minute mean objective (for stationary locomotives) or the NO_2 annual mean objective (for moving locomotives), and carry out a monitoring survey (6-month period minimum) at relevant receptors to determine whether an AQMA should be declared.

Table 7.2 – Rail Lines with a Heavy Traffic of Diesel Passenger Trains

Relevant Rail Lines
Paddington to Swansea
Swindon to Taunton
Bristol Temple Meads to Bristol Parkway
Rugby to Birmingham New Street
Manchester Piccadilly to Wigan
Crewe to Gretna
Manchester to Crewe
Liverpool Lime Street to Allerton (Liverpool Urban area)
Sheffield to Wincobank Junction
Leeds to Bradford only for about 1 mile to west of Leeds station
Glasgow to Edinburgh

Ports

7.19 Large ships generally burn high sulphur content oils in their main engines (bunker oils). For large ports, these may give rise to elevated short-term SO_2 concentrations, which might lead to exceedances of the 15-minute or 1-hour mean objectives. NO_x and PM emissions may also lead to elevated concentrations at sensitive receptors around ports. It is likely that all sources of concern have been assessed in previous rounds of Review and Assessment. However, in case of port extension, leading to a likely increase in shipping activity, or new exposure near existing emission sources, local authorities may need to reassess these, by checking the following:

- Is there more than 5,000 large ship movements[44] per year, with relevant exposure within 250m of the berths and main areas of manoeuvring; or
- Is there more than 15,000 large ship movements per year, with relevant exposure within 1km of these areas?

7.20 If one of the above criteria is matched then the local authority should conclude that there is a risk of exceedance of the short-term objectives for NO_2, PM_{10} and SO_2, and carry out a monitoring survey (6-month period minimum) at relevant receptors to determine whether an AQMA should be declared. This may be supported by dispersion modelling of shipping emissions, although modelling results are likely to be subject to high uncertainties.

Non-Road Mobile Machinery

[44] i.e. cross-channel ferries, ro-ro, bulk cargo, container ships, cruise liners, etc – one ship generating two movements (arrival and departure)

7.21 Non-Road Mobile Machinery (NRMM) refers to mobile machines, transportable industrial equipment or vehicles which are fitted with an internal combustion engine and not intended for transporting goods or passengers on roads.

7.22 Pollutants emitted by NRMM that may have the most significant potential effects on local air quality are particulate matter (PM_{10} and $PM_{2.5}$), and NO_x/NO_2. Within London, in 2010 the NRMM used on construction sites was responsible for 12% of NO_x emissions and 15% of PM_{10} emissions in Greater London[45]. Typically NRMM is associated with construction sites. There is thus a potential for NRMM emissions to adversely affect local air quality, the extent to which is dependent upon the following considerations:

- Duration of works and associated phasing plans;
- Type and number of NRMM to be used on site;
- Operating hours of NRMM;
- Emissions standards to which NRMM comply;
- Proximity of receptors to NRMM working areas; and
- Existing background pollutant concentrations.

7.23 It should be noted that an increased density of construction sites within a Local Authority's area, and 'back-to-back' schemes within the same or nearby geographical area, moves NRMM from a "minor" to "significant" emissions sources, which may in itself lead to a more detailed consideration to the air quality impacts. For this reason, London has introduced an NRMM Low Emission Zone - please refer to the London LAQM Technical Guidance (currently under development) for more details.

7.24 The following provides example measures of how NRMM emissions from construction sites may be minimised:

- Ensure all equipment complies with the appropriate NRMM standards;
- Where feasible, ensure further abatement plant is installed on NRMM equipment, e.g. Diesel Particulate Filters (DPFs);
- Ensure all vehicles switch off engines when stationary – no idling vehicles;
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where possible; and
- Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).

[45] Greater London Authority (2014). *The control of dust and emissions during construction and demolition - Supplementary Planning Guidance*. Available at: https://www.london.gov.uk/sites/default/files/Dust%20and%20Emissions%20SPG%208%20July%202014_0.pdf

7.25 Experience of assessing the exhaust emissions from on-site plant (NRMM) and site traffic suggests that, with suitable controls and site management, they are unlikely to make a significant impact on local air quality. In the vast majority of cases they will not need to be quantitatively assessed – qualitative consideration to the above points will likely provide sufficient screening. Where there is considered to be an elevated risk of local air quality issues arising from NRMM activities, please contact the LAQM Helpdesk for further advice on the methods available to quantitatively assess the potential impacts.

Industrial Sources

7.26 Industrial sources are unlikely to make a significant contribution to annual mean concentrations, but may contribute to elevated short-term concentrations, which may lead to exceedances of the short-term air quality objectives (e.g. 15-minute mean for SO_2, 1-hour mean for NO_2 or 24-hour mean for PM_{10}). The assessment should consider the potential impact of specific industrial processes or chemical storage for all of the regulated pollutants. Generally, those most at risk of requiring further work are NO_2, PM_{10} and potentially SO_2.

7.27 Details of the methodologies to use to screen industrial sources are provided in Table 7.3. Industrial sources to consider are broken into the following categories:

- Industrial installations;
- Major petrol storage depots and petrol stations; and
- Poultry farms.

Industrial Installations

7.28 Local authorities should screen industrial installations by using the Industrial Emissions Screening Tool available for download on the LAQM Support website[46].

7.29 This Excel tool has been developed to help local authorities determine, for each pollutant and air quality objective of concern, the maximum annual emissions from an industrial installation for which a risk of exceedance is unlikely. Therefore, the methodology consists of comparing the actual annual emissions for each industrial installation (identified using Table 7.3) against the maximum annual emissions calculated by the tool.

7.30 If actual emissions are greater than the maximum emissions, then the local authority should proceed to a further assessment[47], based on detailed dispersion modelling.

7.31 The tool is based on a series of nomograms developed as part of previous versions of

[46] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html

[47] To be submitted as either a Detailed Assessment (Wales and Northern Ireland), or supporting information reported in next ASR (England) or APR (Scotland) as an appendix.

LAQM Technical Guidance, but which are still considered relevant[48]. It considers both industrial stack emissions and low-level, fugitive emissions. In order to use this tool, local authorities will need to gather the following information for each industrial installation requiring screening:

- Stack internal diameter;
- Actual stack height above ground level;
- Actual annual emissions for all pollutants of concern;
- Where necessary, exit stack temperature
- Where necessary, distance to nearest relevant exposure;
- Height of nearby buildings, which may prevent good dispersion of the plume; and
- Where necessary, background concentrations of the pollutant assessed.

7.32 Further information is provided in the tool. To determine background pollutant concentrations, local authorities should use suitable pollution monitoring sites nearby or, if unavailable, the UK background maps (see paras 7.55 to 7.57).

7.33 Before using the Industrial Emissions Screening Tool, local authorities should consider the following:

- Emissions from combustion sources from low temperature (<100°C) and high temperature (>100°C) sources are treated separately, due to different buoyancy effects;
- Where there are multiple stacks at the same site, a precautionary approach may be taken by assuming the total emissions (from all stacks) are released from the shortest stack.
- Where there are complex sites, with many stacks, the screening tool is unlikely to be applicable, and authorities are advised to proceed to detailed dispersion modelling.

Petrol Storage Depots and Petrol Stations

7.34 Major petrol fuel depots and petrol stations were identified in previous Technical Guidance as potential sources of concern, due to potential elevated emissions of C_6H_6 (benzene), especially if combined with higher levels from nearby busy roads. However, it is likely that all sources of concern have been assessed in previous rounds of Review and Assessment. No AQMA has been declared for this source since 2010 (when the last AQMA for Benzene was revoked) and, therefore, new assessments are unlikely to be required.

7.35 However, in case of significant changes (new population exposure near the source), the local authority should be able to screen emissions using the following methodology:

[48] Abbott J (2002) Review of pollutant specific guidance for industrial and domestic emissions. AEAT.

Major Petrol Storage Depots:

- Use the Industrial Emissions Screening Tool for benzene. This would require identifying the following parameters (if unsure, the local authority should contact the LAQM Support Helpdesk):
  - Distance to the nearest relevant exposure
  - C_6H_6 annual emissions from the source
  - Height of release (i.e. stack height or ground level if fugitive source)

Petrol Stations:

- Follow the steps described in Table 7.3.

Poultry Farms

7.36 In previous rounds of Review and Assessment, a few local authorities have identified potential exceedances of the PM_{10} objectives due to particulate matter emissions from poultry farms (defined as chickens (laying hens and broilers), ducks and guinea fowl, and turkeys).

7.37 Table 7.3 gives guidance on how to assess PM_{10} emissions from these sources and the proximity of relevant exposure, whilst Box 7.1 provides a worked example of the screening calculations[49].

Box 7.1 – Poultry Farms: Example of Calculation for Screening Assessment

Consider a poultry farm located in England with the following parameters:

- 145,000 turkeys
- Relevant exposure at 50m
- Background annual mean PM_{10} concentration of 18µg/m^3

The 90.4th percentile contribution (PC) to the daily mean PM_{10} concentration is calculated as follows:

$$PC_{90.4} = 0.62 \times (-0.000161 \ln(d) + 0.000793) \times (b))$$
$$= 0.62 \times (-0.000161 \ln(50) + 0.000793) \times (145{,}000 \times 1.5))$$
$$= 22\mu g/m^3$$

The total 90.4th percentile PM_{10} daily mean concentration ($PEC_{90.4}$) is then calculated as:

$$PEC_{90.4} = PC_{90.4} + \text{annual mean } PM_{10} \text{ background}$$
$$= 22 + 18$$
$$= 40\mu g/m^3$$

The calculated total 90.4th percentile daily mean PM_{10} concentration of 40µg/m^3 is below the 24-hour mean PM_{10} objective limit value of 50µg/m^3 for England.

In this instance, the screening assessment has thus concluded that there is no significant risk of exceeding the 24-hour mean PM_{10} objective as a consequence of PM_{10} emissions from the poultry farm. No further detailed consideration is considered necessary.

[49] The most recent poultry guidance is available at: http://uk-air.defra.gov.uk/library/reports?report_id=873

Table 7.3 – Screening Assessment of Industrial Sources

Source Category	Pollutant of Concern	Objectives of Concern	Criteria	What to Report	Action if Screening Confirms Potential Issue	Notes
Industrial Installations	All Pollutants	Long and Short-Term	if no air quality assessment available from planning application - New source or existing source with significant increase (30%) in emissions - with population exposure nearby	air quality assessment available: exceedances predicted in submitted assessment	Declare AQMA / Carry out additional monitoring and/or dispersion modelling beforehand if deemed necessary	Contact the LAQM Support Helpdesk if unsure how to determine emissions
				No air quality assessment available: results of Industrial Screening Tool	Carry out monitoring and/or dispersion modelling	
Major Petrol Storage Depots	C_6H_6	Long-Term	-	Results of Industrial Screening Tool	Carry out monitoring and/or dispersion modelling	
Petrol Stations	C_6H_6	Long-Term	Petrol throughput = 2,000m^3 or 2 million litres per year - Near busy road (>30,000 vehicles/day) - Exposure within 10m from the pumps	Petrol stations matching criteria	Carry out monitoring and/or dispersion modelling	Ignore petrol stations fitted with Stage 2 recovery systems. Ignore diesel throughput - only consider petrol

Source Category	Pollutant of Concern	Objectives of Concern	Criteria	What to Report	Action if Screening Confirms Potential Issue	Notes
Poultry Farms	PM_{10}	Long and Short-Term	Calculate the relevant percentile contribution (PC) to the daily mean PM_{10} concentration for a given number of poultry as follows: PC = (a) x (-0.000161 ln (d) + 0.000793) x (b)) Where: a = 0.62 when calculating 90.4th percentile (England, Wales, Northern Ireland) and 0.83 when calculating 98th percentile (in Scotland) d = distance (m) of receptor from poultry b = number of birds Add the PC value to the annual mean PM_{10} background concentration to calculate the total 90.4th percentile 24-hour mean concentration in England, Wales and Northern Ireland In Scotland, add the PC value to twice the annual mean PM_{10} background concentration to calculate the total 98th percentile 24-hour mean concentration [(1)] The total percentile 24-hour mean should then be compared against the relevant 24-hour PM_{10} air quality objective limit value	Poultry farms matching criteria	Carry out monitoring survey / dispersion modelling	Multiply number of birds by 1.5 to account for turkey's larger size

[(1)] A similar empirical relationship could not be established from derived estimated contributions to annual mean PM_{10} concentrations. Caution is therefore urged when applying the 24-hour mean PM_{10} screening criteria in Scotland, where it is considered that the annual mean PM_{10} objective is more difficult to achieve that the 24-hour mean objective.

Commercial and Domestic Sources

7.38 These sources include biomass combustion sources (both from the commercial and domestic sectors), as well as other solid-fuel combustion sources (from the domestic sector only).

7.39 Details of the methodology to follow to screen these sources are provided in Table 7.4. The sources to consider are broken down into the following categories:

- Commercial and domestic biomass combustion, which is further split into:
  - Individual installations; dealing with the assessment of large installations; and
  - Combined installations; dealing with the combined impact of smaller biomass installations.
  - Domestic other solid-fuel combustion.

Table 7.4 – Screening Assessment of Domestic Sources

Source Category	Pollutant of Concern	Objectives of Concern	Criteria	What to Report	Action if Screening Confirms Potential Issue	Notes
Commercial and Domestic Biomass Combustion - Individual Installations	NO_2 / PM_{10}	Long and Short-Term (NO_2) / Short-Term (PM_{10})	Screen against Target Emission Rate from Biomass Calculator (see paras 7.40-7.45)	Results of Biomass Calculator	Carry out monitoring and/or dispersion modelling	Contact the LAQM Support Helpdesk if unsure how to determine actual maximum emissions rates
Commercial and Domestic Biomass Combustion - Combined Installations	PM_{10}	Long-Term	-	Calculate emissions density (in kg emissions per 500m × 500m area) - Use nomogram in Figure 7.1 outside Scotland and Figure 7.2 in Scotland to compare with threshold	Carry out monitoring and/or dispersion modelling	Limited information is available on the impact of biomass on local air quality. Report "Technical Guidance: screening assessment for biomass boilers" contains a more detailed description of the above approach[50]. There is also guidance for authorities in Scotland in the report "Measurement and modelling of fine particulate emissions (PM_{10} and $PM_{2.5}$) from wood-burning biomass boilers"[51]

[50] Abbott, J "Technical Guidance: screening assessment for biomass boilers". AEA Report reference AEA/ED48673005/R2655- Issue 1, prepared for Defra and the Devolved Administrations, July 2008. Available at http://uk-air.defra.gov.uk/reports/cat18/0806261519_methods.pdf

51 Abbott J, Stewart R, Fleming S, Stevenson K, Green J and Coleman P "Measurement and modelling of fine particulate emissions (PM_{10} & $PM_{2.5}$ from wood-burning biomass boilers" Report prepared for the Scottish Government, ref. CR/2007/38, ISBN 978-0-7559-7296-8, Sep 2008. Available at http://www.scotland.gov.uk/Resource/Doc/243574/0067768.pdf

Source Category	Pollutant of Concern	Objectives of Concern	Criteria	What to Report	Action if Screening Confirms Potential Issue	Notes
Domestic Other Solid-Fuel Combustion	SO_2	Long and Short-Term	Density of coal burning premises = 100 per 500x500m area	Coal burning premises exceeding the criteria	Carry out monitoring and/or dispersion modelling	

Biomass Combustion - Individual Installations

7.40 Biomass burning can lead to an increase in PM_{10} emissions and, compared to conventional gas-burning, can also result in an increase in the overall NO_x emissions.

7.41 Local authorities should screen individual biomass combustion installations by using the Biomass Calculator available for download on the LAQM Support website[52].

7.42 This Excel tool has been developed to help local authorities determine the maximum emission rate (in grammes per second) from a combustion installation for which a risk of exceedance of the relevant air quality objective is unlikely. Therefore, the methodology consists of comparing, for each biomass installation identified (using Table 7.4), the actual maximum emission rate for pollutants against the Target Emission Rate calculated by the tool.

7.43 If the actual emission rate is greater than the Target Emission Rate, then the local authority should proceed to a further assessment[47], based on detailed dispersion modelling.

7.44 The tool is based on a number of nomograms developed as part of the previous version of LAQM Technical Guidance, which are still considered relevant[53]. In order to use this tool, local authorities will need to gather the following information for each of the biomass installations requiring screening:

- Stack internal diameter;
- Actual stack height above ground level;
- Actual NO_x and PM_{10} maximum emission rates;[54]
- Height of nearby buildings, which may prevent good dispersion of the plume; and
- NO_2 and PM_{10} background concentrations around the installation.

7.45 Further information is provided in the tool. To determine background pollutant concentrations, local authorities should use suitable pollution monitoring sites nearby or, if unavailable, use the UK background maps (see paras 7.55 to 7.57).

Biomass Combustion – Combined Installations

7.46 There is also the potential that many small biomass combustion installations (including domestic solid-fuel burning), whilst individually acceptable, could in combination lead to unacceptably high PM_{10} concentrations, particularly in areas where concentrations are close to or above the objectives.

[52] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html

[53] Abbott J (2002) Review of pollutant specific guidance for industrial and domestic emissions. AEAT

[54] See section 3 of this chapter (Estimating Emissions) related to point sources (para 7.237) to obtain emission rates.

7.47 Local authorities should assess combined impacts using the nomograms provided in Figure 7.1 and Figure 7.2. The nomograms are designed to be applied to emissions from the domestic and commercial sectors combined.

7.48 The procedure is as follows, with an example calculation set out in Box 7.2:

- Identify the areas with the highest densities of houses and service sector appliances burning solid fuels.
- Identify the types of solid-fuel appliance used in each area from the list provided on the LAQM Support website[55].
- Count the numbers of each domestic heating appliance type in the identified 500m × 500m squares (equivalent to 25ha[56]). Estimate the floorspace occupied (in hectares) in the service sector in each of the identified 500m × 500m squares for each of the identified types of solid-fuel burning plant.
- Multiply the number of houses for each appliance type by the annual household emission provided on the LAQM Support website[55]. Sum the emissions from each of the domestic appliance types to give the total annual domestic emission from the 500m × 500m square.
- Multiply the service sector floorspace (in hectares) for each appliance type by the annual service sector emission per hectare. Sum the emissions from each of the service sector appliance types to give the total annual service sector emission from the 500m × 500m square. Add the service sector emissions to the domestic emissions to give the total emissions from the square[57].
- Estimate the fraction of space in the 500m × 500m square occupied by solid-fuel burning premises or domestic properties. Divide the annual emission by the fraction occupied by solid-fuel burning to give the emissions density for the square (kg emissions per 500m × 500m area).

7.49 Figure 7.1 describes the annual emissions from a 500m × 500m square (the threshold emissions density) that may give rise to an exceedance of the 24 hour mean objective for PM_{10} for a particular estimated background PM_{10} concentration. If the emissions density from the square exceeds the threshold emissions density shown in Figure 7.1 then the authority will need to proceed to detailed dispersion modelling and/or monitoring.

7.50 Figure 7.2 describes the annual emissions from a 500m × 500m square (the threshold emissions density) that may give rise to an exceedance of the annual mean objective for PM_{10} for Scotland of 18µg/m^3 for a particular estimated background PM_{10} concentration. If the emissions density from the square exceeds the threshold emissions density shown in Figure 7.2, then the authority will need to proceed to

[55] Page to be added to the LAQM Support Website detailing the Estimated Annual Emissions per Household or Hectare of Service Sector Floorspace for typical combustion appliances. These will be updated periodically in line with revisions to the EMEP/CORINAIR Emission Inventory Guidebook and other supporting evidence.

[56] 1 hectare (ha) = 10,000m^2

[57] Emissions from residential or mixed-use residential "energy centres" can also be accounted for, provided the entire heating demand of the facility is taken into account

detailed dispersion modelling and/or monitoring.

Box 7.2 – Combined Biomass Combustion Installations: Example of Calculation for Screening Assessment

Consider a 500m × 500m square (25ha) containing a new 6 hectare development of 400 houses on the outskirts of a large town. The houses are fitted with advanced automatic wood pellet boilers. The new development adjoins an 8 hectare older estate. The older estate has largely converted to gas heating but there remain 50 houses that use conventional boilers burning coal. The 500m × 500m square also contains a school with floor area of 0.2 hectares in a plot of 1 hectare: the school is heated by means of a wood-burning advanced automatic boiler. There is also a public house with floor area of 0.1 hectare in a plot of 0.5 hectare; the public house is heated by open wood fires. The remaining part of the 500m × 500m square does not contain premises burning solid fuels.

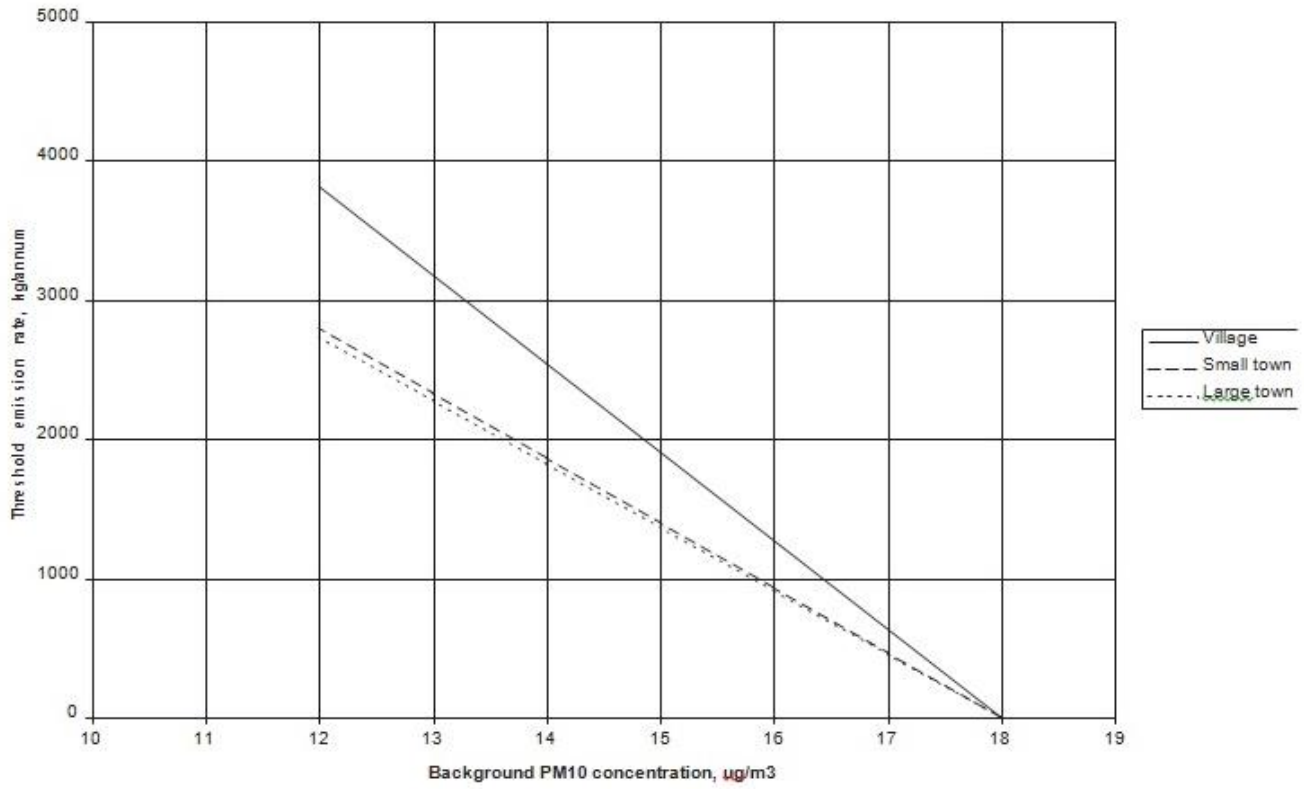
Using the estimates of annual emissions per household or hectare of service sector floorspace provided on the LAQM Support Website[55], the total emissions of PM_{10} from the residential area is (400 × 3.54) + (50 × 23.03) = 1416 + 1152 = 2568 kg. The total emissions of PM_{10} from the school and the public house are (0.2 × 295) + (0.1 × 2,291) = 59 + 229 = 288 kg. The total emissions from all solid fuel sources are then 2,568 + 288 = 2,856 kg.

The area of the 500m × 500m square occupied by solid fuel heated premises is 6+8+1+0.5 = 15.5 hectares. Thus the fraction occupied is 9.5/25 = 0.62. The emissions density is then 2,856/0.62 = 4,606 kg /year.

The background PM_{10} in the area is estimated from the national maps to be 21µg/m^3. From Figure 7.1 the threshold emission density is 5,013 kg/year. In this case, the calculated emissions for the 500m × 500m square are less than the threshold and there is no requirement to carry out further assessment.

Figure 7.1 – Threshold emissions density of emissions from a 500m × 500m area that may produce an exceedance of the daily mean objective for PM_{10}

Figure 7.2 – Threshold emissions density of emissions from a 500m × 500m area that may produce an exceedance of the annual average mean objective for PM_{10} in Scotland



Domestic other solid-fuel combustion

7.51 Previous rounds of Review and Assessment have also identified areas where domestic solid fuel burning gives rise to exceedances of the objective for SO_2. The methodology to screen these sources is provided below:

- Identify areas where significant coal burning takes place. Smokeless fuel has similar sulphur content to coal and so should be treated in the same way. “Significant” is defined as any area of about 500m × 500m with more than 50 houses burning coal/smokeless fuel as their primary source of heating. If necessary use professional judgment to identify such areas, including experience of smoke hanging over the area on a winter’s evening. Further guidance is provided in para 7.292.
- Collect information on the actual use of coal/smokeless fuel in these areas (do not count houses with occasional use of solid fuels);
- If the density of coal burning premises exceeds 100 premises per 500m × 500m area, then the local authority should proceed to a further assessment[47], based on detailed dispersion modelling.

Fugitive or Uncontrolled Sources

7.52 Dust emissions from a range of fugitive and uncontrolled sources can give rise to elevated PM_{10} concentrations. Particular attention needs to be paid to fugitive sources in Scotland, due to the more stringent objective for 24-hour means.

7.53 Dust may arise from:

- onsite activities, such as handling of dusty materials, the cutting of concrete, etc;
- wind-blown dust from stockpiles and dusty surfaces; or
- the passage of vehicles over unpaved ground and along public roads affected by dust and dirt tracked out from dusty sites;

7.54 Details of the methodology to screen fugitive sources of PM_{10} are provided in Table 7.5. The assessment should be carried out if:

- The source has been identified as of potential concern, either from dust complaints (a single, verified complaint may be sufficient to trigger the need for a screening assessment), local knowledge (site inspection) or following an air quality assessment submitted as part of the planning application; and
- There is relevant exposure near the sources of emissions. The distance to consider depends on the local background PM_{10} concentrations, as per Table 7.5, which can be determined from the UK background maps.

Table 7.5 – Screening Assessment of Fugitive or Uncontrolled Sources

Road Source Category	Pollutant of Concern	Objectives of Concern	Criteria	What to Report	Action if Screening Confirms Potential Issue	Notes
Fugitive or Uncontrolled Sources	PM_{10}	Long and Short-Term	In Scotland: exposure within 200m from source of emission - (up to 1km if background PM_{10} > 17µg/m^3)	Sources matching criteria	Carry out monitoring and/or dispersion modelling	If the relevant exposure is within 50m of an off-site road used to access the site and there are visible deposits on the road, then exposure along these sections of road, which may extend up to 1km from the site entrance, should also be considered, as long as the PM_{10} annual mean background concentration is above 11µg/m^3 (in Scotland) or above 25µg/m^3 (rest of the UK)
			Rest of the UK: exposure within 200m of the source of emission (up to 1km if background PM_{10} > 28µg/m^3)			

Background Pollutant Concentrations

7.55 Contribution of emissions from assessed local pollutant sources (such as roads, stacks etc.) should be added to local background concentrations, to determine total pollutant concentrations. In many cases the background contribution will represent a significant or dominant proportion of the total pollutant concentration, and it is thus important that authorities give careful consideration to background levels and how they are estimated for future years.

7.56 Background concentrations are expected to decline in future years as a result of Government and EU policies and legislation to reduce pollutant emissions[58]. In many instances it is strongly recommended that local authorities use the national background maps, which are provided for each 1km × 1km grid square across the UK. These maps are available on the LAQM Support website[59]. However, local authorities in Scotland should use alternative background maps for NO_x, NO_2 and PM_{10} available on the Air Quality in Scotland website[60] as these only use Scottish monitoring data. Where appropriate these data can be supplemented by and compared with local measurements of background, although care should be exercised to ensure that the monitoring site is representative of background air quality.

7.57 For NO_x and $PM_{10,}$ the various source contributions to the estimated background concentration in each 1km × 1km grid square are provided. Therefore, it is possible to remove all sources explicitly modelled. The contributions from emissions inventory sources are provided separately for the sources within or outside the grid square. This is to enable individual sectors to be subtracted from the total if a more detailed local assessment is to be carried out for that sector[61].

Future Year Projections of Background and Roadside Concentrations

7.58 Local authorities may need to estimate background concentrations in specific years, or project forward results from air quality monitoring surveys. A number of different approaches can be used.

7.59 For 1,3-butadiene, benzene, CO and lead local authorities should use the Year Adjustment Calculator spreadsheet available on the LAQM Support website[62].

7.60 For background NO_x, NO_2 and PM_{10}, there is no need to apply adjustment factors, as

[58] Background concentrations of nitrogen dioxide are expected to decline, in the future, despite the recent increasing proportion of primary nitrogen dioxide in nitrogen oxides emissions. This increase in primary nitrogen dioxide has had a greater impact at roadside locations, but even here concentrations of nitrogen dioxide are expected to resume a downward trend

[59] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

[60] http://www.scottishairquality.co.uk/data/mapping?view=data

[61] Note that source contributions for $PM_{2.5}$ are also included in the UK background maps, but not in the Scottish background maps

[62] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#YAF

the UK and Scottish background maps include forecast background concentrations for each year between 2011 and 2030. To adjust monitoring data from background locations, the year adjustment factors appropriate to any 1km ×1km grid square can be simply calculated by comparing the maps for the two years in question.

7.61 However, this approach cannot be used to adjust measured roadside NO_2 concentrations, due to the differing proportions of primary NO_2 emissions assumed in each year. Instead, local authorities should use the appropriate factors as set out in Table 7.6.

7.62 Future year adjustment factors for measured roadside PM_{10} also need a different approach, as set out in Box 7.3.

Table 7.6 – Projecting Measured Annual Mean Roadside NO_2 Concentrations to Future Years

Year	Adjustment Factor to be applied [1]		Example
	HDV Flows ≤ 10%	HDV Flows >10%	
2011	1	1	The measured NO_2 concentration at a roadside site in 2015 is **47.5µg/m^3.** HDV flows on the road are less than 10% of total traffic flows. The projected concentration for 2020 would be: 47.5 × (0.713 / 0.954) = **35.5µg/m^3.** Roadside locations are typically within 1 to 5 metres of the kerbside, but may extend up to 15 metres depending upon the road configuration and traffic flow.
2012	0.988	0.97	
2013	0.977	0.94	
2014	0.965	0.91	
2015	0.954	0.879	
2016	0.906	0.829	
2017	0.857	0.779	
2018	0.809	0.729	
2019	0.761	0.679	
2020	0.713	0.628	
2021	0.691	0.608	
2022	0.67	0.588	
2023	0.648	0.567	
2024	0.627	0.547	
2025	0.605	0.527	
2026	0.599	0.521	
2027	0.592	0.516	
2028	0.586	0.511	
2029	0.579	0.506	
2030	0.572	0.501	

Note that this table may be updated on a regular basis. It is recommended to register for updates with the LAQM Support Helpdesk

[1] These factors are valid for all areas outside London. The current HDV emission projections for NO are expected to decline at a different rate to other vehicle types, i.e. cars and vans. Therefore, factors are provided separately for roads where HDVs contribute less than 10% of the total traffic flow, and roads where HDV flows are over 10% of the total traffic flow.

Box 7.3 – Projecting Measured Annual Mean Roadside PM_{10} Concentrations to Future Years

Annual mean PM_{10} concentrations at roadside locations in future years can be estimated from measured values using the following method. This method is only appropriate for roadside locations and cannot be used at locations where there is a strong influence from fugitive or industrial sources.

Step 1: Identify the total background concentration for the relevant grid square in $\mu g/m^3$, for the measurement year from the national maps.(If the background concentration is more than that measured then project forward using the approach in para 7.60).

Step 2: Subtract the background concentration (Total_PM_{10}) for the appropriate year from the measured concentration to determine the local PM_{10} road concentration in that year.

measured – background = local road concentration

Step 3: For the relevant grid square for the year of monitoring add together concentrations from the following road sources:

- Motorway_in and Motorway_out
- Trunk_A_Rd_in and Trunk_A_Rd_out
- Primary_A_Rd_in and Primary_A_Rd_out
- Minor_Rd_in and Minor_Rd_out
- Brake_Tyre_in and Brake_Tyre_out

motorways + trunk A roads + primary A Roads + minor roads + brake & tyre = background road contribution

Step 4: Repeat step 3 for the future year.

Step 5: Divide the background road contribution in the future year by the background road contribution in the measurement year. The result is the "year adjustment factor".

background road contribution in future year ÷ background road contribution in measurement year = year adjustment factor

Step 6: Multiply the local road concentration (from Step 2) by the adjustment factor (from Step 5) to determine the concentration from local road sources in the future year.

local road measured × adjustment factor = local road concentration in future year

Step 7: Identify the local background concentration in the future year from the national maps published on the LAQM Support website.

Step 8: Add the local road concentration in the future year to the background concentration in that year to determine the total roadside concentration in the future year.

local road concentration + background = Total PM_{10} concentration

Further assistance with this procedure and interpretation of the results can be obtained from the LAQM Support Helpdesk.

Exceedances and Percentiles

7.63 The short-term objectives are framed in terms of the number of occasions in a calendar year on which the objective concentration should not be exceeded. Wherever possible, authorities are encouraged to express the results of their monitoring and modelling in terms of the number of hours, days, etc, above the objective level. This is the clearest basis for strict comparison with the air quality objectives. However, for a

strict comparison on this basis, there should be a minimum of 85% data capture throughout a calendar year[63]. Where the measured data capture is less than 85%, short-term concentrations should be expressed as percentile values approximating the permitted number of exceedances. This should also be the case for dispersion modelling results if the model cannot calculate the number of exceedances or the meteorological dataset used contains less than 85% of valid observations for the year. Relationships between the permitted numbers of exceedances of short-period concentrations and the equivalent percentiles are provided in Table 7.7 below to help express results in relevant terms.

Table 7.7 – Equivalent Percentiles to the Air Quality Objectives

Pollutant	Time Period	Permitted Exceedances	Equivalent Percentile
NO_2	1-hour	18 per year	99.8th percentile
PM_{10}	24-hour	35 per year	90.4th percentile
	24-hour	7 per year	98.1st percentile
SO_2	15-minute	35 per year	99.9th percentile
	1-hour	24 per year	99.7th percentile
	24-hour	3 per year	99.2nd percentile

Fall-off in NO_2 Concentrations with Distance from the Road

7.64 NO_2 concentrations along roads are the focus of attention for many local authorities. However, it is not always possible to measure concentrations at the desired location for a range of practical reasons, for example, continuous monitoring stations require space, security and power, and diffusion tubes should be attached to suitable surfaces.

7.65 Wherever possible, local authorities should ensure that monitoring locations are representative of exposure. However, where this is not possible, the NO_2 concentration at the nearest location relevant for exposure should be estimated, using the NO_2 fall off with distance calculator available on the LAQM Support website[64].

Use of the Design Manual for Roads and Bridges Model

7.66 The Design Manual for Roads and Bridges (DMRB) Air Quality Screening Model is developed by Highways England. The latest version to use and procedures for its use are described on the LAQM Support Helpdesk website[65].

[63] An exceedance of short-term objectives may of course be demonstrated with a much lower data capture rate

[64] http://laqm.defra.gov.uk/tools-monitoring-data/no2-falloff.html

[65] http://laqm.defra.gov.uk/review-and-assessment/tools/modelling.html

7.67 The DMRB model can be used to predict NO_2 and PM_{10} annual mean concentrations.

7.68 Where the DMRB assessment indicates that exceedances of the objectives are likely, more detailed modelling work may then be required. This may include the use of more complex dispersion models, and/or the use of local monitoring. However, where a good agreement between the DMRB model results and monitoring is demonstrated, then this model may be sufficient to determine the area of exceedance of the objective. In circumstances where complex road layouts, such as large junctions or complex street canyons are being assessed, then more detailed modelling is recommended. Further guidance on detailed dispersion modelling of road traffic sources is provided in Section 4 of this chapter (para 7.346).

7.69 Further guidance on modelling for Detailed Assessments is provided in Chapter 6 (see para 6.10).

Relationships between NO_x and NO_2

7.70 NO_x are predominantly emitted into the atmosphere in the form of nitric oxide (NO) which is then converted to nitrogen dioxide (NO_2) through chemical processes in the atmosphere. Under most atmospheric conditions, the dominant pathway for NO_2 formation is via the reaction of NO with ozone (O_3).

7.71 Recent trends in concentrations of NO_x have shown a general downward trend across urban areas, in line with the reductions in emissions from road traffic. However, measured NO_2 concentrations have not declined as expected, particularly at roadside sites, and at some locations have actually increased in recent years.

7.72 A report from the Air Quality Expert Group[66] investigated these unexpected findings, and concluded that the most plausible explanation was an increased proportion of direct (or primary) NO_2 emission from road traffic, often referred to as "f-NO_2"[67]. Increased primary NO_2 emissions are associated with the greater penetration of diesel cars into the vehicle fleet, and the use of catalytically regenerative particle traps on some heavy duty vehicles.

7.73 Defra developed a tool to allow the calculation of NO_2 from NO_x concentrations, taking account of the difference between fresh emissions of NO_x and background NO_x, the concentration of O_3, and the different proportions of primary NO_2 emission in different years.

7.74 This tool (NO_x to NO_2 calculator) is available on the LAQM Support website[68]. This calculator allows the calculation of NO_2 from NO_x and vice versa.

7.75 Other approaches for NO_x to NO_2 conversion may be used, and may be preferred by

[66] AQEG (2007), Trends in primary nitrogen dioxide in the UK. http://uk-air.defra.gov.uk/assets/documents/reports/aqeg/primary-no-trends.pdf

[67] This is the fraction of NO_x emitted as NO_2

[68] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOXNO2calc

the authority depending on the type of dispersion model that is employed. For example, the Generic Reaction Series, or other chemical reaction schemes may be used. In this case, appropriate parameters to describe f-NO_2 and future year O_3 concentrations should be carefully considered and described. However, the "Derwent-Middleton" equation is no longer considered a suitable approach. Where a conversion method is incorporated within a dispersion model, care should be taken to follow the advice given in Box 7.12, which explains that the model should be verified using NO_x and not NO_2.

7.76 The recommended methodology to model NO_2 concentrations from NO_x stack emissions (taking into account background concentrations) are described in Box 7.9. It is consistent with the Environment Agency's recommended methodology and should be used for specific studies investigating stack impacts alone, which are likely to be more related to short-term impacts. However, where stacks are included within models representing wider urban areas with a large number of emissions sources, and where annual mean concentrations are the main focus, the NO_x to NO_2 calculator discussed above may be used for the conversion of total annual mean NO_x to annual average NO_2 concentrations.

Relationship between the Annual Mean and 1-hour NO_2 Objectives

7.77 Predicting exceedances of the NO_2 1-hour objective is not straightforward, as these will be highly variable from year to year, and from site to site. If monitoring is to be relied upon, then this should be carried out for an extended period (preferably a full calendar year) to ensure that the occurrence of occasional peaks is adequately captured. Dispersion models cannot predict short-term concentrations as reliably as annual mean concentrations. Moreover model verification is likely to be challenging.

7.78 Previous research carried out on behalf of Defra and the Devolved Administrations[69] identified that exceedances of the NO_2 1-hour mean are unlikely to occur where the annual mean is below 60µg/m^3. This assumption is still considered valid; therefore local authorities should refer to it if NO_2 1-hour mean monitoring data are not available (typically if monitoring NO_2 using passive diffusion tubes).

Relationship between the Annual Mean and 24-hour Mean PM_{10} Concentrations

7.79 As for NO_2, using a dispersion model to predict exceedances of the PM_{10} short-term (24-hour mean) objective may be challenging. Therefore, to estimate potential exceedances of the PM_{10} 24-hour mean objective, local authorities should use the following relationship, provided in previous Technical Guidance, but still considered adequate:

[69] Laxen D and Marner B (2003). Analysis of the relationship between 1-hour and annual mean nitrogen dioxide at UK roadside and kerbside monitoring sites. Available at http://uk-air.defra.gov.uk/assets/documents/reports/cat06/1hr_NO2_rpt_Final_b.pdf

No. 24-hour mean exceedances = -18.5 + 0.00145 × annual mean^3 + (206/annual mean)

7.80 Important issues regarding the monitoring of PM_{10} concentrations are set out in section 2 of this chapter. It is possible that this relationship will change in the future, Defra and the Devolved Administrations will keep this under review, and will issue revised guidance to local authorities on the LAQM Support website as and when necessary.

Source Apportionment

7.81 As discussed in Chapter 2, carrying out source apportionment to understand the contribution of all sources of emissions to exceedances of the air quality objectives within an AQMA is important to identify priorities whilst prepared an AQAP.

7.82 Source apportionment need not be carried out with absolute precision, but should be detailed enough to allow the authority to identify the predominant sources that contribute the air quality exceedances within its AQMA. An important initial separation, in most cases, will be into:

- **Regional background**, which the authority is unable to influence;
- **Local background**, which the authority should have some influence over;
- **Local sources**, which will add to the background to give rise to the hotspot area of exceedances. These will be the principal sources for the local authority to control within the Action Plan.

7.83 Since the AQAP will mainly propose to influence emissions from local sources, it will also be important to separate these sources into:

- Stationary sources (if relevant) potentially dealing with each source separately;
- Vehicle type potentially split among cars, vans and lorries, taxis and buses and coaches. May be further split by age or according to local or through traffic if these are significant issues;
- Vehicle emissions split between moving and stationary traffic, if congestion is a significant issue;
- Other relevant factors such a road gradients that give rise to excess emissions if these are significant.

7.84 Local authorities should rely on their local knowledge and exercise their judgment to identify significant factors related to local source emissions. They should then take steps to obtain available data that describe these factors and that can be used in the study. For example, the AADT for links in the AQMA split by vehicle type, the age profile of bus fleets or the average queuing time and queue lengths at congested junctions.

7.85 The definition of regional and local background is a straightforward exercise using the national maps, by considering the different sector contributions (see para 7.57).

7.86 The preferred approach to apportionment of local sources is to use dispersion

modelling, using the model to independently predict pollutant concentrations from each source in turn. Once a dispersion model has been set up, this is a relatively straightforward task to undertake. The results may be presented at a number of identified receptor locations, or as concentration isopleths.

7.87 Where a detailed modelling approach is not feasible, source apportionment may be undertaken using a simple spreadsheet approach. For example, where road traffic emissions are the principal concern, the percentage contribution to total NO_x emissions may be calculated using the appropriate emission factors. The level of detail will be dependent upon the road traffic data that are available.

7.88 Local authorities are encouraged to consider an appropriate level of detail within the source apportionment study. For example, it may be appropriate to separately consider buses and HGVs within the assessment, if there is evidence to suggest that one or the other is having a disproportionate effect along a given stretch of road. Once again, this will provide useful evidence to support the proposed measures within the Action Plan. Without such evidence there is a risk that the Action Plan will be disproportionate in addressing emissions.

7.89 Apportionment for NO_2 is not as straightforward, due to the non-linear relationship between the emissions of NO_2 and NO_x. This is additionally complicated by the different proportions of NO_2 in the NO_x emission for different sources, for example, petrol cars or diesel cars. The following advice therefore applies to NO_2 source apportionment:

- **Background contributions:** the national maps will give the total background NO_2 concentration. This should be apportioned to regional and local background using the ratio of the background NO_x concentrations attributable to these two sources, which are also available in the national maps;
- **Local contributions:** the local contribution to NO_2 is the difference between the total (measured or modelled) NO_2 and the total background NO_2. This is then apportioned to the local sources, for example, buses, HGVs, taxis, cars, using the relative contributions of these sources to the local NO_x concentration.

7.90 An example of how to carry out apportionment for NO_2 is set out in Box 7.4.

Box 7.4 – Example of source apportionment for NO_2

The following provides an example of a source apportionment for NO_2 in a hot-spot near to a busy road. The highest annual mean NO_2 concentration [T-NO_2] at a relevant receptor, obtained from a verified model or monitoring is 46µg/m^3.

Step 1: From the national maps of background annual mean concentrations obtain the total background NO_2 for the grid square within which the hot-spot is located [TB-NO_2] = 28µg/m^3 also the total background NO_x [TB-NO_x] = 45µg/m^3 and regional background NO_x [RB-NO_x] = 25µg/m^3. From the total and regional background NO_x derive a local background NO_x:

[LB-NO_x] = [TB-NO_x] – [RB-NO_x] = 20µg/m^3

Step 2: Apportion the total background NO_2 into regional and local using the regional and local NO_x proportions:

- [RB-NO_2] = [TB-NO_2] × ([RB-NO_x] / [TB-NO_x]) = 15.6µg/m^3
- [LB-NO_2] = [TB-NO_2] × ([LB-NO_x] / [TB-NO_x]) = 12.4µg/m^3

Step 3: Calculate the local NO_2 contribution at the worst-case location [L-NO_2] from the total measured minus background:

[L-NO_2] = [T-NO_2] – [TB-NO_2] = 18µg/m^3

Step 4: Apportion the local contributions to total NO_2 concentration using the model concentrations or emission results for NO_x. In this example, it is shown that 44% of the NO_x at the worst-case relevant is from vans and lorries, 22% from buses and 34% from cars.

- NO_2 vans and lorries = 44% × [L-NO_2] = 7.9µg/m^3
- NO_2 buses = 22% × [L-NO_2] = 4.0µg/m^3
- NO_2 cars = 34% × [L-NO_2] = 6.1µg/m^3

The final source apportionment of the worst-case NO_2 46µg/m^3 is thus:

- Regional background = 15.6µg/m^3 (34%)
- Local background = 12.4µg/m^3 (27%)
- Local traffic:
  - vans and lorries = 7.9µg/m^3 (17%)
  - buses = 4.0µg/m^3 (9%)
  - cars = 6.1µg/m^3 (13%)

Calculation of the Required Reduction in Emissions for Action Plans

7.91 As discussed in Chapter 2, local authorities should identify the reduction in pollutant emissions required to attain the objectives within their AQMAs to determine the scale of effort likely to be required.

7.92 In the case of NO_2 alongside roads, the required reduction should be stated as the concentration reduction in µg/m^3, for example, a 5µg/m^3 reduction from 45µg/m^3 to 40µg/m^3. However, the required percentage reductions of local emissions should be expressed in terms of NO_x due to the local road traffic. This is because the primary emission is of NO_x and there is a non-linear relationship between NO_x concentrations and NO_2 concentrations.

7.93 Calculation of the NO_x reduction requires the current 'road NO_x' concentration (road NO_x-current) to be calculated, i.e. the difference between total NO_x (calculated or measured) and local background NO_x. The next step is to calculate the road NO_x

concentration required to give a total NO_2 concentration of 40µg/m^3 (road NO_x-required). This can be done using the $NO_{x\ to}$ NO_2 calculator (see para 7.73), by entering a total NO_2 concentration of 40µg/m^3, along with the local background NO_2 concentration. The ratio of 'road NO_x-required' to 'road NO_x-current' gives the required percentage reduction in local road NO_x emissions to achieve the objective. An example is presented in Box 7.5. Help with these calculations can be obtained from the LAQM Support Helpdesk.

Box 7.5 – Example of Calculated Reduction in Road NO_x Emissions

The following is provided as an example of how to calculate the reduction in road NO_x emission required to meet the 40µg/m^3 annual mean objective for NO_2. The measured or modelled NO_2 at the worst-case relevant exposure location is 45µg/m^3. It is based on the required reduction in the road NO_x concentration at the worst-case relevant exposure location.

Step 1: Use the NO_x to NO_2 calculator (see para 7.73) to obtain the NO_x concentration that equates to the 45µg/m^3 NO_2, which in this example is 99.0µg/m^3.

Step 2: Obtain the local background concentrations of NO_x and NO_2 for the year of interest. For this example these are 39.8 and 28.8µg/m^3 respectively, from the background maps (see para 7.56).

Step 3: Calculate the current "road NO_x" concentration (road NO_x-current), i.e. the difference between total NO_x (calculated or measured) and local background NO_x. In this example road NO_x-current will be 59.2µg/m^3 (99.0 minus 39.8µg/m^3).

Step 4: Calculate the road NO_x concentration required to give a total NO_2 concentration of 40µg/m^3, i.e. the annual mean objective (road NO_x-required). This can be done using the NO_2 from NO_x calculator by entering a total NO_2 concentration of 40µg/m^3 along with the local background NO_2 concentrations. The calculator gives the road NO_x-required concentration which in this example is 44.3µg/m^3.

Step 5: Calculate the road NO_x reduction to go from the road NO_x-current to the road NO_x-required. In this example the road NO_x reduction is 14.9 µg/m^3 (59.2 minus 44.3µg/m^3), which represents a 25.2% reduction in road NO_x (14.9/59.2 as a percentage).

Estimating $PM_{2.5}$ from PM_{10} Measurements

7.94 As a general simplification, $PM_{2.5}$ is regionally influenced and with secondary formation of nitrate and sulphate species prevalent in the overall burden. However, primary emissions from vehicle exhaust and industry arise. PM_{Coarse} (the fraction of PM between 10µm and 2.5µm, i.e. PM_{10} minus $PM_{2.5}$) is more often local in origin and can be attributed to activities such as construction, demolition, waste transfer operations, and tyre wear. Estimation of PM_{10} data from $PM_{2.5}$ data and vice versa should only be used to give an indication of PM fractions where only one of the two metrics is available, or where estimates on modelled $PM_{2.5}$ can be derived from modelled PM_{10}. Local Authorities should clearly indicate where PM concentrations have been estimated based upon the below methods.

7.95 Where there are local sites measuring both PM_{10} and $PM_{2.5}$, then the ratio of $PM_{2.5}/PM_{10}$ can be calculated for this site. At local sites of the same site classification where there are only PM_{10} data, then the annual average $PM_{2.5}$ concentration can be estimated by multiplying the annual average PM_{10} concentration by this locally derived

ratio. Similarly, at local sites of the same site classification where there are only $PM_{2.5}$ data, then the annual average PM_{10} concentration can be estimated by dividing the annual average $PM_{2.5}$ concentration by this locally derived ratio.

7.96 Where no appropriate local sites measuring both PM_{10} and $PM_{2.5}$ are available, then a nationally derived correction ratio of 0.7 can be used. This factor was calculated as the average of all ratios of $PM_{2.5}/PM_{10}$ found for years 2010 to 2014 for forty sites within the AURN where both PM_{10} and $PM_{2.5}$ are measured on an hourly basis. Further information on the derivation of this factor is provided in Annex B.

7.97 Local authorities may find it useful to use available funding on $PM_{2.5}$ monitoring (where required) to use the information gathered to appraise the compliance with PM_{10} short-term objectives. For example, if the 24-hour mean $PM_{2.5}$ concentration exceeds 35 $\mu g/m^3$ on more than 7 occurrences a year (Scotland) or 35 occurrences a year (Rest of the UK), then the Local Authority should consider installing a PM_{10} analyser in that location.

2 – Air Quality Monitoring

Air Quality Monitoring Strategy for Review and Assessment

7.98 Most local authorities progressively adapted their monitoring strategy in accordance to the air quality issues specific to their administrative area. Over the years, many local authorities have relocated kerbside monitoring sites to roadside or other sites relevant of public exposure. Monitoring networks have also been progressively extended to identify all potential hot spots, whilst a number of sites have been moved elsewhere or closed in areas where data showed continued compliance.

7.99 Therefore, it is likely that the existing monitoring network for most local authorities is now adapted to respond to the requirements of the LAQM system. As a result, it is not expected that local authorities need extensive guidance in relation to air quality monitoring strategies, such as how to determine the best location, the number of monitoring sites required, etc. Therefore, only a brief summary of key aspects is provided below as a useful reminder:

- Local monitoring campaigns should be planned with due regard to the air quality objectives of concern and monitoring equipment installed at locations relevant for public exposure. This is to ensure that the data are fit for purpose, and results do not need to be corrected (such as adjustments to account for the distance to the nearest sensitive receptors);
- The monitoring programme should be designed to assist the authority in defining the geographical extent of any exceedances;
- Locations should be selected bearing in mind that results are likely to be used to help demonstrate the performance of dispersion. Therefore, care should be taken to ensure that the monitoring site is sufficiently close to the dominant pollution source (i.e. in the vast majority of cases, at roadside sites);
- Screening assessments should provide useful information on the likely locations where the air quality objective for the pollutant of concern may be exceeded. This information can be used to select a monitoring site for detailed studies using automatic monitors;
- Monitoring should also be undertaken at a number of background sites to obtain a representative background concentration for the area, supplementing the information provided by the national background maps (see para 7.56). Urban background monitoring is valuable in determining long-term trends, as such sites are less likely to be affected by variations in local sources, for example, changes in traffic on a particular road;
- To validate NO_2 diffusion tube data (bias adjustment), additional tubes should be exposed in triplicate at a suitable nearby automatic monitoring station, using the same monthly exposure periods as the other sites; and
- Monitoring results, provided that they comply with QA/QC procedures and are located at suitable locations relevant of worst-case public exposure, should take precedence over modelling results. Therefore, if monitoring data do not indicate a likely exceedance of an air quality objective, there should be no need to declare an AQMA.

7.100 As a general rule, before embarking on a monitoring programme, it is important to have a clear understanding of what monitoring will achieve, and how it will aid the Review and Assessment process. Box 7.6 lists some of the basic points to consider.

7.101 It is important that the financial and other implications of embarking on a monitoring programme are fully understood before any action is taken. Local authorities are advised to seek assistance from the LAQM Support Helpdesk if they are uncertain about the best way to proceed.

Box 7.6 – Basic Considerations Before Proceeding with Air Quality Monitoring

The following points should be considered to determine a suitable air quality monitoring strategy:

- Which pollutants need to be monitored?
- What monitoring methods are appropriate?
- What monitoring equipment is needed?
- How much will it cost - to purchase and to operate?
- How long to monitor for?
- Where to monitor?
- How many monitoring sites are needed?
- What data quality is required?
- How to process and evaluate the data?

Introduction to Monitoring

7.102 For local authorities, the majority of monitoring undertaken will focus on NO_2 and particulate matter (PM_{10} and $PM_{2.5}$) as the concentrations of other pollutants have generally fallen below levels at which they are considered harmful. Monitoring of other pollutants are likely to only be required if there is a source for which an assessment may show a potential risk to compliance. One exception is where there is a national network monitor within the boundary of the local authority. In this case, then ratified data and statistics should be taken directly from the appropriate website (e.g. the UK-Air website[70]). It is important to note that the data on the national websites are verified several months after the end of the calendar year, and as such the data available may be provisional and subject to further ratification. Local authorities should aim to use verified data, and specify in LAQM statutory reports whether verified or provisional data have been used.

7.103 For NO_2, SO_2 and CO, a series of reference method instruments have been approved for use by Defra and the Devolved Administrations. For NO_2, it is also permissible to use diffusion tubes. Instruments that employ alternative technologies such as electrochemical sensors, DOAS and cavity ringdown spectroscopy are not currently approved for NO_2, SO_2 or CO, as they have not yet been tested, though they may be suitable as supplementary monitoring to help local authorities Review and Assess air

[70] uk-air.defra.gov.uk/

quality, or for local campaigns. Should alternative instruments be approved in the future, then this information will be disseminated to local authorities.

7.104 For PM_{10} and $PM_{2.5}$, a large number of different technologies have been approved by Defra and the Devolved Administrations.

7.105 For Lead, Defra and the Devolved Administrations have approved the use of a method that employs the subsequent analysis of sampled filters.

7.106 For Benzene and 1,3 Butadiene, Defra and the Devolved Administrations have approved the use of chromatography based methods. A DOAS method has also been approved through the MCERTS certification scheme.

7.107 In order to make the best use of the measured air quality monitoring data for dispersion modelling or source apportionment analysis, it is often useful to install meteorological sensors at the monitoring station.

7.108 This Section discusses general siting requirements of the instruments used to monitor air pollution. The available instruments and reporting requirements are then discussed for each pollutant in turn.

7.109 Ideally, monitoring should be for a full calendar year. However, annualisation techniques can be used in order to estimate an annual average from a part year average. These are described in the following sections. Should monitoring be required for such as construction or demolition, then it is recommended that monitoring shall be undertaken for at least 3 month prior to site activity in order to ascertain background levels. It is also necessary to monitor throughout the construction or demolition phases of the work.

Site Classifications

7.110 The 2008 Air Quality Directive redefined site classifications. There are many possible permutations of site classifications allowed, but the UK uses just six of these to describe the National Network. These are summarised in Table 7.8. Local authorities are encouraged to use the revised classifications for future reporting. It is stressed that no sites should be moved as a part of the reclassification, rather, the term used to define the site should be changed.

Table 7.8 – Air Quality Monitoring Site Classification

New Classification	Old Classification	Description
Urban Traffic	Roadside or Kerbside	Sites in an urban area at least 25 metres from the edge of major junctions and no more than 10 metres from the kerbside. It is important to state the distance from the roadside when submitting LAQM reports.
Urban Background	Urban Background or Urban Centre	Sites in an urban area away from major roads that are representative of exposure of the general population. Urban background sites should not be dominated by single sources and should be representative of a wide area.
Suburban Background	Suburban	Sites in a suburban area away from major roads that are representative of exposure of the general population. A suburban area is defined as a location type situated in a residential area on the outskirts of a town or city. Suburban background sites should not be dominated by single sources and should be representative of a wide area.
Rural Background	Rural	Sites in a rural area away from roads that are representative of exposure of the general population. Rural background sites should not be influenced by agglomerations or industrial sources and should be representative of a wide area
Urban Industrial	Industrial	Site in an urban residential area downwind of specific industrial source.
Suburban Industrial	Industrial	Site in a suburban area downwind of specific industrial source. A suburban area is defined as a location type situated in a residential area on the outskirts of a town or city.

7.111 Diffusion tubes can be installed in many locations, and this is discussed in more detail in the NO_2 diffusion tube section below.

Installing New Continuous Monitoring Sites

7.112 Continuous monitoring stations require a permanent power supply, and dependent upon the equipment installed, often require air conditioned enclosures. The power supply must be of sufficient rating to support the equipment to be installed. In some cases such as roadside monitoring it is possible to arrange to draw power from a nearby facility (such as street lighting) without having to install significant lengths of underground or over-ground cables. However, not all such installations offer an uninterrupted power supply.

7.113 Sites should be located in one of the six classifications provided in Table 7.8. The site selection process should take into account the spatial distribution and variability of gaseous pollutants. It is often not possible to find one site which is ideal for all pollutants: for example, concentrations of traffic pollutants such as NO_2 are highest at

roadside locations, whereas SO_2 concentrations may be highest at urban background or rural locations as a result of emissions from a point source. In such circumstances, some degree of compromise may be required, or it may be necessary to set up separate sites for the different pollutants. Urban background monitoring is useful if there is a need to monitor long-term trends in pollutant concentration or population exposure. Urban background monitoring sites are less likely than traffic sites to be affected by very local factors, for example changes in traffic on a particular road.

7.114 It is necessary to consider certain micro-scale siting requirements:

- Sites should be in as open a setting as possible in relation to surrounding buildings. Immediately above should be open to the sky, with no overhanging trees, structures or buildings. The flow around the inlet sampling probe shall be unrestricted without any obstructions affecting the airflow in the vicinity of the sampler (normally some metres away from buildings, balconies, trees and other obstacles and at least 0.5m from the nearest building in the case of sampling points representing air quality at the building line);
- In general, the inlet sampling point shall be between 1.5m (the breathing zone) and 4m above the ground. For security reasons, the inlet should be greater than 2m, though it is recognised that lower sampling heights better reflect the ambient conditions encountered by members of the public;
- The inlet probe shall not be positioned in the immediate vicinity of sources in order to avoid the direct intake of emissions unmixed with ambient air;
- The sampler's exhaust outlet shall be positioned so that recirculation of exhaust air to the sampler inlet is avoided;
- The site should not be close to local or point emissions sources, unless these have been specifically targeted for investigation. For industrial sites, where specific sources are being targeted, monitoring should be carried out at the point of maximum impact as determined by modelling;
- For urban or suburban background sites there should be no major sources of pollution (for example a large multi-storey car park) within 50m. There should be no medium sized emission sources (for example, petrol stations, or ventilation outlets to catering establishments) within 20m.

7.115 Regular review of site suitability is necessary as the micro-scale environment can change quickly. It is important to note that vegetation needs cutting back occasionally.

7.116 Other important considerations are:

- Interfering sources;
- Security;
- Access;
- Availability of electrical power and telephone communications;
- Visibility of the site in relation to its surroundings;
- Safety of the public and operators. Examples include: Sloping roofs, ladder restraints, fencing around roof, direction in which door through fencing opens,

safety of steps and handrails;

- The desirability of co-locating sampling points for different pollutants;
- Planning requirements.

7.117 Generally, there is a large amount of time involved in the coordination of the planning authorities, the highways agency, traffic management services, instrument suppliers, enclosure suppliers, delivery companies, air conditioning engineers, electricity suppliers, site electricians, the company that builds the plinth and the telecommunications suppliers. As such, local authorities are advised to procure the services of the equipment supplier or a consultancy company in order to assist in the process.

7.118 It is generally advised that all data are collected, stored and analysed in GMT irrespective of the season. However this means that anyone carrying out analysis of the data needs to be aware that, for example, the rush hour peak, are an hour out in the summer. Also, when investigating or plotting diurnal patterns over a full year, the BST/GMT correction needs to be made otherwise the diurnal patterns will be incorrect. When both reporting data and using data from other sources, it is imperative to make it clear whether the date and time stamp assigned to the data corresponds to the beginning or the end of the monitoring period.

Identifying Erroneous Data

7.119 Different instruments require data to be processed in different ways. This is discussed in the individual sections on each pollutant later. However, in all cases, the local authority should identify and delete erroneous data, and there are various common themes irrespective of pollutant or instrument.

- *Instrument history and characteristics:* Has the equipment malfunctioned in this way before?
- *Calibration factors and drift:* Rapid or excessive response drift can make data questionable.
- Negative or out of-range data: Are the data correctly scaled?
- *Rapid excursions or "spikes":* Are such sudden changes in pollution concentrations likely?
- *Characteristics of the monitoring site:* Is the station near a local pollution sink or source which could give rise to these results?
- *Effects of meteorology:* Are such measurements likely under these weather conditions?
- *Time of day and year:* Are such readings likely at this time of day/week/year?
- *The relationship between different pollutants:* Some pollutant concentrations may rise and fall together (for example, from the same source). For example, CO, NO_x and PM_{10} are all vehicle derived pollutants.
- *Results from other sites in the network:* These may indicate whether observations made at a particular site are exceptional or questionable. Data from national network or other sites in the area can be compared for a given period to determine

if measurements from a particular station are consistent with general pollution concentrations. If any high concentrations are identified (seen as spikes) at the local site, further examination is required.

- *QA Audit and Service reports:* These will highlight any instrumental problems and determine if any correction of the data is necessary for long-term drift etc.

7.120 Defra and the Devolved Administrations have approved a number of different monitoring technologies to be equivalent to the reference method. In some cases the data have to be corrected before they can be used. A summary of technologies approved to date is as follows. As more instruments are approved, they will be listed under the '*Deemed equivalent by Defra'* column in the UK Air website[71].

7.121 Instruments are available which pass air through a filter which is weighed before and after sampling. The concentration of PM_{10} or $PM_{2.5}$ can then be calculated as the increase in mass of the filter divided by the volume of the sample expressed to ambient conditions. It is recommended that local authorities use Emfab filters for PM_{10} or $PM_{2.5}$ measurements. If the filters are required for subsequent analysis for component pollutants, then other filter materials may be more suitable. Due to the very tight controls that should be applied to the filter weighing procedures, local authorities are advised to use an independent filter weighing service. The service should be UKAS accredited to CEN standard EN12341.

7.122 The reference method (CEN Standard EN12341:2014) can by definition be used without the need for correction for slope and/or intercept. Several manufacturers make versions of the reference method. It is recommended that local authorities use an instrument that automatically changes filters.

7.123 The PM_{10} Partisol 2025 and $PM_{2.5}$ Partisol 2025 have both been declared equivalent to the reference method. Local authorities can use these without the need for correction for slope and/or intercept.

Tapered Element Oscillating Microbalances (TEOMs)

7.124 TEOMs collect particles on a small oscillating filter. The change in oscillation frequency of the filter is proportional to the change in PM_{10} and $PM_{2.5}$ concentrations. TEOMs are operated at 50°C and as such lose volatile components of the PM_{10} and $PM_{2.5}$.

7.125 The PM_{10} TEOM1400AB can be used by local authorities after correction by the volatile correction model. This method adds the 1.87 times the volatile fraction as measured by remote FDMSs (see below) to the TEOM data in order to correct for the underestimation of PM concentrations by the TEOM. Tools to process TEOM data are available at the Volatile Correction Model website[72];

[71] uk-air.defra.gov.uk/networks/monitoring-methods?view=mcerts-scheme

[72] www.volatile-correction-model.info

7.126 The $PM_{2.5}$ TEOM1400AB, PM_{10} TEOM1405 and $PM_{2.5}$ TEOM1405 have not been tested for equivalence and should not be used by local authorities.

TEOM - Filter Dynamics Measurement System (TEOM-FDMS)

7.127 The Tapered Element Oscillating Microbalance Filter Dynamics Measurement system (TEOM-FDMS) is a modification of the TEOM. The instrument operates at 30 °C rather than 50°C; removes water from the sample stream with a nafion drier; and alternates between taking ambient air samples and blank samples on a 6 minute frequency.

7.128 The PM_{10} FDMS 8500, $PM_{2.5}$ FDMS 8500, PM_{10} FDMS 1405F, $PM_{2.5}$ FDMS 1405F and the FDMS1405DF (which measures both PM_{10} and $PM_{2.5}$ at the same time) have all been declared equivalent to the reference method. Local authorities can use any of these FDMS variants without the need for correction for slope and/or intercept.

Beta Attenuation Monitors (BAMs)

7.129 Beta Attenuation Monitors (BAMs) pass air through a filter material and monitor the increase in mass by the attenuation of beta radiation. BAM instruments are made by multiple manufacturers.

7.130 The Met One PM_{10} Smart Heated BAM 1020 can be used by local authorities after correction for slope by dividing the data by 1.035;

7.131 The Met One $PM_{2.5}$ Smart Heated BAM 1020 can be used by local authorities without the need for correction for slope and/or intercept;

7.132 The Met One PM_{10} Unheated BAM 1020 can be used by local authorities after correction for slope by dividing the data by 1.2. Rather than dividing by 1.2, data on UK Air are multiplied by 0.833. Both methods are permissible. The instrument should be set up to report the data to US standard conditions (25°C, 1 atmosphere) in order to mimic the set-up of the instrument during the original equivalence tests;

7.133 The Met One $PM_{2.5}$ Unheated BAM 1020 has not been tested for equivalence and should not be used by local authorities;

7.134 FAI produce many variants of their SWAM BAM instrument (PM_{10} SWAM 5a 24 Hour, $PM_{2.5}$ SWAM 5a 24 Hour, SWAM 5a DC 24 Hour (which measures both PM_{10} and $PM_{2.5}$ at the same time), SWAM 5a DC Hourly (which measures both PM_{10} and $PM_{2.5}$ at the same time)). All of these have been declared equivalent to the reference method. Local authorities can use any of these BAM variants without the need for correction for slope and/or intercept. The instruments should be operated with GF10 glass fibre filters;

7.135 The PM_{10} Opsis SM200 should be operated with stretched Teflon membrane filters that are provided by the manufacturer. When used to calculate concentrations using Beta radiation, local authorities can use the PM_{10} Opsis SM200 without the need for correction for slope and/or intercept. However, if the filters are to be weighed before and after sampling, then local authorities should correct for slope and intercept by first

subtracting 1.286, then dividing by 0.819;

7.136 The $PM_{2.5}$ Opsis SM200 has not been tested for equivalence and should not be used by local authorities.

Light-Scattering Monitors

7.137 A light-scattering monitor measures pulses from light scattered in a particular direction and outputs a signal determined by the size and the concentration of airborne particles in the sample stream. The PM_{10} and $PM_{2.5}$ are calculated by conversion of particle numbers measured per unit time into mass per unit volume using dedicated multi-regression analysis or with pre-set particle densities.

7.138 The Palas Fidas 200 measures both PM_{10} and $PM_{2.5}$ at the same time. The instrument is currently going through the UK certification process. Should it be approved, the information (including any required correction factors), will be disseminated via the UK-Air website[73].

7.139 Many other optical instruments are available, and have been certified using the Environment Agency's Indicative instrument certification scheme[74]. These instruments are not suitable for measuring the annual PM_{10} or $PM_{2.5}$ or the number of exceedances as they are not accurate enough to meet the expanded uncertainty requirements of equivalent instruments. These instruments are however useful for identifying short-term pollution events at construction, demolition or waste transfer sites[75] and are suitable for short, local campaigns.

Other Instruments

7.140 In addition, a number of instruments exist that have not been approved by Defra, but have approval in other European countries, namely the: Sharp 5030i; Sharp 5014i; Sharp 5030, Grimm EDM180; $PM_{2.5}$ Opsis SM200 and the APDA-371 BAM. If local authorities operate any of these instruments, then they should contact the LAQM Support Helpdesk for advice on how best to process the data that they produce.

General Considerations

7.141 Regardless of the instrument used:

- Local authority personnel should attend the site at frequent intervals and follow procedures as set out by the manufacturers in the instrument operating manuals.

[73] uk-air.defra.gov.uk/networks/monitoring-methods?view=mcerts-scheme

[74] www.csagroupuk.org/wp-content/uploads/2015/08/MCERTSCertifiedProductsIndicativeCAMS.pdf

[75] www.iaqm.co.uk/wp-content/uploads/guidance/monitoring_construction_sites_2012.pdf

While the procedures differ by instrument, common procedures include: changing filters; cleaning the inlet; leak checks; flow checks and zero checks.

- Instruments should be periodically checked by an independent organisation accredited to perform QA/QC checks to ISO17025:2005. Ideally this should be performed every six months.
- Instruments should be periodically serviced by the manufacturer or an approved service unit. Ideally this should be performed every six months and within three weeks of the independent QA/QC audit. Maintenance schedules for the replacement of consumable parts, diagnostic checks and equipment overhaul should in all cases follow manufacturer's recommendations. Routine and non-routine service visits should be fully documented to describe in detail any adjustments, modification or repairs undertaken.

7.142 All erroneous data should be disregarded before any averaging or data interpretation is undertaken. The approved instruments produce a data record every 15 minutes, 1 hour or 24 hours. In order to calculate the 24 hour average data:

- Where data are produced on a 15 minute basis, it is required to calculate the 24 hour average data by averaging 96 records. The 24 hour average will only be valid if there was at least 75% data capture, i.e. 72 valid 15 minute averages.
- Where data are produced on a 1 hour basis, it is required to calculate the 24 hour average data by averaging 24 records. The 24 hour average will only be valid if there was at least 75% data capture, i.e. 18 valid 1 hour averages.
- Where data are produced on a 24 hour basis, there is no requirement to average the data further.

7.143 PM_{10} and $PM_{2.5}$ data capture can be calculated as the number of valid 24 hour averages divided by the number of days in the year, and this is expressed as a percentage by multiplying by 100. For example, if there were 300 valid days of PM_{10} data in a non-leap year, then the data capture is (100 × 300) / 365, which is 82.2%.

7.144 For both PM_{10} and $PM_{2.5}$, the annual average can be calculated by averaging all of the valid 24 hour average data for the calendar year.

7.145 For PM_{10} it is required to report the number of days where there was greater than 50µg/m^3 over a calendar year. With the exception of Scotland, there are allowed to be no more than 35 exceedances per calendar year. The number of exceedances should only be reported where data capture is more than 85% of a full year. If data capture is less than 85% or monitoring is for less than a full year, then local authorities should instead report the 90.4th percentile for 24 hour PM_{10}. For example, if the available 24 hour average data are in Column A in an Excel spreadsheet, then the Excel formula would be =PERCENTILE(A:A,0.904). If the 90.4th percentile is greater than 50µg/m^3, then this means that if there had been 100% data capture, then there have been greater than 35 exceedances of 50µg/m^3 per calendar year.

7.146 In Scotland, there are allowed to be no more than 7 exceedances per calendar year. If data capture is less than 85% or monitoring is for less than a full year, then Scottish local authorities should instead report the 98.1st percentile for 24 hour PM_{10}.

7.147 In Scotland, the annual PM_{10} average should be below 18µg/m^3, and for the rest of the UK, the annual PM_{10} average should be below 40µg/m^3. If the data capture was below 75%, then it is necessary to annualise the data as per the example in Box 7.7. The reason for annualisation is that the concentration varies throughout the year, and the instrument may have been operational for a period of above or below average concentrations.

7.148 In Scotland, the annual $PM_{2.5}$ average should be below 10µg/m^3. Although there is no objective for the $PM_{2.5}$ annual mean for the rest of the UK, it should be calculated and reported. If the data capture is below 75%, then it is necessary to annualise the data as per the example in Box 7.6.

Box 7.7 – Example: Annualising Continuous Monitoring Data

It has only been possible to carry out a monitoring survey at site for six months between July and December 2015. The measured mean concentration **M** for this period is 30.2µg/m^3. How can this be used to estimate the annual mean for this location?

- Identify two to four nearby, long-term, continuous monitoring sites, ideally those forming part of the national network. The data capture for each of these sites should ideally be at least 85%. These sites should be background (Urban Background, Suburban Background or Rural Background) sites to avoid any very local effects that may occur at Traffic (formerly known as Roadside/Kerbside) sites, and should, wherever possible lie within a radius of about 50 miles. If no background sites are available, and the site to be annualised is itself a traffic site, then it is permissible to annualise using traffic sites rather than background sites, though this should be clearly stated in the annual report.
- Obtain the annual means, $\mathbf{A_m}$, for the calendar year for these sites.
- Work out the period means, $\mathbf{P_m}$, for the period of interest, in this case July to December 2015.
- Calculate the ratio, **R**, of the annual mean to the period mean ($\mathbf{A_m/P_m}$) for each of the sites.
- Calculate the average of these ratios, $\mathbf{R_a}$. This is then the annualisation factor.
- Multiply the measured period mean concentration **M** by this annualisation factor $\mathbf{R_a}$ to give the estimate of the annual mean for 2015.

For this example the best estimate of the annual mean for site S in 2015 will be **$\mathbf{M \times R_a = 30.2 \times 0.944 =$ 28.5µg/m^3.**

Background Site	Annual mean 2015 (A_m)	Period Mean 2015 (P_m)	Ratio (A_m/P_m)
A	28.6	29.7	0.963
B	22.0	22.8	0.965
C	26.9	28.9	0.931
D	23.7	25.9	0.915
Average (R_a)			**0.944**

If the short-term period covers, for instance, February to June 2016, and the work is being carried out in August 2016, then an annual mean for 2016 will not be available. The calculation can then be carried out using the ratio to the 2015 annual mean, but the result is then an estimate of the 2015 annual mean at the short-term site.

NO_x and NO_2 Monitoring

NO_2, NO and NO_x by Chemiluminescence

7.149 The reference method for NO_2 monitoring is chemiluminescence. A number of instruments have been approved under the MCERTS scheme[76].

7.150 This technique alternates between two modes:

- Measuring NO by reacting NO with ozone which forms a photon of light which is measured and is proportional to the NO mixing ratio in parts per billion by volume (ppbV);
- Catalysing the NO_2 in the air over a molybdenum convertor which converts the NO_2 to NO. The air is then reacted with ozone. This gives the mixing ratios of both NO and NO_2 together, which is known as oxides of nitrogen (NO_x).

7.151 NO_2 is then calculated as NO_x minus NO. All are given in mixing ratios of ppbV, and it is necessary to convert them to concentrations in $\mu g/m^3$ (see para 7.155).

7.152 Ideally, local authority personnel should attend the site every two weeks for sites in traffic locations, and every four weeks for sites at other locations. At this time, the filter should be changed and the instrument's calibration should be checked. This is done by introducing nominally 450 ppbV NO in nitrogen to the system and then noting the values of NO_2, NO and NO_x from the front panel of the instrument after the readings have stabilised. 450 ppbV is chosen as this is 90% of the 500 ppbV full span of the instrument. The zero of the instrument is then checked by passing synthetic air or ambient air that has been purified. Again, the values of NO_2, NO and NO_x are noted from the front panel of the instrument. If one is available, then additionally, the process may be repeated with a 450 ppbV cylinder of NO_2 in synthetic air. This is used to check the efficiency of the molybdenum convertor, and the results are not used to calibrate the data. The 450 ppbV NO in nitrogen cylinder should be traceable to a national or international reference cylinder so that the concentration is accurately known.

7.153 Instruments should be periodically checked by an independent organisation accredited to perform QA/QC checks to ISO17025:2005. Ideally this should be performed every six months. It is important that the QA/QC process checks the calibration using both NO in nitrogen and NO_2 in synthetic air.

7.154 Instruments should be periodically serviced by the manufacturer or an approved service unit. Ideally this should be performed every six months and within three weeks of the independent QA/QC audit. It is expected that the response of the instrument to NO in nitrogen will increase following the service as the optical components within the instrument are cleaned. Maintenance schedules for the replacement of consumable parts, diagnostic checks and equipment overhaul should in all cases follow manufacturer's recommendations. Routine and non-routine service visits should be fully documented to describe in detail any adjustments, modification or repairs undertaken.

[76] www.csagroupuk.org/wp-content/uploads/2015/05/MCERTSCertifiedProductsCAMS.pdf

7.155 In order to correct for the drift in instrument calibration and then to convert from ppbV to µg/m^3, it is necessary to follow the below procedure:

- Erroneous calibrations should be identified by observing the trend in the ppbV readings of NO_x and NO from the front of the instrument when the nominally 450 ppbV NO in nitrogen and zero gases were introduced. Readings which do not follow anticipated trends should be ignored;
- For each day that the calibration was checked on the instrument, the NO zero is taken to be the ppbV mixing ratio of NO that was displayed on the front of the instrument when the zero gas was introduced. It is possible for the NO zero to be incorrect, and instead the correct zero may be identified by observing trends in the lowest concentration of the ambient NO data;
- For each day that the calibration was checked on the instrument, the NO span is taken to be the ppbV mixing ratio of NO that was displayed on the front of the instrument when the 450 ppbV NO in nitrogen gas was introduced;
- For each day that the calibration was checked on the instrument, the NO range is calculated as NO span minus NO zero;
- For each day that the calibration was checked on the instrument, the NO calibration factor is calculated by taking the exact known NO ppbV mixing ratio of the NO in nitrogen cylinder and dividing this by the NO range;
- For each day that the calibration was checked on the instrument, the NO_x zero is taken to be the ppbV mixing ratio of NO_x that was displayed on the front of the instrument when the zero gas was introduced. It is possible for the NO_x zero to be incorrect, and instead the correct zero may be identified by observing trends in the lowest concentration of the ambient NO_x data;
- For each day that the calibration was checked on the instrument, the NO_x span is taken to be the ppbV mixing ratio of NO_x that was displayed on the front of the instrument when the 450 ppbV NO in nitrogen gas was introduced;
- For each day that the calibration was checked on the instrument, the NO_x range is calculated as NO_x span minus NO_x zero;
- For each day that the calibration was checked on the instrument, the NO_x calibration factor is calculated by taking the exact known NO_x ppbV mixing ratio of the NO in nitrogen cylinder and dividing this by the NO_x range;
- The NO calibration factor, NO_x calibration factor, NO zero and NO_x zero should be defined for every 15 minute monitoring period that monitoring was undertaken. It is important that a step change in calibration factors is accounted for whenever the instrument was serviced or repaired. It is considered sufficient to take the NO calibration factor, NO_x calibration factor, NO zero and NO_x zero to be the same for every record following each calibration check prior to the following calibration check. It is however more accurate to linearly interpolate the NO calibration factor, NO_x calibration factor, NO zero and NO_x zero between calibration checks;
- The 15 minute NO ppbV readings from the instrument are zero corrected by subtracting the NO zero assigned to that 15 minute record;
- The 15 minute zero corrected NO ppbV readings are span corrected by multiplying by the NO calibration factor assigned to that 15 minute record;

- The 15 minute NO_x ppbV readings from the instrument are zero corrected by subtracting the NO_x zero assigned to that 15 minute record;
- The 15 minute zero corrected NO_x ppbV readings are span corrected by multiplying by the NO_x calibration factor assigned to that 15 minute record;
- The 15 minute NO_2 ppbV mixing ratio is calculated by subtracting the zero and span corrected NO mixing ratio from the zero and span corrected NO_x mixing ratio;
- NO_2 ppbV is converted to µg/m^3 by multiplying by 1.91;
- NO ppbV is converted to µg/m^3 by multiplying by 1.25;
- NO_x ppbV is converted to µg/m^3 by multiplying by 1.91. This is because NO_x is expressed as if all of the molecules were NO_2, and is commonly referred to as "NO_x as NO_2".

7.156 All erroneous data should be disregarded before any averaging or data interpretation is undertaken. Chemiluminescent monitors produce a data record every 15 minutes, whereas the objectives for NO_2 relate to hourly and annual µg/m^3 averages. In order to calculate the 1 hour average data, four 15 minute µg/m^3 records are averaged. The 1 hour average will only be valid if there was at least 75% data capture, i.e. 3 valid 15 minute averages. The annual average is calculated as the average of all valid 1 hour averages in the year.

7.157 1 hour data capture can be calculated as the number of valid 1 hour averages divided by the number of hours in the year, and this is expressed as a percentage by multiplying by 100. For example, if there were 8560 valid 1 hour averages of NO_2 data in a non-leap year, then the data capture is (100 × 8560) / 8760, which is 97.7%.

7.158 It is required to report the number of hours where there was greater than 200µg/m^3 over a calendar year. There are allowed to be no more than 18 exceedances per calendar year. The number of exceedances should only be reported where data capture is more than 85% of a full year. If data capture is less than 85% or monitoring is for less than a full year, then local authorities should instead report the 99.8th percentile for 1 hour NO_2. For example, if the available 1 hour average data are in Column A in an Excel spreadsheet, then the Excel formula would be =PERCENTILE(A:A,0.998). If the 99.8th percentile is greater than 200µg/m^3, then this means that if there had been 100% data capture, then there have been greater than 18 exceedances of 200µg/m^3 per calendar year.

7.159 The annual NO_2 average should be below 40µg/m^3. If the data capture was below 75%, then it is necessary to annualise the data as per the example in Box 7.6. The reason for annualisation is that the concentration varies throughout the year, and the instrument may have been operational for a period of above or below average concentrations.

NO_2 by Diffusion Tubes

7.160 Diffusion tubes take samples over an approximately 1 month period. As such they are useful for assessing the annual objective of 40µg/m^3, but cannot be used to assess the number of hours greater than 200µg/m^3. As they are not the reference method,

and passive diffusion typically results in a low accuracy, it is necessary to bias correct the results based upon local or national collocation studies with chemiluminescent analysers. It is also necessary to calculate the data capture, and if this is less than 75%, the results should be annualised.

7.161 Diffusion tubes are inexpensive and many can be installed over a geographical area. The low cost per tube permits sampling at a number of points in the area of interest; which is useful in highlighting "hotspots" of high concentrations, such as alongside major roads. They are less useful for monitoring around point sources or near to industrial locations where greater temporal resolution is required for particular objectives. They are useful both for annual monitoring as well as short term monitoring projects. They can be placed in many different locations, though are typically placed on building facades in heavily trafficked areas, and in urban background locations. Unlike for sites used for continuous monitoring, it is common for tubes to be placed within 25m of the junction or greater than 10m from the roadside. If there are any continuous NO_2 chemiluminescent monitors within the local authority area, then three diffusion tubes should be collocated within 1m of the chemiluminescent sampler's inlet.

7.162 The site should be open to the sky, with no overhanging vegetation or buildings. It is important to place diffusion tubes where there is free circulation of air around the tube, but the opposite extreme should also be avoided, i.e. areas of higher than usual turbulence. For this reason, the tube should not be located on the corner of a building. Care should be taken to avoid any very localised sources, sinks of NO_2, or disturbances to the airflow. For example, tubes should be mounted greater than 10m from the following:

- heater flues (particularly low level balanced flues);
- bushes or trees overhanging or surrounding the tube location;
- air conditioning outlets;
- extractor vents; or
- underground ventilation shafts.

7.163 Many different types of diffusion tube are available. These differ in three ways:

- the analytical laboratory;
- whether the solvent used to prepare them was water or acetone, and
- the percentage of Triethanolamine (TEA) used in the preparation of the tubes.

7.164 When selecting an appropriate type of tube to use, local authorities should research the spread in the bias correction factors of tubes analysed in previous years.

7.165 Tubes should be put out in accordance to the Diffusion Tube Calendar. This will be disseminated to local authorities towards the end of the previous calendar year. The calendar splits the year in to 4 and 5 week blocks and suggests that tubes are changed on a Wednesday. It is preferable to change the tubes on the Wednesday, but Tuesday and Thursday are also acceptable. Monday and Friday are acceptable under exceptional circumstances. The first date of the calendar is generally around the 8th of

January. This is in order to avoid the requirement to change tubes over the Christmas and New Year period. As such, the annual average is not identical to the calendar year, but is offset by about a week. If diffusion tubes are left out for significantly longer or shorter periods than the 4 and 5 weeks recommended, then the data may not be reliable as the diffusion rate may not have been accurately defined. Local authorities should discuss this with their diffusion tube supplier.

7.166 The end of the tube that should be removed prior to mounting them is typically clear or white, but will be specifically dictated by the laboratory that supplied them. The tube must be vertical, with the open end downwards. It is important that the open end of the tube is exposed to free circulation of air. Avoid placing diffusion tubes in any form of recess, and the fittings should be mounted so that the tubes can be changed easily. Tubes must not be fixed directly to walls or similar surfaces, even when the objective is to monitor at a building façade. A spacer block of at least 5 cm may be used between the surface and the tube. The specific spacer technique used to mount the tubes will depend upon the specific equipment supplied by laboratory which prepared them.

7.167 The procedures below should be followed when deploying diffusion tubes:

- Diffusion tubes should be stored in a cool, dark place (preferably a fridge), in a sealed plastic container, before and after exposure;
- Remove tubes from the refrigerator on the day that they are to be put out, and ensure each one is clearly labelled with an identification number (if this hasn't already been done by the supplying laboratory). The label should be weatherproof;
- Take tubes to the site in a snap-seal bag or sealable plastic box. Travel blanks should be identified and their code numbers noted on the exposure details form provided by your laboratory;
- At each site, select a tube. Record its ID number, and the site at which it is to be exposed, on the exposure details form;
- Remove the end cap, and position the tube is positioned vertically in its holder, with its open end downwards;
- Record the date and time of the start of the exposure period on the exposure details form, and make a note of any site irregularities (for example building/road works, traffic diversions);
- Keep the end caps in the bag, for use when the exposure period is completed;
- When collecting the exposed tubes, at each site, remove the exposed tube from the sample holder and replace the end cap tightly. (Any uncapped tubes will be rejected by the analyst);
- Record the time and date of the end of the exposure period on the exposure details form, against the appropriate tube number. Again, make a note of any site irregularities or anything which might affect, or even invalidate, the tube's results (for example, the tube found on the ground, insects, dirt, or liquid inside the tube);
- Tubes that are damaged or have splits in the end-caps should not be used;
- Keep the exposed tubes in a sealed container, in a cool place (a fridge is best) until they can be returned to the laboratory for analysis, which should happen as

soon as possible;

- Ensure that the tubes are used and analysed within the specified “use by” date – typically within three months of preparation;
- When visiting sites, it is recommended that the operator takes some spare tube end caps, also some spare mounting clips and spacer blocks to replace any missing or damaged.

7.168 It is recommended that travel blanks are routinely deployed. Travel blanks are used to identify possible contamination of diffusion tubes while in transit or in storage by the user. Travel blanks are sent out with the tubes for exposure. They go everywhere the exposed tubes go, but are not themselves exposed. They are taken to the site when the tubes are put out, but returned to the user’s refrigerator (in their sealed bag) for the duration of the exposure period. They are taken to the site again when the tubes are collected after exposure, and sent to the laboratory for analysis along with the exposed tubes (Note: the results of travel blanks are not meant to be routinely subtracted from those of the exposed tubes: rather, their purpose is to highlight any contamination issues).

7.169 Sometimes, a diffusion tube result may be much higher or lower than usual results from the site. The first step should be to check with the analyst, to ensure that the result has been correctly calculated and reported. Have details such as the exposure period been correctly reported? Having ruled out calculation or reporting errors, it will be necessary to decide whether the value should be rejected. Some general guidelines are as follows:

- Low concentrations (3µg/m^3 or less) are rare at urban background or roadside sites in built up areas. If such a low concentration is measured at an urban site, where measured NO_2 concentrations are usually much higher, it is unlikely to be genuine, and more likely due to a faulty diffusion tube. This does not apply at rural sites, where such low concentrations may well be typical;
- High concentrations: unless there is a reason why the result is likely to be spurious, it is best to err on the side of including high values rather than rejecting them;
- The exposure records should be checked for any possible explanations (for example nearby bonfires during exposure, insects or foreign objects in the tube, or evidence of tampering), which may lead the operator to conclude that the result is not valid.

7.170 Once erroneous data have been deleted, it is necessary to calculate the annual average. The data need to be annualised, and then bias corrected. In order to do this, firstly the annual average is calculated for all sites. So long as the diffusion tube calendar is adhered to, then even though the periods that the tubes are out varies, it is acceptable to do a simple average. If the periods that the tubes were out varied beyond the 4 to 5 week recommendation, then it may be necessary to do a time weighted average. In order to do this, each concentration is multiplied by the number of days that the tube was out. These results are then added together for every period of the year. Finally, this is divided by the total number of days that all the tubes were out. For example, if Tube 1 was out for 32 days and had a 45µg/m^3 average, and Tube 2 was out for 46 days and had a 25µg/m^3 average, the simple average is (45+25)/2 =

35µg/m^3; whereas the time weighted average = ((45×32)+(25×46))/(32+46) = 33.2µg/m^3.

7.171 For those sites with fewer than 9 months' worth of data, it is necessary to perform annualisation. This can be undertaken using the technique discussed in Box 7.6, but if there are many sites to be corrected then local authorities are advised to use the technique described in Box 7.8.

Box 7.8 – Example: Annualising NO_2 Diffusion Tube Monitoring Data

A diffusion tube site (D1) has 8 months' worth of data and so it is necessary to annualise. A continuous background site (B1) has greater than 85% data capture for the year. The tubes were set out in accordance with the recommended calendar for 2015. If there are many locations to be annualised then it can be quicker to average the background site data to the same calendar as the diffusion tubes. The results are given in the below table. In addition, the results are given for the background site for those months that D1 data are available (Column B1 when D1).

Start Date	End Date	B1	D1	B1 when D1
7 January 2015	4 February 2015	15.6	38.4	15.6
4 February 2015	4 March 2015	38.3		
4 March 2015	1 April 2015	22.7	43.1	22.7
1 April 2015	29 April 2015	22.2		
29 April 2015	27 May 2015	24.9	51.3	24.9
27 May 2015	1 July 2015	20.8		
1 July 2015	29 July 2015	18.1	31.3	18.1
29 July 2015	26 August 2015	16.1	26.8	16.1
26 August 2015	30 September 2015	25.5	41.0	25.5
30 September 2015	28 October 2015	21.1		
28 October 2015	2 December 2015	28.1	29.8	28.1
2 December 2015	6 January 2016	32.0	39.8	32.0
Average		**23.8**	**37.7**	**22.9**

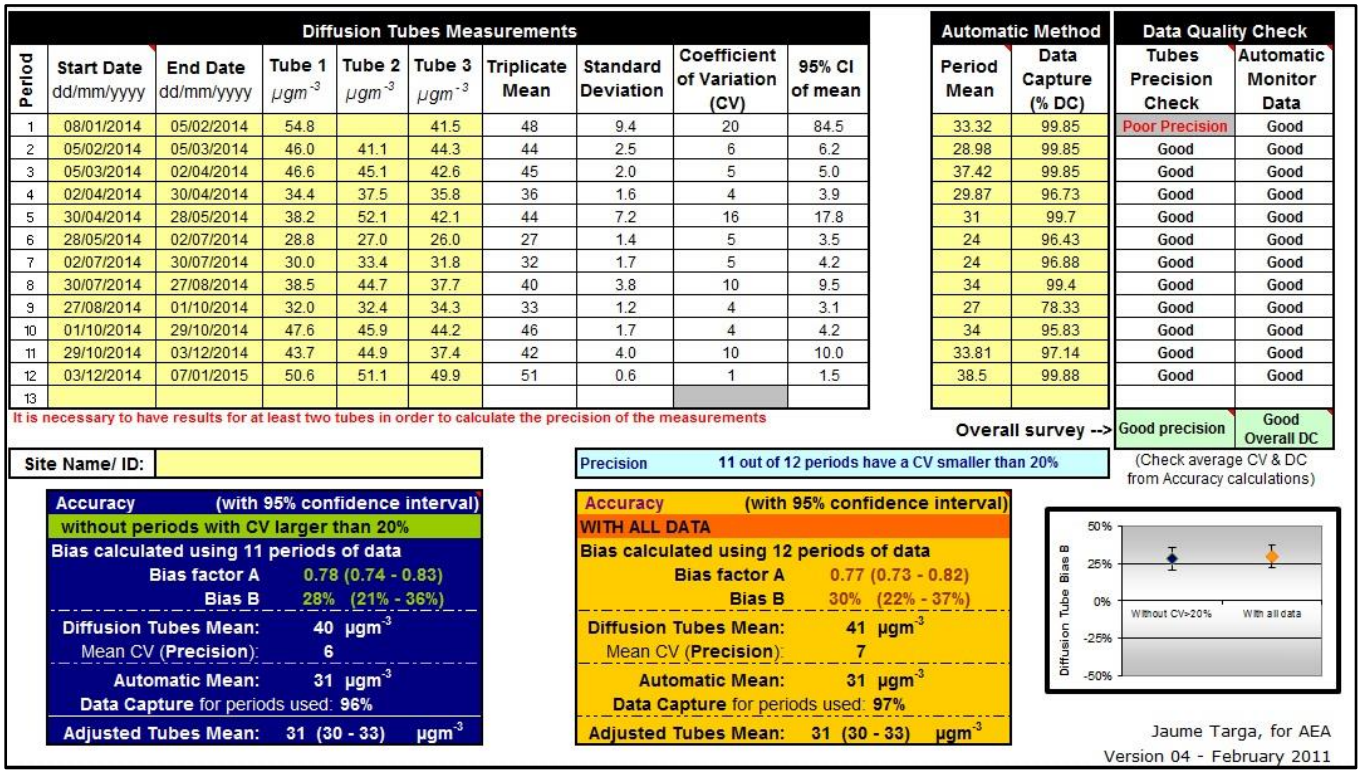
The annual mean (**A_m**) of B1 is 23.8µg/m^3. The period mean (**P_m**), of B1 is 22.9µg/m^3. The ratio **R** of the annual mean to the period mean (**A_m/P_m**) is 1.04. This process should be repeated for all continuous background sites. If no continuous monitoring sites are available, then diffusion tube sites from background locations with 12 months' data may be used. In either case, the more background sites that can be identified the better. Calculate the average of these ratios **R_a**. This is then the annualisation factor.

The measured period mean concentration **M** is 37.7µg/m^3. Multiply by this annualisation factor Ra to give the estimate of the annual mean for 2015. Assuming that all other background sites yielded an annualisation factor of 1.04, then Ra in this example is 1.04; and the annualised average of **$D1 = M \times R_a = 37.7 \times 1.04 = 39.2 \mu g/m^3$.**

If the periods that the tubes were out varied beyond the 4 to 5 week recommendation, then it may be necessary to do a time weighted average rather than simple average in order to calculate M, A_m and P_m.

7.172 After annualisation, the tubes should be corrected for bias. Bias represents the overall tendency of the diffusion tubes to under or over-read relative to the reference chemiluminescence analyser. This should not be confused with precision, which is an indication of how similar the results of duplicate or triplicate tubes are to each other. While it is possible to adjust diffusion tube results to account for bias, it is not possible to correct for poor precision. A spreadsheet-based tool[77] has been developed that allows local authorities to easily calculate the bias and precision of their tubes. An example of the output is illustrated in Figure 7.3.

Figure 7.3 – Local Bias Adjustment Factor Tool



Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	08/01/2014	05/02/2014	54.8		41.5	48	9.4	20	84.5
2	05/02/2014	05/03/2014	46.0	41.1	44.3	44	2.5	6	6.2
3	05/03/2014	02/04/2014	46.6	45.1	42.6	45	2.0	5	5.0
4	02/04/2014	30/04/2014	34.4	37.5	35.8	36	1.6	4	3.9
5	30/04/2014	28/05/2014	38.2	52.1	42.1	44	7.2	16	17.8
6	28/05/2014	02/07/2014	28.8	27.0	26.0	27	1.4	5	3.5
7	02/07/2014	30/07/2014	30.0	33.4	31.8	32	1.7	5	4.2
8	30/07/2014	27/08/2014	38.5	44.7	37.7	40	3.8	10	9.5
9	27/08/2014	01/10/2014	32.0	32.4	34.3	33	1.2	4	3.1
10	01/10/2014	29/10/2014	47.6	45.9	44.2	46	1.7	4	4.2
11	29/10/2014	03/12/2014	43.7	44.9	37.4	42	4.0	10	10.0
12	03/12/2014	07/01/2015	50.6	51.1	49.9	51	0.6	1	1.5
13									

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
33.32	99.85	Poor Precision	Good
28.98	99.85	Good	Good
37.42	99.85	Good	Good
29.87	96.73	Good	Good
31	99.7	Good	Good
24	96.43	Good	Good
24	96.88	Good	Good
34	99.4	Good	Good
27	78.33	Good	Good
34	95.83	Good	Good
33.81	97.14	Good	Good
38.5	99.88	Good	Good
Overall survey -->		Good precision	Good Overall DC

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:

Precision: 11 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%
Bias calculated using 11 periods of data
Bias factor A: 0.78 (0.74 - 0.83)
Bias B: 28% (21% - 36%)
Diffusion Tubes Mean: 40 μgm^{-3}
Mean CV (Precision): 6
Automatic Mean: 31 μgm^{-3}
Data Capture for periods used: 96%
Adjusted Tubes Mean: 31 (30 - 33) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA
Bias calculated using 12 periods of data
Bias factor A: 0.77 (0.73 - 0.82)
Bias B: 30% (22% - 37%)
Diffusion Tubes Mean: 41 μgm^{-3}
Mean CV (Precision): 7
Automatic Mean: 31 μgm^{-3}
Data Capture for periods used: 97%
Adjusted Tubes Mean: 31 (30 - 33) μgm^{-3}

Jaume Targa, for AEA
Version 04 - February 2011

7.173 The yellow cells are those to be completed by the local authority. Precision is calculated based on the diffusion tube data only. Tube precision is categorised as good or poor. Good precision applies where the coefficient of variation (CV) of triplicate diffusion tubes for eight or more periods during the year is less than 20%, and the average CV of all monitoring periods is less than 10%. Poor precision applies where the CV of four or more periods is greater than 20% and/or the average CV is greater than 10%. Bias is calculated only if the period mean and data capture from a collocated chemiluminescence analyser are included on the spreadsheet. Two boxes are output by the spreadsheet, a blue one and an orange one. Local authorities should use the blue box, in which the spreadsheet automatically disregards the diffusion tubes where there is poor precision. Two bias factors are output, A and B, and in this

[77] http://laqm.defra.gov.uk/documents/AEA_DifTPAB_v04.xls

example they are 0.78 and 28% respectively. The Bias factor A is the local bias correction factor. If there is more than one local collocation study, then the A factors should not be averaged. Instead, a reasonable approximation can be derived by averaging the B values. For example, if there were 2 studies of 22% and 28%, then the average would be 25%. This is then expressed as a factor, *e.g.* 25% is 0.25. Next add 1 to this value, *e.g.* 0.25 + 1.00 = 1.25. Finally, take the inverse to give the bias adjustment factor, *e.g.* 1/1.25 = 0.80.

7.174 Where local authorities have collocation studied, then the results of the studies should be sent to the LAQM Support Helpdesk. This information is used to formulate a national bias adjustment factor for each type of tube. Figure 7.4 shows an example output from the National Diffusion Tube Bias Adjustment Factor Spreadsheet. In this example, there were five different studies throughout the UK, and the average bias factor was 0.79.

7.175 Local authorities should compare the results of correcting data by the locally derived factor (in this example 0.80); to that of the nationally derived factor (in this example 0.79). It is important to stress that correction should not be done by both the local and national factors at the same time. If the factors are significantly different from each other, and/or if it makes a difference as to which sites are greater or less than 40µg/m^3, then this should be clearly discussed in the LAQM report. The nationally derived factor will also include any locally derived factors based on collocation data sent to NPL. As such, the national factor is likely to be the more reliable.

Figure 7.4 – National Bias Adjustment Factor Spreadsheet

National Diffusion Tube Bias Adjustment Factor Spreadsheet — Spreadsheet Version Number: 06/15

Follow the steps below **in the correct order** to show the results of **relevant** co-location studies
Data only apply to tubes exposed monthly and are not suitable for correcting individual short-term monitoring periods
Whenever presenting adjusted data, you should state the adjustment factor used and the version of the spreadsheet
This spreadhseet will be updated every few months: the factors may therefore be subject to change. This should not discourage their immediate use.

This spreadsheet will be updated at the end of September 2015

LAQM Helpdesk Website

The LAQM Helpdesk is operated on behalf of Defra and the Devolved Administrations by Bureau Veritas, in conjunction with contract partners AECOM and the National Physical Laboratory.

Spreadsheet maintained by the National Physical Laboratory. Original compiled by Air Quality Consultants Ltd.

Step 1:	Step 2:	Step 3:	Step 4:
Select the Laboratory that Analyses Your Tubes from the Drop-Down List	Select a Preparation Method from the Drop-Down List	Select a Year from the Drop-Down List	Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.
If a laboratory is not shown, we have no data for this laboratory.	If a preparation method is not shown, we have no data for this method at this laboratory.	If a year is not shown, we have no data[2]	If you have your own co-location study then see footnote[4]. If uncertain what to do then contact the Local Air Quality Management Helpdesk at LAQMHelpdesk@uk.bureauveritas.com or 0800 0327953

Analysed By[1]	Method (To undo your selection, choose (All) from the pop-up list)	Year[2] (To undo your selection, choose (All))	Site Type	Local Authority	Length of Study (months)	Diffusion Tube Mean Conc. (Dm) (µg/m^3)	Automatic Monitor Mean Conc. (Cm) (µg/m^3)	Bias (B)	Tube Precision[5]	Bias Adjustment Factor (A) (Cm/Dm)
ESG Didcot	20% TEA in water	2014	KS	Marylebone Road Intercomparison	12	114	80	42.6%	G	0.70
ESG Didcot	20% TEA in water	2014	R	Rhondda Cynon Taf CBC	11	34	30	10.5%	G	0.90
ESG Didcot	20% TEA in water	2014	KS	South Lakeland District Council	9	41	32	29.2%	G	0.77
ESG Didcot	20% TEA in water	2014	UB	Wigan Council	13	28	22	27.5%	P	0.78
ESG Didcot	20% TEA in water	2014		Overall Factor[3] (4 studies)				Use		0.79

SO_2 Monitoring

7.176 The reference method for SO_2 monitoring is ultraviolet fluorescence. A number of instruments have[74] been approved under the MCERTS scheme.

7.177 This technique is based on the emission of light by SO_2 molecules excited by UV radiation and is proportional to the SO_2 mixing ratio in parts per billion by volume

(ppbV). It is necessary to convert the ppbV mixing ratios to concentrations in $\mu g/m^3$ (See below).

7.178 Local authority personnel should attend the site every two weeks for sites in traffic locations, and every four weeks for sites at other locations. At this time, the filter should be changed and the instrument's calibration should be checked. This is done by introducing nominally 450 ppbV SO_2 in synthetic air to the system and then noting the value of SO_2 from the front panel of the instrument after the reading has stabilised. 450 ppbV is chosen as this is 90% of the 500 ppbV full span of the instrument. The zero of the instrument is then checked by passing synthetic air or ambient air that has been purified. Again, the value of SO_2 is noted from the front panel of the instrument. The 450 ppbV SO_2 in synthetic air cylinder should be traceable to a national or international reference cylinder so that the concentration is accurately known.

7.179 Instruments should be periodically checked by an independent organisation accredited to perform QA/QC checks to ISO17025:2005. Ideally this should be performed every six months. It is important that the QA/QC process checks the calibration using SO_2 in synthetic air.

7.180 Instruments should be periodically serviced by the manufacturer or an approved service unit. Ideally this should be performed every six months and within three weeks of the independent QA/QC audit. Maintenance schedules for the replacement of consumable parts, diagnostic checks and equipment overhaul should in all cases follow manufacturer's recommendations. Routine and non-routine service visits should be fully documented to describe in detail any adjustments, modification or repairs undertaken.

7.181 In order to correct for the drift in instrument calibration and then to convert from ppbV to $\mu g/m^3$, it is necessary to follow the below procedure:

- Erroneous calibrations should be identified by observing the trend in the ppbV readings of SO_2 from the front of the instrument when the nominally 450 ppbV SO_2 in synthetic air and zero gases were introduced. Readings which do not follow anticipated trends should be ignored;
- For each day that the calibration was checked on the instrument, the SO_2 zero is taken to be the ppbV mixing ratio of SO_2 that was displayed on the front of the instrument when the zero gas was introduced. It is possible for the SO_2 zero to be incorrect, and instead the correct zero may be identified by observing trends in the lowest concentration of the ambient SO_2 data;
- For each day that the calibration was checked on the instrument, the SO_2 span is taken to be the ppbV mixing ratio of SO_2 that was displayed on the front of the instrument when the 450 ppbV SO_2 in synthetic air gas was introduced;
- For each day that the calibration was checked on the instrument, the SO_2 range is calculated as SO_2 span minus SO_2 zero;
- For each day that the calibration was checked on the instrument, the SO_2 calibration factor is calculated by taking the exact known SO_2 ppbV mixing ratio of the SO_2 in synthetic air cylinder and dividing this by the SO_2 range;
- The SO_2 calibration factor and SO_2 zero should be defined for every 15 minute monitoring period that monitoring was undertaken. It is important that a step

change in calibration factors is accounted for whenever the instrument was serviced or repaired. It is considered sufficient to take the SO_2 calibration factor and SO_2 zero to be the same for every record following each calibration check prior to the following calibration check. It is however more accurate to linearly interpolate the SO_2 calibration factor and SO_2 zero between calibration checks;

- The 15 minute SO_2 ppbV readings from the instrument are zero corrected by subtracting the SO_2 zero assigned to that 15 minute record;
- The 15 minute zero corrected SO_2 ppbV readings are span corrected by multiplying by the SO_2 calibration factor assigned to that 15 minute record;
- SO_2 ppbV is converted in to $\mu g/m^3$ by multiplying by 2.66.
- All erroneous data should be disregarded before any averaging or data interpretation is undertaken. Ultraviolet fluorescence monitors produce a data record every 15 minutes. The objectives for SO_2 relate to 15 minute, hourly and 24 hour $\mu g/m^3$ averages. In order to calculate the 1 hour average data, four 15 minute $\mu g/m^3$ records are averaged. The 1 hour average will only be valid if there was at least 75% data capture, i.e. 3 valid 15 minute averages. The 24 average is calculated as the average of all valid 1 hour averages in the day. The 24 hour average will only be valid if there was at least 75% data capture, i.e. 18 valid 1 hour averages.
- As the objectives for SO_2 relate to 15 minute, hourly and 24 hour averages, three different data capture rates should be calculated based upon the number of valid 15 minute, 1 hour and 24 hour average in the year. For example, if there were 30720 valid days of 15 minute SO_2 data in a leap year, then the data capture is (100 × 30720) / 35136, which is 87.4%.
- It is required to report the number of 15 minute periods where there was greater than $266\mu g/m^3$ over a calendar year. There are allowed to be no more than 35 exceedances per calendar year. The number of exceedances should only be reported where data capture is more than 85% of a full year. If data capture is less than 85% or monitoring is for less than a full year, then local authorities should instead report the 99.9^{th} percentile for 15 minute SO_2. For example, if the available 15 minute average data are in Column A in an Excel spreadsheet, then the Excel formula would be =PERCENTILE(A:A,0.999). If the 99.9^{th} percentile is greater than $266\mu g/m^3$, then this means that if there had been 100% data capture, then there would have been greater than 35 exceedances of $266\mu g/m^3$ per calendar year.
- It is required to report the number of 1 hour periods where there was greater than $350\mu g/m^3$ over a calendar year. There are allowed to be no more than 24 exceedances per calendar year. The number of exceedances should only be reported where data capture is more than 85% of a full year. If data capture is less than 85% or monitoring is for less than a full year, then local authorities should instead report the 99.7^{th} percentile for 1 hour SO_2.
- It is required to report the number of 24 hour periods where there was greater than $125\mu g/m^3$ over a calendar year. There are allowed to be no more than 3 exceedances per calendar year. The number of exceedances should only be reported where data capture is more than 85% of a full year. If data capture is less than 85% or monitoring is for less than a full year, then local authorities should instead report the 99.2^{nd} percentile for 24 hour SO_2.

Carbon Monoxide Monitoring

7.182 The reference method for CO monitoring is non-dispersive infrared spectroscopy. A number of instruments have been approved under the MCERTS scheme[74].

7.183 This technique is based on the attenuation of infrared light passing through a sample cell which is proportional to the CO mixing ratio in parts per million by volume (ppmV). It is necessary to convert the ppmV mixing ratios to concentrations in mg/m^3 (See below).

7.184 Local authority personnel should attend the site every two weeks for sites in traffic locations, and every four weeks for sites at other locations. At this time, the filter should be changed and the instrument's calibration should be checked. This is done by introducing nominally 20 ppmV CO in synthetic air to the system and then noting the value of CO from the front panel of the instrument after the reading has stabilised. The zero of the instrument is then checked by passing synthetic air or ambient air that has been purified. Again, the value of CO is noted from the front panel of the instrument. The 20 ppmV CO in synthetic air cylinder should be traceable to a national or international reference cylinder so that the concentration is accurately known.

7.185 Instruments should be periodically checked by an independent organisation accredited to perform QA/QC checks to ISO17025:2005. Ideally this should be performed every six months. It is important that the QA/QC process checks the calibration using CO in synthetic air.

7.186 Instruments should be periodically serviced by the manufacturer or an approved service unit. Ideally this should be performed every six months and within three weeks of the independent QA/QC audit. Maintenance schedules for the replacement of consumable parts, diagnostic checks and equipment overhaul should in all cases follow manufacturer's recommendations. Routine and non-routine service visits should be fully documented to describe in detail any adjustments, modification or repairs undertaken.

7.187 In order to correct for the drift in instrument calibration and then to convert from ppmV to mg/m^3, it is necessary to follow the below procedure:

- Erroneous calibrations should be identified by observing the trend in the ppmV readings of CO from the front of the instrument when the nominally 20 ppmV CO in synthetic air and zero gases were introduced. Readings which do not follow anticipated trends should be ignored;
- For each day that the calibration was checked on the instrument, the CO zero is taken to be the ppmV mixing ratio of CO that was displayed on the front of the instrument when the zero gas was introduced. It is possible for the CO zero to be incorrect, and instead the correct zero may be identified by observing trends in the lowest concentration of the ambient CO data;
- For each day that the calibration was checked on the instrument, the CO span is taken to be the ppmV mixing ratio of CO that was displayed on the front of the instrument when the 20 ppmV CO in synthetic air gas was introduced;
- For each day that the calibration was checked on the instrument, the CO range is

calculated as CO span minus CO zero;

- For each day that the calibration was checked on the instrument, the CO calibration factor is calculated by taking the exact known CO ppmV mixing ratio of the CO in synthetic air cylinder and dividing this by the CO range;
- The CO calibration factor and CO zero should be defined for every 15 minute monitoring period that monitoring was undertaken. It is important that a step change in calibration factors is accounted for whenever the instrument was serviced or repaired. It is considered sufficient to take the CO calibration factor and CO zero to be the same for every record following each calibration check prior to the following calibration check. It is however more accurate to linearly interpolate the CO calibration factor and CO zero between calibration checks;
- The 15 minute CO ppmV readings from the instrument are zero corrected by subtracting the CO zero assigned to that 15 minute record;
- The 15 minute zero corrected CO ppmV readings are span corrected by multiplying by the CO calibration factor assigned to that 15 minute record;
- CO ppmV is converted in to mg/m^3 by multiplying by 1.16.

7.188 All erroneous data should be disregarded before any averaging or data interpretation is undertaken. Non-dispersive infrared spectroscopy monitors produce a data record every 15 minutes. The objectives for CO relate to a running 8 hour mg/m^3 average. This is an 8 hour average that is updated once every hour – i.e. there are 8760 running 8 hour averages beginning in a non-leap year, though only 8752 of these will lie entirely within the year. It is first necessary to calculate the 1 hour average data, to do this; four 15 minute mg/m^3 records are averaged. The 1 hour average will only be valid if there was at least 75% data capture, i.e. 3 valid 15 minute averages. Eight 1 hour averages are then averaged for every 8 hour period. The 8 hour average will only be valid if there was at least 75% data capture, i.e. 6 valid 1 hour averages. The running 8 hour average is not allowed to exceed $10mg/m^3$ on any single occasion during the year.

7.189 Rolling 8 hour data capture can be calculated as the number of rolling 8 hour averages divided by the number of hours in the year, and this is expressed as a percentage by multiplying by 100. For example, if there were 7852 valid rolling 8 hour averages of CO data in a non-leap year, then the data capture is (100 × 7852) / 8760, which is 89.6%.

Lead Monitoring

7.190 Defra and the Devolved Administrations have approved a number of similar methods for the analysis of lead in air. It is first necessary to take PM_{10} sample filters using an approved method PM_{10} sampling method that utilises filters, i.e. the reference method, Partisol, Opsis SM200 or FAI SWAM (see para 7.134). It is possible to analyse multiple one day filters together, or to take a single filter sample over multiple days. When taking a multiple day sample, it is important that the sample flow does not drop below 10% of the nominal value, and that the total volume is accurately measured. The filters can be any of quartz, cellulose nitrate or cellulose acetate membrane, so long as the filter lead content can be demonstrated to be low and constant. The

analysis can be any either Graphite Furnace Atomic Absorption Spectrometry (GFAAS), or Inductively Coupled Plasma – Mass Spectrometry (ICP-MS), so long as the detection limit can be demonstrated to be sufficient for the lead concentrations to be monitored for: The concentration in µg/m^3 of each sample is taken as the mass of lead in µg divided by the sample volume in m^3. The PM sampler and the instrument used to quantify the metals content should be subjected to six monthly QA/QC and servicing schedules.

7.191 The annual mean should be below 0.25µg/m^3. This can be calculated as the average of all the samples taken during the year. If the time of each sample was not constant, then it is necessary to calculate a time weighted average. First multiply each sample concentration by the number of days over which that sample was taken. These values are then added up. Finally, this value is divided by total number of days over which the samples were taken.

Benzene and 1,3-Butadiene Monitoring

7.192 Benzene and 1,3-butadiene are monitored by collecting a sample on to an adsorbent material and then subsequently analysing this by gas chromatography. One of three methods can be used for this:

- Taking hourly or multi-hour samples by sucking air through the adsorbent, and then automatically analysing these on-site. The resultant chromatographs may be analysed automatically on-site or analysed off-site at a later date. This method is expensive, but is both highly accurate and allows for highly time resolved data;
- Taking longer samples by sucking air through the adsorbent, and then sending these to a laboratory for analysis. The Defra pumped benzene network takes two week samples using this method. This method is moderately affordable and the data are accurate, but it only allows for infrequently time resolved data;
- Leaving tubes containing the adsorbent outside in order for the benzene or 1,3 butadiene to diffuse on to the adsorbent, then sending these to a laboratory for analysis. This method is affordable, but passive diffusion is less accurate than active sampling, and it only allows for infrequently time resolved data.
- Continuous methods should be subjected to six monthly QA/QC and servicing schedules.
- Diffusion tubes are very sensitive to interference by solvents, so it is important that they are protected from any such sources of contamination during storage, transport and deployment. The use of solvent based marker pens should also be avoided.
- In addition, a DOAS based benzene sampler has been approved under the MCERTS scheme[74].
- For Benzene in England and Wales, the annual mean should be below 5µg/m^3. This can be calculated as the average of all the samples taken during the year. If the time of each sample was not constant, then it is first necessary to multiply each sample concentration by the number of days over which that sample was taken. These values are then added up. Finally, this value is divided by total number of

days over which the samples were taken.

- For Benzene in Scotland and Northern Ireland, the running annual average should be below 3.25µg/m^3. This can be calculated in the same way as the annual average, but it is required to calculate a different running annual average for each period that a sample was taken.
- For 1,3-Butadiene throughout the UK, the running annual average should be below 2.25µg/m^3.

3 – Estimating Emissions

Introduction

7.193 This section provides authorities with guidance on determining emissions associated with those sources that are, based upon the evidence of recent years, most likely to be identified as contributing to poor air quality and thus increase the potential for air quality exceedances.

7.194 In the majority of cases, road transport and stationary large point sources are likely to be the most common problems. However, residential areas burning solid fuel may also be of concern. Estimating emissions from these sources for input into detailed studies is therefore the focus of this section. For advice on compiling emissions estimates for other sources that may warrant detailed consideration, such as large ship ports, railways or airports, the LAQM Support Helpdesk should be contacted.

7.195 Emissions data should be gathered for the specific sector(s) that require detailed consideration following the guidance below. In addition, background emissions and concentrations data can be used to account for sectors not specifically assessed in the detailed studies. These data can be obtained from the National Atmospheric Emissions Inventory (NAEI) website[78] and the UK-Air website[70]. Further detail on these data sources is included in Appendix C.

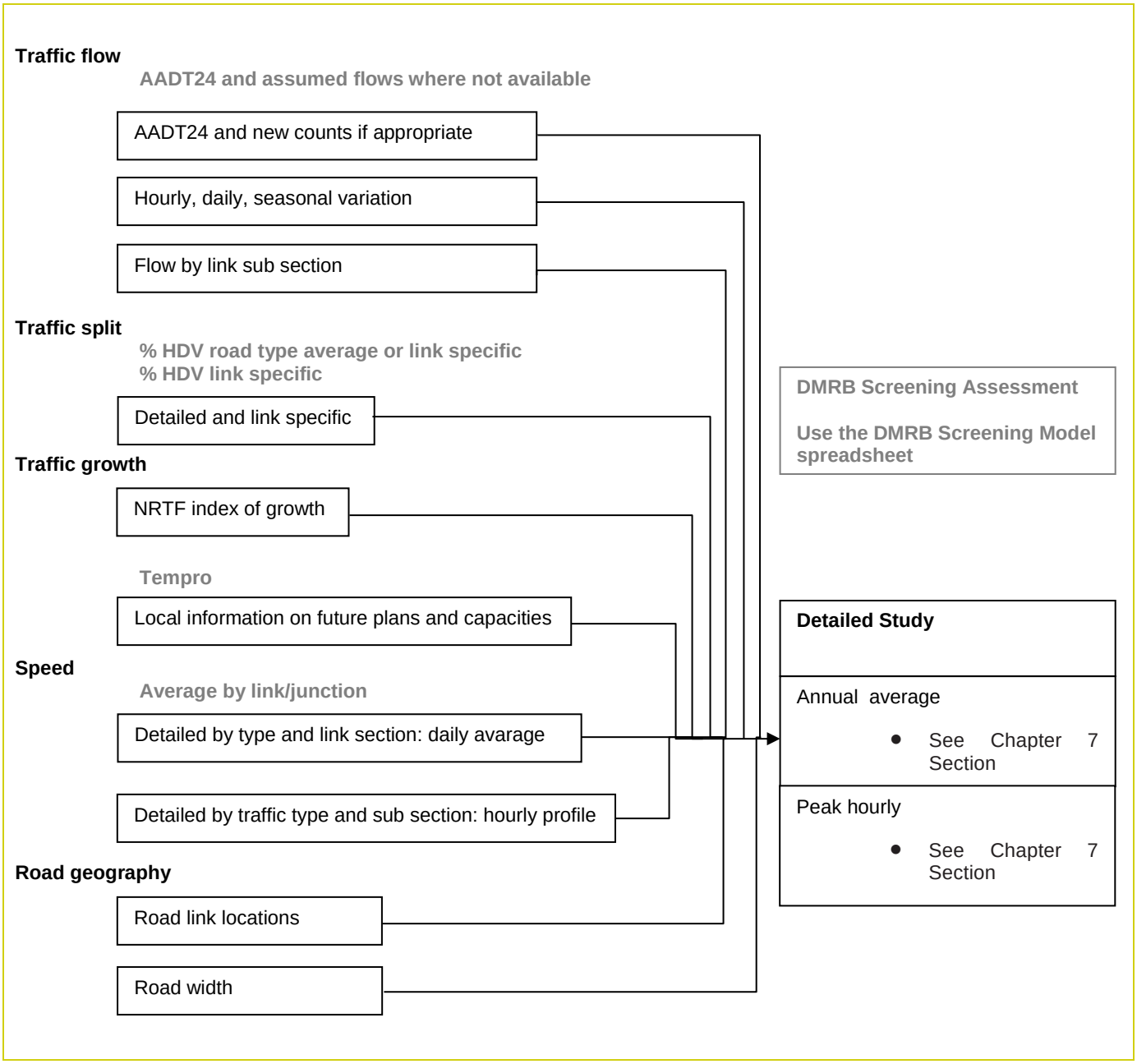
Road Transport

Introduction

7.196 A detailed study of road traffic emissions will involve some form of modelling, requiring high quality emissions estimates and other data as inputs. Figure 7.5 illustrates the data required for both screening assessments and detailed studies of road transport sources.

[78] http://naei.defra.gov.uk/

Figure 7.5 – Collecting Emissions Data: Road Transport Sources



7.197 With such sufficient information, the emissions for each road link can be estimated using the Emissions Factors Toolkit (EFT) – a spreadsheet tool published by Defra, which allows the calculation of road traffic exhaust emissions for different vehicle categories and splits, at various speeds, and on different road types. Emission factors (EFs) for each specific link being assessed will be calculated, which can then be used as input into a dispersion model. The latest version of the EFT and an associated User Guide are available via the LAQM Support website[79]. Alternatively, if not using the EFT then the raw vehicle EF data are available from the NAEI website[78].

[79] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

7.198 As a minimum, the following information will be required for each link in order to estimate the associated pollutant emissions:

- Road type, i.e. whether motorway, urban or rural in nature;
- Traffic flows;
- Fleet composition; and
- Vehicle speeds and congestion.

7.199 Whilst not essential for the calculation of emissions, road geometry information (including OS coordinates of road centrelines and accurate road widths) is required to accompany the emissions data input into a model.

7.200 Further guidance on key elements that require careful consideration when calculating EFs for road transport sources is provided in the sections below.

Traffic Flows

7.201 Traffic flow data in 24-hour Annual Average Daily Traffic (AADT) format) is required.

7.202 There are two main categories of traffic flow information from which AADT flows can be estimated:

- **Traffic counts:** made either by human observation ('manual counts') or machine ('automatic' or 'continuous' counts), which are (usually) 'classified' based upon the main vehicle types over a time period. These should be used in preference to traffic model data; and
- **Traffic/transportation models**: a computerised representation of traffic flows on the road network.

7.203 Data from traffic models is generally considered less robust as this has a greater amount of uncertainty associated with it than measured flows at the individual link level. However, there are several disadvantages of 'Traffic Count' data to be aware of:

- Resource-intensive to collect for other than a small number of links;
- Care needs to be taken in extrapolating what are essentially point-based observations to whole 'roads'; and
- Data do not take account of changes to traffic flow in subsequent years.

7.204 Depending upon the format of the provided data, it will often be required to transform the traffic data, e.g. from AM/PM peaks, 12-hour counts or 18-hour AAWT (Annual Average Weekday Traffic) flows (commonly used for noise assessments), to the required 24-hour AADT format. Council transport Departments should be able to provide factors to achieve this. Where possible, local conversion factors should be used in preference to national factors where available.

7.205 If using short-term counts to factor traffic flows to 24-hour AADT format, careful consideration should be given to whether the measurement period is considered

typical or not. For example, Friday and Monday counts are likely to overestimate AADT flows, while weekend counts are likely to underestimate AADT flows.

7.206 Some authorities will also need to consider seasonal patterns, particularly in tourist areas, when estimating AADT flows. This can be achieved by comparing the flows on the day of the manual count with 24-hour flows from Automatic Traffic Count (ATC) or similar data over the same period.

7.207 For instance, if manual count was taken on a Friday local authorities should:

- Obtain ATC data for the same period on a similar road;
- Compare the same Friday with the rest of the week to check if there were significant differences between the average on that day and the 7-day average;
- If the data from the ATC is available over a wider time period, check to see if that week was typical of the wider period or season;
- Other long-term traffic data can also be used to confirm estimates of traffic flows.

7.208 Local authorities may need to project traffic flows forward to the relevant assessment year. Each transport department within a local authority should have estimates of the expected growth on roads under their jurisdiction. Year-by-year growth factors based on road types should be used, as the growth on motorways for example is likely to be different to the growth on urban roads.

7.209 The Department for Transport (DfT) Road Traffic Forecasts[80] provided for England from the National Traffic Model (NTM) should be used to undertake the necessary projections where local information is not available. For areas outside England, the Scottish Government, the Welsh Assembly Government or the Department of Regional Development (Northern Ireland) should be contacted. In addition, the National Modelling Maps can be used to help assess current and future modelled exceedances (including those for $PM_{2.5}$, which will be of particular benefit for Scotland).

7.210 Forecast estimates specific to each local authority district in Great Britain are provided by the Department for Transport Trip End Model Presentation Programme (TEMPro)[81]. TEMPro provides forecast data on trips for transport planning purposes. However, it does not take into account changes to fuel cost and vehicle operating cost over time, so is not suitable for direct use as a growth factor to be applied to traffic flows. It therefore needs to be used with DfT's published forecast from the NTM. Consideration should be given to the appropriateness of NTM derived 'regional' traffic growth forecasts for the roads under study, particularly where (as is the case in many cities) roads are effectively already operating at "maximum capacity".

7.211 Specific future plans (either to reduce traffic congestion or to develop housing or commercial areas) will have an effect on the traffic flows and may even include the construction of new roads. Depending on the maturity of these plans there may

[80] https://www.gov.uk/government/publications/road-traffic-forecasts-2015

[81] https://www.gov.uk/government/collections/tempro

already be flow estimates and even impact assessment data available from the planning department of the local authority or the County Council.

7.212 Traffic flow data may be sourced from a variety of locations, including the local traffic/transport/highways department. Street-level traffic data for every junction-to-junction link on the 'A' road and motorway network in Great Britain is also published on DfT's Traffic Counts website[82].

Fleet Composition

7.213 The proportion of HDV/LDV split is required as a minimum, but further breakdown of vehicle classes is preferable, e.g. percentage of Cars, LGVs, HGVs, Buses and Coaches and Motorcycles.

7.214 Basic vehicle splits (as a minimum including the percentage of HDVs/LDVs) should be provided with the traffic flow information. In circumstances where such local information is not provided, estimates by region and road type can be obtained from the NAEI[83], for both the current and forecasted national traffic split.

Vehicle Speeds

7.215 Speed data may be obtained directly from a traffic model, although users should understand the basis (and any associated limitations) upon which the model speeds are calculated. Speed data may also be obtained from "floating-car" studies or from theoretical extrapolations based on speed limit/flow.

7.216 Consideration of hourly speeds on each link throughout the day may also be necessary. This should be assessed locally if possible.

7.217 For junctions, common sense, driving experience and local knowledge are helpful to estimate speeds. For example, for a section of road leading up to traffic lights, the aim should be to estimate average speeds over a 50m section of road:

- Traffic pulling away from the lights, e.g. 40-50 kph;
- Traffic approaching the lights when green, e.g. 20-50 kph; and
- Traffic on the carriageway approaching the lights when red, e.g. 5-20 kph, depending on the time of day and how congested the junction is.

7.218 It is considered that the combined effect of these three conditions is likely in most instances to be a two-way average speed for all vehicles of 20 to 40 kph. Speeds in similar ranges would also apply at roundabouts, although on sections of large roundabouts, speeds may well average between 40-50 kph. EFs for the determined

[82] http://www.dft.gov.uk/traffic-counts/

[83] http://naei.defra.gov.uk/data/ef-transport

speeds should then be calculated.

Temporal Variations

7.219 It is often important to consider temporal variations with regards to both traffic flows and speed data. This should include details of local diurnal and weekly variation for peak hour exceedance calculations, and for some authorities, consideration to seasonal patterns, particularly in tourist areas, will be required.

7.220 An example of diurnal traffic flow profiles is provided in Figure 7.6, and diurnal speed profiles provided in Figure 7.7.

Figure 7.6 – Example of Diurnal Traffic Flow Profiles

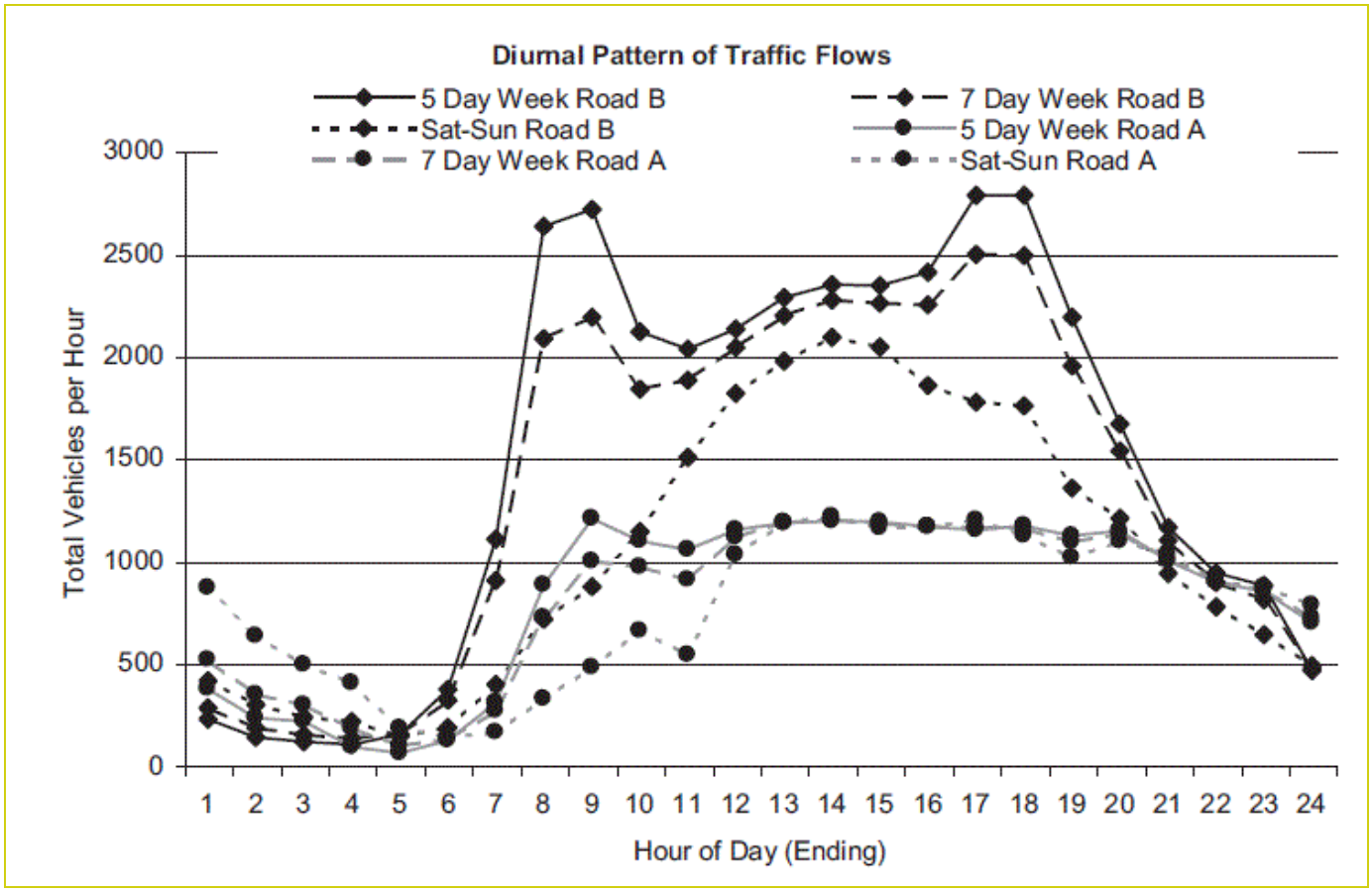
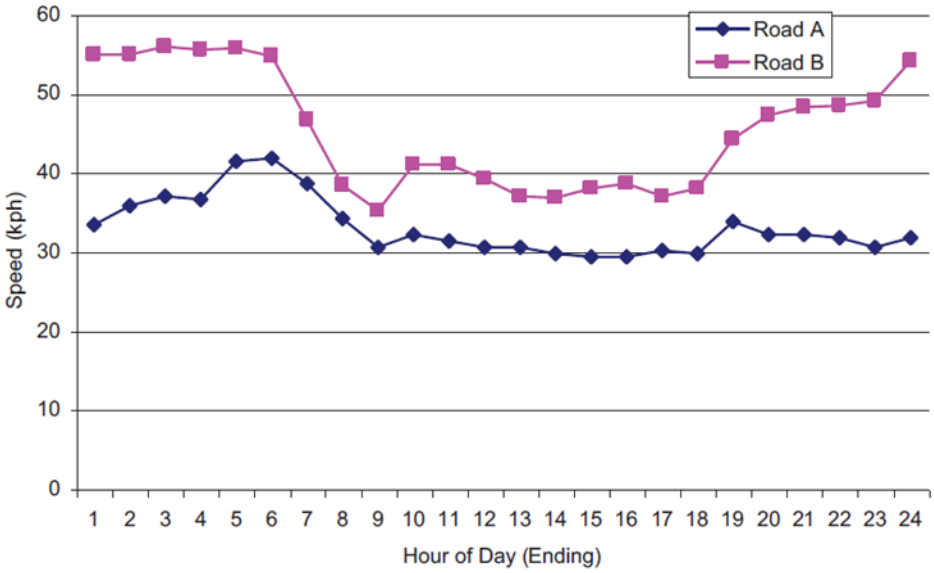


Figure 7.7 – Example of Diurnal Speed Profiles



7.221 Where such variations are considered to be of relevance to the detailed consideration of road traffic emissions, suitable data that allows comparable profiles for traffic flows and speeds to be calculated should be obtained. Many dispersion models allow diurnal and other time varying factors to be included as a model input.

Congestion

7.222 Average vehicle speeds during traffic congestion will fall, and there is no simple factor that can be applied to the average speed to calculate a speed applicable to congested periods. The preferred approach it to calculate the emission rate for the affected sections of each road for each hour of the day or week on the basis of the road speeds and traffic flows for each hour. The calculated emissions profile could then be used in the dispersion model.

7.223 In some circumstances it may be necessary to calculate a weighted average EF due to particular model constraints. The LAQM Support Helpdesk can provide further support if such circumstances arise.

7.224 Where local information with regards to congestion and associated speeds is not available, assumptions can be made as follows:

- For a busy junction, assume that traffic approaching the junction slows to an average of 20kph. These should allow for a junction, which suffers from a lot of congestion and stopping traffic. In general, these speeds are relevant for approach distances of approximately 25m;
- For other junctions (non-motorway) and roundabouts where some slowing of traffic occurs, you should assume that the speed is 10kph slower than the average free flowing speed; and

- For motorway or trunk slip roads you should assume average speeds of 40–45kph close to the junction.

Idling Vehicles

7.225 It may be necessary to calculate the exhaust emissions from stationary traffic, for instance at bus stops or taxi ranks. In such circumstances, the EF may be assumed to be equal to that corresponding to the vehicle travelling at 5kph (the lowest possible speed in the EFT).

Gradients

7.226 Hills with slight gradients can increase the power demanded from the vehicle engine, particularly for HDVs. As the power-demand increases, emissions increase. For vehicles going down the hill, the opposite occurs, and emissions decrease.

7.227 For passenger cars and LDVs, the normal speed-related EFs should be used, taking into account that the average speed on the hill section may differ from that on the flatter sections either side of the hill.

7.228 There are larger and significant changes in emissions generated by HDVs. The general equation for the amended speed-related EF for vehicles going up a hill is[84]:

$$EF_2 = EF_1 (1+ G \times [C_1 \times V + C_2])$$

where:

EF_1 = emission factor for vehicles travelling at the speed V on a level road (grams per vehicle km).

EF_2 = revised (greater) emission factor for vehicles travelling uphill at the speed V (grams per vehicle km).

V = vehicle speed (km per hour)

G = the gradient of the hill, expressed as a decimal fraction (for example, a 6% gradient should be expressed as 0.06), and C_1, and C_2 are constants, which differ according to the HDV type, emission standard and the pollutant. These constants are given in Table 7.9 below, along with a worked example.

7.229 For vehicles going down a hill the amended (reduced) EF is:

$$EF_2 = EF_1 (1- G \times [C_1 \times V + C_2]) \text{ for gradients} \leq 2.5\%, \text{ and}$$

$$EF_2 = EF_1 (1- 0.025 \times [C_1 \times V + C_2]) \text{ for gradients} > 2.5\%,$$

[84] These relationships were developed from fitting speed related emission factors in the EMEP CORINAIR Emissions guidebook for =2%, +4% and +6% gradients.

7.230 The overall effect of these two equations is that for roads with gradients up to 2.5% and with approximately equal numbers of vehicles ascending and descending the hill, there are no net changes in emissions, i.e. the effect of gradients on all vehicles can be justifiably neglected.

Table 7.9 – Gradient Coefficients

Vehicle Category	Post-2001 Vehicles				Pre-2001 Vehicles			
	NO_x	NO_x	PM	PM	NO_x	NO_x	PM	PM
Vehicle weight category	C1	C2	C1	C2	C1	C2	C1	C2
Small rigid HGV	0.29	10.74	0.12	-2.29	0.32	12.47	0.35	-1.35
Medium rigid HGV	0.48	10.81	0.36	-2.27	0.60	12.15	0.54	-3.25
Articulate trucks	0.62	12.44	0.46	-0.80	0.54	18.90	0.76	-2.86
Urban buses and coaches	0.48	7.41	0.17	5.01	0.53	10.20	0.46	1.14
Example gradient calculations for vehicles travelling at 24 and 40 kph								
	24 kph				40 kph			
	Post-2001 Vehicles		Pre-2001 Vehicles		Post-2001 Vehicles		Pre-2001 Vehicles	
	NO_x	NO_x	PM	PM	NO_x	NO_x	PM	PM
Vehicle weight category	C1	C2	C1	C2	C1	C2	C1	C2
Small rigid HGV	2.06	1.31	2.34	1.43	2.21	1.42	2.52	1.76
Medium rigid HGV	2.34	1.38	2.80	1.73	2.59	1.58	3.17	2.10
Articulate trucks	2.64	1.61	3.23	2.06	2.91	1.92	3.43	2.65
Urban buses and coaches	2.14	1.55	2.60	1.71	2.38	1.73	2.88	2.17

Cold Starts

7.231 It may be necessary to consider cold start emissions. Emission factors for cold starts are provided in the Data section of the NAEI website[85]. For example, in the case of cold start emissions from large car parks, the number of trip ends (i.e. half the number of overall vehicle movements to/from the car park) can be used in combination with the NAEI EFs to obtain an estimate of the associated cold start emissions from the car park.

Hot Soaks

7.232 'Hot soaks' represent the evaporation of petrol fuel vapour from the fuel delivery system when a hot engine is turned off and the vehicle is stationary, which can lead to significant increases in benzene emissions. It arises from the transfer of heat from the engine and hot exhaust to the fuel system where fuel is no longer flowing. Emissions from hot soaks can be estimated in a similar manner to those from cold starts, i.e. on the basis of the number of trip ends and the EFs for hot soaks obtained from the Data section of the NAEI website[85].

Particulate Matter Resuspension

7.233 Emissions of particulate matter from brake and tyre wear and road abrasion are now included in the EFT emissions calculations. However, it may be necessary in certain circumstances to calculate the additional emissions associated with resuspended material from the road surface, e.g. in proximity to construction sites where roads are experiencing track-out.

7.234 There are no direct measurements available that quantify resuspension emissions in terms of grams per kilometre. The significance of resuspension is governed by many factors (for example, vehicle type, road surface condition and meteorological conditions), resuspended material is highly variable in terms of its source emission rate. In the event that such emissions are required to be considered in detail, please contact the LAQM Support Helpdesk for further advice.

Minor Roads

7.235 Roads not being assessed in detail will include minor roads and rural or more distant major roads. These may still collectively contribute to exceedances of the Air Quality Objectives.

7.236 Although local data describing traffic flows on minor roads is often sparse, in the absence of such data, emissions can be accounted for using the estimates provided by the NAEI[78]. These datasets distribute the UK total minor road emissions, based on

[85] http://naei.defra.gov.uk/data/

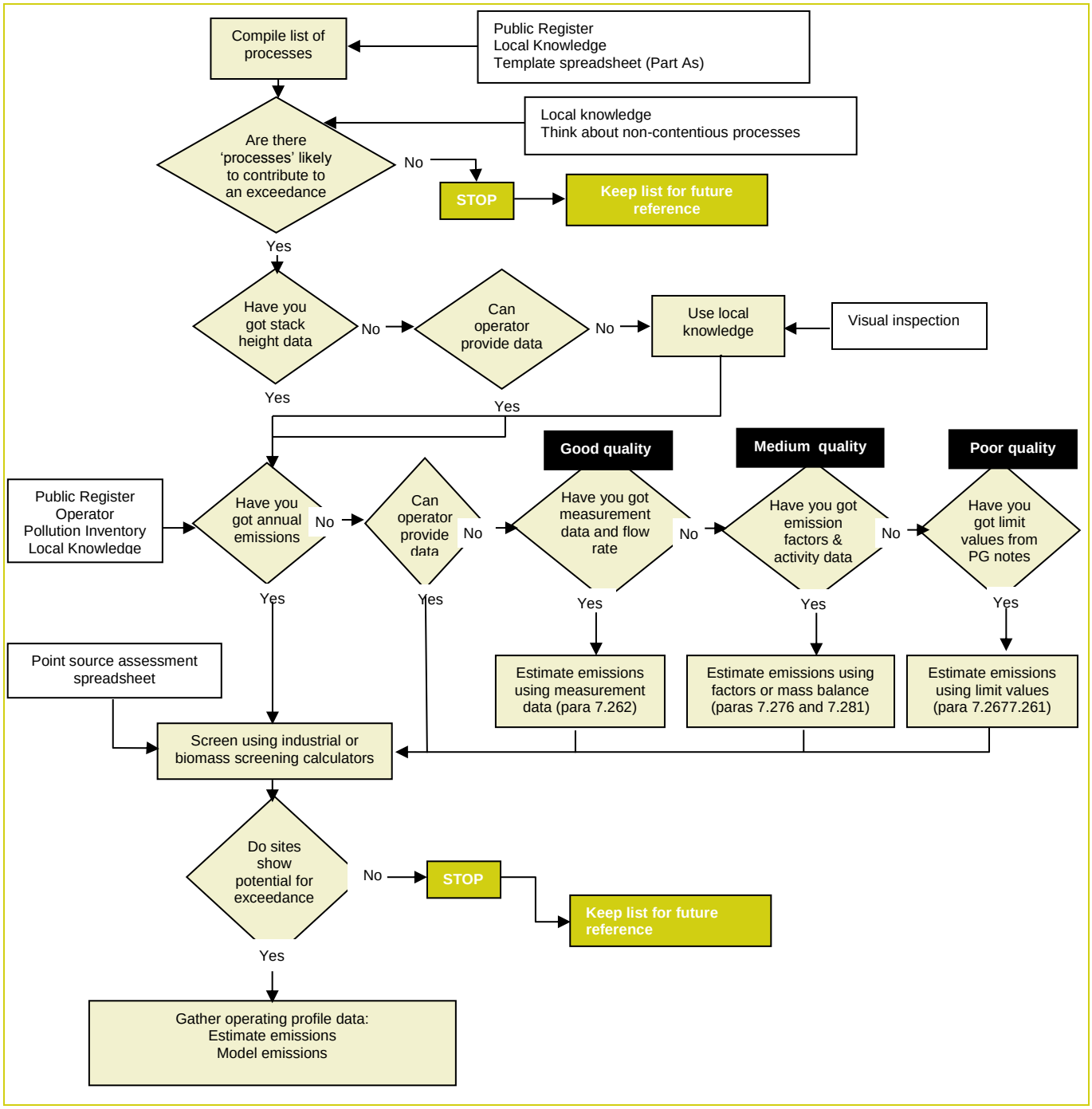
average flow by road type and OS minor road density maps.

Point Sources

Introduction

7.237 A detailed study of point source emissions will involve some form of screening or modelling, requiring high quality emissions estimates and other data as inputs. Figure 7.8 illustrates the data required for screening assessment and detailed studies for point sources.

Figure 7.8 – Collecting Emissions Data: Point Sources



7.238 Significant emissions may arise from a number of different installations. This may include:

- Part A1 Integrated Pollution Prevention and Control (IPPC) installations controlled by the Environment Agency (EA) in England, Natural Resources Wales (NRW) in Wales, the Scottish Environment Protection Agency (SEPA) in Scotland and the Northern Ireland Environment Agency (NIEA) in Northern Ireland;
- Part A2 IPPC installations controlled by the local authority in England and Wales, and SEPA in Scotland;

- Part B[86] installations Local Air Pollution Prevention and Control (LAPPC) installations controlled by the local authority in England and Wales, SEPA in Scotland and NIEA in Northern Ireland);
- Smaller unregulated processes, such as sites where multiple smaller boilers may be present, including:
- Large schools and colleges;
- Hospitals;
- Office headquarters; and
- District heating schemes.

7.239 As well as defined stack emissions (i.e. point sources), industrial installations may also give rise to fugitive emissions. This is particularly relevant to emissions of benzene, 1,3-butadiene, particulate matter and lead. Fugitive emissions generally arise at ground level, for example from chemical storage and handling plant, quarries and some metal refining activities. Emissions from fugitive sources are difficult to quantify using simple methods, and may require consideration as area and/or volume sources within a model. Both may require consideration from a site as part of a detailed emissions study.

7.240 Emission tests or continuous emission monitoring data, when available, are usually the preferred option for estimating air pollutant emissions from an installation. Generally, installation specific tests and/or continuous emissions monitoring programmes allow determination of the pollutant contribution from an existing source more accurately than the use of EFs. Even then, the results will be applicable only to the conditions existing at the time of the testing or monitoring. To provide the best estimate of longer term (i.e. yearly or typical day) emissions, these conditions should be representative of the installation's routine operations. The various sources of emissions data are discussed further below.

Sources of Emissions Data

7.241 There are a number of data sources available to assist with the estimation of point source emissions from both regulated and unregulated installations.

7.242 A large quantity of data for regulated Part A and B installations will be contained in the public register. Local authorities should contact the appropriate regulator for the data before contacting operators directly. In England and Wales, the Part A installations public register is available from the EA[87], whilst local authority registers will contain information about Part B (LAPPC) and/or Part A2 installations. In Scotland, the SEPA

[86] Part B activities are usually referred to as Part C in Northern Ireland.

[87] http://epr.environment-agency.gov.uk/ePRInternet/searchregisters.aspx

register holds information about IPPC Part A and Part B installations[88]. In Northern Ireland the public register holds information about IPPC Part A1/A2 and Part B installations and is maintained by the Industrial Pollution and Radiochemical Inspectorate (IPRI) of the NIEA[89]; local authorities hold Part A and B information for installations in their areas. The exact details of any data held in the register depend on those included within the site-specific permit and any subsequent variations. Public registers will not contain information that is considered to be commercially confidential.

7.243 To assist authorities further, the EA, NRW, SEPA, and NIEA, have committed to provide local authorities with information on any changes that may affect emissions from existing installations, and any new installations that have been, or will be, permitted. The information will be provided from the local office on request.

7.244 A list of major point sources in the industrial and commercial sector for the UK as a whole can be found on the NAEI website[90].

7.245 The European Commission also collate and publish data on emissions from all installations covered by the IPPC Directive. The dataset is available with an associated search facility and interactive map via the European Pollutant Release and Transfer Register (E-PRTR)[91].

7.246 Site specific data may also be sourced direct from the site operator. Depending upon the nature of the process, this may include up to date emissions monitoring, which may be required as a condition of their environmental permit. More recent monitoring data is preferable to commissioning data collected when a plant first starts to operate.

7.247 Emissions data from unregulated installations is often more difficult to acquire. For example, to obtain data for smaller boilers, direct application to the boiler operators will usually be necessary. Data may also be sourced direct from manufacturer technical data sheets, should details pertaining to make and model of plant be available.

Public register for Part A industrial installations

7.248 For each Part A permitted installation, the information referenced in Table 7.10 should be available from the public register.

[88] http://www.sepa.org.uk/environment/environmental-data/spri/

[89] http://www.doeni.gov.uk/niea/waste-home/public_reg.htm

[90] http://naei.defra.gov.uk/data/map-large-source

[91] http://prtr.ec.europa.eu/

Table 7.10 – Permitted Part A Installations

Public Register Entity	Information Included
Initial application for permit and details of subsequent variation to conditions of permit	• installation description • details of installation equipment – including any arrestment plant • activity data – throughput/production rates • release points • stack parameters • potential releases to atmosphere • commissioning data (including monitoring / modelling data) • modelling studies • operating hours • site plans – possibly detailing building dimensions
Permit conditions and details of subsequent variations to operating conditions	• emission limits (annual/instantaneous) • reporting requirements • definition of release points
Compliance monitoring data	• emission limits (annual/instantaneous) • reporting requirements • definition of release points
Annual emissions data	• emissions estimates
Revocation, variation and enforcement notices	• emission exceedances and operating problems
Modelling studies*	• emissions estimates • stack parameters (for example, diameter, velocity, flow rate and temperature)
Emission reduction plans	• emission reductions

7.249 The availability of data on the Part A public register tends to vary for different installation types. Combustion processes are tested regularly and relevant information is often readily available, including configuration and location. Organic installations, on the other hand, are often less well documented and information may be available about a large multitude of stacks and vents with no easily discernible differentiation.

Public register for Part A2 and Part B industrial installations

7.250 For each Part A2 and Part B permitted installation, the information referenced in Table 7.11 should be available from the public register.

Table 7.11 – Permitted Part A2 and Part B Installations

Public Register Entity	Information Included
Initial application for permit and details of subsequent variation to conditions of permit	• brief installation description • details of installation equipment – including any arrestment plant • activity data – throughput/production rates • release points • stack parameters • potential releases to atmosphere • commissioning data (including monitoring/modelling data) • modelling studies • Operating hours • Site plans – possibly detailing building heights
Permit conditions	• emission limits (annual/instantaneous) • reporting requirements • definition of release points
Details of subsequent variations to operating conditions	• operating profiles
Modelling studies	• unusual for Part B installations
Emission reduction/upgrading plans	• emission reductions

7.251 The Part A2 and Part B public register is continually updated and contains information on each permitted installation, usually in the form of an individual dataset for each installation.

7.252 In general, these public registers are less comprehensive than their Part A1 counterparts. In particular, information relating to release points and stack parameters is likely to be sparse, partly due to the fact that they are less polluting and therefore require less compliance monitoring than Part A1 installations. A brief summary of the level of information that can be obtained from the Part B public register for the main installation types is given below:

- Combustion installation operators may provide emission monitoring data for SO_2, NO_X, CO, particulate matter and organic compounds, although a complete set of data would be unusual. Waste oil burners rarely report emissions of fuel use data. When monitored data are not available emissions can be calculated, using the annual fuel use or boiler size with relevant EFs.
- Ferrous and non-ferrous metal installation operators may provide some monitored emissions data for SO_2, NO_X, CO, particulate matter, organic compounds and lead/metals. Data are often incomplete and recourse will usually need to be made to EFs, based on a description of the installation characteristics.
- The cement and mineral industries are a potential source of particulate matter but there is usually very little data relating to emissions. For some of these installations, use can be made of the emission factors published via the NAEI,

provided that material throughput/production rates are known.

- Incinerator operators may provide emission monitoring data for SO_2, CO, particulate matter, metals and organic compounds. When monitored data are not available emissions can be calculated for clinical waste incinerators from EFs.
- Coating and timber installation operators do not often provide monitored emissions data. Where particulate matter or hydrocarbon emissions from these installations are of interest, these may be estimated on the basis of materials throughput. Where incinerators or other hydrocarbon arrestment equipment is employed NO_X and CO emissions may be reported.
- The animal and vegetable processing industries vary greatly in the data supplied. Animal feed processors may have particulate matter emissions data only, whereas the tobacco industry often has a reasonable set of monitored emissions data. A limited number of EFs are available for some of these installations. Details of throughput/output will be needed to calculate emissions.

7.253 Activity data such as throughput of raw materials/production rates and operating hours given in the original application for permit may have changed significantly since the initial application. Although information concerning substantial changes and variations to the original permit should be kept on the public register, relatively minor changes may not be documented. This is particularly the case for Part B installations. It is therefore recommended that, for sites that are significant, data taken from the public register be checked with the operator.

Getting Data from the Regulator

7.254 The specific requirements for reporting releases from Part A installations are set out in the conditions of each individual permit. However, in England, Wales and Northern Ireland all Part A permits include a condition that requires installation operators to report annual releases of the regulated substances (including those identified in national/international legislation as well as those associated with health and/or environmental effects) where appropriate, into the Pollution Inventory (PI). The PI includes reporting on annual emissions of certain substances to air, controlled waters and land, and off-site transfers in wastewater and waste. The equivalent for SEPA regulated industrial sites in Scotland is the Scottish Pollutant Release Inventory (SPRI).

7.255 Emissions data from Part A installation are submitted to the PI in a standard format against a common list of substances. Each substance listed in the PI has a ‘threshold reporting value’. Operators are only required to report installation emissions where they exceed the threshold reporting values. Annual releases given on the PI for Part A installations are given for the entire plant. As a result the annual release figures could relate to many distinct stacks and could include fugitive emissions. The PI does not allow dissemination of these data, nor does it provide details of the release points that contribute to the total release of a substance. Releases are only reported on the PI if they exceed the EA’s reporting threshold values. Some Part A installations may emit quantities of a substance that could be significant with regard to local air quality but fall below these thresholds. Such installations should not necessarily be discounted from Review and Assessment solely on the basis of their releases being below the

reporting thresholds. This is especially the case for locations where there are several sources of a pollutant in close proximity.

7.256 Where required, particulate monitoring for Part A and Part B installations is nearly always undertaken for total particulate. For certain installations PM_{10} emissions can be estimated from total PM emissions using EFs for which particle size distribution studies have been undertaken; otherwise total particulate may be taken as a proxy for PM_{10}.

7.257 The situation is similar for lead emissions. Monitoring of lead emissions is usually undertaken for total metals. Releases of lead from industrial sources are frequently reported as total metals for a defined group of metals/metal compounds.

Getting Data from the Operator

7.258 It is recommended that the operator be consulted when estimating emissions and operating profiles. The extent of consultation will depend on both the detail and currency of the available data from the public register. However, the public register, PI, regulatory bodies and the E-PRTR should be consulted first. In cases where the sources are likely to be significant, the operator should be asked to confirm the validity of the information used. They should also be asked to provide additional information where necessary which is not available from the centralised sources.

7.259 Responses from operators are likely to take time and require pursuing. It is however worthwhile and should be started as early as possible.

Getting Data from Guidance Notes

7.260 In the event that emission monitoring has not been done or data are not available, the following guidance notes contain useful information, such as process/sector specific Emission Limit Values (ELVs) - often quoted in the environmental permit - from which emissions estimates can be estimated:

- Process Guidance Notes (For Part B installations);
- Sector Guidance Notes (For Part A2 installations).
- These also provide a useful reference with regards to detailed methodologies for calculating emissions estimates from the specific source type(s) covered by the Guidance Note.

Using Monitoring or Emission Limit Data

7.261 Estimating annual emissions from stack/flue concentration data is achieved in two steps:

- **Step one** calculates the mass emitted per second based on the measurement or limit values; and

- **Step two** calculates the annual emission based on the operating profile of the plant.

Step One: Calculating Emissions (in g/s) from Concentration Values

7.262 ***Using Monitoring Data:*** There are two types of monitoring, continuous or periodic. Continuous monitoring will measure the concentration continuously and an average of this measurement is adequate for estimating an annual emission. Periodic monitoring exercises relate to a fixed instant in time. The release rate, exit velocity and exit temperature of efflux gases will relate specifically to the conditions under which the monitoring exercise was undertaken. For installations that continually operate under the same conditions, variations from one monitoring exercise to another should be minimal. For batch installations that frequently change their operating conditions and start-up/shut down/emergency procedures, a one-off annual monitoring exercise will not necessarily represent process emissions accurately.

7.263 The permit conditions define the reporting conditions for monitoring data. Generally only those specified in the conditions of permit will be reported. In the absence of specific data, the flow from similar ducts and stacks that have not been measured should also be considered assuming the same emission concentration as those measured.

7.264 Where monitoring data are used to derive long term average concentrations, typical or average emission rates should be adequate. For pollutants with short term averaging periods a number of worst case scenarios should also be considered.

7.265 Monitoring data for point sources are usually recorded as concentrations on a mass or volumetric basis (either mg/m^3 or ppm). Generally, releases are reported in units of milligrams per 'normal' (N) cubic metre, i.e. mg/Nm^3. A normal cubic metre of gas is a cubic metre of dry gas at 273 K, 101.3 kPa. Where monitoring results are given in units of ppm (parts per million) it may be necessary to convert to units of mg/m^3 or mg/Nm^3.

7.266 Monitoring data from point sources are usually corrected to standard reference conditions to take account of the effects of temperature, moisture content, oxygen content and pressure. The standard reference conditions are different for different installations and processes. For example, pollutant concentrations in the discharge from a crematorium may be expressed at reference conditions of 273 K, 101.3 kPa and 11 % oxygen dry gas. Volumetric flow rates in the discharge are also usually corrected to the same reference conditions. If the volumetric flow rate and the pollutant concentration are both expressed at the same reference conditions then it is straightforward to calculate the rate of emission. However, significant errors may arise if the flow rate and concentration are expressed at different conditions. If in doubt, the LAQM Support Helpdesk can be contacted for further advice.

7.267 ***Using Emission Limits Values (ELVs):*** Care should be taken when estimating emissions in this manner, as data relating to ELVs represents release limits that will have obvious limitations relative to accurate quantification of actual emissions released and where variable temporal profiles of emissions is required. Many installations operate well within their specified emission limits, and thus the use of release limits may lead to over estimation of emissions. Where limits apply over different time periods, care should be taken to distinguish between the maximum

permissible release over a short interval and the maximum permitted over a longer period.

7.268 Consideration to the number of processes/units operating at a particular installation is required relative to the specification of the ELVs, e.g. ELVs may be quoted per incinerator whilst more than one may be operated. Knowledge of any emissions control/abatement technology that is installed is also required, as this will likely affect the ELV quoted for a particular process and associated emissions.

7.269 ***Calculation:*** To obtain the emission rate in units of grams per second, the following information will be required:

- Release concentration (mg/Nm^3 or mg/m^3 at standard reference conditions) from monitoring data or emission limit; and
- Volumetric flow rate (Nm^3/s or m^3/s at the same reference conditions).

7.270 When the volumetric flow rate is not reported, an estimate can be calculated from the stack diameter and the stack gas velocity:

Volumetric flow rate (m^3/s) = cross sectional area of stack (m^2) × stack velocity (m/s)

7.271 When performing such calculations, it is important to be aware that this will typically provide a volumetric flow rate based upon actual conditions. It may therefore be necessary to adjust this to 'normal' conditions (Nm^3/s) before proceeding to calculate the emissions rate.

7.272 The emission rate can then be obtained from the following calculation:

Emission rate (g/s) = release concentration (mg/Nm^3) × volumetric flow (Nm^3/s) × 0.001

Step Two: Calculating the Annual Emission

7.273 Once the emission rate in g/s has been calculated, annual emissions can then be calculated on the basis of the emission rate and the operating profile for the process. This profile will be based on the operation of the installation over the course of the hours of the day, days of the week and months of the year. For more information on estimating operating profiles and using the default datasets see para 7.285.

7.274 For example, a crematorium with a volumetric flow rate of 2.1 Nm^3/s emits CO emissions at 173 mg/Nm^3. It operates for 2,000 hours per year. The annual CO emissions can be calculated as:

Annual CO emission (kg/yr) = 173 (mg/Nm^3) × 2.1 (Nm^3/s) × 3,600 (s/hr) × 2,000 (hr/yr) × 0.000001 (kg/mg) = ***2,616 kg/yr***

7.275 For the above example, the CO emission rate can be calculated as:

CO emission rate (g/s) = 173 (mg/Nm^3) × 2.1 (Nm^3/s) × 0.001 = ***0.36 g/s.***

Using Emissions Factors

7.276 Emission factors (EFs) can be used to calculate annual emissions from activity data, e.g. fuel consumption, production, throughput or consumption statistics.

7.277 Appendix A provides worked examples of the use of EFs for calculating emissions for an industrial installation.

7.278 The use of EFs often requires a detailed knowledge of an installation and it is important to consider the 'appropriateness' or 'relevance' of an EF before applying it. Some EFs are more robust than others, depending on how they were derived and how much test data was available, and this should be taken into account when considering the accuracy of emissions estimated from EFs. Despite their limitations, EFs are frequently used for estimating emissions in circumstances where data from source-specific emission tests or continuous emission monitor are not available, or variability of actual emissions over a prolonged period of time is not suitably defined by the available source-specific emission tests or continuous emission monitoring.

7.279 EFs can be based on one or several sets of measurement from similar installations and can be very generalised (such as an average for coal combustion in boilers) or highly specific (such as coal combustion in a tangential grate boiler). As such, some installation types are better represented by EFs than others:

- Combustion installations (Part A and Part B) have been well studied and a wealth of EFs are available for a large range of pollutants;
- The metal industries have generated a reasonable number of EFs. Some of these are more applicable to the larger Part A installations than Part B installations. EFs for this industry sector tend to be dominated by particulate matter releases. Some EFs exist for fugitive releases from these installations. A relatively detailed knowledge of the installation itself and the installation equipment (i.e. furnace type, abatement technology) is required to use these EFs effectively;
- Mineral installations are reasonably represented by EFs. For some installations, such as cement batching, factors are available for fugitive particulate emissions. However, particulate size distribution data are limited, hence accurate estimations of PM_{10} are more difficult;
- There are relatively few EFs for the chemical industries as these installations tend to be unique. Engineering judgement or mass balance techniques coupled with local knowledge are recommended for estimating emissions from the chemical industries sector;
- The waste disposal industries are well documented. EFs are available for a large range of substances; and
- For 'other industries', EFs are relatively sparse or rely on activity data that may be difficult to obtain.

7.280 EFs generally relate the release of a substance to an activity associated with that process. The actual activity data required to carry out emissions estimation varies depending on the installation in question. For most installations, raw material usage

(throughput) data or production rate data are necessary. For example, EFs for combustion installations require fuel use activity data, whilst EFs for steel manufacturing processes require steel production activity rates. The most up to date and reliable activity data is typically best sourced direct from the operator.

Material Balance (Mass Balance) and Engineering Judgment

7.281 A mass balance approach may provide reliable average emissions for specific sources. For example, a material balance may provide a better estimate than emission tests alone in situations where a higher percentage of material is lost to atmosphere via fugitive means, e.g. storage tanks. In contrast, material balance may be inappropriate where a material is consumed or chemically combined in the process, or where losses to the atmosphere are a small portion of the total process throughput.

7.282 If no other reasonable option exists, releases can be estimated using best engineering judgment. This can be based on release data from other similar installations (where releases are already known) combined with knowledge of the physical and chemical properties of the materials involved. For example, for certain installations, vapour pressure and/or equipment design information can be used to make appropriate assumptions in order to estimate the amount of a substance released.

Estimating Future Emissions

7.283 There will be very little information on future emissions. Where possible, get the regulatory body to provide details of likely future emissions from plant which they regulate, or alternatively the operator should be able to provide details of likely future emissions. If this data is not available then forecast profiles for specific industrial sectors can be obtained from the Department of Energy & Climate Change[92].

Estimating Fugitive Emissions

7.284 Fugitive emissions may also give rise to significant emissions for some large installations or storage facilities. This is particularly relevant to emissions of benzene, 1,3-butadiene, particles and lead. Emissions can be calculated from mass balances or loss inventories for products or feedstock compiled by the operators. Where the fugitive emissions are from an installation and the release is not product or feedstock loss then it can only be estimated using EFs and activity data. EFs for some fugitive sources can be found on the NAEI website[78].

Operating Profiles

[92] https://www.gov.uk/government/collections/energy-and-emissions-projections

7.285 For detailed studies of processes that do not operate at a constant level all day/week/year, it is important to understand the operating profile of the process. In these cases the annual emission may be concentrated into only a short period of the year and will be far more likely to contribute to exceedances of the short-term Air Quality Objectives.

7.286 Such information can then be used to factor any emissions calculations as appropriate, or as a time varying emissions profile input into a dispersion model as part of a detailed study.

7.287 It is highly recommended that these data be compiled in consultation with the operator especially for complex batch installations. If no data are available, or the processes follow general patterns, then default profiles can be used.

Other Stationary Sources

7.288 In evaluating the possible contribution from these sources (e.g. biomass burning and low level domestic / commercial combustion), it is particularly important that local authorities are clear about the definition of this group of emissions, so that the potential for double-counting is avoided. The definition of the scope of these emissions that is usually applied is “emissions arising from the combustion of the remaining fuel in an area-wide consumption statistic once fuel giving rise to emissions already identified as point- or line- based sources (particularly Part A/B installations and boilers treated explicitly as point sources) have been subtracted”.

7.289 Emission estimations for this source suffer particularly from difficulties associated with obtaining good activity data, and the relatively poor quality of the available EFs. A general method for estimating area-based emissions sources is given in Example 2 in Appendix A. Users should note that spatial re-apportionment across several different geographical bases may be required. The following sections confine themselves to a discussion of some of the more important issues relating to activity data and EFs.

Biomass Burning

7.290 The local authority may obtain details of the maximum thermal capacity of the appliance instead of the maximum rates of emission. Local authorities may then estimate rates of emission based on the Clean Air Act exemption limits or on the basis of typical EFs for solid fuel appliances provided in the EMEP/CORINAIR Emission Inventory Guidebook – 2013[93].The LAQM Support website provides a summary table with the latest emission factors for small combustion sources[94]. In smoke-controlled areas, biomass burners require exemption under the Clean Air Act. Exempted

[93] http://www.eea.europa.eu/publications/emep-eea-guidebook-2013

[94] Page to be added to the LAQM Support Website detailing the Emissions Factors for Small Combustion Sources. These will be updated periodically in line with revisions to the EMEP/CORINAIR Emission Inventory Guidebook and other supporting evidence.

appliances are required to emit less than 5g/h PM plus 0.1 g/h per 0.3kW of heat output.

7.291 Appendix A provides a worked example of calculation to determine the emission rates from small biomass plant use of EFs for calculating emissions for an industrial installation.

Low Level Domestic and Commercial Combustion

7.292 For SO_2 and PM_{10}, in areas that are particularly associated with the domestic combustion of high solid or high sulphur liquid fuel, it is important to fully consider cumulative emissions from these sources. For other pollutants it is unlikely that emissions from low-level domestic and commercial combustion will contribute a significant quantity of emissions and will not warrant detailed consideration.

7.293 Appendix A provides worked examples of preparing an emissions inventory from coal combustion over a residential area and estimating emissions from small boiler combustion over a mixed use area.

7.294 In cases where local knowledge can show that there is no significant domestic or non-point source commercial combustion of coal or oil then NAEI background emissions grids[78] for domestic and commercial emissions can be used and no further investigation is needed.

7.295 Many domestic fuel use surveys have been undertaken in Northern Ireland, so it is worth checking to see what information is already available in these areas before conducting further assessments.

7.296 Where it is likely that there will be significant emissions from domestic or commercial sources then detailed consideration of the spatial emissions should be undertaken, which considers at least at a 500m × 500m emission map of domestic and commercial solid/liquid burning for the appropriate year.

7.297 Using local knowledge and maps, the areas where solid or high sulphur liquid is burned (e.g. estates, commercial areas, etc) should be identified. These areas will be used to constrain the distribution of solid and high sulphur fuel burning in the emission maps. If there are significant commercial sites then these should be treated as point sources and dealt with according to the point source guidance.

7.298 In some cases coal/smokeless solid fuel (SSF) or other solid fuel sales data may be available from coal merchants, possibly on the basis of postcode or other sales areas. It is important to attribute these sales to the point of use, which is potentially different from point of sales. Population or household numbers are a useful surrogate for distributing this sales data within the areas defined as ‘solid/liquid fuel burning areas’.

7.299 Local surveys undertaken under the Home Energy Conservation Act (HECA) can provide detailed local level survey data on domestic fuel consumption by fuel type. This data, if available, can be obtained from the local authority Energy Conservation officer. This data can give quantitative as well as spatial activity data for solid, liquid and gaseous fuel consumption.

7.300 If no local data is available, estimates of emissions from domestic fuel burning on a 1km × 1km grid square basis can be obtained from the mapping section of the NAEI website[78].

7.301 EFs for the combustion of the majority of solid fuels (e.g. coal, peat) and liquid fuels (e.g. gas oil) commonly used are provided in the EF section of the NAEI website.

7.302 It is not expected that emissions from the combustion of gaseous fuels will need to be evaluated in detail, although emissions estimates for commercial and domestic gas consumption are available via the NAEI website should they be required.

Other Sources

7.303 There are a wide variety of other sources that give rise to emissions of pollutants for which objectives have been prescribed. This includes

- Poultry farms;
- Airports;
- Inshore, estuarine shipping and associated port operations;
- Rail;
- Non-Road Mobile Machinery;
- Quarrying and other mineral extraction; and
- Materials handling processes.

7.304 Whilst in the majority of cases these will not require detailed consideration by local authorities, in some instances it may be necessary to estimate these sources in more detail depending on their significance. In such circumstances, local authorities should contact the LAQM Support Helpdesk for further advice.

Appendix A: Worked Examples

Example 1: Use of Emissions Factors for Calculating Emissions for Industrial Installations

7.305 The following case study illustrates the general procedures used to calculate emissions from point-source installations using EFs. Some of the features illustrated in this case study are:

- The scope of ideal activity data requirements from process operators;
- The limitations of commonly available activity data;
- The use of key engineering assumptions in completing the set of activity data required for the application of EFs; and
- The selection and use of EFs.

Case Study 1

7.306 This case study illustrates the use of EFs where the operator has provided sufficient information such that no assumptions, regarding the installation itself, need to be made.

7.307 The following information has been obtained from the process operator:

Installation	Part B Stationary Combustion in Manufacturing Industry
No of flues	One
Fuel use	Diesel (Fuel Oil)
Density of diesel fuel at 15°C	835 kg/m^3
Diesel fuel consumption	150 m^3/yr
Operating hours	3,000 hours/year

7.308 The basic details supplied by the operator are sufficient for a simple emissions calculation, using the EFs from the NAEI website (Category = Energy, Stationary Combustion in Manufacturing Industries and Construction). The EFs for SO_2, NO_X, CO, PM_{10} and $PM_{2.5}$ from the NAEI (kt per Mt fuel consumed) are provided in Table 7.12 (for fuel category = Fuel Oil, i.e. diesel), along with the corresponding EFs presented in units of kg/m^3, calculated as follows:

$$\mathbf{EF_{kg/m3} = EF_{kt/Mt} / 1000 \times D}$$

Where:

$\mathbf{EF_{kg/m3}}$ is the pollutant emission factor (kg/m^3).

$EF_{kt/Mt}$ is the emission factor obtained from the NAEI (kt/Mt fuel consumed).

D is the density of diesel (kg/m^3).

7.309 Therefore, by way of example with respect to NO_x, the EF expressed in units of kg/m^3 is equal to:

$$11.14 / 1000 \times 835 = \mathbf{9.30\ kg/m^3}$$

Table 7.12 – Emission Factors for Diesel Combustion in Manufacturing Industry

Emission Factor	SO_2	NO_x	CO	PM_{10}	$PM_{2.5}$ [a]
EF (kt/Mt fuel consumed)	15.01	11.14	2.25	0.69	0.69
EF (kg/m^3)	12.53	9.30	1.87	0.58	0.58

[a] Note, the $PM_{2.5}$ EF from the NAEI for the Energy, Stationary Combustion in Manufacturing Industries and Construction (Fuel Oil) category is identical to that provided for PM_{10}. In circumstances where the ratio of $PM_{10}/PM_{2.5}$ is known, e.g. from on-site stack monitoring or literature source, then use of a site-specific derived EF for $PM_{2.5}$ is preferable.

7.310 Using this information, the following calculation can be made to estimate annual emissions for these pollutants:

$$\mathbf{E_{tot} = F \times T}$$

Where:

E_{tot} is the total annual emission for one of the case study pollutants (kg/yr).

F is the emission factor for a Part B combustion process (kg/m^3).

T is the annual throughput of fuel oil (m^3/yr).

7.311 Therefore, by way of example with respect to NO_x, the annual emissions estimate is equal to:

$$9.30 \times 150 = \mathbf{1{,}395\ kg/yr}$$

7.312 Application of the above equation results in the annual emissions estimates provided in Table 7.13

Table 7.13 – Annual Emissions from Diesel Combustion in Manufacturing Industry (kg/yr)

Pollutant	SO_2	NO_x	CO	PM_{10}	$PM_{2.5}$
Emission	1,879	1,395	281	87	87

Case Study 2

7.313 This case study illustrates the use of EFs where the operator has provided insufficient information to enable a straight forward calculation of annual emissions from EFs. This study highlights the limitations of activity data and the nature of the assumptions that may be required in order to complete emission calculations.

7.314 The following information has been obtained from the process operator:

Process	Part B Stationary Combustion in Manufacturing Industries
No of flues	One
Fuel Use	Fuel Oil
Thermal Rating	0.5 MW

7.315 The throughput can be estimated from the thermal rating of a boiler. To calculate the throughput the following information is required:

- Annual operating hour; and
- Calorific value of the fuel.

7.316 In cases where the operating hours are not available, but are necessary to calculate annual emissions, it is reasonable to make an educated guess. The composition of waste oil varies according to its former use and, as such, it is difficult to provide fuel parameters that will be representative for all types of waste oil. In the absence of a detailed fuel specification it is possible to use fuel parameters for Heavy Fuel Oil (HFO)/residual oils. Average fuel parameters are available on the NAEI website.

7.317 Thus, to estimate fuel consumption the following assumptions have been made:

Annual operating hours	9.5 hr/day, 6 day/week, 52 week/yr (total over the year = 2,964 hr/yr)
Calorific value of fuel oil (diesel)	37,575 MJ/m^3

7.318 Using these assumed values the annual throughput can be calculated as follows:

$$\mathbf{T = (R \times 3{,}600 \times H) / C_{val}}$$

Where:

T is the annual throughput of fuel oil.

R is the thermal rating of the boiler (MW).

H is the annual operating hours (hr/yr).

$\mathbf{C_{val}}$ is the calorific value (of the fuel oil) (MJ/m^3).

7.319 Therefore, the annual throughput is equal to:

$$(0.5 \times 3{,}600 \times 2{,}964) / 37{,}575 = \mathbf{142\ m^3/yr}$$

7.320 It should be noted that in calculating the throughput from the thermal rating of the boiler the following, additional, assumptions have been made:

- The engine is continually operating at full load, and that fuel is consumed with 100% efficiency.

7.321 Having calculated the annual throughput of fuel oil, the annual emissions can be calculated on the basis of the NAEI EFs following the methodology as described above. Therefore, , by way of example with respect to NO_x, the annual emissions estimate is equal to:

$$9.30 \times 142 = \mathbf{1{,}321\ kg/yr}$$

7.322 Application of the above equation results in the annual emissions estimates provided in provided in Table 7.14.

Table 7.14 – Annual Emissions from Diesel Combustion in Manufacturing Industry (kg/yr)

Pollutant	SO_2	NO_x	CO	PM	PM_{10}
Emission	1,779	1,321	266	82	82

Example 2: Area Sources – Preparing an Emissions Inventory from Coal Combustion over a Residential Area

7.323 The following worked example illustrates the general procedures used to calculate emissions from area-based sources. An example of emissions from general coal combustion over a small residential area where there is high solid fuel or coal use is given. Particular features illustrated by this worked example are:

- The form of the base activity data commonly received from data suppliers.
- Spatial re-apportionment using the capabilities of a mapping package/GIS.
- The importance of recognising and eliminating double counting of emissions in area – source estimates.

7.324 Activity data for area sources is often available only on a spatially-aggregated basis to protect commercial confidentiality, or simply due to the impracticality of obtaining more detailed data. Where this is the case data needs to be re-apportioned from the original geography (which may typically be a postcode sector, electoral ward, county or even national level statistics) to the kilometre grid squares common to the other sources in the inventory. Data may also be estimated per household and apportioned per household. Coal sales data for an area were obtained from the several coal suppliers and merchants in the area for the last full year on a postcode-sector basis. Table 7.15 illustrates the typical form of the raw activity data. If the area in question is a smoke control area, the solid fuel used will in fact be SSF.

Table 7.15 – Coal Sales Data (as received from Fuel Suppliers)

Postcode Sector	Domestic Coal (tonnes per year)	Coke (tonnes per year)
BX8 3	102	19
BX9 1	38	12
BX9 2	45	0
BX9 3	57	5
BX10 7	62	0
BX11 0	110	10
BX11 8	54	3
BX11 9	81	2
BX20 0	70	0

7.325 Industrial and commercial coal (for example, hospitals, council buildings) should be counted under point sources, where possible. If coal is accounted for as an area source, care should be taken not to double-count.

7.326 To be used in an emissions inventory, the original data (on a postcode sector basis) needs to be re-apportioned to the 1km × 1km grid square geography. This can be done using the capabilities of a mapping package. In this case, a simple re-apportionment based on area proportion is used (i.e. the individual grid squares are assigned values depending upon the extent to which they overlie postcode sectors with different total values). More complex re-apportionments (e.g. weighted by relative population density or road length) can be devised if appropriate.

7.327 The spatially re-apportioned fuel usage per kilometre grid square is then multiplied by the EF to produce the emissions per grid square for each pollutant. The EFs for domestic coal (as an example) are given in Table 7.16, and the final calculated emissions from domestic coal in Table 7.17, by multiplying the coal used per square by the relevant EF.

Table 7.16 – Coal Sales Data re-apportioned by Kilometre Grid Square

Grid square (reference ID)	Domestic coal (tonnes per year)	Coke (tonnes per year)
354500,178500	17.97	1.60
355500,178500	12.38	0.68
356500,178500	6.14	0.05
354500,177500	16.89	1.20
355500, 177500	14.72	0.07

356500,177500	18.99	1.58
354500,176500	12.35	0.06
355500,176500	14.96	0.09
356500,176500	17.68	1.20

Source: NAEI

Table 7.17 – Emissions Factors for Domestic Coal (kg of Pollutant per Tonne of Fuel)

Pollutant	SO_2	NO_x	CO	PM
Factor	24.32	3.47	180.69	9.7

Table 7.18 – Calculated Emissions from Domestic Coal

Grid square (reference ID)	Domestic Coal Burnt (tonnes/year)	Emissions (kg/yr)				
		SO_2	NO_x	CO	C_6H_6	PM
354500, 178500	17.97	377	536	24,114	6,945	72,226
355500, 178500	12.38	260	369	16,613	4,784	49,758
356500, 178500	6.14	129	183	8,239	2,373	24,678
354500, 177500	16.89	355	504	22,665	6,527	67,885
354500, 177500	14.72	309	439	19,753	5,689	59,163
355500, 177500	18.99	399	566	25,483	7,339	76,326
354500, 176500	12.35	259	368	16,572	4,773	49,638
355500, 176500	14.96	314	446	20,075	5,782	60,128
356500, 176500	17.68	371	527	23,725	6,833	71,060

Example 3: Area sources – Emissions from Small Boiler Combustion over a Mixed Use Area

7.328 Solid fuel burning tends to be concentrated into small areas or estates, which generally cover less than 1 km^2. The procedure requires authorities to:

- Identify the areas with the highest densities of houses and service sector appliances burning solid fuels.
- Identify the types of solid fuel appliance used in each area from the list provided on the LAQM Support website[55]
- Count the numbers of each domestic heating appliance type in the identified 500 × 500m squares. Estimate the floorspace occupied in the service sector in each of the identified 500m × 500m squares for each of the identified types of solid fuel burning plant.
- Multiply the number of houses for each appliance type by the annual household

emission provided on the LAQM Support website[55]. Sum the emissions from each of the domestic appliance types to give the total annual domestic emission from the 500m × 500m square.

- Multiply the service sector floorspace (in hectares) for each appliance type by the annual service sector emission per hectare. Sum the emissions from each of the service sector appliance types to give the total annual service sector emission from the 500m × 500m square. Add the service sector emissions to the domestic emissions to give the total emissions from the square.

7.329 Estimate the fraction of space in the 500m × 500m square occupied by solid fuel burning premises or domestic properties. Divide the annual emission by the fraction occupied by solid fuel burning to give the emissions density for the square (kg emissions per 500m × 500m area). This emissions density can then be compared to the relevant nomograms to determine if a detailed study is required or not.

7.330 Consider a 500m × 500m square containing a new six hectare development of 400 houses on the outskirts of a large town. The houses are fitted with advanced automatic wood pellet boilers. The new development adjoins an eight hectare older estate. The older estate has largely converted to gas heating but there remain 50 houses that use conventional boilers burning coal. The 500m × 500m square also contains a school with floor area of 0.2 hectares in a plot of one hectare: the school is heated by means of a wood-burning advanced automatic boiler. There is also a public house with floor area of 0.1 hectare in a plot of 0.5 hectare; the public house is heated by open wood fires. The remaining part of the 500m × 500m square does not contain premises burning solid fuels.

7.331 The total emissions of PM_{10} from the residential area are: 400 × 3.54 + 50 × 23.03 = 2,568 kg. The total emissions of PM_{10} from the school and the public house are 0.2 × 295 + 0.1 × 2,291 = 288 kg. The total emissions from all solid fuel sources are then 2,568 + 288 = 2,856 kg.

7.332 The area of the 500m × 500m square occupied by solid fuel heated premises is 6 + 8+ 1 + 0.5 = 15.5 hectares. Thus the fraction occupied is 9.5/15.5 = 0.61. The emissions density is then 2,856 / 0.61 = 4,660 kg/year.

7.333 The background PM_{10} in the area is estimated to be 21µg/m^3. From Figure 7.1, the threshold emission density is 5,013 kg/year. In this case, the calculated emissions for the 500m × 500m square are less than the threshold and there is no requirement to carry out a detailed study.

Example 4: Biomass Plant 50 kW to 20 MW

7.334 A 500 kW net thermal input capacity pellet stove is installed in a building 15m high. The stack height is 21m and the stack diameter is 0.5m.

7.335 The pollutant emission rates are estimated from the factors for pellet stoves given in Appendix A. These are 76 g/GJ for PM_{10} and $PM_{2.5}$ and 90 g/GJ for NO_X. The emission rates are then $76 \times 500 \times 10^{-6} = 0.038$ g/s for PM_{10} and $PM_{2.5}$, and $90 \times 500 \times 10^{-6} = 0.045$ g/s for NO_X.

7.336 The background annual mean NO_2 concentration is 35µg/m^3. The background annual mean PM_{10} concentration is 25µg/m^3. Table 7.19 shows the calculated background adjusted emission rates.

7.337 The effective stack height is $1.66 \times (21-15) = 10$m.

7.338 Table 7.19 also shows the threshold emission rates determined from the Biomass Calculator provided by Defra (see paras 7.40 to 7.45) in the main chapters. In each case the background adjusted emission rate is less than the threshold emission rate and so further detailed consideration is not required.

Table 7.19 – Background Adjusted Emission Rates and Threshold Emissions Rates

Parameter	PM_{10}	Annual mean NO_2	1-Hour Mean NO_2
Emission rate (g/s)	0.038	0.045	0.045
Background concentration (µg/m^3)	25	35	35
Background adjusted emission rate (g/s)	0.0054	0.009	0.014
Threshold emission rate, for 10m effective stack height (g/s)	0.0063	0.020	0.10

Appendix B: Sources of Emissions Factors

7.339 The UK NAEI[78] was developed to aid in the Review and Assessment procedure. The NAEI database includes UK average emission factors for a large number of different source sectors including industrial processes, combustion, transport and residential and commercial combustion. The database also includes a number of screening factors based on employment, number of processes and population.

Other Information Sources

7.340 An atmospheric emission inventory guidebook has been prepared by the expert panels of the UNECE/EMEP Task Force on Emissions Inventories and is published and distributed by the European Environment Agency[95]. The Guidebook is designed to provide a comprehensive guide to atmospheric emission inventory methodology for each of the emission-generating activities listed in the Selected Nomenclature for Air Pollution (SNAP) and Nomenclature For Reporting (NFR) formats reports.

7.341 The United States Environmental Protection Agency (USEPA) has developed a large compendium of EFs, known as AP-42, which includes EFs for most of the pollutants covered by LAQM Regulations[96]. The USEPA reviews and revises its air pollutant EFs every three years.

7.342 Each AP-42 EF is given a rating from “A” through “E”, with “A” being considered as being the most reliable. A factors rating is a general indication of the reliability, or robustness, of that factor. This rating is assigned based on the estimated accuracy of the tests used to develop the factor and on both the amount of data available from tests and the representative characteristics of that data. In general, factors based on many observations, or on more widely accepted test procedures, are assigned higher rankings. Since ratings are subjective and only indirectly consider the inherent scatter amongst the data used to calculate factors, the ratings should be used as approximations. An A rating should be considered an indicator of the accuracy and precision of a given factor being used to estimate emissions from a large number of sources.

[95] http://www.eea.europa.eu/themes/air/emep-eea-air-pollutant-emission-inventory-guidebook/emep

[96] www.epa.gov/ttn/chief/ap42

Appendix C: NAEI Data

7.343 The NAEI's Data section contains up-to-date emissions data for different sources and pollutants. Data are available for online viewing and download.

Emissions Data Section

7.344 This is an online archive of emissions and supporting mapping data available for use by local authorities, the wider scientific community and the public. The datasets provide local authorities with the specific component emissions data that they need to inform detailed assessments.

Local Authority NAEI Data

7.345 Data are stored on the NAEI subdivided for each local authority. A number of datasets are produced under the NAEI, which are useful to Local Authorities and public users interested in their local areas[97]. These datasets include:

- Local and Regional CO_2 emissions;
- Road transport fuel consumption; and
- Non-gas, non-electricity and non-road transport fuel consumption;

[97] http://naei.defra.gov.uk/data/local-authority

4 – Dispersion Modelling of Emissions

Introduction

7.346 This section provides advice to local authorities on the use of air quality dispersion models for the purposes of Review and Assessment. Dispersion models are a valuable tool for a variety of reasons:

- to quantify the contribution of pollutant emissions arising from different sources types on overall concentrations;
- concentrations can be predicted across a wider geographical area than is possible through monitoring alone;
- geographic boundaries of any exceedances of the air quality objectives can be determined;
- concentrations can be predicted for future years, taking into account changes in emissions sources and emissions data; and
- scenario testing can be undertaken in order to determine the source contributions and effects of AQAP measures on predicted concentrations.

7.347 The purpose of this section of the Technical Guidance is to:

- promote best practice and the efficient use of resources for dispersion modelling;
- provide local authorities with useful information and methods to consider when undertaking detailed dispersion modelling;
- help obtain as reasonable results as practicably possible from dispersion models and increase the confidence in model predictions; and
- assist in the sensible interpretation of results.

7.348 This section consider the following topics, which should cover the main issues faced by local authorities when carrying out dispersion modelling:

- How to model road-traffic sources;
- How to model point sources (i.e. stacks from industrial facilities or commercial and domestic sources such as biomass combustion sources);
- How to model fugitive sources;
- How to verify modelled results using monitoring data.

7.349 The main sources requiring detailed dispersion modelling of emissions should be identified through the screening assessments carried out by local authorities. Based on the findings of the previous rounds of Review and Assessments, these sources are expected to include mainly road transport and some industrial processes. Therefore, this section mainly focuses on these sources. However, a number of other transport sources (aircraft, railways and shipping) or fugitive sources such as quarries, waste transfer sites and major construction sites, may require modelling in certain circumstances. In this case, the local authority may want to contact the LAQM Support Helpdesk to obtain further information.

Modelling Road Traffic Sources

7.350 The main roads of concern requiring detailed dispersion modelling should have been identified through a screening assessment using the DMRB air quality screening tool (see para 7.66), the National Modelling Maps, and/or air quality monitoring reported in the local authority's LAQM reports.

7.351 The information in the sections below provides further information on methods to assess road traffic sources in more detail based on more complex dispersion models.

7.352 Local authorities are reminded that any detailed dispersion modelling, should be compared against local monitoring data in order to provide confidence in the results and any decisions made based on the outcome of the modelling. However, this should be only possible if the measurements are of good quality, have been measured over a reasonable time period, and are representative of the receptor location assessed. Although the DMRB air quality model is not considered below (as not a detailed dispersion model), DMRB results should also be compared with local monitoring data wherever possible.

7.353 Monitoring data should also be considered as part of any detailed dispersion modelling work, as they can provide further information on pollution levels in complex areas, such as large and/or congested junctions, street canyons or other situations that may not be assessed well by dispersion models.

7.354 Most local authorities proceeding to detailed modelling of road traffic sources will be mainly concerned with potential exceedances of the annual mean (for NO_2 and/or PM_{10}) and the 24-hour mean PM_{10} objectives. However, the potential for exceedances of the 1-hour mean NO_2 objective should also be considered at relevant receptor locations. In some instances, authorities may also consider annual mean $PM_{2.5}$ concentrations, with reference to the potential to increase $PM_{2.5}$ emissions (England) or the objective limit value (Scotland).

Traffic Input Data for Dispersion Modelling

- The level of detail of traffic input data will vary depending on how much information is available, but in general, should include the following as a minimum, for all identified roads: Traffic flows as Annual Average Daily Traffic (AADT);
- Average vehicle; and
- Fleet composition including at least the split between LDVs and HGVs (generally provided as %HDVs within the total traffic flows).

7.355 When carrying out detailed dispersion modelling, local authorities may consider focusing on small specific areas and sensitive receptors to scales of 10's of metres, as opposed to wider scale modelling that may miss out the details at roadside locations where exceedances are more likely and so miss pollution hotspots. However, it is recognised that some authorities have already set up models covering wider urban areas, or city / town centres as a whole, which may include many different types of

sources. It may however be useful for some sources to be refined in more detail where there are specific local concerns or where local knowledge indicates that an area requires greater attention.

7.356 In general, the use of complex dispersion models will require geographical information such as:

- a numerical model of the road layout to be included in the dispersion model, using a Geographical Information System (GIS) to extract OS coordinates of all roads, including all vertices representing the path of the road;
- the width and elevation of each road sections;
- the grid reference of all specific receptors at which pollution levels need to be assessed; and
- a grid of receptors so that pollutant concentration contour maps showing the potential exceedance of the relevant air quality objectives can be produced, based on the dispersion modelling results

7.357 It is important that to model the source-to-receptor distance as accurately as possible. A visual check (through model interface or GIS) should be carried out to ensure that the modelled roads follow the actual alignment appropriately, and that the start/end nodes and vertices of links are in the correct place.

7.358 The use of GIS can be a quick and easy way to map the correct coordinates for sources and export them directly into dispersion models. In addition, web-based aerial mapping sites can be extremely useful when building dispersion models, as they can provide information on layout and alignment of roads.

Traffic Patterns

7.359 Most dispersion models can take into account complex traffic patterns such as:

- Variations of AADT flows during a week, month or season; and
- Hourly variations of traffic flows along the day (including change of patterns during weekends).

7.360 A diurnal pattern of average hourly speeds may also be available to use in modelling predictions. Local authorities may consider further splitting a road link, for example at the approach of a junction, in order to model the reduction in average speed in these locations.

7.361 Local authorities may consider different vehicle speeds over different time periods in order to account for congestion during peak hours and more free flowing traffic at night. Example time periods could be as follows:

- Morning Peak (7am – 9am)
- Inter-peak (10am – 4pm)
- Evening Peak (5pm – 7pm)

- Night-time (8pm – 6am).

7.362 It should be noted that diurnal patterns (both in terms of traffic flow and speed) may be related to two-way flows, and therefore the road links within a model should reflect this. Where a road, for example a motorway or A-road, has been modelled as separate sources depending on direction of flow, then the diurnal patterns for each of these sources should also reflect the direction of flow. This may be important for example where a road experiences a larger volume of traffic in one direction in the morning, whilst the flow on the other direction has a different pattern, with large flows in the afternoon.

Modelling Variable Speeds

7.363 Average vehicle speed can vary significantly throughout the day, with much lower speeds observed during AM and PM peak hours. Where significant variations in hourly speeds are known to occur, it may be useful to account for speed variations. Some models may allow detailed variations to be input relatively easily. Other models may require the user to split or duplicate links a number of times in order to emulate variable inputs. A few options are discussed below.

7.364 The simplest way to consider variable speeds is to split road links into three sections – one at each end of the link representing the sections of the road approaching a junction (considering a lower speed over these sections), whilst the middle section represents the average free flowing speed. This is not strictly a variable pattern as the same speed for each hour is still considered, but provides an easy method to account for lower average speeds, for example where queuing is known to occur.

7.365 Where a model does not allow the user to input hourly speed information, a more complex method may still be used, which involves overlapping links a number of times and using hourly emissions profiles to apply different emissions at the appropriate hours in the day. This is illustrated with the example below:

- Enter the same link a number of times within the model and provide emissions for the relevant speed as representative of the hour required for each copied link.
- Use variable emissions profile to effectively “turn-on” or “turn-off” the relevant link in the dispersion at the appropriate time. For example, a link may be copied four times thus:
- Link1_AM: AM peak speed (hours beginning 7am - 8am);
- Link1_PM: PM peak hour speed (hour beginning 5pm - 6pm);
- Link1_Eve: Night-time speed (for hours between 7pm – 6am); and
- Link1_Inter: Inter-peak speed (for all other hours)
- When setting up the road links, the speed for the relevant hour may be:
- Link1_AM: 10 mph
- Link1_PM: 15 mphLink1_Eve: 40 mph
- Link1_Inter: 30 mph

7.366 The emission profile for Link1_AM will then be provided so that only the hours 7am-8am have emissions accounted for. This can be done by providing a factor of one for these two hours, whilst all other hours are set to 0 (zero emission).

7.367 The use of this overlapping system allows greater variability of inputs, and may also be used to vary other data such as proportions and speeds of HDVs. In this way, detailed traffic flows and speeds can be considered within dispersion models. An example of when this type of detailed approach may be useful is when assessing the impact of traffic management measures expected to reduce queue lengths of traffic, improve speeds on roads, or vary the diurnal pattern or speed of traffic flows on specific roads.

Varying Speeds and Traffic Flows for Different Hours

7.368 In many models, the user can vary the number of vehicles per hour per link assuming a particular speed. For example, the vehicles per hour entered for Link1_AM is 1200 vehicles per hour at 10mph, which represents the 7am traffic flow and speed. The emissions profile for that link can also be used to alter the traffic flow for the hour 8am but keeping the same speed. For example, the traffic flow at 8am is twice that of the 7am flow (with an average speed of 10mph). Using the emissions profile, the factor for the hour 7am remains at one, but for 8am is factored up by two (thus doubling the hourly traffic flow whilst maintaining the same speed).

7.369 Note, it may be more difficult to use the emissions profiles in the same way to vary the proportion of HDV and speed at the same time as the factors are more difficult to determine (unless emissions tools and inventories are used to perform the calculations). If this is required, and a model does not allow hourly input to this level, a duplicate set of links may be entered, one for example for LDVs only, and one set for HDVs only. Each can then be varied for speed and/or flow throughout the day using link copies.

Modelling Congestion

7.370 In many cases, the area requiring detailed dispersion modelling is likely to include busy junctions where traffic congestion is a main concern. Modelling congestion can be carried out in a number of ways depending on the constraints of the model, in particular the number of links that can be entered.

7.371 A simple way to model congestion is to split the road link into three sections, similar to that representing a junction or crossing, and reduce the speeds in those sections where queuing traffic is known to occur. Additional complex methods may also involve accounting for the variable speeds during different hours as described above.

7.372 However, other model setups may be considered, such as varying certain links representing queues. For that purpose, estimates of the following would be required:

- queue length;

- traffic speed; and
- variability of congestion throughout the day.

7.373 To represent the variability of congestion during the day, the method described above for overlapping links can also be used. Local authorities should be careful not to double count emissions of traffic when modelling queues and diurnal patterns. Both variable speeds and idling emissions could be used in some specific locations, for example for complex junctions.

Modelling Accurate Vehicle Fleet Composition

7.374 Whilst some models may only allow LDV and HDV flows as input data, most models should allow entering user-defined pollutant emissions rates, allowing a better representation of the actual vehicle fleet composition.

7.375 These may include (but are not limited to) the following vehicle type classifications:

- cars (petrol and diesel);
- LGVs (petrol and diesel);
- HGVs (rigid and articulated);
- buses and coaches; and
- taxis (sometimes defined as a separate category when derived from traffic models).

7.376 A combined emission rate can be entered for a road link based on the relevant proportions of each type of vehicle. If this is the case, the speed for all vehicles will be assumed to be the same. In some cases the speed may be different (for example, HDVs on motorways), or a local authority may be interested in calculating the contribution a certain type of vehicle makes to the total pollutant concentrations at a nearby sensitive receptor. This may be done using the “layering” system described above, by setting up several emission sources on top of each other for each vehicle type, and entering in emissions for that type only. For example, a road source termed “Road1” which incorporates all vehicle types could be modelled as ”Road1_Cars”, ”Road1_LGVs”, “Road1_HGVs” and “Road1_Buses” as separate sources.

7.377 This type of setup can be useful as the contribution of each road link to concentrations predicted at a receptor can easily be determined, and the model input can also easily be changed. For example, this can be used to determine what happens if the vehicle speed or number of vehicles changes for a specific vehicle category.

7.378 Local authorities may have more detailed estimates of vehicle classifications such as proportions of diesel and petrol cars and LGVs, rigid and articulated HGVs, along with separate estimates of buses and coaches. Local estimates should be included in dispersion modelling where available. However, in the absence of local estimates, default splits of petrol/diesel and EURO emission categories are built into the EFs within the NAEI and the EFT.

Source Apportionment for Different Vehicle Types

7.379 Source apportionment studies should be carried out as part of LAQM assessments in order to determine the relative contribution of vehicle types at specific worst-case receptor locations. These source apportionment studies can also be useful when considering the impacts of different traffic management options, for example as part of scenario testing within action plans. The methodology is described in para 7.81 and a worked example provided in Box 7.4.

Modelling Street Canyons

7.380 Accurate dispersion modelling in urban areas can be difficult due to the presence of obstacles (buildings, trees, walls, etc) that modify the wind flow locally and alter dispersion. This is especially the case in so called “street canyons”, where buildings on both sides of the road can lead to the formation of vortices and recirculation of air flow that can trap pollutants and restrict dispersion (often termed as the “canyon effect”). Street canyons can generally be defined as narrow streets where the height of buildings on both sides of the road is greater than the road width. However, broader streets may also be considered as street canyons where buildings result in reduced dispersion and elevated concentrations (which may be demonstrated by monitoring data). Therefore canyon effects can occur both in small towns or large cities.

7.381 Studies involving monitoring campaigns on both sides of street canyons have shown that background concentrations influence pollutant levels within street canyons, as the air mass at rooftop level moves into the canyon, leading to increased ventilation and “flushing out” of polluted air. Similarly, gaps between buildings may allow increased wind flows to enter the canyon thus re-circulating pollutants away from the junctions, but causing increased concentrations further away. The opposite effect however may occur if the gap is at junction, where road traffic emissions are carried into the canyon, resulting in higher concentrations.

7.382 Even when using complex three dimensional models (Computational Fluid Dynamics – CFD models), it is unlikely that such degrees of complexity are adequately accounted for, and the uncertainties of modelled results can be difficult to quantify.

Street Canyon Models

7.383 Models designed for the prediction of air pollution concentrations within street canyons aim to calculate the zone of recirculation of wind flow in order determine the resulting concentrations within these locations. Wind direction and velocity is used to determine where (for example on which side), and how large the recirculation zone may be. The size of the recirculation zone varies and may occupy the whole width of the street, or the leeward side only (the upwind side). Concentrations within the recirculation zone are considered to be uniform (or homogenous) by many dispersion models.

Main Parameters to Consider when Modelling Street Canyons

7.384 Weather conditions such as wind speed, direction and temperature will affect the dispersion of pollutants within street canyons. These parameters are usually included in a meteorological file (generally hourly sequential data for a whole year) as model input data. Other parameters that need to be considered (for each modelled road link assumed to be a street canyon) are:

- the street canyon width, which is not the road width, but the distance measured as façade to façade of buildings on either side of the street; and
- the average height of buildings on both sides of the road (some models may allow specifying different heights for each side).

7.385 Where a street can be partially classified as a street canyon, for example where there are gaps in between blocks of buildings, monitoring in such locations may indicate elevated concentrations. It is therefore recommended that local authorities consider these links as street canyons; otherwise predicted concentrations are likely to be underestimated.

Potential Issues Associated with Street Canyon Modelling

7.386 The limitations associated to street canyon modelling should be understood by consulting model suppliers and user guides. A common mistake is to model specific receptors outside of a street canyon. Models accounting for street canyons generally split the modelled area in two parts: the actual street canyon (delimited by the canyon width) and areas outside the canyon on both sides of the road. While predicted concentrations within the canyon are higher, modelled concentrations outside the canyon may decrease rapidly. Therefore, it is recommended to check the distance of receptors to the centre of the road and compare to the canyon width, to ensure they are correctly located within the street canyon.

Installing Monitoring Sites in a Street Canyon

7.387 Local authorities are advised in most circumstances to monitor concentrations at the roadside and building façade at a number of locations within a street canyon. In the absence of widespread monitoring in a number of street canyons, the results from a single detailed study could be used to help assess similar areas on the bases of comparisons of traffic flows and to compare against the predictions from models.

Modelling Junctions

7.388 Junctions are relatively easy to set up in a dispersion model. The model set up should consider changes in speeds, road widths, queue lengths and congestion as described in the sections above. In many cases a simple approach may be sufficient to model a junction, by accounting for reduced speeds on road links within 25m to 50 m of the junction, and including diurnal patterns of traffic flows. More detailed modelling may be

required, such as considering street canyons (see para 7.380), splitting the main roads into multiple lanes to account for separate traffic movements on the various arms of the junction (see para 7.405), including bus lanes. The requirement to increase the level of detail at a junction will depend on the level of relevant exposure at the location and the risk of exceeding the objectives. Local knowledge and data gathered through local monitoring studies will assist in this regard.

Modelling Car Parks

7.389 Car parks are unlikely to require detailed modelling for Review and Assessment. However, local authorities should still consider the local access roads, which are of more concern locally, particularly where queuing or congestion is created on these roads (typically during peak hours). In some cases, local authorities may wish to consider the impact of a proposed new car park on local air quality, if there are receptors close by. Information on the potential ways to model car parks is provided below.

7.390 There are a number of different types of car parks including surface, multi-storey, underground and mezzanine. Car park emissions may be fugitive, through open-to-air façades, or controlled via mechanical or passive ventilation systems. Emissions from surface and multi-storey car parks may be typically modelled as area or volume sources, whilst emissions from underground car parks fitted with a mechanical ventilation system may be modelled as point sources. Model developers and user guides should be referred to for the specific requirements associated to these sources.

7.391 It is recommended that for multi-storey car parks, a series of area sources be used as opposed to one single volume source, to better represent the spatial distribution of emissions in relation to nearby receptors.

7.392 Where detailed modelling of car parks is deemed necessary the following information is likely to be required:

- the hourly profile of number of vehicles entering and leaving the car park;
- assumptions related to idling time for vehicles. This may vary for short-term and long-term car parks, but emissions should be calculated (in the absence of idling emission factors) assuming a speed of 5kph;
- assumption of the proportion of vehicles assumed to enter and/or leave the car park under cold start conditions;
- assumption of the proportion of vehicles assumed to experience ‘hot soaks’ (only of relevance for benzene);
- an estimated average distance travelled by each car within the car park and the average speed (often a speed limit of 5 to 10 mph is in place). Where this is not known, it may be assumed, for example, that each vehicle travels a distance equivalent to the perimeter of the car park; and
- diurnal profile of traffic flows on the car park access roads.

Modelling Bus Stations and Bus Stops

7.393 It is sometimes necessary to include the contribution of emissions from a bus station or bus stops when carrying out detailed modelling, as these are often responsible for hot spots of pollution concentrations in urban areas. In particular, emissions from bus stations and bus stops may lead to exceedances of the 1-hour mean objective for NO_2. As modelling exceedances of this objective is difficult, local authorities should focus on identifying modelled NO_2 annual mean > 60µg/m^3 (see further information in para 7.78).

7.394 The main difficulty in bus station/stop modelling is the uncertainty associate to bus EFs, especially from idling engines.

7.395 Note that if a bus station or bus stop is modelled as part of a wider area (part of a town or city centre), a separate model verification may be necessary for the bus station area alone (based on monitoring data from sites located near the station), while the rest of the model is verified with results from typical roadside monitoring sites.

Bus Stations

7.396 Modelling a bus station should not be undertaken without robust monitoring data to verify modelled results, as these are likely to be subject to significant uncertainties. Given these uncertainties, local authorities may even choose to rely on monitoring alone to determine whether there is a risk of exceedance of the air quality objectives.

7.397 The most common way of modelling a bus station is to include an area or volume source in the model set up with a specific EF, as well as modelling emissions from the access roads. EFs should be combined with local parameters such as:

- the number of buses per hour stopping at the station, and
- the average time of idling.

7.398 This should allow the calculation of an overall emission rate that reflects the local conditions.

7.399 The diurnal pattern should also be included to reflect the variations of bus flows throughout the day. This could involve undertaking detailed traffic counts on relevant roads close to bus stations in order to determine patterns appropriately, or bus station timetables could be used to determine the frequency of buses throughout the day.

7.400 In the absence of idling emissions factors for buses, it is possible to estimate emissions assuming buses travelling at a low speed (the lowest speed allowed by the EFT should be used, typically 5kph). If using speed related EFs for idling buses, the method described above (for car parks) should be used, with the relevant EFs for buses, and the estimated idling time for each bus to determine the emission rate. It is recommended that idling times are based on the observed operation of buses as these may vary.

Bus Stops

7.401 In practice, it can be difficult to model all bus stops within a large area. Therefore, the decision to include bus stops in the model set-up should, wherever possible, be based on evidence from monitoring data that the air quality objectives are at risk of being exceeded at sensitive receptors nearby.

7.402 Local authorities should take care when selecting suitable monitoring locations near bus stops, as these sites are only likely to be representative in terms of exposure to the 1-hour mean objective for NO_2 (if there are no residential properties or other sensitive receptors relevant for the annual mean objectives nearby).

7.403 As for bus stations, bus stops may be modelled as area or volume sources. The overall emission rate should ideally be based on:

- an idling EF;
- the number of buses per hour (or per day); and
- a diurnal pattern to take into account variability in bus traffic throughout the day.

7.404 If a bus stop affects the speed of traffic locally, it may be useful to split road links close to the bus stop to assign appropriate lower speed to vehicles.

Modelling Multiple Lanes of Traffic

7.405 In certain circumstances, it can be useful to model separate traffic lanes (for different directions) instead of modelling one road. This is likely to improve the accuracy of predicted results along the road of concern. Locations where separate lanes may be useful to consider include:

- wide roads, like dual carriageway, A-Roads or motorways;
- queuing on one side of the road near a junction while the other side is free-flowing.

7.406 Care should be taken with regard to how the model deals with road widths, particularly in areas that are being modelled as street canyons.

7.407 If traffic data are available, detailed dispersion modelling of wide roads may include separate road sources for each direction. This may be beneficial as it should allow a better representation of different speeds for traffic travelling in different directions (for example approaching or leaving a major junction), and different proportions of vehicles and diurnal traffic patterns may be incorporated.

7.408 Splitting wide roads into different directions may prevent the effect of vehicle-induced turbulence to be correctly taken into account within the dispersion model. However, in many cases, having a more accurate representation of traffic flows in the model is likely to overcome this potential issue.

Modelling Road Gradients

7.409 As discussed in section 3 of this chapter dealing with emission estimates (para 7.226), road-traffic emissions on roads with significant gradient (> 2.5%) can increase significantly (especially exhaust emissions from HDVs), as the engine power demand for vehicles going can increase significantly.

7.410 Adjusted HDV emissions factors for roads with significant gradient have been described in this Chapter (section 3 para 7.226).

7.411 Local authorities may want to model the effect of road gradient on overall road traffic emissions using this methodology. This should require identification of all roads with a gradient > 2.5%. This information should be available from the Council's transport department.

Taking Terrain into Account

7.412 Most of the dispersion models have been developed to predict pollutant concentrations on flat terrain, i.e. without taking topography into account. However, in reality complex terrain such as hills or valleys may have a significant effect on the dispersion of pollutants, especially for large scale modelling (over 1km). A number of dispersion models may include an option to model the effect of terrain on pollutant dispersion, based on a Digital Terrain Model (DTM), which can be entered in the model set-up.

7.413 However, the effect of terrain is mostly considered in the case of point source modelling, where emissions from stacks can have an impact far from the source. This case is discussed in further detail in para 7.434.

7.414 Model providers should be contacted for advice on including terrain when modelling sources such as roads. The standard criterion in considering terrain is a 10% gradient in slopes. Under this value, it is generally unnecessary to include terrain in the model set- up. However, in practice, it is likely that the effect of buildings in urban areas, and in particular the street canyon effect, will be a more important parameter affecting the dispersion of pollutants. Therefore, modelling the dispersion of road-traffic emissions is generally not recommended.

Modelling Road Layouts which Vary with Height

7.415 In most cases, modelling the dispersion of road traffic emissions will not include road elevation, as the difference in height between the source of emission (the road) and nearby sensitive receptors can be modelled by setting up receptors at the correct height relative to the source. For example, the model will be typically set up by considering emissions from road traffic occur at ground level (0m in the model), and receptors are at 1.5m (or at a particular building storey height). Some dispersion models allow the type of road to be defined including bridges, depressions and cuttings, embankments, elevated roundabouts and slip roads.

7.416 Setting up the model to account for varying road source heights, especially where there are sensitive receptors, is an important point to consider.

7.417 The key consideration should be to assign road and receptor heights taking into consideration the relative difference in height between source and receptor.

7.418 Model suppliers should be contacted for further advice on representing variably source heights within models, particularly where heights greater than 10m are thought to be required as vertical wind profiles determined within models may affect modelled concentrations. As for many detailed dispersion modelling options, some testing of the sensitivity of results to these options is recommended, particularly where model verification is being performed.

Spatial Resolution of Modelled Receptors

7.419 The aim of detailed dispersion modelling is to focus on specific hot spots such as single roads or junctions where potential exceedances of the air quality objectives have been identified through previous screening assessments.

7.420 Typically, dispersion models should be set up so that concentrations can be predicted at:

- Specific receptor locations representative of exposure; and
- On a grid of receptors with a 5m resolution or less near to the roadside to determine the extent of areas where exceedances are more likely to occur, which can then be used to declare AQMAs.

7.421 Where models generate receptor locations automatically (for example based on a function determined by road width) local authorities should check that receptor locations are representative of relevant exposure and do not miss out the areas closest to the road source (worst-case locations).

7.422 Concentration contours are generally drawn for the areas where exceedances have been identified based on verified dispersion modelling of road traffic sources. This does not mean that whole urban areas need to be contoured, particularly background locations in smaller towns where pollutant concentrations are unlikely to approach the objectives. Specific receptors should first be used for any detailed modelling at the roadside and then contours produced for the relevant areas with, or close to exceedances. This approach can save considerable time and resources.

7.423 Where contour maps for a whole urban area are required, these should include greater detail within 30m to 50m of roads (sometimes further for dual carriageways or motorway sites, where the drop-off distance for concentrations to reach background levels is greater), and generally be based on a grid spacing of 5m to 10m. General background concentrations for most urban areas are well known and do not require detailed contouring. However, verified modelled background concentrations based on local emission inventories may be useful for wider decision making purposes.

7.424 The risk of modelling pollutant concentrations in large regions with a low spatial resolution is that the model is likely to miss hot spots of air pollution where exceedances are likely. It is particularly important for dispersion modelling of road traffic emissions, as concentrations tend to reduce quickly as the distance from the

road increases. Therefore, the spatial resolution of a modelled grid of receptors is a key parameter of model setup.

Background Concentrations for Road Traffic Modelling

7.425 Dispersion models may allow users to provide hourly background concentrations. However, in most cases, annual mean background concentrations should be sufficient for road traffic assessments. Hourly mean backgrounds may be used in certain circumstances, such as when a model undertakes the conversion of NO_x to NO_2 directly.

7.426 The way to project annual mean background concentrations to future years is set out in para 7.58. Local authorities will also need to project hourly background data for future years where these values are used in an assessment. In the absence of more detailed projection factors, the hourly background concentrations may be adjusted using the projection factors derived from the annual mean data.

Modelling Point Sources

7.427 When predicting the impacts of stack emissions for Review and Assessment purposes, the use of Emission Limit Values (ELVs) for authorised processes is often pessimistic and many plants operate well below these. The modelling assumptions should be realistic but conservative. The onus has to be on information from the operators. Useful data may also be obtained from the annual returns from process operators to the regulatory agencies (see para 7.241).

7.428 It is important to identify the emissions profiles for point sources as these have an impact on the contributions to short-term concentrations. It is also advisable for local authorities to contact the regulatory agencies for information on any previous modelling assessments they may have carried out, in order to avoid duplication of effort and ensure consistency.

Modelling Variable Emissions from Stacks

7.429 In the first instance, modelling stack emissions assuming a constant annual emission rate should be carried out. Modelling variable emissions should only be carried out if this simpler approach has indicated potential exceedances of the relevant air quality objective (considering both stack and background contributions to overall concentrations). For large industrial facilities, it is likely that continuous emission rates, on an hourly basis, will be available.

7.430 For other processes for which this data is not available, local authorities should collate general operation times for processes (hours of operation per day, days per month etc).For a process identified as having batch cycles that cannot be described temporally, liaison with the operator and/or regulatory agency will be required. The LAQM Support Helpdesk may also be able to help for specific situations.

7.431 Random infrequent events such as cleaning start-up/shut down and failure should not be modelled for Review and Assessment purposes. In general monitoring is not available during these times.

7.432 If information regarding future abatement, planned changes fuel use, operation times or future production is known, these should be considered for modelling of future years. It is recommended that any such information should be discussed and emissions to consider agreed with the regulatory agency prior to modelling.

7.433 Monitoring is sometimes only undertaken for total particulate matter (generally referred to as TSP – Total Suspended Particulate), not PM_{10} or $PM_{2.5}$. For certain processes, the $PM_{10}/PM_{2.5}$ emissions can be estimated from particle size distributions reported in the literature[98]. The LAQM Support Helpdesk may also be able to assist. As a worst-case assumption, all the TSP emissions can be assumed to be in the $PM_{10}/PM_{2.5}$ fraction. However, this may be too pessimistic for detailed stack modelling where the contribution of the stack is significant. Similarly, monitoring may only be carried out for total heavy metals and total VOCs, rather than for specific species of concern for LAQM reporting (respectively lead and benzene).

Taking the Effect of Buildings and Terrain into Account

7.434 Most dispersion models include options to take into account the effects of nearby tall buildings and topography on the dispersion of stack plumes, which can be significant. However, model uncertainty using these options is generally considered greater and it is always recommended to carry out sensitivity tests (particularly when modelling buildings) as part of the assessment.

7.435 When building wake effects and/or terrain effects are included, results from different dispersion models can be very different[99,100] and caution should be exercised in the interpretation of these predictions.

7.436 The difficulties with modelling terrain and building downwash effects should be borne in mind, and a greater margin of uncertainty allowed for, when deciding on a declaration of an AQMA. It is noteworthy that terrain modelling is usually unnecessary if the slope is less than 10%.

Building Wake Effect

7.437 In the case of building wake effects, particular care should be paid to results predicted at receptors:

[98] US EPA AP 42 Compilation of Air Pollution Emission Factors - http://www3.epa.gov/ttnchie1/ap42/

[99] R&D Technical Report P353: A review of dispersion model Intercomparison studies using ISC, R91, AERMOD and ADMS

[100] R&D Technical Report P362: An Intercomparison of the AERMOD, ADMS and ISC dispersion models for regulatory applications

- within the main plume recirculation zone (lee of the building), where a proportion of a plume is can be trapped (or entrained), and
- in the turbulent wake zone, which is at a greater distance on the leeside of the building.

7.438 In many cases, these areas are within or close to the site boundary of facilities with no public exposure nearby, but where concentrations are predicted to approach the objectives it is recommended that further model sensitivity tests are undertaken. In some cases where there are relevant receptors, monitoring may be required to support the findings of the dispersion modelling.

7.439 Modellers should take care when considering the number of buildings to be input to dispersion models and the model suppliers should be contacted for further advice, as the treatment of large numbers of buildings vary depending on the model used. It is important that the buildings upon which stacks sit (on top or adjacent to) are considered as in many cases these will be the most significant buildings affecting the plume dispersion. However, there may be other tall buildings on industrials sites which may also have an impact on plume dispersion and these should be included. Where there are very complex layouts with many buildings, some sensitivity testing should be carried out as a means of determining the most significant buildings.

7.440 Where there are a large number of buildings in the vicinity of stack source, those closest (and often tallest) should be included, and the modelled surface roughness may be increased as a proxy to model the effect of the remaining buildings on plume dispersion.

7.441 In some cases, the impact of plumes on high rise buildings may need to be assessed. This can be achieved by modelling receptors at varying heights in the location of interest.

Rain Shields, Vents, Areas and Volume Sources

Rain Shields

7.442 Rain shields fitted on stacks affect the vertical plume rise. It is “custom and practice to set the exit velocity at 1 m/s for such releases. This effectively allows only the thermal buoyancy of the efflux gases to affect plume rise and stack tip downwash (or stack induced downwash) calculations are often performed by models in these circumstances.

Non-Vertical Vents

7.443 Release points are sometimes non-vertical, e.g. an horizontal vent protruding from the side of a wall. Whilst most models can take this type or source into account, complex plume entrainment between buildings is likely, which cannot always be modelled reliably by dispersion models.

Area and Volume Sources

7.444 Most models allow users to model emissions as area and volume sources. Predicted contributions from these sources are more uncertain. Although volume and areas sources may be used interchangeably, it is important to note that for area source allow varying the temperature and efflux velocity, but this is not always the case for volume sources. Where the temperature of the emission source emits equal to or higher than ambient temperature, thermal buoyancy will lead to plume rise; and modelling that kind of sources as an area source is likely to be more appropriate. Moreover, for volume sources, the modelled source height and depth are important parameters that may have a significant on predicted concentrations.

Coastal Effects

7.445 Some advanced dispersion models allow for the simulation of coastal effects. Coastal effects are meteorological events triggered by the temperature difference (and therefore air pressure) between the sea and land. These include the development of a see breeze (or onshore wind) during the morning, and the reverse land breeze (offshore wind) in the evening. These meteorological events can have a significant impact on the way plumes from industrial stacks disperse in the atmosphere. Generally these effects are understood to be important only for stack sources within a maximum of 5km of the coastline. Modelling of coastal effects requires some additional meteorology data, such as sea surface temperature and temperature over land near the sea.

7.446 For the purpose of Review and Assessment, coastal modelling should not be required. However, in particular circumstances, local authorities may choose to investigate the impacts using dispersion modelling coastal effect options. For this purpose, local meteorological data used as input data should be representative of the coastal location. It is also recommended that modelling is carried out with and without the coastal effects module in order to understand the difference between the predicted concentrations, as concentrations predicted using the coastal effect option in dispersion models are generally subject to more uncertainties.

Spatial Resolution of Modelled Receptors

7.447 Where local authorities are assessing point sources, receptor grid resolution should be in the order of 25m-50m, particularly where relevant exposure exists within 500m of a stack. Greater spacing can result in areas of impact being missed (see example in Figure 7.9).

Figure 7.9 – Difference in Contours based on modelling using a 200m (upper) and 50m (lower) receptor grid resolution

Meteorological Data

Sources of Data

7.448 There are a number of suppliers of meteorological data in the UK including the Met Office[101], MeteoArchive[102] and ADM[103]. When purchasing meteorological data it is

[101] www.metoffice.gov.uk

[102] http://uk.meteoarchive.com/

[103] www.aboutair.com

important to confirm with the supplier that the proper Quality Assurance and Quality Control (QA/QC) has been undertaken. The Met Office website contains a list of observation sites for which observed data for modelling are available. Links to sources of relevant information on equipment and site locations, and changes to the site, are also provided. References are also available for the quality control processes used for the datasets provided by the Met Office.

7.449 Information on the source of data and. where possible. the type of instrumentation employed should be obtained. Users should confirm whether the data provided are hourly sequential, as measured, or whether missing hours have been filled. For example, some automatic stations provide data every three or five hours, and algorithms are used to calculate the missing data. Where possible hourly measured data should be used.

7.450 The number of meteorological sites providing manual cloud cover is limited across the UK, but there are a large number of sites with automatic cloud cover measurements.

7.451 In some cases local authorities may have access to local meteorological data, including wind speed and direction, temperature and rainfall measurements. Local meteorological data can assist in many studies, particularly where it is undertaken as part of monitoring campaigns.

7.452 The Met Office can be contacted for advice on the placement and operation of meteorological stations. In addition, locally operated meteorological stations may not provide all of the required parameters required for dispersion modelling, for example cloud cover. The Met Office can advise on the combination of information from different stations, commonly cloud cover from one site, combined with other parameters from a different site. Local authorities should not undertake this without further advice, as suitable checks on the data should be necessary to ensure the modelling is based on robust meteorological data.

Treatment of Calm and Missing Meteorological Data

7.453 In calm wind conditions (i.e. very low wind speeds), a number of models will not calculate pollutant concentrations for the relevant hours, unless some approximation is built into the model. The high percentiles of pollutants from ground level sources (for example road traffic) often occur in such calm conditions, and are therefore difficult to model with confidence. Anemometers should be capable of measuring very low wind speeds; ultrasonic anemometers are especially well suited to this.

7.454 Modelled outputs should be checked to identify the number of missing hours and calm hours ignored by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances.

Calculation of Percentiles and/or Number of Exceedances of the Air Quality Objectives

7.455 When hourly meteorological data available is less than 85% over a year (due to missing or invalid data, or calm wind conditions ignored by the model), modelled short-

term concentrations should be expressed as percentiles, rather than as number of exceedances.

Use of Numerical Weather Prediction (NWP) Data

7.456 The Met Office uses the Unified Model (UM) for numerical weather prediction[104]. This allows meteorological data to be interpolated for any desired location, which can be used for dispersion modelling. However, when using Numerical Weather Prediction (NWP) data, modelled concentrations should be compared with those predicted based on standard meteorological observations data (OBS). Comparing modelled predictions against local monitoring may also be undertaken in order to determine the change in model performance when using NWP data.

7.457 NWP data may be a useful alternative to OBS data where there are no suitable meteorological data available, or where OBS data are unlikely to represent local meteorological conditions around the modelled source. NWP data may also be useful in coastal areas or location with complex terrain features if there are no OBS data available from a suitable local site, as the structure and atmospheric stability may be better represented. Detailed comparisons of the meteorological data needed for dispersion modelling, such as wind speed and direction, cloud cover, boundary layer depth, and atmospheric stability, have been carried out, which give reasonable confidence in the use of NWP data, provided that care is taken to assess the local geography and recognise the limitations associated with each type of data, OBS and NWP105.

Selecting Year of Meteorological Data

7.458 There will be some difference in the prediction of the contribution of sources when using different years of meteorological data. However, this will vary between site, sources modelled, and averaging period being predicted.

7.459 For the purposes of Review and Assessment only one year of meteorological data need be used. The year of data used should be the same for:

- emissions estimates;
- monitoring data;
- background estimates; and
- meteorological data.

7.460 The choice of year of meteorological data may have less influence in modelled concentrations compared to the background pollutant contributions, which can vary significantly from one year to another. Decisions regarding requirements for AQMAs

[104] http://www.metoffice.gov.uk/research/modelling-systems/unified-model

[105] Papers by Middleton D R available for two conferences, harmo 11 and harmo 12, available at www.harmo.org

and areas of exceedance should therefore be based on the worst-case year of assessment. Predictions for future years should also be based on a suitable worst-case year (see para 6.11).

7.461 Where point sources are modelled, choosing meteorological data for different years will have an impact on the predicted location of maximum concentrations.

Background Concentrations for Point Source Modelling

7.462 Background concentrations used for point source dispersion modelling may be based on annual mean or hourly mean background data. As the main focus for point sources is usually the shorter term air quality objectives (with high percentiles or number of exceedances to be predicted) this generally requires detailed consideration of background pollution, and hourly mean background data should be used when available.

7.463 However, annual mean background should be sufficient in case there hourly pollutant emission rates are not available. This is described in more detail below in order to allow local authorities to account for predictions of short-term percentiles.

7.464 The EA provides information on methods for combining background and the process contribution of sources[106] in relation to the relative contributions of these sources, and the risk of exceeding the relevant air quality objectives.

7.465 The estimates of the process contribution and background concentrations should match the relevant air quality objective or Environmental Assessment Level (EAL). For short-term air quality objectives, it is not meaningful to add percentiles of process contribution to percentiles of background as the meteorological conditions under which high ground level concentrations from a stack occur will not coincide with those that lead to high background concentrations.

7.466 For the assessment of annual mean concentrations, background and process contributions should be added to estimate total annual mean concentrations.

7.467 For the assessment of short-term concentrations, the preferred method is to add hourly mean background from a suitable background monitoring station to the hour-by-hour predicted process contribution. However, detailed hour by hour consideration of background and process contribution may not be required in the first instance. Local authorities may use the methods provided in Box 7.9 to account for background concentrations when modelling point sources and determine if the air quality objectives are likely to be exceeded or not[107]. If, following the methodology in Box 7.9, more detailed modelling is required; this may include variable hourly emissions (as opposed assuming continuous operations), and/or the addition of hour by hour

[106] Environment Agency Science Report SC030174/1 SR1 and SR2 October 2006 - https://www.gov.uk/government/organisations/environment-agency

[107] Environment Agency Science Report SC030174/1 SR1 and SR2 October 2006 - https://www.gov.uk/government/organisations/environment-agency

background to hour by hour predicted process contributions. It should also be noted that this simple method cannot be used determine the location or extent of exceedances. Therefore, when deciding on the extent of the AQMA, using this method will require a much larger AQMA to be declared than may be necessary. It is recommended that local authorities proceeding to a declaration based on stack emissions sources alone carry out more detailed modelling incorporating hourly background concentrations to better define the extent of the AQMA.

Box 7.9 – Approaches to Adding Industrial Installation Contributions to Background Concentrations

For the purposes of predicting NO_2, PM_{10} and SO_2 concentrations due to point source emissions, the following approach is recommended in the first instance. The approach described below is likely to be conservative compared to combining modelled hourly mean process contribution with background hourly mean concentrations.

NO_2

Where this approach suggests that the predicted increase in the 99.8th percentile above the background is more than 75% of the available headroom (the difference between the objective and background), then a more detailed approach will be required.

The 99.8th percentile of total NO_2 is equal to the minimum of either equation a or b:

a) 99.8th percentile hourly background total oxidant + 0.05 × (99.8th percentile process contribution NO_x); or

b) the maximum of either:

- b1) 99.8th percentile process contribution of NO_x +(2 × annual mean background NO_2); or
- b2) 99.8th percentile hourly background NO_2 + (2 × annual mean process contribution of NO_x).

Note: In equation a, the total oxidant is the sum of O_3 and NO_2 (as NO_2 equivalents) and should be based on summing the hour by hour concentrations from a suitable background monitoring site in order to derive the 99.8th percentile

PM_{10}

Where this approach suggests that the predicted increase in the 90.4th (or 98.1st for Scotland) percentile above the background is more than 50% of the available headroom (the difference between the objective and background), then a more detailed approach will be required.

The 90.4th percentile total 24-hour mean is equal to the maximum of either equation a or b;

a) 90.4th percentile 24-hour mean background + annual mean process contribution; or

b) 90.4th percentile 24-hour mean process contribution + annual mean background.

The 98.1st percentile total 24-hour mean (Scotland) is equal to the maximum of either equation a or b:

a) 98.1st percentile 24-hour mean background + (2 × annual mean process contribution); or

b) 98.1st percentile 24-hour mean process contribution + (2 × annual mean background contribution)

Note: for the 90.4th percentile for 24-hour mean, the method does not incorporate twice the annual mean contribution of the process or background.

SO_2

Where this approach suggests that the concentrations exceed 75% of the air quality objective (for example, if the total predicted 99.9th percentile of 15-minute mean SO_2 concentrations is great than 200µg/m^3) a more detailed approach will be required.

The 99.9th percentile of total 15-minute mean is equal to the maximum of either equation a or b:

a) 99.9th percentile 15-minute mean background + (2 × annual mean process contribution); or

b) 99.9th percentile 15-minute mean process contribution + (2 × annual mean background contribution)

The 99.7th percentile of total 1-hour is equal to the maximum of either equation a or b;

a) 99.7th percentile hourly background + (2 × annual mean process contribution); or

b) 99.7th percentile hourly process contribution + (2 × annual mean background contribution)

The 99.2nd percentile of total 24-hour mean is equal to the maximum of either equation a or b;

a) 99.2nd percentile 24-hour mean background + (2 × annual mean process contribution); or

b) 99.2nd percentile 24-hour process contribution + (2 × annual mean background contribution).

SO_2 Concentrations - What if the model does not predict 15-minute mean concentrations?

7.468 Some dispersion models do not predict 15-minute mean concentrations, and normally predictions of 15-minute mean concentrations should be solely relied upon. Therefore, the 99.9th percentile of hourly means can be multiplied by 1.34 to derive the 99.9th percentile 15-minute mean required in the equations above. Where a stack is very tall (>75m) a factor of two should be considered. Where a model provides the predicted 99.9th percentile of 15-minute means this should be compared against that derived by factoring the 99.9th percentile hourly mean and higher value should generally be used.

I don't have a continuous background monitor in my area so how can I estimate the relevant percentile of background?

7.469 The nearest background monitoring, for example one operated within the AURN, can be used to determine the relationship between the annual mean and the relevant percentile. This relationship can then be applied to the data for the area required such as annual mean monitoring, or mapped background concentrations.

How do I avoid double counting of my process contribution?

7.470 The reports provided by the EA suggest that most of the AURN background monitoring sites are suitable to assess background concentrations of annual mean NO_x and PM_{10}, without the need to avoid double counting. However, there may be some locations where significant process contributions are expected, such as areas close to steel works and some power stations. The contribution of the process at the background monitoring site may be predicted, and compared to the measured concentration. Where the process contribution is greater than approximately 10% of the background, it may be assumed that the background from this location is not suitable and some double counting is likely to occur. For SO_2, the contribution of

industrial sources to background SO_2 is much larger than that for NO_x and PM_{10}, and therefore some double counting is more likely.

7.471 Further consideration of the background contribution is likely to be required where the air quality objective is approached.

7.472 The background maps provide the estimated source contribution of point sources within a grid square and this may be used to adjust the background concentrations. However, where the contribution is due to multiple sources, it would not be appropriate to remove the entire point source component as this may reduce background concentrations by too much.

7.473 Where an area has multiple point sources, removing the contribution of one source may be more difficult and it is recommended that values of Defra mapped background are selected from those grid squares outside the maximum process contribution footprint.

7.474 Additional methods to remove process contributions from background sites include consideration of wind and pollution roses in order to identify and remove those hours where a significant contribution from a point source has occurred.

Fugitive and Other Sources

7.475 There may be occasions where other sources of pollution are identified through the checklists provided in the main body of this guidance. These sources may include (but are not limited to):

- intensive poultry farms;
- railways;
- ports;
- waste transfer stations;
- airports;
- domestic solid fuel burning;
- mineral extraction sites;
- construction sites.

7.476 The screening assessment methodology and tools provided in section 1 of this chapter should be used to determine if a more detailed investigation of these sources is needed. Dispersion modelling of these types of sources is likely to include multiple sources, for which emissions estimates will be required. Section 2 of this chapter provides information on the sources of data available to assist in emissions estimates for different sources through the NAEI.

7.477 It will be important to obtain the appropriate activity data for these types of sources and the operators and/or regulator of sites should be contacted in order to obtain relevant information.

7.478 Fugitive emissions generally arise at ground level and are difficult to quantify. Typically these are treated as area or volume sources, where emission rates can be estimated. Operators may be able to assist in the estimation of emissions due to fugitive losses from a site or process through mass balance calculations. In the case of storage tanks emissions, material balance calculations may be more appropriate.

7.479 The LAQM Support Helpdesk can be contacted for further advice regarding modelling and estimation of these types of sources. However, due to the complex nature of many of these sources, including variability of activity and uncertainty of emissions estimates, monitoring will be play an important role in the assessment of the air quality concentrations in their vicinity.

7.480 It is recommended that monitoring is undertaken in order to determine the requirement for more detailed studies, and this monitoring can assist in the verification of any modelling undertaken. Monitoring will also assist authorities in determining the extent of any exceedances of air quality objectives, and in the confirming the need to declare any AQMAs. However, modelling alone of these sources may be insufficient as the uncertainties around the emissions estimates and source parameters are not well defined.

Model Validation, Verification, Adjustment and Uncertainty

7.481 Model validation refers to the general comparison of modelled results against monitoring data carried out by model developers. The model used should have some form of published validation assessment available and/or should be recognised as being fit for purpose by the regulatory authorities.

7.482 However, in most cases, the validation studies performed by model developers are unlikely to have been undertaken in the area being considered. Therefore, it is necessary to perform a comparison of the modelled results versus monitoring results at relevant locations. The results of this comparison should be included in Review and Assessment reports, and is referred to here are model verification.

7.483 The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons:

- estimates of background concentrations;
- meteorological data uncertainties;
- uncertainties in source activity data such as traffic flows, stack emissions and emissions factors;
- model input parameters such as roughness length, minimum Monin-Obukhov; and overall model limitations; and
- uncertainties associated with monitoring data, including locations.

7.484 Model verification is the process by which these and other uncertainties are investigated and where possible minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all of these aspects.

7.485 Throughout the Review and Assessment process it has been recognised that in many cases an adjustment of modelled results is required in order ensure that the final concentrations presented are representative of monitoring information from an area.

7.486 It is important that local authorities review the results of their modelling carefully and bear in mind that model adjustment is not the first step in improving the performance of a dispersion model. Before adjustment of a model is applied, local authorities should check their model setup parameters and input data in order reduce the uncertainties. Common improvements that can be made to a "base" model include:

- checks on traffic data;
- checks on road widths;
- checks on distance between sources and monitoring as represented in the model;
- consideration of speed estimates on roads in particular at junctions where speed limits are unlikely to be appropriate;
- consideration of source type, such as roads and street canyons;
- checks on estimates of background concentrations; and
- checks on the monitoring data.

7.487 Once reasonable efforts have been made to reduce the uncertainties of input data for a model, further comparison of modelled and monitored results can be undertaken. Where discrepancies still remain, local authorities may need to consider adjusting the model.

7.488 The modelled results from industrial sources alone are not expected to be adjusted. It is recognised that appropriate monitoring around stacks may not be available to allow verification of the modelled results. Furthermore, the comparison of a stack model at one monitoring location does not necessarily provide a good indication of the model performance, particularly as the location at which peak concentrations are predicted, will vary from year to year, due to changes in meteorological conditions, and may not be represented by the monitoring data. Where long-term monitoring is available it should be compared against the modelled results and commented upon.

7.489 The results of dispersion modelling of point sources may not agree with the results of monitoring for a number of reasons including:

- uncertainties in emissions estimates;
- difficulties in determining emissions profiles;
- model parameters related to complex effects such as buildings and terrain; and
- meteorological data.

7.490 Local authorities comparing modelled and monitored results for a stack can contact the LAQM Support Helpdesk for further advice and assistance.

7.491 For the purposes of Review and Assessment, model adjustment is generally only required for road traffic modelling, not for stack or other sources modelling.

What Type of Sites Should be Used for Verification?

7.492 Kerbside sites are generally not recommended for the adjustment of road traffic modelling results as the inclusion of these sites may lead to an over-adjustment of modelling at roadside sites. The exception is where kerbside sites are relevant for exposure, for example properties fronting directly onto the road. In that case, kerbside sites may be used in the model verification process.

7.493 Dispersion models may perform differently at kerbside, roadside and background sites. For example, models may predict reasonable concentrations towards background sites, but under-predict at locations closer to the roadside. In most cases, local authorities are concerned with the predictions closer to roadside sites as these are at more risk of exceeding the air quality objectives and model verification is generally based on these locations.

7.494 Where a model has been used to predict background concentrations (for example based on an emissions inventory), the modelled background concentrations should also be verified and where necessary adjusted.

7.495 If national background maps are used, these should first be compared against any local monitoring to check they are representative of the area. In most cases there is good agreement with local monitoring, but some locations may not agree. Local authorities are not expected to verify and adjust the national background maps. Where these estimates do not agree with local monitoring, either local monitoring may be used, or local authorities may consider adjusting the background maps. The LAQM Support Helpdesk should be contacted for advice on adjusting national maps.

7.496 In addition to the consideration of roadside and background sites during model verification, local authorities should also consider separating different types of locations when comparing modelling and monitoring. For example, modelling undertaken for roadside sites in urban areas may require a different adjustment to modelling undertaken for roadside sites near motorways or trunk roads in open settings. In some cases, local authorities may also identify some urban sites such as street canyons, which perform differently to more typical urban locations. Where large differences in an adjustment factor are determined for different types of location, local authorities should consider undertaking separate adjustments within a model area in order to avoid over or under-predicting at the different types of location. For example, adjusting modelling results close to a motorway based on verification and adjustment at street canyon sites could lead to a large over-prediction of results.

What Type of Monitoring Data Should be Used for Verification and Adjustment?

7.497 All monitoring used for verification and/or adjustment of modelling results should be undertaken to the standards described in section 2 of this chapter.

7.498 For the verification and adjustment of NO_x/NO_2, a combination of continuous monitoring and diffusion tubes is recommended. As described above, some types of sites can perform differently, and it is considered better to have multiple sites at which

to verify results rather than just one continuous monitor. The use of one continuous monitor alone to derive the adjustment factor for a model is not recommended as the monitoring site may not be representative of other locations modelled, and the adjustment factor derived will be heavily dependent on the source to receptor relationship as represented by the meteorological data file used in the dispersion model.

7.499 Where only diffusion tubes are available for model verification, annualisation of any short-term datasets should be undertaken as described in section 2 of this chapter (see worked example in Box 7.8). Longer-term diffusion tube monitoring is preferred to short-term studies and it is recommended that local authorities implement more diffusion tube monitoring in locations identified as requiring detailed dispersion modelling. For example, if a single junction is identified from a screening assessment or the results of a single diffusion tube, then more diffusion tubes should be placed at relevant locations around the junction as soon as possible. This will provide the local authority with more information on the spatial variation of concentrations, and will assist when model verification is undertaken.

How do I Verify and Adjust my Modelling?

7.500 The process of verifying and possible adjusting models can be a difficult process. Box 7.10 and Box 7.11 set out some of the common steps to be taken in order to assist local authorities in understanding if their modelling is appropriate, and to help identify when adjustment of models may be required. This information is provided for NO_x/NO_2 of road traffic sources, but the same methods can be applied to PM modelling. However, local authorities generally have much more limited PM_{10} (and even less $PM_{2.5}$) monitoring sites, and may only have one site. Therefore, care needs to be taken when applying model adjustment based on one monitoring site only as the adjustment may not be representative of other locations.

7.501 In the absence of any PM_{10} data for verification, it may be appropriate to apply the road-NO_x adjustment to the modelled road-PM_{10}. If this identifies exceedances of the objective, then it would be appropriate to monitor PM_{10} to confirm the findings.

7.502 When only road traffic sources have been modelled, the predicted concentration from the model, without any background, should be referred to as the “road source contribution”. The contribution can be estimated for both monitored and modelled data by subtracting the background concentration from the total concentration. This may be for NO_x, NO_2 and PM.

7.503 As described above, there are a number of reasons why modelling and monitoring results differ. When modelling road traffic sources, errors are likely to apply to both the road source contribution and background contributions, however, it is common to apply the adjustment to the road source contribution.

7.504 When model adjustment is undertaken this should be based on NO_x and not NO_2, as explained in Box 7.12. Where diffusion tubes are used in the calculation of the model adjustment, NO_x will need to be derived from NO_2 using the NO_x to NO_2 Calculator published on the LAQM Support website[68].

7.505 Local authorities are reminded that adjustment of modelling should not be based on the total NO_x (or NO_2) concentrations unless the adjustment is very small (for example within 5%). This is because any adjustment of the total concentration would also be applied to the background contribution. In many cases background is based on national maps or local monitoring, adjustment of this component could results in unrepresentative estimates of the background concentrations across the area. Such adjustment could result in unrealistic estimates of different source contributions and may affect the outcome of source apportionment studies undertaken as part of further assessments and action plans.

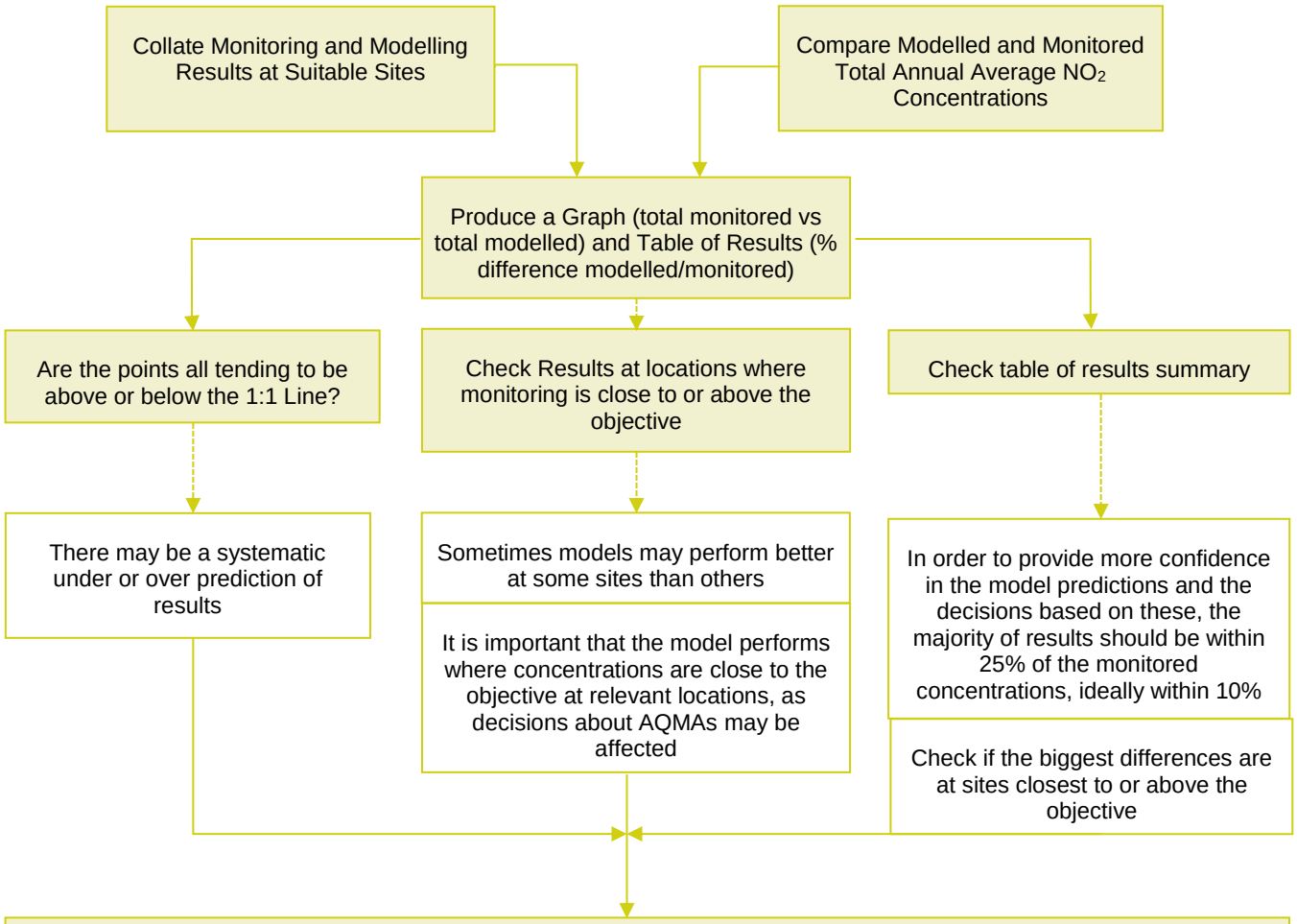
7.506 It is important to remember that a number of assumptions are made when undertaking model adjustment and it should be recognised that any adjustment carried out is a reflection of the specific scenario modelling and the availability and quality of input data and monitoring data.

7.507 Local authorities are encouraged to contact the LAQM Support Helpdesk for advice and assistance during the verification process.

Box 7.10 – Initial Comparison of Modelled and Monitored Total NO_2 Concentrations

These comparisons may be performed when using NO_2 concentrations predicted by dispersion models directly (including background assumptions and chemical conversions)

If a model is used to predict the road contribution of NO_x only or the comparison of modelled and monitored NO_2 indicates that model adjustment is required, then Box 7.11 should be used to verify and adjust the NO_x concentrations before they are used within empirical equations or models



If your checks confirm that:

- there is no systematic under or over prediction;
- predictions at sites where monitoring shows concentrations are close to the objective show good comparison; and
- the majority of results are within 25% (or 10%) of monitored concentrations.

Then you do not necessarily need to adjust your modelling results. However, you may consider model adjustment as this can lead to further improvements in the results obtained, for example where all results move to within 10% of monitored concentrations.

Otherwise you will need to consider altering the model inputs and rerunning in order to improve the results of the comparison and verification. You should ensure that checks on model input parameters include aspects such as background assumptions, receptor locations, source setup (street canyons, widths), and traffic data assumptions (for example speeds). It is also important to check that the units of measurements are consistent (i.e. you are not comparing ppb with µg) and that monitoring data are also checked again to ensure locations, averaging and annualisation are correct.

Box 7.11 provides some guidance to assist local authorities in adjusting the road traffic contribution. Check if the biggest differences are at sites closest to or above the objective.

Box 7.11 – Comparison of Road-NO_x Contributions Followed by Adjustment

The recommended method for converting NO_x to NO_2 and vice versa is described in paras 7.70 to 7.76. The modelled NO_x must be verified (which may include adjustment) before they are used within empirical equations or models.

The adjustment of NO_x is often carried out on the component derived from local Road Traffic emissions – the Road Contribution

If continuous monitoring is included within the model verification, then it is recommended that you check that the method used for converting NO_x to NO_2 applies at the monitoring site. Where the monitored NO_2 differs significantly from that derived using the conversion method, users may find additional adjustment is required as part of the model verification in order to correct for these differences

Produce a table of information on monitored and modelled data including:

background NO_x and NO_2 used in the model, the modelled road contribution to NO_x (from road sources), and the monitored road contribution NO_x, and NO_2

→ The road contribution to NO_x (or NO_2) is derived by subtracting the background NO_x (or NO_2) from total NO_x or NO_2

Where monitoring is based on diffusion tubes only, the NO_x can be derived using the tools described in Chapter 7, Section 1

↓

At each comparison site, calculate the ratio of Monitored Road Contribution to Modelled Road Contribution NO_x

→ This information may help identify sites which may be performing differently than others. These sites can then be investigated and inputs to the model may be varied to improve the performance of these sites Alternatively, these ratios can be used to separate locations which may be street canyons, from more open or typical urban sites, e.g. the ratio is often much higher at sites which could be considered street canyons (as they have limited dispersion) and separate adjustments may be required

↓

Prepare a graph of modelled versus monitored road contribution NO_x. Include a trend line. Derive the equation of the trend line

→ The equation of the trend line should be in the format of

$y = mx$ (intercept at 0)

y is monitored road contribution NO_x and

x is modelled road contribution NO_x

m is the regression correction factor to apply to the modelled road contribution NO_x

↓

Apply the adjustment factor for road contribution NO_x at all sites and derive Total NO_2 Concentrations based on the method described in Chapter 7, Section 1

→ It can be useful to reproduce a graph of adjusted road contribution NO_x versus monitored road contribution.

The graph can help easily identify any sites which appear to perform less well than others

↓

Apply the adjustment factor for road contribution NO_x at all sites and derive Total NO_2 Concentrations based on the method described in Chapter 7, Section 1

→ Perform the same checks described in Box 7.10 (check position of points to 1:1 line, check results close to the objective, check table of results summary

Box 7.12 – Importance of an Approach to Verifying Modelled NO_2 Concentrations from Road Traffic

There are two important reasons why initial verification of the model output should be based on the source contribution to NO_x, rather than the total NO_x concentration (i.e. source plus background NO_x) or the NO_2 concentration alone:

- The contribution of source NO_x to total NO_x (including the background NO_x) is often small. If the source and background NO_x values are added together, the effect will be to 'smooth' the performance of the model, and any adjustment of the model output based on the verification study will be weighted towards the background assumptions.
- The annual mean NO_2 to NO_x relationship is relatively flat in the principal region of interest (i.e. around the 40µg/m^3 objective). Relatively large changes in NO_x around this region may result in only small changes in predicted NO_2 levels. Again, the effect is to 'smooth' the model performance.

Example

The following example illustrates the reason why it is important to verify the modelled road contribution separately. A modelling study gives rise to an unadjusted annual mean NO_x contribution from a small road network **[NO_x(road)]** of 15µg/m^3 at the monitoring site alongside the road. The annual mean background NO_x for this location is 60µg/m^3, and annual mean background NO_2 is 34.5µg/m^3. This gives rise to a calculated **total NO_2** of 39.2µg/m^3.

The measured NO_2 concentration at the roadside monitor at the receptor location is 41.5µg/m^3. Comparison of the predicted and measured NO_2 concentrations would indicate that the model is performing well and under-predicting by only 6%. However, to achieve a predicted **[NO_x(total)]** concentration of 41.5µg/m^3 requires the predicted **[NO_x(road)]** concentration to be increased from 15µg/m^3 to 23µg/m^3. In reality the model is under-predicting the NO_x contribution from the road by 53%.

Model Uncertainty

7.508 Local authorities may wish to evaluate their model performance, where possible, in order to establish confidence in model results. The total uncertainty associated with the model could be associated with a variety of factors including[108]:

- model uncertainty – due to model formulations;
- data uncertainty – due to errors in input data, including emissions estimates, background estimates and meteorology; and
- variability – randomness of measurements used.

7.509 A number of statistical procedures are available to evaluate model performance and assess the uncertainties. A detailed study[109] about estimating the model uncertainty recommended that a subset of statistical parameters be used to describe the general uncertainties of dispersion models. The statistical parameters include (but are not

[108] Morgan, M.G., Henrion, M., 1990. Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis. New York: Cambridge Univ. Press

[109] Carlos Borrego, Ana Isabel Miranda, Ana Margarida Costa, Alexandra Monteiro, Joana Ferreira, Helena Martins, Oxana Tchepel, Ana Cristina Carvalho, 2006. Cross-Cutting 2: Uncertainties of Models & Monitoring. Report produced for EU under project Air4EU

limited to):

- the correlation coefficient;
- fractional bias; and
- Root Mean Square Error (RMSE).

7.510 These parameters estimate how the model results agree or diverge from the observations.

7.511 These calculations can be carried out prior to, and after adjustment, or based on different options for adjustment, and can provide useful information on model improvement. The formulae for correlation coefficient, fractional bias and RMSE are provided in Box 7.13.

Box 7.13 – Methods and Formulae for Description of Model Uncertainty

Statistical parameter	Formula	Comments	Ideal value
Correlation Coefficient	$r = \left[\frac{\sum_{i=1}^{N} (Obs_i - Avg.Obs)\,(Pred_i - Avg.Pred)}{Stedv.Obs \times Stedv.Pred} \right]$	It is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship. This statistic can be particularly useful when comparing a large number of model and observed data points.	1.00
Root Mean Square Error	$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (Obs_i - Pred_i)^2}$	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared.	0.01
Fractional Bias	$FB = \frac{(Avg.Obs - Avg.Pred)}{0.5\,(Avg.Obs + Avg.Pred)}$	It is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between +2 and -2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	0.0

Definitions:

i = the number of observation compared, 1, 2, 3 …. N, *N* = total number of observations compared, *Obs* = observed concentration
Pred = predicted concentration, *Avg.Obs* = average of all observed concentrations, *Avg.Pred* = average of all predicted concentrations
Stdev.Obs = standard deviation of observed concentrations, *Stdev.pred* = standard deviation of predicted concentrations

7.512 These statistical methods could be used for the following comparisons:

- To compare the observations against the predictions from a given model in order to evaluate its performance and uncertainty.
- To compare the observations with the predictions from a number of set ups of a given model, often termed model sensitivity. This may help to identify which model set up performs better. An example may be comparing the outcomes of modelling

based on different sets of meteorological data.

- To compare the observations with predictions from different models. This will show which model performs better for a given scenario.

7.513 In the first instance, where a local authority wishes to assess the uncertainty of a model, RMSE is quite simple to calculate, providing an estimate the average error of the model in the same units as the observations. The RMSE is often easier to interpret than other statistical parameters and many local authorities may find calculation of the RMSE the most useful of the other parameters.

7.514 If the RMSE values are higher than ±25% of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. For example, if the model predictions are for the annual mean NO_2 objective of 40µg/m^3, if an RMSE of 10µg/m^3 or above is determined for a model, the local authority would be advised to revisit the model parameters and model verification. Ideally an RMSE within 10% of the air quality objective would be derived, which equates to 4µg/m^3 for the annual average NO_2 objective.

7.515 The fractional bias of the model may be used in order to identify if the model shows a systematic tendency to over or under predict. However, care should be taken when using this statistic particularly where local authorities are concerned about the performance of the model at concentrations close to the air quality objective being assessed. The fractional bias provides the tendency of the whole model to under or over predict and local authorities should consider the performance at each sites as described in the model verification examples provided above.

7.516 The correlation coefficient could be applied particularly in cases where large datasets such as hourly observations and predictions are being compared but this is not recommended for smaller datasets. It is generally less useful for smaller datasets, and can be controlled by single points at the upper or lower ranges of datasets.

7.517 However, local authorities are reminded that it is important to check that a model is performing where concentrations close to the relevant objective are being considered. For example, a model may over-predict at background locations, but under-predict at higher concentrations close to the objective. Therefore the average performance of a model is not necessarily a good description of the performance at all locations. Local authorities should consider this as decisions related to declaration of AQMAs may be affected.

7.518 Local authorities are not required to assess the uncertainty of their model predictions. However, the statistical methods provided will assist in providing more confidence in model results and the decisions based on the results. The LAQM Support Helpdesk may be contacted for further information on the calculation of model uncertainty.

Annex A. LAQM Action Tool Box

Introduction

A.01. This tool box is designed to assist local authorities with their duties with the Local Air Quality Review and Assessment process prescribed under Part IV of the Environment Act 1995. It brings together examples of actions that local authorities have taken to improve air quality in their area. It is intended to share information about the types of measures used by different authorities. Decisions about the types of measures appropriate in different local areas, using knowledge about local circumstances remain a matter for local authorities. Inclusion of an example within the toolbox does not constitute an endorsement under existing Government policy.

A.02. This tool box should be used in conjunction with guidance contained on the Local Air Quality Management (LAQM) Support website (see Box 1.2).

Background

A.03. The existing tools available to local authorities should be used to assess local air quality, decide whether further action is needed which will help identify the key emissions sources to tackle in order to improve local air quality. The range of measures that can be taken locally will evolve as more evidence emerges on the sources of pollutants, what solutions are possible and what actions have worked in other areas.

A.04. In order to build and implement effective actions, it is important for each local authority to identify their key stakeholders, which will include organisations responsible for managing emissions sources (e.g. major roads), local industry and large businesses, other departments within the same local authority and other local authorities that "share" the same issues. These organisations may also have access to specific funding (e.g. Clean Bus Technology Fund).

A.05. A holistic approach is the best one for local authorities to take. As well as synergies, other actions taken as part of a local authority's responsibilities can also conflict with the goal to improve air quality. A full understanding of all actions being undertaken in a local area will enable a robust Air Quality Action Plan to be developed. A balanced approach with other local authority responsibilities may be needed to ensure actions are effective.

Guide to the Criteria Used to Assess Effect on Emissions

- Low effect – action focused on a small proportion of sources contributing to an exceedance
- Medium effect – action focused on only one key emissions source
- High effect – action focused on dealing with key high emitting sources, or a number of emissions sources

A.06. These criteria are intended as a guide to the impact of each type of measure, and should not be used by local authorities as a way of ranking which measures to take

forward. It may be the case that many measures that have a 'low' impact are necessary before measures with a 'high' impact can be introduced. Some 'low' impact measures may also have co-benefits for other policies not immediately connected to air pollution, such as tackling obesity through 'walk-it' schemes and sustainable transport initiatives.

A.07. A tick against an action in the column 'reduces $PM_{2.5}$ emissions' means it is likely to help reduce these emissions.

Tool Box

A.08. The Tool Box links to a number of sources which give an overview of what actions can be taken. Quantified measures have been used where possible. The tool box is a live document that will be updated as new evidence and examples of effective actions come forward. If you are aware of further case studies, reports or details of benefits and costs that help fill in gaps or will add more depth to the examples mentioned below, then please contact laqm.review@defra.gsi.gov.uk.

Table A.1 – Action Tool Box

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
Traffic Management	Urban Traffic Control systems, Congestion management, traffic reduction	low	✓	**Smarter Choices – Changing the Way We Travel** Chiltern District Council developed the CLAIRE (Chiltern Local AIR and Environment) programme to encourage behavioural change. Aylesbury Vale District Council examined measures to reduce emissions via a UTMC scheme and also to optimise it for freight and buses. Coventry City Council also investigated how its existing UTMC network can be integrated with air quality monitoring devices to allow real time traffic management changes in line with pollution levels, or known time periods where pollution levels or congestion are high. London Borough of Hounslow has tested whether SCOOT can be used to help smooth traffic flow, ease congestion and improve air quality.
	Reduction of speed limits, 20mph zones	low	✓	Imperial College carried out research published in 2013 - An evaluation of the estimated impacts on vehicle emissions of a 20mph speed restriction in central London - https://www.cityoflondon.gov.uk/business/environmental-health/environmental-protection/air-quality/Documents/speed-restriction-air-quality-report-2013-for-web.pdf - It concluded that the

[110] The measures category is used by Defra for EU reporting and are linked to the categories in the Air Quality Action Plan and ASR/APR templates

[111] Low effect – action focused on a small proportion of sources contributing to an exceedance

Medium effect – action focused on only one key emissions source

High effect – action focused on dealing with key high emitting sources, or a number of emissions sources

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				effects of a 20mph speed restriction were shown to be mixed, with particular benefit seen for emissions of particulate matter and for diesel vehicles. It also concluded that air quality is unlikely to be made worse as a result of 20mph speed limits on streets in London. This analysis is suitable for per-vehicle emission rates, but did not consider secondary effects such as congestion.
	Road User Charging (RUC)/ Congestion charging	low	✓	The Greater London Authority has used Congestion Charging to reduce traffic numbers entering London during the busiest times of the week; 07:00 to 18:00, Monday to Friday. Its final report - Central London Congestion Charging Impacts monitoring Sixth Annual Report, July 2008 - https://tfl.gov.uk/cdn/static/cms/documents/central-london-congestion-charging-impacts-monitoring-sixth-annual-report.pdf Showed that although congestion charging and other changes originally led to reductions in emissions, this did not feed through to observable improvements to measured air quality. This was to be expected and reflects the extent and diversity of other influences on ambient air quality measurable at air quality monitoring stations, as opposed to emissions; diluting and obscuring any change to emissions within the zone. However, all other things being equal, reduced emissions will feed through to relative improvements in outdoor air quality, against conditions in the hypothetical absence of the scheme.
	Anti-idling enforcement	low	✓	**Examples of Air Quality Action Plan Measures, June 2013** **Pages 20 – 21** Corporation of London – carried out a 3 month publicity campaign to inform people that it intends to issue fixed penalty notices (FPN) to drivers who refuse to turn off their vehicle engines. The approach was highly focused. Construction sites, businesses and deliveries companies were all directly targeted along with

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				entertainment venues and coach companies. A marketing consultancy was used to design a set of posters, campaign material and appropriate health messages to work with air quality champions. The campaign was primarily aimed at employees in the City. A communications consultancy was used to engage directly with businesses. Changes were also made to the London Air website to provide consistency with Defra's banding system. A short instructional film was produced explaining how to use the index and practical ways to minimise exposure and health effects. Best practice documents are available on the City of London's CityAir website. In addition, the CityAir principals were rolled out to neighbouring boroughs.
	Testing Vehicle Emissions	low		Remote-sensing instruments measure the tailpipe emissions of vehicles as they drive-through a monitoring site. The technology works by scanning the exhaust plume trailing the vehicle. The instrument used in these types of studies is able to characterise emissions from thousands of vehicles per day. The measurements, when combined with detailed vehicle registration information allow the on-road vehicle fleet emissions to be characterised, broken down by vehicle type (Car, Van, light and heavy commercial vehicle, Bus), age, fuel type, and emission standard (e.g. Euro 0 - 5). This information can be very useful in developing effective emission reduction measures
	Other	low	✓	**Examples of Air Quality Action Plan Measures, June 2013** **Pages 14 - 15** Smarter driving: London borough of Merton - Provided 'smarter driving' training to staff

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				who have to drive as part of their work - cars, HGVs and other vehicles - to help drivers reduce fuel consumption and emissions.
Promoting Travel Alternatives	Workplace Travel Planning	low	✓	http://webapps.stoke.gov.uk/uploadedfiles/Airmazing_leaflet.pdf Stoke-on-Trent City Council introduced a Clean Air Grant to increase the use of low emission and sustainable transport within workplaces and businesses in Stoke-on-Trent
	Encourage / Facilitate home-working	low	✓	Working from home reduces the need to travel and, along with working flexible hours, helps reduce congestion and peak traffic numbers
	Personalised Travel Planning			DfT published a practitioner's guide in 2008. It stated that within the UK, Personalised Travel Planning has been reported to typically reduce car driver trips by 11% (among the targeted population) and reduce the distance travelled by car by 12%. Projects can also deliver health benefits and improve local air quality http://webarchive.nationalarchives.gov.uk/20101124142120/http:/www.dft.gov.uk/pgr/sustainable/travelplans/ptp/practictionersguide.pdf Also see: http://laqm.defra.gov.uk/action-planning/measures/travel-plans.html
	School Travel Plans			The GLA has produced a 'Cleaner Air 4 Primary Schools Toolkit' which provides a teaching pack for pupils to investigate air quality around their schools and developing actions to combat it. https://www.london.gov.uk/sites/default/files/CA4S%20Toolkit[1].pdf Also see:http://laqm.defra.gov.uk/action-planning/measures/travel-plans.html

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
	Promotion of cycling	low	✓	**Examples of Air Quality Action Plan Measures, June 2013** **Pages 10-11** Investing in cycling can help bring about a modal shift away from use of private vehicles, thereby reducing emissions of relevant air pollutants. There are also co-benefits in encouraging cycling by way of health benefits. The sorts of projects covered in the case studies include those designed to give an impetus to start cycling or to cycle more often (Chichester District Council), such as the cycle challenge events and 'In Town Without My Car' days. This policy can also link to highways authority plans to provide well designed cycling infrastructure to further encourage modal shift. Encouraging cycling can also be linked to workplace and school travel plans
	Promotion of walking	low	✓	A large proportion of car journeys are local and many of these can be walked instead; helping reduce traffic emissions with additional health benefits. See NICE guidance: https://www.nice.org.uk/advice/lgb8/chapter/what-can-local-authorities-achieve-by-encouraging-walking-and-cycling
	Promote use of rail and inland waterways	medium	✓	Alternative methods to transport freight may help reduce emissions and they can be integrated into hubs to aid distribution. Using rail and inland waterways can remove heavy traffic from roads.
Public Information	Via the Internet, leaflets, radio, television or other mechanisms			Many measures can include a level of communication – e.g. with project stakeholders, the general public or other local authorities that may also benefit from taking similar actions.

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				To improve understanding of air quality, particularly by the general public, Defra recommends using appropriate forms of communication to simply explain the reasons why action is being taken.
Transport Planning and Infrastructure	Public transport improvements-interchanges stations and services	low	✓	Improving the range or capacity of public transport and providing travel for to enable workers with unsociable hours can help reduce trips which would only be practical by car.
	Public cycle hire scheme	low		The Mayor of London has developed a cycle-hire scheme across London to encourage more trips to take place by bicycle
	Cycle network	low	✓	Many actions include improving or extending cycle networks (and the provision of adequate parking in public spaces and at workplaces) to encourage greater uptake of cycling.
	Bus route improvements	high	✓	Buses, along with HGVs can emit a greatest amount of NO_x and particulate matter per vehicle and so are potentially significant sources in many locations. Many projects have investigated the impact of improving routes to reduce per vehicle emissions from this sector; particularly in urban areas. Actions to improve route improvements can also be included within LEZs and LEPs.
Alternatives to private vehicle use	Bus based Park & Ride	medium	✓	East Hertfordshire District Council has investigated the impact on NO_x transport emissions around two AQMAs by introducing a Park and Ride scheme, as part of its Urban Transport plans for Hertford and Bishop's Stortford.
	Rail based Park & Ride			Railway stations can offer the opportunity to provide park and ride services. Many local authorities have investigated it as a measure. For

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				example, Cheshire West and Chester Council http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=6&ved=0CD4QFjAFahUKEwio5ay494_IAhWDvxQKHQyZCw8&url=http%3A%2F%2Fwww.cheshirewestandchester.gov.uk%2Fmicrosites%2Fchester_renaissance%2Fa_changing_city%2Fchester_transport_strategy%2Fidoc.ashx%3Fdocid%3D5c236416-9154-4464-977c-655ffc303746%26version%3D-1&usg=AFQjCNEPB5sHkigd9QIug3UIiRzsp1W5pw
	Car & lift sharing schemes			**Examples of Air Quality Action Plan Measures, June 2013** **Pages 18 – 19** Colchester Borough Council - 'Love ur Car' Campaign was designed to raise awareness of, and encourage the use of car sharing as well as smarter driving techniques and travel planning, with the aim of reducing nitrogen dioxide concentrations. It focused on making car journeys more fuel efficient and promoted car sharing in a fun, innovative and thought provoking way. Car sharing promotion was aimed at the 18-30 age group as this is the most likely group to car share. The brand was promoted via competition, radio and billboard campaigns, flyers, posters, local newspaper articles, Facebook, Twitter and workplace promotion. It was linked to local travel clubs
	Car Clubs	low	✓	Car sharing and car club schemes tend to reduce the number of journey trips and reduce emissions. http://laqm.defra.gov.uk/action-planning/measures/car-sharing.html
Policy Guidance and Development	Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air			Collective action across areas that have similar air quality problems, e.g. the local authorities that make up a city or region, can speed up air quality improvement and help to reduce costs.

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
Control	quality			
	Air Quality Planning and Policy Guidance			
	Sustainable Procurement Guidance			Including air quality measures within procurement strategies will help large organisations focus on actions that reduce emissions. Examples include specifying the Euro standard of delivery vehicles. https://www.gov.uk/guidance/sustainable-procurement-tools
	Low Emissions Strategy	high	✓	**Examples of Air Quality Action Plan Measures, June 2013** **Pages 6-7** Low Emission Strategies (LES) aim to deliver cost effective and practical interventions supported by robust impact assessment, particularly in the areas of accelerating the adoption of low emission transport fuels and technology and use of emission based assessment to support policy and action. Many LES are designed to be implemented through the planning process, as conditions for new developments. Some are used as an umbrella for a package of measures and can inform every aspect of a Local Authority's activities. For example, Oxford City Council create a 'whole picture' Integrated Emissions Assessment Framework (IEAF) to cover both air quality and climate change emissions to help establish what emission reduction options are available to the authority. It included building a database

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				and assessing the data requirements and issues involved in revising the draft Low Emission Strategy (LES) for Oxford.
Freight and Delivery Management	Freight Consolidation Centre	medium	✓	TfL has published a case study which outlines the lessons learned from a Consolidation Centre set up to serve the London boroughs of Camden, Enfield, Islington and Waltham Forest. https://tfl.gov.uk/cdn/static/cms/documents/lbbc-case-study.pdf
	Route Management Plans/ Strategic routing strategy for HGV's	high	✓	HGVs, along with buses can emit the greatest amount of NO_x and particulate matter per vehicle and so are potentially significant sources in many locations. Many projects have investigated the impact of improving routes to reduce per vehicle emissions from this sector; particularly in urban areas. Actions to improve route improvements can also be included within LEZs and LEPs, and can be formalised within Freight Quality Partnerships
	Quiet & out of hours delivery	low	✓	Encouraging bulk deliveries (e.g. to supermarkets) out of hours can help reduce congestion at busy times. However, these deliveries may encounter other issues that need to be managed, such as noise disturbance late at night.
	Delivery and Service plans	medium	✓	Delivery and Service Plans can be used to help co-ordinate vehicle movements to a property, increasing efficiency and reducing congestion and emissions.
	Freight Partnerships for city centre deliveries	high	✓	FQPs (Freight Quality Partnerships) and ECOStars (Efficient and Cleaner Operations) fleet recognition schemes are now recognised mechanisms to reduce emissions from freight vehicles
Vehicle Fleet Efficiency	Driver training and ECO driving aids	Medium	✓	The Energy Saving Trust is one organisation that provides driver training to companies looking to improve driving efficiency within their

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				fleet and reduce emissions and overall costs.
	Promoting low emission public transport	high	✓	Promoting low emission public transport, such as buses, can help reduce emissions and running costs as well as provide a visible example of new technologies to the fare-paying public and other road users. Government has used grant schemes, such as the Green Bus Fund (Clean Bus Technology Fund) , to lower the capital cost of these new technologies
	Vehicle retrofitting programmes	medium	✓	Vehicle retrofitting can be a cheaper way to deliver emissions benefits when the alternative would be to buy a new vehicle. It can be a way for vehicle operators to meet the emissions criteria for LEZs or CAZs cost-effectively. The TfL website contains more information of retrofitting particle traps; more alternatives include converting to CNG/LPG or fitting a newer engine
	Fleet efficiency and recognition schemes	medium	✓	See 'Freight Partnerships for city centre deliveries' and 'Public Vehicle Procurement -Prioritising uptake of low emission vehicles' for information on fleet efficiency and recognition schemes.
	Testing vehicle emissions	low		If a local authority has designated an Air Quality Management Area., then the council can test vehicles at the roadside and issue fixed penalties to drivers whose vehicles fail. More information is available at www.legislation.gov.uk/uksi/2002/1808/made
Promoting low emission transport	Low emission zone (LEZ) Clean Air Zone (CAZ)	high	✓	A Clean Air Zone (CAZ) or Low Emission Zone (LEZ) is an area where certain types of vehicles cannot enter without meeting set emission standards. For example, the London Low Emission Zone covers the whole of London and has emissions standards for Heavy Goods Vehicles, buses and coaches. Oxford and Norwich have a city centre LEZ which controls buses, and Brighton is introducing a bus LEZ from 2015.

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
				Other cities and towns have assessed whether an LEZ would be an effective approach to improve air quality. The Defra Grant Programme funded 19 LEZ feasibility studies during 2011 and 2012. These have considered a wide range of vehicle categories and geographical areas, ranging from one key road to the entire city.
	Public Vehicle Procurement - Prioritising uptake of low emission vehicles	high	✓	Low emission vehicles are defined on their exhaust emissions in relation to those from comparable 'conventional' models. Technologies that are defined as low emission include: battery electric, hybrid petrol, plug-in hybrid and CNG, LNG and hydrogen (as single, or dual fuel versions). Many vehicles require a fuelling/charging infrastructure to be installed as well to ensure the vehicles full low emission properties can be realised. The action can form part of a more encompassing policy such as LEZs, LEPs, FQPs, , vehicle pooling, car clubs, ECOStars
	Company Vehicle Procurement -Prioritising uptake of low emission vehicles	high	✓	
	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging	high	✓	
	Priority parking for LEV's	high	✓	
	Taxi Licensing conditions	medium	✓	Taxi licensing authorities can set licensing conditions to determine a threshold on emissions or age, where vehicle that exceed these conditions are not eligible to hold a license to operate.
	Taxi emission incentives	medium	✓	
Promoting Low Emission Plant	Public Procurement of stationary combustion sources			The Mayor of London has produced Supplementary Planning Guidance - The Control of Dust and Emissions during Construction and Demolition – which "seeks to reduce emissions of dust, PM_{10} and $PM_{2.5}$ from construction and demolition activities in London. It also aims to manage emissions of nitrogen oxides (NO_x) from construction and
	Low Emission Fuels for stationary and mobile sources			

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
	in Public Procurement			demolition machinery by means of a new non-road mobile machinery ultra-low emissions zone (ULEZ)".
	Emission control equipment for small and medium sized stationary combustion sources / replacement of combustion sources			https://www.london.gov.uk/sites/default/files/Dust%20and%20Emissions%20SPG%208%20July%202014_0_0.pdf
	Other measure for low emission fuels for stationary and mobile sources			
	Regulations for fuel quality for low emission fuels for stationary and mobile sources			
	Shift to installations using low emission fuels for stationary and mobile sources			
Environmental permits	Introduction/increase of environment charges through permit systems and economic instruments	medium	✓	The Environment Agency has published guidance for regulators and operators of facilities that are covered by the Environmental Permitting (England and Wales) Regulations 2010.
	Measures to reduce pollution through IPPC Permits going beyond BAT	medium	✓	The Environment Agency has published guidance for regulators and operators of facilities that are covered by the Environmental Permitting (England and Wales) Regulations 2010.
	Large Combustion Plant Permits and National Plans	high	✓	The aim of the Large Combustion Plant Directive (LCP) is to reduce emissions of acidifying pollutants, particles, and ozone precursors. Controlling emissions from large combustion plants (with rated thermal

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
	going beyond BAT			inputs equal to or greater than 50 MW) is critical to reducing air pollution, particularly acidification, eutrophication and ground-level ozone across Europe.
	Tradable permit system through permit systems and economic instruments			Tradable permits can be used to reduce overall emissions of pollutants and introduce an element of the 'polluter pays' principle. Schemes generally work best on a multi-national scale. For example, The EU Emissions Trading Scheme for CO2 (and equivalents) covers all EU countries and includes larger power stations and industrial plants.
	Other			http://www.chiltern.gov.uk/article/4555/Green-wall-grows-on-Chesham-offices Chiltern District Council has constructed and maintained a Green Wall on the front wall of the Health Zone on a major road, within the AQMA, for 3 years and will then assess the results. **Wood burning:** **Examples of Air Quality Action Plan Measures, June 2013** **Pages 16-17** Brighton & Hove City Council – developed leaflets to promote the use of non-combustion renewables in the city centre AQMA and solid-fuel systems in the city fringe. The leaflets are available for use by other Local Authorities with Smoke Control Areas.
Improving AQ modelling and assessment	Improving modelling predictions of NO_2 concentrations	low		London Borough of Ealing has investigated the impact of accelerating diesel locomotives on air quality close to residential properties bordering the London Paddington Main Line, to ensure the modelling results, which predict NO_2 exceedances are corroborated by

Measures category[110]	Measure Classification	Effect on reducing NO_x and PM_{10} emissions (low, medium, high)[111]	Reduces $PM_{2.5}$ emissions	Examples of measure
[112]				measurements and to derive new NO_x, NO_2 and PM emissions factors for diesel locomotives and multiple units (both accelerating and cruising trains) if necessary.
	Tools to assess traffic management schemes prior to implementation	low		London Borough of Hillingdon, with Leicester City Council, has developed a 'Ready Reckoner' tool to allow transport engineers and planners to assess traffic management schemes, particularly for low speed measures, for emissions impacts prior to implementation. Maidstone Borough Council has assessed actions aimed at improving air quality. Further quantification of air quality and health impacts and cost were carried out for the most promising measures.
	Tool to evaluate measures to reduce traffic emissions	low		London Borough of Hounslow – have developed a tool to identify main traffic polluters by using DfT traffic composition data available and data from a video camera survey, along sections of non-compliant roads; and using a software tool to evaluate scenarios such as traffic speed profile, traffic flow and composition of vehicle type with the aim of reducing emissions
	Investigating specific measures and issues to understand their air quality impact			Royal Borough of Kensington and Chelsea investigated 3 separate road traffic issues; the impact of roadworks on network performance, third phase of the London LEZ and emissions at a busy taxi rank.

[112] This category is not included in Defra's EU reporting, but were useful projects that have attracted Air Quality Grant funding

Location of documents cited:

- Examples of Air Quality Action Plan Measures, June 2013

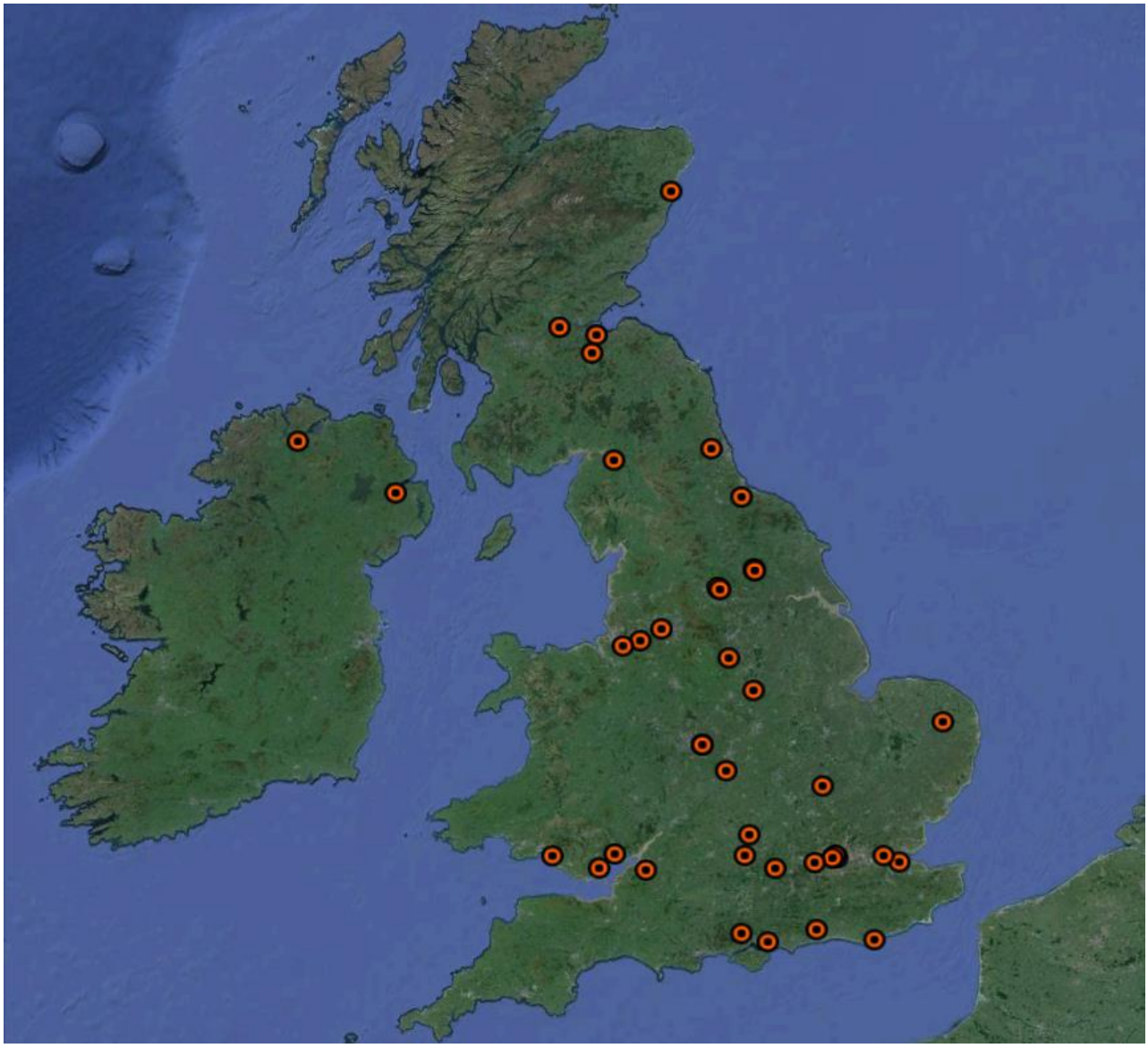
- http://uk-air.defra.gov.uk/assets/documents/reports/cat05/1306261052_Examples_of_Air_Quality_Action_Plan_Measures_J1255_25June13.pdf

- 14 Cost Effective Actions to Cut Central London Air Pollution, Royal Borough of Kensington and Chelsea - https://www.rbkc.gov.uk/pdf/air_quality_cost_effective_actions_full_report.pdf

Annex B. Derivation of $PM_{2.5}$ to PM_{10} Ratio

B.01 Local authorities may wish to estimate $PM_{2.5}$ data from PM_{10} data and vice versa. In order to investigate potential estimation methods, forty sites were identified within the AURN for where there are collocated PM_{10} and $PM_{2.5}$ FDMSs. The location of these sites is shown in Figure B.1.

Figure B.1 - Location of the PM_{10} and $PM_{2.5}$ monitoring sites utilised in this study



B.02 It is noted that there are large regions of the UK where there are no nearby monitoring sites with collocated hourly PM_{10} and $PM_{2.5}$ measurements in the AURN. However, there may be suitable instruments in other networks.

B.03 The hourly ratified data were downloaded for each site for each year from 2010 to 2014. Two methods were investigated, one utilising the ratio of $PM_{2.5}/PM_{10}$, and another the concentration of PM_{Coarse} in $\mu g/m^3$ was calculated as PM_{10} -

$PM_{2.5}$.

B.04 OpenAir was used to plot time-variation plots of the hourly, daily and monthly variations. Two examples of these plots are shown in Figure B.2 and Figure B.3.

Figure B.2 - The hourly variation of the ratio of $PM_{2.5}/PM_{10}$ for each site

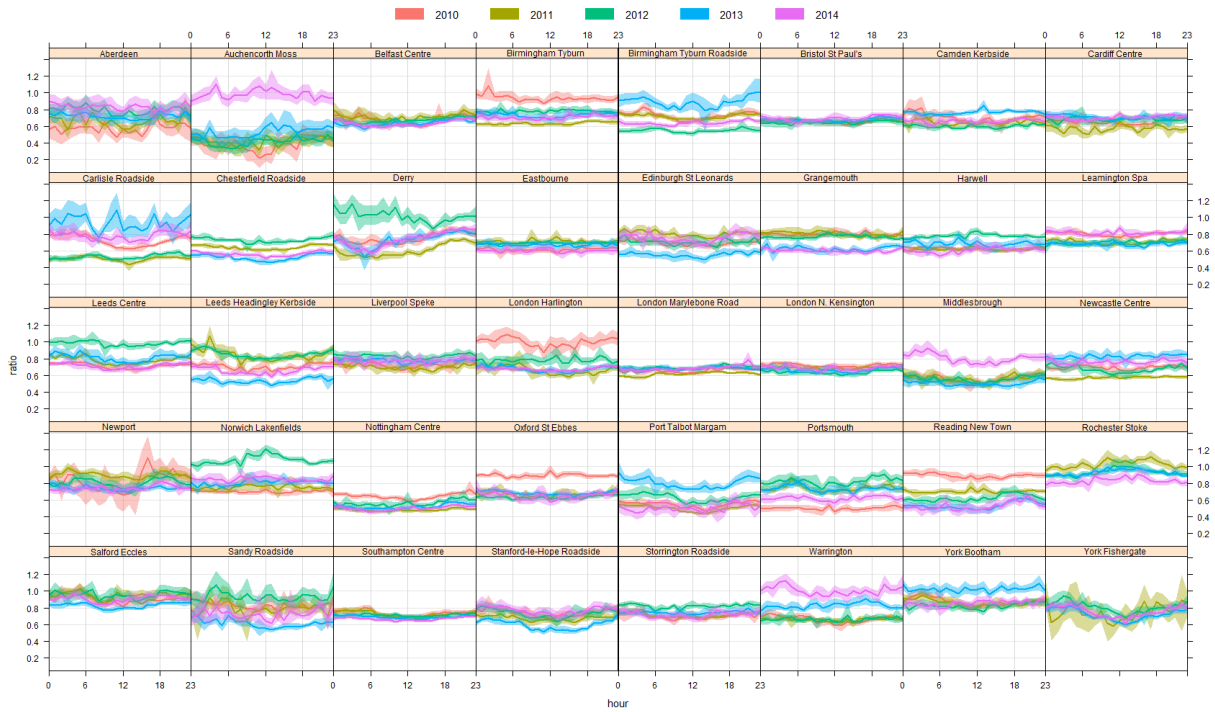
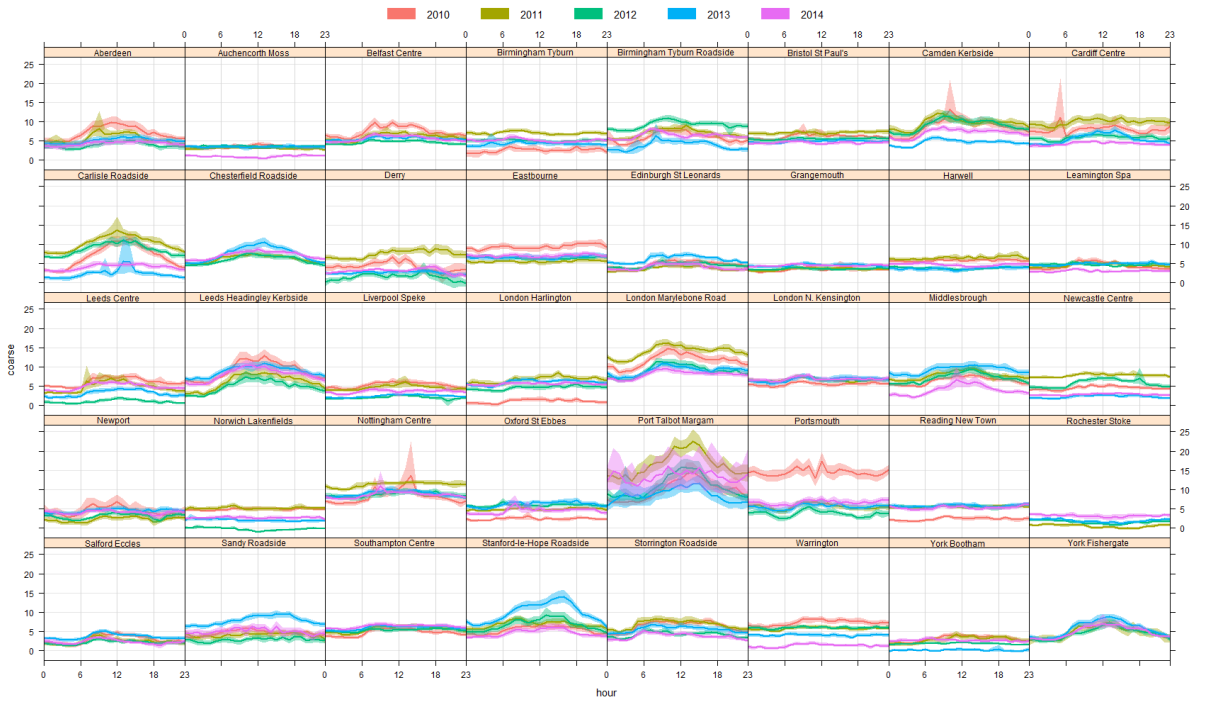


Figure B.3 - The hourly variation of PM_{Coarse} µg/m^3 for each site



B.05 It is noted that there is a large variation in ratios between sites, and in some cases, between different years at a single site.

B.06 In addition, box and whisker pots were plotted, and four examples are shown below.

Figure B.4 - A box and whisker plot showing the spread in the annual average PM_{Coarse} µg/m^3 as a function of Site Classification for all years

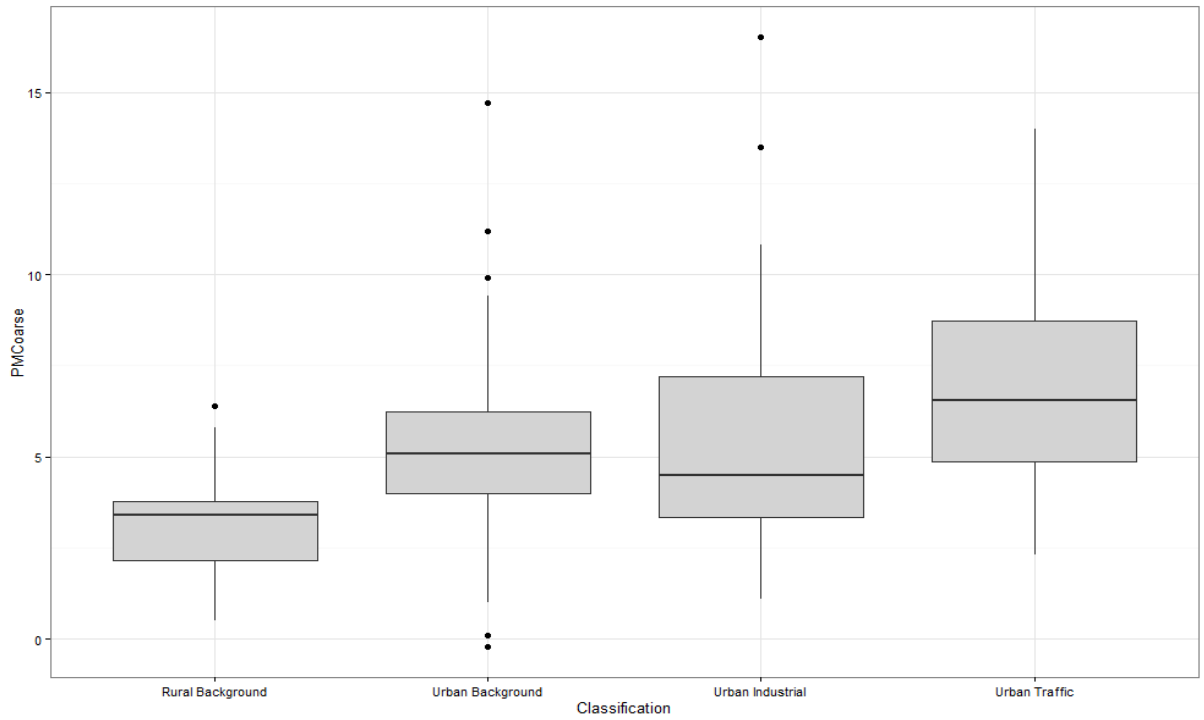


Figure B.5 - A box and whisker plot showing the spread in the annual average PM_{Coarse} µg/m^3 as a function of Region for all years

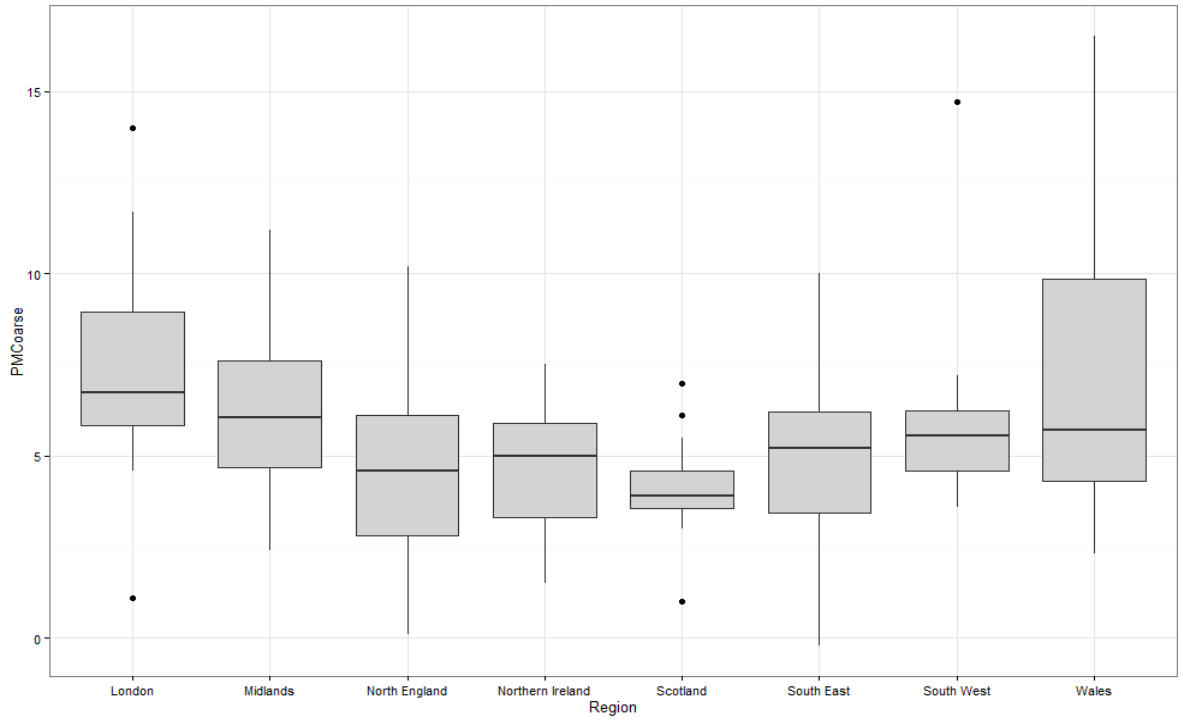


Figure B.6 - A box and whisker plot showing the spread in the annual average ratio of $PM_{2.5}/PM_{10}$ as a function of Site Classification for all years

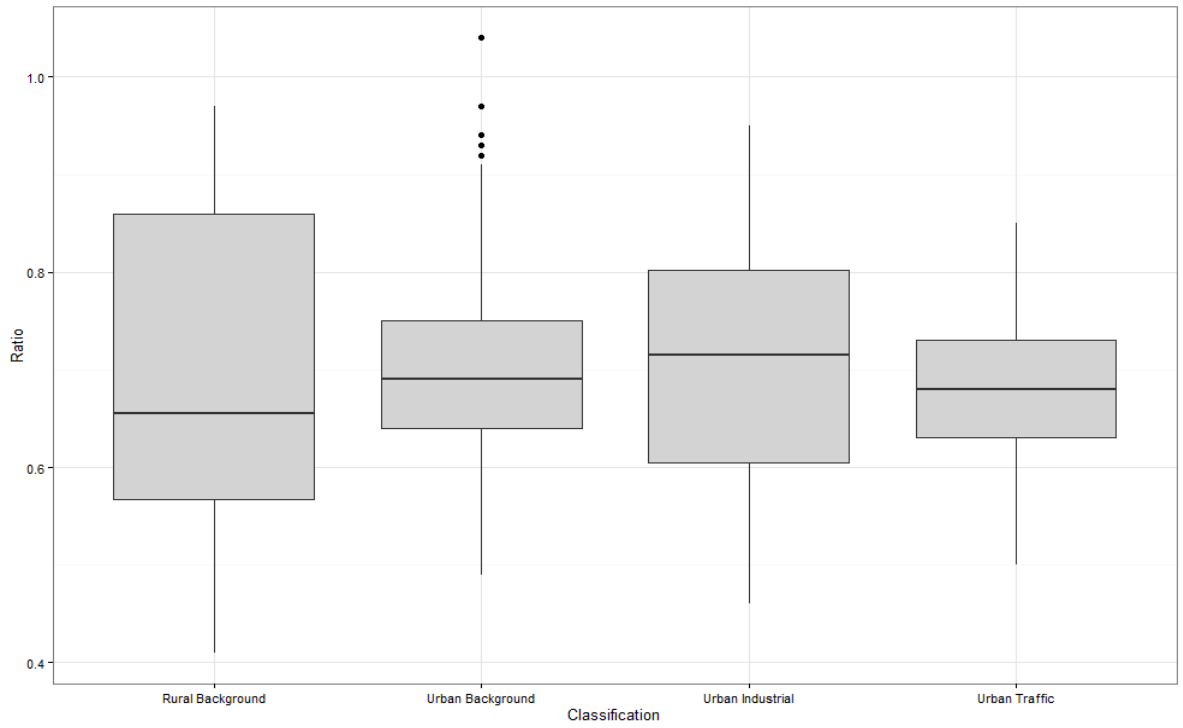
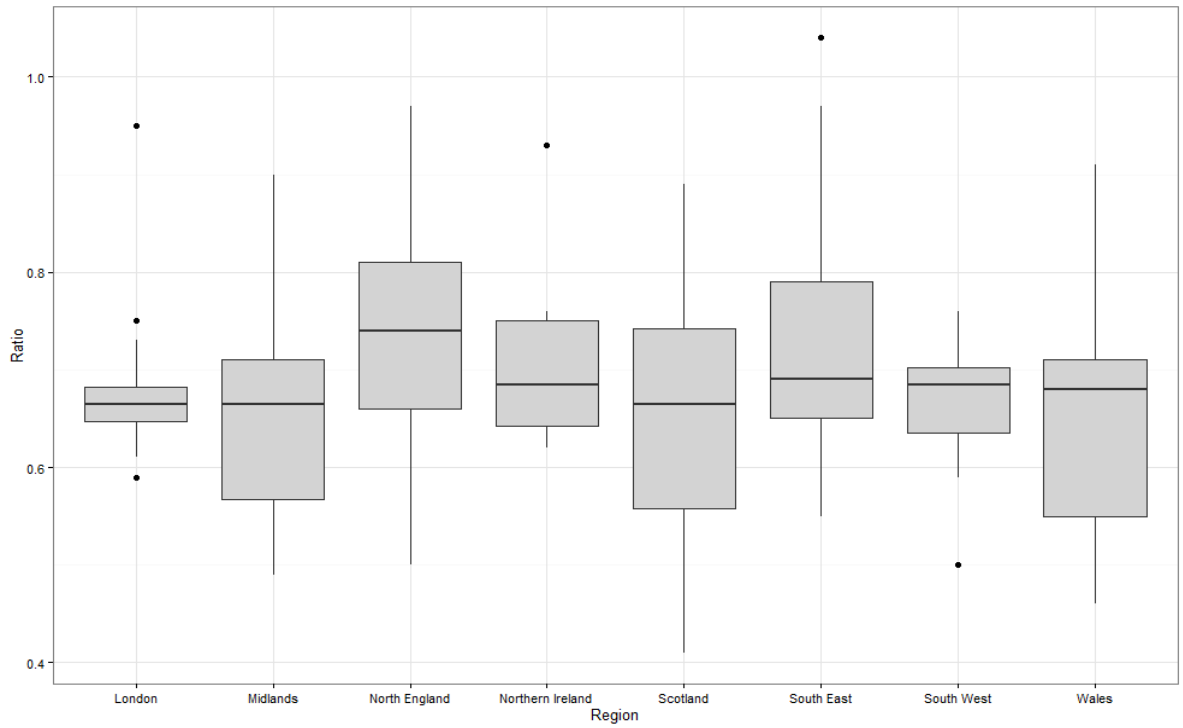


Figure B.7 - A box and whisker plot showing the spread in the annual average ratio of $PM_{2.5}/PM_{10}$ as a function of Region for all years



B.07 Sites in Scotland and Rural Background sites both stand out as have significantly lower PM_{Coarse} concentrations than other sites in the UK. Conversely, sites in London and Urban Traffic sites both stand out as having significantly higher

PM_{Coarse} concentrations than other sites in the UK. The ratio of $PM_{2.5}/PM_{10}$ shows much less of a variation as a function of Site Classification or Region. Previous research highlighted in the AQEG report on $PM_{2.5}$[16] stated that the ratio of $PM_{2.5}/PM_{10}$ varied with distance from Dover. Such a degree of variation is not evident in this analysis.

B.08 The daily averages were calculated for PM_{10} and $PM_{2.5}$ for those days with greater than 90% data capture. PM_{Coarse} and the ratio of $PM_{2.5}/PM_{10}$ were calculated based upon these daily averaged concentrations. Annual averages were then calculated from the daily averaged data. Statistics summarising the distribution of data were calculated for different levels of annual Data Capture (DC) are given in Table B.1.

Table B.1 - Maximum, minimum, mean and standard deviation of the $PM_{2.5}/PM_{10}$ ratio for all sites for years 2010 to 2014 and for three different data capture limits

Statistic	Data Capture	Ratio	PM_{Coarse} (µg/m^3)
Count	No DC Limit	197	197
Maximum	No DC Limit	1.04	16.5
Minimum	No DC Limit	0.41	-0.2
Mean	No DC Limit	0.69	5.5
Standard Deviation	No DC Limit	0.11	2.6
Count	75% DC	109	109
Maximum	75% DC	1.04	16.5
Minimum	75% DC	0.41	-0.2
Mean	75% DC	0.70	5.2
Standard Deviation	75% DC	0.11	2.6
Count	90% DC	44	44
Maximum	90% DC	0.86	16.5
Minimum	90% DC	0.46	1.8
Mean	90% DC	0.70	5.2
Standard Deviation	90% DC	0.09	2.5

B.09 Considering the scenario where no annual averages have been deleted due to low data capture, there is a large spread in the ratio of $PM_{2.5}/PM_{10}$ from 0.41 to 1.04. A ratio of greater than 1 may indicate a problem with the data for that site. It may also indicate that the PM_{10} and $PM_{2.5}$ concentrations were similar, but both within the prescribed 25% expanded uncertainty allowed by the Air Quality Directive 2008/50/EC. The mean ratio of $PM_{2.5}/PM_{10}$ was 0.69 ± 0.11 for where no data have been deleted due to low data capture; 0.70 ± 0.11 for where data have been deleted as below 75% data capture; and 0.70 ± 0.09 for where data have been deleted as below 90% data capture. The mean concentration of PM_{Coarse} was 5.5 ± 2.6µg/m^3 for where no data have been deleted due to low

data capture; 5.2 ± 2.6µg/m^3 for where data have been deleted due to below 75% data capture; 5.2 ± 2.5µg/m^3 for where data have been deleted due to below 90% data capture. This would suggest that outliers are having little effect upon the mean and standard deviation of annual average PM_{Coarse}, and the ratio of $PM_{2.5}/PM_{10}$.

B.10 Two correction methodologies were tested:

- **Method 1.** Subtracting the average annual average PM_{Coarse} of nearby sites from the annual average PM_{10} concentration of the site to be corrected; and
- **Method 2.** Multiplying the annual average PM_{10} concentration of the site to be corrected by the average ratio of $PM_{2.5}/PM_{10}$ of 0.7.

B.11 Six scenarios were investigated:

- All Urban Background sites in the North of England for years 2010 to 2014 (6 sites);
- All sites in Scotland for years 2010 to 2014 (4 sites);
- All sites in Wales for years 2010 to 2014 (3 sites);
- All sites in Northern Ireland for years 2010 to 2014 (2 sites);
- Traffic sites in London for years 2010 to 2014 (2 sites); and
- All Urban Industrial Sites in the UK for years 2010 to 2014 (4 sites).

B.12 Two parameters were calculated:

- Method 1 Difference: Method 1 predicted $PM_{2.5}$ minus Measured $PM_{2.5}$; and
- Method 2 Difference: Method 2 predicted $PM_{2.5}$ minus Measured $PM_{2.5}$.

B.13 The results are summarised in Table B.2.

Table B.2 - Variation of maximum, minimum and spread of the 'Method 1 Difference' and 'Method 2 Difference'

	North Urban Background		Scotland		Wales		Northern Ireland		London Traffic		UK Industrial	
	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2
Maximum	6.4	3.0	2.3	2.2	10.4	7.7	4.1	1.8	4.4	2.9	12.2	7.7
Minimum	-4.6	-4.0	-3.2	-1.3	-12.3	-4.4	-4.3	-3.6	-4.4	-1.3	-6.4	-3.4
Spread	11.0	6.9	5.5	3.5	22.6	12.1	8.3	5.4	8.8	4.2	18.6	11.1

B.14 In all of the six scenarios, the spread in the range of concentrations calculated by Method 2 is always lower than that calculated by Method 1. This analysis would suggest that Method 2 is the better of the two methods.

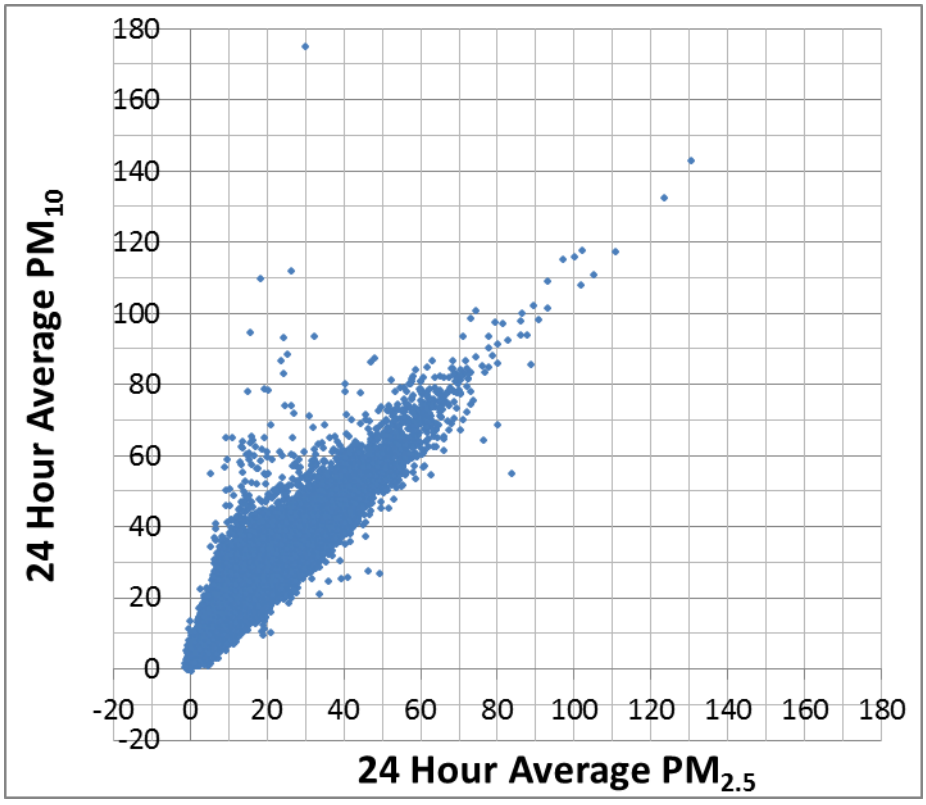
B.15 It is also important to consider that:

- Method 2 is easier for Local Authorities to undertake; and
- When using Method 1, it may be difficult to find enough suitable nearby sites of the same site classification that measure both PM_{10} and $PM_{2.5}$.

B.16 It is recommended that Method 2 is utilised), i.e. multiplying the annual average PM_{10} concentration of the site to be corrected by the ratio of $PM_{2.5}/PM_{10}$. Where suitable sites of the same site classification are available nearby, then a locally derived ratio may be used. If no sites are available, then Local authorities should use the UK average ratio of 0.7.

B.17 Figure B.8 shows the 24-hour mean $PM_{2.5}$ concentration (x-axis) plotted against the 24-hour mean PM_{10} concentration (y-axis). There are 53,294 points on the graph.

Figure B.8 - Scatter Graph comparing 24-hour mean PM_{10} and $PM_{2.5}$ concentrations



B.18 Taking a transect of $PM_{2.5}$ concentrations where PM_{10} = 50µg/m^3, the majority of points lie within the range 30 to 50 µg/m^3 for $PM_{2.5}$.This would suggest that if the 24-hour mean $PM_{2.5}$ concentration exceeds 30µg/m^3 on more than 7 (Scotland) or 35 (Rest of the UK) occurrences a year, then the local authority should consider installing PM_{10} analyser in that location. Next, taking a transect of PM_{10} concentrations where $PM_{2.5}$ = 30µg/m^3, the majority of points lie within the range 25 to 55 µg/m^3 for PM_{10}. This would suggest that setting a threshold of 30µg/m^3 for the 24-hour mean $PM_{2.5}$ concentration would be erring on the side of extreme

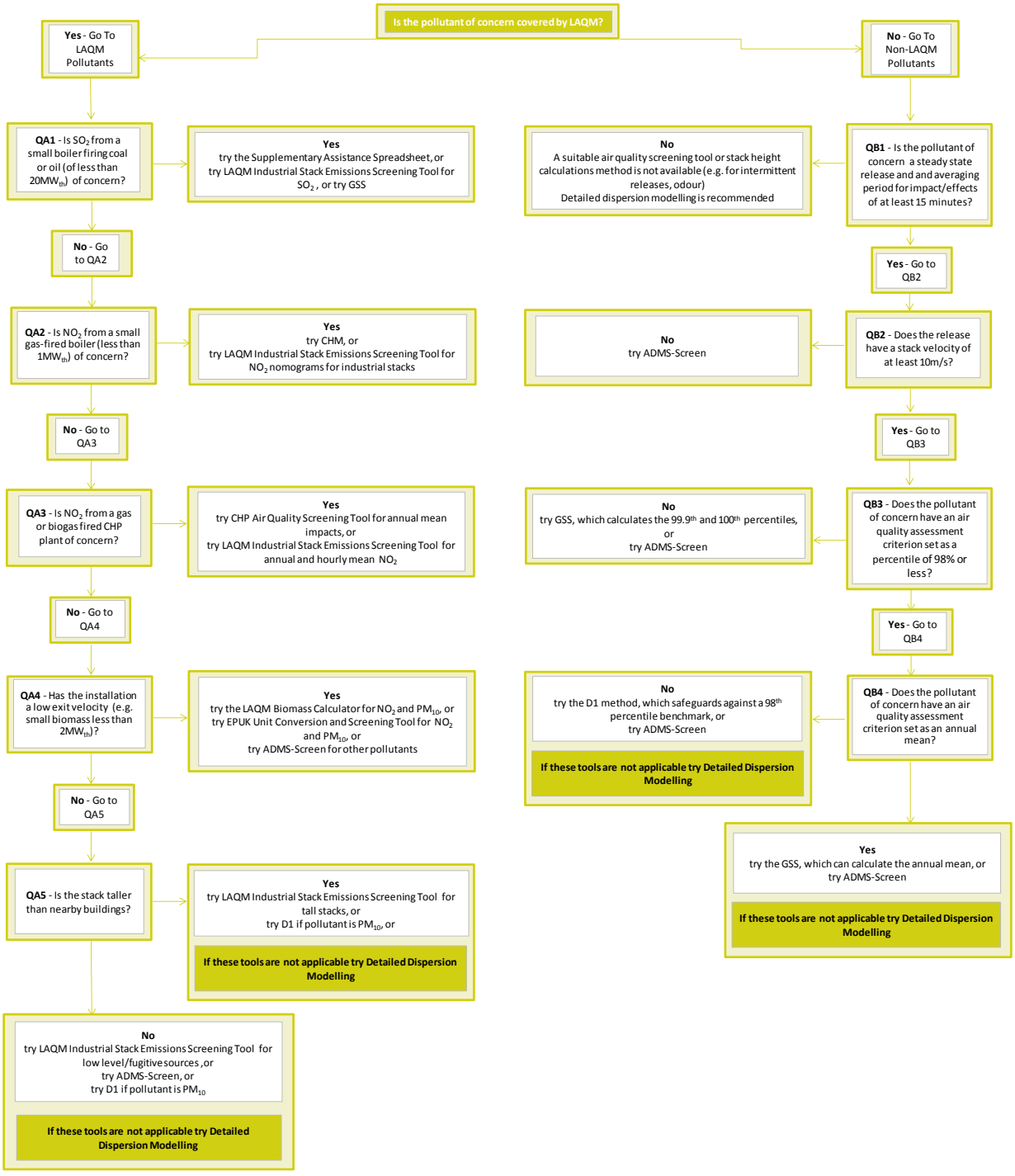
caution, and would identify more sites for PM_{10} monitoring than are probably necessary. It is therefore recommended to recommend a threshold of 35µg/m^3 for the 24-hour mean $PM_{2.5}$ concentration, as in addition to being less cautious, is also consistent with the proposed ratio of $PM_{2.5}/PM_{10}$ of 0.7.

Annex C. Stack Screening Method Selection Tool

C.01 The flow chart provided below is intended to assist local authorities in selecting the most appropriate screening method to assess the impact of stack emissions on local air quality, either for planning or LAQM purposes.

C.02 It is relevant to the smaller industrial processes, which come under local authority control, and is based upon the applicability and limitations of the various air quality screening tools and stack height calculation methods that are available, as discussed in Chapter 7 Part 1 – Screening Tools and Methodology.

Figure C.1 – Choosing the Most Appropriate Stack Emissions Screening Method



CHM – Department of Environment (DoE) Chimney Height Memorandum (CHM) 3rd Edition

GSS – Environment Agency (EA) Guidance on Stationary Sources (GSS)

Template: Annual Status Report (ASR)

Insert LA Logo Here

INSTRUCTIONS

This is the Annual Status Report (ASR) for submission to Defra by April[113] of each calendar year.

Blue boxes provide instructions and/or further information to help local authorities complete the report. These boxes should be deleted before submitting the report.

Red text indicates where the local authority needs to fill in information.

<insert year> Air Quality Annual Status Report (ASR) for

Local Authority Name

In fulfilment of Part IV of the

Environment Act 1995

Local Air Quality Management

Date (Month, Year)

[113] For the first year of operation the submission date will be 30th June.

Local Authority Officer	Enter name(s) here
Department	Enter Department Name
Address	Enter Address
Telephone	Enter Telephone
E-mail	Enter email address
Report Reference number	Enter Report Reference
Date	Enter Date of Report

Overview of Air Quality in Our Area

INSTRUCTIONS

Please summarise the main findings and conclusions of the report here. This should include:

- Key news/headlines about how you've improved air quality in your area
- Current challenges/priorities for addressing air quality in your area
- How the public is or can get involved – e.g. walk don't drive; anti-idling, car sharing etc.

- 1-2 pictures of air quality initiatives in your borough, if possible.

This overview is designed to provide a summary for those living and working in your local authority area of the state of air quality in the area and progress on the actions that you and others, including the public, are taking or could take to improve air quality. It is also an opportunity to indicate whether any changes are required to your Action Plans.

Delete this box when the document is finished

<insert standard text here as to why addressing air quality matters>

Air quality in <local authority name>

Include a brief summary of the main air quality issues in your local area – what are the main pollutants of concern, what is the latest monitoring saying (levels going up or down), any new major sources of emissions. Include the introduction of any new AQMAs, Action Plans or strategies. Briefly explain how your local authority works to manage local air quality and how you work with your partners e.g. County Council, Environment Agency.

Actions to improve air quality

Include a brief summary of core actions (and in particular success stories or lessons learnt) to target sources of pollution in your area over the past year, indicate any quantitative improvements from actions taken (if known), and include a summary of progress on any grant funded projects.

Local Priorities and Challenges

Include here a brief summary of what the priorities are for the local authority in addressing air quality for the coming year and briefly set out any challenges.

How to get involved

Include a brief note on how the public can help improve air quality in your area, any action groups, and where they can obtain further information.

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INSTRUCTIONS

Please:

- update Table on completion of report (select some text below> right click > update field>Update Entire Table)
- include hyperlinks in the PDF version

Delete this box when the document is finished

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Please insert a list of Tables here.

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6 Local Air Quality Management

Standard text: This report provides an overview of air quality in <Local Authority Name> during <year>. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where an exceedance is considered likely the local authority must declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives. This Annual Status Report (ASR) is an annual requirement showing the strategies employed by <Local Authority Name> to improve air quality and any progress that has been made.

The statutory air quality objectives applicable to LAQM **in England** can be found in Table 1.1 in Annex D.

7 Actions to improve air quality

INSTRUCTIONS

If an AQMA has been declared and an AQAP has been published, please provide in this section details on progress made to implement each of the AQAP measures. If no AQMA has been declared, but an Air Quality Strategy or other document has been prepared, you should link to the relevant document(s). If action on air quality is being addressed through other plans e.g. Local Transport Plans or climate change strategies, please indicate here with links and any progress.

Please provide further information below the table including:

- Key actions completed, in progress or planned since last year, and outcomes in terms on benefits for air quality
- Any difficulties encountered / why measures have not been progressed, and if

measures have slipped, how this will be addressed

- Forecast progress up to next year's Annual Status Report

Local authorities in England no longer have to report on 1,3-Butadiene, Benzene, Carbon Monoxide and Lead, but if you have decided to report, then state clearly which pollutant and why.

Local authorities are now asked to work towards reducing levels of $PM_{2.5}$ (fine particulates). You should use this section to briefly set out how your authority has decided to do this, why and what measures are being taken – further information is provided in LAQM policy and technical guidance.

Delete this box when the document is finished

1.01 Air Quality Management Areas

Air Quality Management Areas (AQMAs) are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority must prepare an Air Quality Action Plan (AQAP) within 12-18 months setting out measures it intends to put in place in pursuit of the objectives.

Amend the following as necessary:

A summary of AQMAs declared by <Local Authority Name> can be found in Table 2.1. Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online at <insert link to local authority's AQMA webpage – this should look like http://uk-air.defra.gov.uk/aqma/local-authorities?la_id=xxx– see full list at http://uk-air.defra.gov.uk/aqma/list>.

Or:

<Local Authority Name> currently does not have any AQMAs. <insert reference to air quality strategy or similar document>

Add text if necessary: We propose to declare a new AQMA in <x> area (see monitoring section). We propose to amend <AQMA Name> (see monitoring section). We propose to revoke <AQMA Name> (see monitoring section).

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Pollutants and Air Quality Objectives	City / Town	One Line Description	Action Plan
AQMA Name 1	• NO_2 annual mean • PM_{10} 24-hour mean	Name	E.g. An area encompassing a number of properties at the junction of road 1 and road 2.	Name and Link to Action Plan
AQMA Name 2	NO_2 annual mean	Name	E.g. Residential properties along road name 1. The AQMA was further extended in April 2013 to include road name 2.	Name and Link to Action Plan
AQMA Name 3	SO_2 1-hour mean	Name	E.g. An area encompassing residential properties near <industrial facility>	Name and Link to Action Plan

1.02 Progress and Impact of Measures to address Air Quality in <Local Authority Name>

<Local Authority Name> has taken forward a number of measures during the current reporting year of <XXXX> in pursuit of improving local air quality. Details of all measures completed, in train or planned are set out in Table 2.2. More detail on these measures can be found in their respective Action Plans <insert names of other plans or strategies if appropriate>. Key completed measures are: <set out bullet of main measures below and any key outcomes from these – keep text brief>.

Delete as appropriate: Progress on the following measures has been slower than expected due to: <insert any explanation>.

<Local Authority Name> expects the following measures to be completed over the course of the next reporting year: <set out measures and brief explanation of expected impact of these measures>. <Local Authority name> priorities for the coming year are <set out briefly with explanation>.

INSTRUCTIONS

Please fill in the table below (examples have been included as a guide). The “EU Category” and “EU Classification” columns should be populated based on the following options, to be consistent with the National Air Quality Plans:

EU Measure Category	**EU Measure Classification**
Alternatives to private vehicle use	Bus based Park & Ride
	Car & lift sharing schemes
	Car Clubs
	Rail based Park & Ride
	Other
Environmental Permits	Introduction/increase of environment charges through permit systems and economic instruments
	Introduction/increase of environmental funding through permit systems and economic instruments
	Large Combustion Plant Permits and National Plans going beyond BAT
	Measures to reduce pollution through IPPC Permits going beyond BAT
	Other measure through permit systems and economic instruments
	Tradable permit system through permit systems and economic instruments

	Other
Freight and Delivery Management	Delivery and Service plans
	Freight Consolidation Centre
	Freight Partnerships for city centre deliveries
	Quiet & out of hours delivery
	Route Management Plans/ Strategic routing strategy for HGV's
	Other
Policy Guidance and Development Control	Air Quality Planning and Policy Guidance
	Low Emissions Strategy
	Other policy
	Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air quality
	Sustainable Procurement Guidance
Promoting Low Emission Plant	Emission control equipment for small and medium sized stationary combustion sources / replacement of combustion sources
	Low Emission Fuels for stationary and mobile sources in Public Procurement
	Other measure for low emission fuels for stationary and mobile sources

	Public Procurement of stationary combustion sources
	Regulations for fuel quality for low emission fuels for stationary and mobile sources
	Shift to installations using low emission fuels for stationary and mobile sources
	Other Policy
Promoting Low Emission Transport	Company Vehicle Procurement -Prioritising uptake of low emission vehicles
	Low Emission Zone (LEZ)
	Priority parking for LEV's
	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging
	Public Vehicle Procurement -Prioritising uptake of low emission vehicles
	Taxi emission incentives
	Taxi Licensing conditions
	Other
Promoting Travel Alternatives	Encourage / Facilitate home-working
	Intensive active travel campaign & infrastructure
	Personalised Travel Planning
	Promote use of rail and inland waterways

	Promotion of cycling
	Promotion of walking
	School Travel Plans
	Workplace Travel Planning
	Other
Public Information	Via leaflets
	Via other mechanisms
	Via radio
	Via television
	Via the Internet
	Other
Traffic Management	Anti-idling enforcement
	Emission based parking or permit charges
	Reduction of speed limits, 20mph zones
	Road User Charging (RUC)/ Congestion charging
	Strategic highway improvements, Re-prioritising road space away from cars, inc Access management, Selective vehicle priority, bus priority, high vehicle occupancy lane

	Testing Vehicle Emissions
	UTC, Congestion management, traffic reduction
	Workplace Parking Levy, Parking Enforcement on highway
	Other
Transport Planning and Infrastructure	Bus route improvements
	Cycle network
	Public cycle hire scheme
	Public transport improvements-interchanges stations and services
	Other
Vehicle Fleet Efficiency	Driver training and ECO driving aids
	Fleet efficiency and recognition schemes
	Promoting Low Emission Public Transport
	Testing Vehicle Emissions
	Vehicle Retrofitting programmes
	Other

Delete this box when the document is finished

Table 2.2 - Progress on Measures to Improve Air Quality

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Key Perfor-mance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
1	Title	Select from the categories in blue box	Select from the subcategories in blue box		Date	Date				Date	
2											
3											
4											

1.03 $PM_{2.5}$ – Local Authority Approach to Reducing Emissions and or Concentrations

INSTRUCTIONS

Briefly set out how you have chosen to interpret the requirement to work towards reducing $PM_{2.5}$ in your local area as set out in LAQM Policy Guidance and why. Unless this approach changes, this text is likely to remain standard in future years.

Please then set down any measures that you are taking or planning and whether they have links to the Public Health Outcomes Framework.

Delete this box when the document is finished

Standard text: Local Authorities are expected under section <x> of Policy Guidance LAQM.PG16 to work towards reducing emissions and/or concentrations of pollutant $PM_{2.5}$. There is clear evidence that particulate matter ($PM_{2.5}$) has a significant impact on human health, including premature mortality, allergic reactions, and cardiovascular diseases.

<Local Authority Name> is working to address $PM_{2.5}$ through the following way/s: <insert explanation>.

We are taking the following measures: <insert text – include whether new or existing measures (please refer to specific number of measures in the Progress Report on Action Plans in the section above) that may also be addressing other pollutants as well and any partnership working>.

8 Air Quality Monitoring Data and Comparison with Air Quality Objectives and National Compliance

1.01 Summary of Monitoring Undertaken

INSTRUCTIONS

Please include a brief summary of monitoring data in this section, with an explanation of any changes in the past 12 months and if those changes have led to the declaration of an AQMA, decision to amend or revoke an AQMA, or appropriate local strategy. Include also the level of exceedance in comparison with national/EU Limit Values. The tabular details should be supplied in an Appendix and/or link.

If changes have led to a decision to declare an AQMA, please indicate whether you are moving to immediate declaration or whether you have decided to seek additional evidence before declaration; and indicate what that is and timescales (taking into account LAQM Guidance). Any extra information should be placed in Annex C.

If any change to your monitoring strategy has been made during the past 12 months or is planned, briefly set out here and explain why.

Delete this box when the document is finished

Automatic Monitoring Sites

This section sets out what monitoring has taken place and how it compares with objectives.

<Local Authority Name> undertook automatic (continuous) monitoring at <X> sites during <year>. Table A.1 in Appendix A shows the details of the sites. NB. Local authorities do not have to report annually on the following pollutants: 1,3 butadiene, benzene, carbon monoxide and lead, unless local circumstances indicate there is a problem. National monitoring results are available at <please insert link>.

Maps showing the location of the monitoring sites are provided in <Appendix X/ or link>. Further details on how the monitors are calibrated and how the data has been adjusted are included in Appendix C.

Non-Automatic Monitoring Sites

<Local Authority Name> undertook non- automatic (passive) monitoring of NO_2 at <X> sites during <year>. Table A.2 in Appendix A shows the details of the sites.

Maps showing the location of the monitoring sites are provided in <Appendix X/ or link>. Further details on Quality Assurance/Quality Control (QA/QC) and bias adjustment for the diffusion tubes are included in Appendix C.

1.02 Individual pollutants

INSTRUCTIONS

You may wish to include any trend data from previous years in an Appendix, showing any increasing or decreasing trends (5 years data is usually considered the minimum necessary to identify a significant trend). Any apparent trends in this data should be discussed. When trends/result are presented in a graph, please indicate clearly in the graph the relevant objectives for that pollutant so that conclusions can be drawn easily by members of the public.

Delete this box when the document is finished

The air quality monitoring results presented in this section are, where relevant, adjusted for "annualisation" and bias. Further details on adjustments are provided in Appendix C.

Nitrogen Dioxide (NO_2)

INSTRUCTIONS

Comment on whether there are exceedances of the air quality objectives for NO_2 and whether they occur:

- Within or outside AQMAs
- At locations of relevant exposure or not

If an exceedance is measured at a monitoring site which is not representative of public exposure, please use the procedure specified in Technical Guidance LAQM.TG16 to estimate the concentration at the nearest receptor, and discuss these results.

Monitoring data should be included in Tables A.3 and A.4 in Appendix A

You should state whether the information led to the declaration of an AQMA, including the main points/trends coming out of the data – e.g. where are the exceedances or areas of concern?

Delete this box when the document is finished

Table A.3 in Appendix A compares the ratified and adjusted monitored NO_2 annual mean concentrations for the past 5 years with the air quality objective of 40µg/m^3.

For diffusion tubes, the full <most recent year of data> dataset of monthly mean values is provided in Appendix B.

Table A.4 in Appendix A compares the ratified continuous monitored NO_2 hourly mean concentrations for the past 5 years with the air quality objective of 200µg/m^3, not to be exceeded more than 18 times per year. Briefly describe the exceedances of the air quality objectives here, considering annual means greater than 60µg/m^3, which indicates that an exceedance of the 1-hour mean objective is also likely at these sites.

Particulate Matter (PM_{10})

INSTRUCTIONS

Comment on whether there are exceedances of the air quality objectives for PM_{10} and whether they occur:

- Within or outside AQMAs
- At locations of relevant exposure or not

Monitoring data should be included in Tables A.5 and A.6 in Appendix A.

You should state whether the information led to the declaration of an AQMA, including the main points/trends coming out of the data – e.g. where are the exceedances or areas of concern?

Delete this box when the document is finished

Table A.5 in Appendix A compares the ratified and adjusted monitored PM_{10} annual mean concentrations for the past 5 years with the air quality objective of 40µg/m^3.

Table A.6 in Appendix A compares the ratified continuous monitored PM_{10} daily mean concentrations for the past 5 years with the air quality objective of 50µg/m^3, not to be exceeded more than 35 times per year.

Briefly describe the exceedances of the air quality objectives here

Particulate Matter ($PM_{2.5}$)

INSTRUCTIONS

Although not covered by the LAQM regulations, if you carry out monitoring of $PM_{2.5}$, please report it here. This may be useful as $PM_{2.5}$ is the pollutant which has the biggest impact on public health and on which the Public Health Outcomes Framework (PHOF) indicator is based.

If you don't monitor $PM_{2.5}$, please delete this section.

Delete this box when the document is finished

Sulphur Dioxide (SO_2)

INSTRUCTIONS

If SO_2 monitoring is available then provide a table of results.

If you don't monitor SO_2, please delete this section.

Comment on whether there are exceedances of the air quality objectives for SO_2 and whether they occur:

- Within or outside AQMAs
- At locations of relevant exposure or not

You should state whether the information led to the declaration of an AQMA, including the main points/trends coming out of the data – e.g. where are the exceedances or areas of concern?

Delete this box when the document is finished

Table A.7 in Appendix A compares the ratified continuous monitored SO_2 concentrations for year 2015 with the air quality objectives for SO_2.

Discuss exceedances of the air quality objectives here.

Appendices

Appendix A: Tables: Monitoring Details

Appendix B: Full Monthly NO_2 Diffusion Tube Results

Appendix C: Supporting Technical Information/QA-QC for Air Quality Monitoring Data

Appendix D: Summary of Air Quality Objectives in England

Appendix A: Monitoring Results

Table A.1 – Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
CM1	Name1	Roadside	332395	433175	NO_2; PM_{10}	Y	Chemiluminescent; FDMS	5	3	1.5
CM2	Name2	Urban background	332200	433540	NO_2	N	Chemiluminescent	0	N/A	1.5

(1) 0 if the monitoring site is at a location of exposure (e.g. installed on the façade of a residential property).

(2) N/A if not applicable.

Table A.2 – Details of Non-Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?
DT1	Name1	Roadside	332395	433175	NO_2	Y	1	3	Y

(1) 0 if the monitoring site is at a location of exposure (e.g. installed on/adjacent to the façade of a residential property).

(2) N/A if not applicable.

Table A.3 – Annual Mean NO_2 Monitoring Results

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2015 (%) (2)	NO_2 Annual Mean Concentration ($\mu g/m^3$) (3)				
					2011	2012	2013	2014	2015
CM1	Roadside	Automatic	95	95	**<u>61.0</u>**	**48.1**	**44.1**	**43.2**	35.1
CM2	Urban Background	Automatic	100	50	27.0	28.2	31.5	27.8	30.2
DT1	Roadside	Diffusion Tube	75	75	**<u>61.0</u>**	**48.1**	**44.1**	**43.2**	35.1

Notes: Exceedances of the NO_2 annual mean objective of 40µg/m3 are shown in **bold**.

NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 1-hour mean objective are shown in **<u>bold and underlined.</u>**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) Means for diffusion tubes have been corrected for bias. All means have been “annualised” as per LAQM.TG16 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Table A.4 – 1-Hour Mean NO_2 Monitoring Results

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2015 (%) (2)	NO_2 1-Hour Means > 200µg/m^3 (3)				
					2011	2012	2013	2014	2015
CM1	Roadside	Automatic	95	95	**19**	11	12	15	**20**
CM2	Urban Background	Automatic	80	80	N/A	N/A	N/A	**22 (235)**	16 (185)

Notes: Exceedances of the NO_2 1-hour mean objective (200µg/m^3 not to be exceeded more than 18 times/year) are shown in **bold.**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 90%, the 99.8th percentile of 1-hour means is provided in brackets.

Table A.5 - Annual Mean PM_{10} Monitoring Results

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2015 (%) (2)	PM_{10} Annual Mean Concentration ($\mu g/m^3$) (3)				
				2011	2012	2013	2014	2015
CM1	Roadside	95	95	**61.0**	**48.1**	**44.1**	**43.2**	35.1
CM2	Urban Background	100	50	27.0	28.2	31.5	27.8	30.2

Notes: Exceedances of the PM_{10} annual mean objective of 40$\mu g/m^3$ are shown in **bold.**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) All means have been "annualised" as per Technical Guidance LAQM.TG16; valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Table A.6 – 24-Hour Mean PM_{10} Monitoring Results

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2015 (%) (2)	PM_{10} 24-Hour Means > 50µg/m^3 (3)				
				2011	2012	2013	2014	2015
CM1	Roadside	95	95	**36**	26	22	29	**38**
CM2	Urban Background	80	80	N/A	N/A	N/A	**36 (55)**	27 (35)

Notes: Exceedances of the PM_{10} 24-hour mean objective (50µg/m^3 not to be exceeded more than 35 times/year) are shown in **bold.**

(1) data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 90%, the 90.4th percentile of 24-hour means is provided in brackets.

Table A.7 – SO_2 Monitoring Results

Site ID	Site Type	Valid Data Capture for monitoring Period (%) (1)	Valid Data Capture 2014 (%) (2)	Number of Exceedances (percentile in bracket) (3)		
				15-minute Objective (266 µg/m^3)	1-hour Objective (350 µg/m^3)	24-hour Objective (125 µg/m^3)
CM1	Roadside	98	94	4	1	0
	Urban Background					

Notes: Exceedances of the SO_2 objectives are shown in **bold** (15-min mean = 35 allowed a year, 1-hour mean = 24 allowed a year, 24-hour mean = 3 allowed a year)

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%)

(3) If the period of valid data is less than 90%, the relevant percentiles are provided in brackets.

Appendix B: Full Monthly Diffusion Tube Results for 2015

Table B.1 – NO_2 Monthly Diffusion Tube Results - <Year>

Site ID	NO_2 Mean Concentrations ($\mu g/m^3$)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean	
													Raw Data	Bias Adjusted (1)
DT1	26.2	42.1	-	-	28.2	35.3	-	26.3	31.5	38.4	45.2	41.5	35.0	40.2
DT2														

(1) See Appendix C for details on bias adjustment

Appendix C: Supporting Technical Information / Air Quality Monitoring Data QA/QC

INSTRUCTIONS

Please include here any additional information required to support the ASR. This may require:

- Indication, if necessary, of any significant changes to sources, and therefore any screening assessment of identified new or changed sources of pollution based on DMRB, industrial nomograms, biomass tools, etc. (see Chapter 7 in Technical Guidance LAQM.TG16). Outline whether this has resulted / will result in any change to monitoring.
- Reporting of any detailed dispersion modelling of emissions, or results of monitoring campaigns carried out to determine whether an AQMA needs to be declared, amended or revoked.
- A summary of any additional evidence gathered or being gathered in support of measures for Action Plans and links to any final reports.
- QA/QC on monitoring data, including bias adjustments etc.

Delete this box when the document is finished

Appendix D: Summary of Air Quality Objectives in England

Table 1.1

Pollutant	Air Quality Objective[114]	
	Concentration	**Measured as**
Nitrogen dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
	40 µg/m^3	Annual mean
Particulate Matter (PM_{10})	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
	40 µg/m^3	Annual mean
Sulphur dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean

[114] The units are in microgrammes of pollutant per cubic metre of air (µg/m^3).

Glossary of Terms

Please add a description of any abbreviation included in the ASR – An example is provided below.

Abbreviation	Description
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the LA intends to achieve air quality limit values'
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed / are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
ASR	Air quality Annual Status Report
AURN	Automatic Urban and Rural Network (UK air quality monitoring network)
Defra	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges – Air quality screening tool produced by Highways England
FDMS	Filter Dynamics Measurement System
LAQM	Local Air Quality Management
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5µm or less

QA/QC	Quality Assurance and Quality Control
SO_2	Sulphur Dioxide

References

Template: Action Plan

Insert LA Logo Here

INSTRUCTIONS

This is the Air Quality Action Plan (AQAP) template published by Defra to help local authorities prepare their AQAP

- Blue boxes provide instructions and/or further information to help local authorities complete the report.
- Red text indicates where the local authority needs to fill in information.

These boxes and red text should be deleted before submitting the report.

- Local Authority Name
- Air Quality Action Plan
- In fulfilment of Part IV of the
- Environment Act 1995
- Local Air Quality Management
- Date (Year)

Local Authority Officer	Enter name(s) here
Department	Enter Department Name
Address	Enter Address
Telephone	Enter Telephone
e-mail	Enter email address
Report Reference number	Enter Report Reference
Date	Enter Date of Report

Executive Summary

This Air Quality Action Plan (AQAP) {has been produced as part of our duty to Local Air Quality Management}. It outlines the action we will take to improve air quality in <Local Authority Name> between <add dates>.

This action plan replaces the previous action plan which ran from <add dates>. Highlights of successful projects delivered through the past action plan include: <add bullets which describe achievements e.g. implementing cleaner public transport; engaged with businesses, with outcomes if possible>.

Air pollution is associated with a number of adverse health impacts. It is recognised as a contributing factor in the onset of heart disease and cancer. Additionally, air pollution particularly affects the most vulnerable in society: children and older people, and those with heart and lung conditions. There is also often a strong correlation with equalities issues, because areas with poor air quality are also often the less affluent areas.[115,116]

The annual health cost to society of the impacts of particulate matter alone in the UK is estimated to be roughly £16 billion[117]. <Council Name> is committed to reducing the exposure of people in <Local Authority Name> to poor air quality in order to improve health.

<Amend as appropriate> We have developed actions that can be considered under <add number> broad topics:

- Alternatives to private vehicle use
- Environmental permits
- Freight and delivery management
- Policy guidance and development control
- Promoting low emission plants;
- Promoting low emission transport
- Promoting travel alternatives
- Public information
- Transport planning and infrastructure

[115] Environmental equity, air quality, socioeconomic status and respiratory health, 2010

[116] Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006

[117] Defra. Valuing the overall impacts of air pollution, March 2010

- Traffic management
- Vehicle fleet efficiency

Our priorities are <e.g. tackle emissions due to servicing and freight vehicles, and so we will introduce virtual parking bays on main roads to be used in off-peak hours, reducing congestion and emissions>.

We have worked hard to engage with stakeholders and communities which can make a difference to air quality in <Local Authority>. We would like to thank all those who have worked with us in the past and we look forward to working with you again as well with new partners as we deliver this new action plan over the coming years.

In this AQAP we outline how we plan to effectively tackle air quality issues within our control. However, we recognise that there are a large number of air quality policy areas that are outside of our influence (such as vehicle emissions agreed in Europe), but for which we may have useful evidence, and so we will continue to work with regional and central government on policies and issues beyond <Local Authority Name>'s direct influence.

Responsibilities and Commitment

This AQAP was prepared by the <Environmental Health Department> of <Local Authority Name> Council with the support and agreement of the following officers and departments:

List officers/departments involved in the preparation of the AQAP

This AQAP has been approved by:

<Details of high level Council members who have approved the AQAP (NB: In two tier authorities this could include sign off from County Councils) e.g. Head of Transport Planning, Head of Public Health, with e-signatures>.

This AQAP will be subject to an annual review, appraisal of progress and reporting to the relevant Council Committee (specify if relevant). Progress each year will be reported in the Annual Status Reports (ASRs) produced by <Local Authority Name>, as part of our statutory Local Air Quality Management duties.

If you have any comments on this AQAP please send them to <report author> at:

Address

Telephone

Email

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INSTRUCTIONS

Please:

- update Tables on completion of report (select some text below> right click > update field>Update Entire Table)
- include hyperlinks in the PDF version

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3 <Local Authority Name>'s Air Quality Priorities 7

4 Development and Implementation of <Local Authority Name> AQAP 7

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1

2 List of Tables

3 Please insert a list of Tables here.

4 **Table 7.20 - Consultation Undertaken**

5 **Table 7.21 - Air Quality Action Plan**

6 List of Figures

7 Please insert a list of Figures/charts here.

Abbreviations

AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
LAQM	Local Air Quality Management
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
PM_{10}	Particulate matter less than 10 micron in diameter
$PM_{2.5}$	Particulate matter less than 2.5 micron in diameter

9 Introduction

This report outlines the actions that <Local Authority> will deliver between <add dates of AQAP e.g. 2016-2020> in order to reduce concentrations of air pollutants and exposure to air pollution; thereby positively impacting on the health and quality of life of residents and visitors to the < district/local authority's administrative area>.

{It has been developed in recognition of the legal requirement on the local authority to work towards Air Quality Strategy (AQS) objectives under Part IV of the Environment Act 1995 and relevant regulations made under that part and to meet the requirements of the Local Air Quality Management (LAQM) statutory process}.

This Plan will be reviewed every five years at the latest and progress on measures set out within this Plan will be reported on annually within <local authority name>'s air quality ASR.

10 Summary of Current Air Quality in <Local Authority Name>

Please refer to the latest ASR from <Local Authority Name>

11 <Local Authority Name>'s Air Quality Priorities

INSTRUCTIONS

Describe here the Council's priorities and drivers for pursuing some actions to improve air quality and not others. This may include a description of the health context in the local authority's administrative area, major sources of pollutants such as road hotspots, the planning context (upcoming developments) and other Council policies, such as transport and/or climate change.

Source apportionment dispersion modelling studies may assist in identifying priorities. For example, in an AQMA declared for NO_2 primarily due to emissions from road traffic and, e.g. if bus emissions are identified to contribute a high proportion of the total road-NO_x, it may be sensible to prioritise AQAP measures that specifically target this source group.

If there are other documents or strategies that set out information on the local authority's approach to air quality, please provide brief information (and any links) about them and how they have been accounted for within this Action Plan.

This is an opportunity to lay out the Council's rationale and prioritisation.

Delete this box when the document is finished

12 Development and Implementation of <Local Authority Name> AQAP

1.01 Consultation and Stakeholder Engagement

In developing/updating this AQAP, we have worked with other local authorities, agencies, businesses and the local community to improve local air quality. Schedule 11 of the Environment Act 1995 requires local authorities to consult the bodies listed in **Table 7.20**. In addition, we have undertaken the following stakeholder engagement:

- E.g. website

- Articles in local newspaper
- Questionnaires distributed directly to households along major roads
- etc

The response to our consultation stakeholder engagement is given in Appendix A.

Table 7.20 - Consultation Undertaken

Yes/No	Consultee
	the Secretary of State
	the Environment Agency
	the highways authority
	all neighbouring local authorities
	other public authorities as appropriate, such as Public Health officials
	bodies representing local business interests and other organisations as appropriate

1.02 Steering Group

INSTRUCTIONS

Report on your Steering Group: composition, the groups activity (e.g. number of meetings) and in what ways the Steering Group has pushed forward the implementation of the AQAP.

The members of the Steering Group should include local authority officers across the different local authority departments, including at county level (in two-tier authorities) and may include officers from different local authorities. The Steering Group would decide on engaging support from other outside bodies, businesses and local community groups to take the process forward.

Other local authority departments and external bodies should be constructively engaged in agreeing actions to improve air quality and meet the legal requirement to work towards air quality objectives.

The following, in particular, should engage constructively in improving air quality:

- transport planners;
- local highway authorities;
- land use planners and town centre managers;
- environmental protection and energy management officers;
- waste managers;
- economic development, regeneration and tourism departments;
- corporate policy and resources;
- the Environment Agency; and
- Highways England.

Delete this box when the document is finished

13 AQAP Measures

Table 5.1 shows the <Local Authority Name> AQAP measures. It contains:

- a list of the actions that form part of the plan
- the responsible individual and departments/organisations who will deliver this action
- estimated cost of implementing each action (overall cost and cost to the local authority)
- expected benefit in terms of pollutant emission and/or concentration reduction;
- the timescale for implementation
- how progress will be monitored

NB. Please see future ASRs for regular annual updates on implementation of these measures

INSTRUCTIONS

Where relevant, the Council should add further detail below with regards to the measures adopted in their AQAP, beyond the summary level information provided in **Para 13Error! Reference source not found.** In particular if there are measures that re considered a priority or drawing out where local public support or action may be required.

Delete this box when the document is finished

INSTRUCTIONS

Please fill in the table below. The “EU Category” and “EU Classification” columns should be populated based on the following options, to be consistent with the National Air Quality Plans:

EU Measure Category	**EU Measure Classification**
Alternatives to private vehicle use	Bus based Park & Ride
	Car & lift sharing schemes
	Car Clubs
	Rail based Park & Ride
	Other
Environmental Permits	Introduction/increase of environment charges through permit systems and economic instruments
	Introduction/increase of environmental funding through permit systems and economic instruments
	Large Combustion Plant Permits and National Plans going beyond BAT
	Measures to reduce pollution through IPPC Permits going beyond BAT
	Other measure through permit systems and economic instruments

	Tradable permit system through permit systems and economic instruments
	Other
Freight and Delivery Management	Delivery and Service plans
	Freight Consolidation Centre
	Freight Partnerships for city centre deliveries
	Quiet & out of hours delivery
	Route Management Plans/ Strategic routing strategy for HGV's
	Other
Policy Guidance and Development Control	Air Quality Planning and Policy Guidance
	Low Emissions Strategy
	Other policy
	Regional Groups Co-ordinating programmes to develop Area wide Strategies to reduce emissions and improve air quality
	Sustainable Procurement Guidance
Promoting Low Emission Plant	Emission control equipment for small and medium sized stationary combustion sources / replacement of combustion sources
	Low Emission Fuels for stationary and mobile sources in Public Procurement

	Other measure for low emission fuels for stationary and mobile sources
	Public Procurement of stationary combustion sources
	Regulations for fuel quality for low emission fuels for stationary and mobile sources
	Shift to installations using low emission fuels for stationary and mobile sources
	Other Policy
Promoting Low Emission Transport	Company Vehicle Procurement -Prioritising uptake of low emission vehicles
	Low Emission Zone (LEZ)
	Priority parking for LEV's
	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging
	Public Vehicle Procurement -Prioritising uptake of low emission vehicles
	Taxi emission incentives
	Taxi Licensing conditions
	Other
Promoting Travel Alternatives	Encourage / Facilitate home-working
	Intensive active travel campaign & infrastructure
	Personalised Travel Planning

	Promote use of rail and inland waterways
	Promotion of cycling
	Promotion of walking
	School Travel Plans
	Workplace Travel Planning
	Other
Public Information	Via leaflets
	Via other mechanisms
	Via radio
	Via television
	Via the Internet
	Other
Traffic Management	Anti-idling enforcement
	Emission based parking or permit charges
	Reduction of speed limits, 20mph zones
	Road User Charging (RUC)/ Congestion charging

	Strategic highway improvements, Re-prioritising road space away from cars, inc Access management, Selective vehicle priority, bus priority, high vehicle occupancy lane
	Testing Vehicle Emissions
	UTC, Congestion management, traffic reduction
	Workplace Parking Levy, Parking Enforcement on highway
	Other
Transport Planning and Infrastructure	Bus route improvements
	Cycle network
	Public cycle hire scheme
	Public transport improvements-interchanges stations and services
	Other
Vehicle Fleet Efficiency	Driver training and ECO driving aids
	Fleet efficiency and recognition schemes
	Promoting Low Emission Public Transport
	Testing Vehicle Emissions
	Vehicle Retrofitting programmes
	Other

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Table 7.21 - Air Quality Action Plan

Measure No.	Measure	EU Category	EU Classification	Lead Authority	Planning Phase	Implementation Phase	Indicator	Target Pollution Reduction in the AQMA	Estimated Completion Date	Cost	Comments
1	Title	Select from the categories in blue box	Select from the subcategories in blue box	Name of Council departme nt(s) with responsibi lity for action implemen tation	Date	Date			Date		

Appendix A - Response to Consultation

Table A.1 - Summary of Responses to Consultation and Stakeholder Engagement on the AQAP

Consultee	Category	Response
e.g. Chamber of Commerce	Business	E.g. Disagree with plan to remove parking on High Street in favour of buses and cycles; consider it will harm business of members.

Appendix B - Reasons for Not Pursuing Action Plan Measures

Table B.1 - Action Plan Measures Not Pursued and the Reasons for that Decision

Action category	Action description	Reason action is not being pursued (including Stakeholder views)
	Complete table for all measures that will not been pursued.	Add a 2-3 sentence summary for each action

<Appendix C - Add Additional Appendices as Required>

INSTRUCTIONS

The Council should add additional supporting appendices as required.

For example, where the selection of AQAP measures has been supported by further studies, e.g. quantitative appraisal of action plan measures through dispersion modelling, or other feasibility studies, this work should be included here.