

Preliminary Assessment of PAH and heavy metal levels in the UK

**Report to Department for Environment, Food and
Rural Affairs, the Scottish Executive, Welsh
Assembly Government and the Department of the
Environment in Northern Ireland**

AEA/ENV/2243
Issue 1
February 2007

Title	Preliminary Assessment of PAH and heavy metal levels in the UK
Customer	Department for Environment, Food and Rural Affairs, the Scottish Executive, Welsh Assembly Government and the Department of the Environment in Northern Ireland
Customer reference	CPEA15
Confidentiality, copyright and reproduction	Unrestricted
File reference	dd2005/dd4/ dd4prelim_rep_issue1.doc
Reference number	AEA/ENV/R/2243

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1 Introduction

The Framework Directive (Council Directive 96/62 EC) has established a system under which the EU will set limit values and target values for concentrations in ambient air of specified pollutants. The 4th Daughter Directive (Directive 2004/107/EC) sets target values to be achieved for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons in the form of benzo-*a*-pyrene (BaP) in ambient air.

Article 10 of the 4th Daughter Directive specifies that Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 15 February 2007 at the latest.

Monitoring of air quality in the UK is carried out through national networks of air quality monitoring stations. In addition, local authority funded monitoring activities operate throughout the UK, although in general, these are not combined with the national network and are relatively limited for the pollutants covered by this Directive. This report describes how the national monitoring networks are to be extended to meet the requirements of the Framework Directive and 4th Daughter Directive.

2 Preliminary Assessment

Under Article 5 of The Framework Directive, a requirement has been placed upon Member States to undertake a preliminary investigation of ambient air quality, prior to the implementation of the 4th Daughter Directive (see Appendix 1).

The objectives of this assessment are to establish estimates of the overall distribution and levels of pollutants covered by this Directive, and to identify additional monitoring requirements, which may be necessary in order to fulfil obligations under the Framework and 4th Daughter Directive. This report provides details of the number of additional monitoring stations, which will be required to supplement existing stations for arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons (PAH). A description is provided of the assessment methods that have been applied throughout the UK. The assessment for heavy metals draws on previous work carried out by the National Physical Laboratory (Brown and Butterfield, 2004).

3 General Approach

For the purpose of this assessment, the UK has been divided into 15 zones based on official Government Office boundaries within England and boundaries provided or authorised by the relevant Government offices within Scotland, Wales and Northern Ireland. A further 28 agglomeration zones (areas of urban population > 250,000) have also been agreed. These were based on Government geographical information system (GIS) data on urban areas for England, Scotland, Wales and Northern Ireland (Scottish Executive 2004, ONS 2004 and NISRA 2005). UK zones and agglomerations are presented in Figure 1.

To ensure a consistent estimate of pollutant concentrations and distribution within the UK, modelled estimates of pollutant concentration have been used to assess exceedences of the Assessment Thresholds and Target Values as defined in the 4th Daughter Directive (see Appendix 2). Areas requiring additional monitoring have been identified by an examination of the current monitoring network and coverage of areas with high estimated concentrations. The number of additional monitoring stations for assessment of diffuse sources has been calculated using the exceedences identified and the population of the relevant zone or agglomeration based on guidance provided by Annex III of the Directive. Annex III provides further guidance for monitoring close to point sources which has been interpreted in paragraph 2 below.

The following assumptions and definitions have been adopted for the purposes of this assessment:

1. The UK is comprised of 28 agglomeration zones and 15 non-agglomeration zones.
2. Where sources of information other than fixed measurements are available, the number of monitoring stations for fixed measurements may be reduced (see paragraph 8 of the Directive). In particular, we have taken this to apply to monitoring close to point sources regulated by Annex III of the Directive. Hence, within the UK, where model outputs and emissions inventories can provide information on the distribution and density of emissions, ambient concentrations and estimates of personal exposures, we propose that a minimum of two monitoring stations per point source are required to assess compliance with Target Values; one downwind of the source in the nearest residential area to characterize maximum exposure and one upwind of the source to characterize local background levels.
3. Where concentrations above the Lower Assessment Threshold (LAT) are predicted for point sources and the footprint of the area of exceeding encompasses more than one zone, one pair of upwind and downwind monitoring stations per point source is sufficient for assessment levels close to point source relative to Target Values.
4. Where exceedences of the LAT are predicted for more than one point source in close proximity to each other, characterisation of the local background levels can be achieved using one upwind monitoring station.
5. Where concentrations of these pollutants are expected to be below the LAT, no monitoring is required. In such cases compliance with Directive Target Values may be checked using modelling and emission inventories.

In order to ensure that the modelled exceedence statistics provided by this approach do not systematically underestimate ambient levels, a comparison with available measurement data has been performed at sites within the current monitoring networks for the relevant pollutants. These comparisons are presented in Appendix 4

3.1 Modelled data used in this assessment

Estimates of the distribution of annual mean BaP and heavy metals concentrations used in this report have been derived from previously developed high resolution pollutant maps (Vincent K et al, 2007 and Vincent K and Passant N, 2006). These maps draw heavily upon measurement data from the UK's national networks, and have been verified using measurements from these networks. The pollutant concentration maps presented in this report are for the calendar years 2005 and 2003, for BaP and heavy metals, respectively.

Modelling approaches for both BaP and heavy metals utilise the UK's National Atmospheric Emissions Inventory (NAEI) to estimate emissions to atmosphere from both area and point sources. A dispersion kernel modelling approach has been used to model annual mean concentrations from the area sources at a 1km receptor resolution. Contributions to the annual mean from point source emissions in the form of releases from chimney stacks and fugitive emissions have been modelled explicitly using the ADMS 3 dispersion modelling software and individual point source release characteristics. Full details of the modelling approach are provided in the literature cited.

The contribution from heavy metal emissions to ambient concentrations is complex in comparison to BaP. With the exception of fugitive emissions from coking plant, the majority of BaP emissions arise from combustion related sources which are well characterised, both in-terms of accuracy of the emission estimate and release parameters. However, for heavy metals, the emission releases are less well understood, particularly for fugitive emissions, which are not reported nationally to the Environment Agency's Pollution Inventory or the Scottish Environment Protection Agency's equivalent. Fugitive releases have been estimated to be up to 3 times the reported release for some point sources (Vincent K and Passant N, 2006).

In order to provide an indication of the relative importance of emissions from small industry or non-industrial sources emissions relative to emissions from large industrial sources, this work has estimated ambient concentrations of heavy metals with fugitive elements included and excluded. This

approach will enable additional monitoring requirements to be better targeted towards the most appropriate locations.

3.2 Measured data used in this assessment

Measured data from the UK's PAH and heavy metals networks have been used in the development of the models and model outputs presented in this assessment. In addition, they are also used to check that the model outputs do not systematically underestimate concentrations relative to the LAT and UAT.

Measurements of BaP from the UK network for 2005 presented in this report have been made using a technique, which differs from the draft CEN standard which may, when finalised, be accepted as the reference method specified by AnnexV (II) of the Directive. The method used thus far in the UK may differ from the reference method in several ways;

1. Sampled air is collected through an inlet with a 50% sampling efficiency for particles with a mean aerodynamic diameter of 15 μm rather than 10 μm as specified in the directive.
2. The present UK sampling system collects both the particle and vapour phase. The draft CEN standard requires only particle phase PAH to be collected.
3. Samples are currently collected over a 14-day period, extracted and bulked to produce quarterly mean concentrations, which are subsequently aggregated to give an annual mean. The Directive requires that samples be collected over a 24-hour period and then combined for analyses over periods no longer than 1 month to calculate the annual mean.
4. The current sampling system approximately corrects for the losses during sampling through the use of isotope labelled standards added before sampling. The proposed CEN standard does not.

The combined effect of the factors outlined above may result in differences in concentrations measured following the draft CEN method and those measured using the present UK method. However, whether the UK method under or over-estimates relative to the CEN draft method is unclear at present. As of 2006, a revised CEN compliant sampling system is being commissioned across the UK PAH monitoring network.

Measurements of particulate phase heavy metals in the UK urban metals network are made using Partisol 2000 instruments fitted with PM₁₀ heads. In accordance with Annex V (I) of the Directive, the instruments are calibrated in accordance with EN 12341:1998. Analysis is performed using ICP-MS and is fully compliant with the requirements of EN 14902:2005.

4 Benzo-a-pyrene (BaP)

4.1 Methodology

Benzo-a-pyrene (BaP) concentrations throughout the UK have been assessed at background and industrial locations. Estimates of pollutant concentrations have been derived using a dispersion model approach described in Vincent et al (2007) updating earlier work and using a revised emission inventory for 2004 (NAEI, 2006). Measurement data from the national BaP monitoring network have been used to verify the model outputs, full details are presented in the cited literature. Exceedence statistics for Upper and Lower Assessment Thresholds (UAT and LAT) have also been calculated based upon available measured data to check that the model outputs do not systematically underestimate concentrations relative to the LAT and UAT; measured and modelled exceedence statistics are presented in Appendix 4.

Figure 2 presents a map of estimated annual average BaP concentrations at background locations in the UK. Colour coding indicates exceedences of the Target Value (1 ng/m^3), Upper Assessment Threshold (0.6 ng/m^3) and Lower Assessment Threshold (0.4 ng/m^3).

Table A4.1 in Appendix 4 shows that the measured and modelled exceedences of the Lower and Upper Assessment Thresholds for BaP, generally correlate well at the locations of national network BaP monitoring stations. The preliminary assessment exceedence category, also presented in Table A4.1, is the criterion that will be declared for the zone or agglomeration within which the monitoring station is located. This metric shows, that when all modelled exceedences in a zone or agglomeration are considered, rather than just those at the monitoring stations, our assessment approach using modelled data is precautionary, capturing a more realistic estimate of the scale of exceedences than would otherwise be possible with measurements alone.

Guidance on determining the minimum number of monitoring stations required for assessment of diffuse sources and point sources is provided by Annex III of the Daughter Directive (see Appendix 3). Where sources of information other than fixed measurements are available, the number of monitoring stations for fixed measurements may be reduced (see Article 4 (11) of the Directive). For the assessment of releases from point sources, we have assumed a minimum of two monitoring stations is required; one downwind from the source in the nearest residential area and one upwind of the source to characterise the local background. Information on BaP distribution patterns and potential human exposures will be provided from modelled outputs and emission inventories.

4.2 Observations and Proposals

Figure 2 shows that estimated annual mean BaP concentrations at background locations away from large point sources in 2005 are expected to be below the Lower Assessment Thresholds in the majority of the mainland Great Britain. Large point sources in South Wales contribute to levels between the Upper and Lower Assessment Thresholds. Two point sources in Yorkshire and Humberside contribute to exceedences of the Upper Assessment Threshold and Target Value.

In the Northern Ireland zone and Belfast Metropolitan Urban Area agglomeration there are widespread exceedences of the Lower and Upper Assessment Thresholds in urban areas. The incidence of comparatively higher concentrations in Northern Ireland is driven by the high use of domestic solid fuel in this part of the UK.

Within the North East Scotland zone model outputs have identified exceedences of the Lower Assessment Threshold within the City of Dundee. These modelled concentrations appear to be driven by emissions of BaP from solid smokeless fuel (SSF) combustion in domestic heating. Investigation of emission inventory methodology indicates that a larger proportion of UK BaP emissions from SSF combustion are allocated to the Dundee area compared with elsewhere in the UK. The distribution of

emissions in this way is based on based on the population of the area, assumptions relating to the total domestic energy demand and gas use for the area and the existence of a smoke control area. Similar exceedences have not been predicted at comparable locations elsewhere in the UK for diffuse sources, which calls the modelled predictions for this area in to question. As a result, the prediction concentrations made using the mapped emissions for Dundee is likely to be unreliable and for the purposes of this study has been disregarded.

In addition to measurements of PAH in the form of BaP presented in Tables 1 and 2, Article 4 (8) of the Directive specifies that Member States should also undertake measurements of other relevant PAH compounds. At a minimum within the UK, it is proposed that such measurements shall be undertaken at the background and deposition sampling locations described in Section 6. In addition, a recommendation is made for measurements in representative urban locations and also close to significant point sources, in order to inform on the temporal trend and geographic distribution of these pollutants.

At a minimum the additional PAH compound to be measure will include; benz[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*j*]fluoranthene, benzo[*k*]fluoranthene, indeno[1,2,3-*cd*]pyrene, and dibenz[*a,h*]anthracene as specified in Article 4 (8).

4.2.1 Requirements within agglomerations

The number of monitoring locations required in UK agglomerations, based on the threshold exceedences presented in Figure 2 is presented in Table 1.

Table 1 indicates that exceedences of the Lower Assessment Threshold in agglomerations and arising from point sources are limited to the Swansea Urban Area. Exceedences of the Upper Assessment Threshold resulting from diffuse sources can be found in the Belfast Metropolitan Urban Area and are related to domestic solid fuel combustion. Table 1 also shows that when the current (2005) network of BaP monitoring stations and the supplementary assessment techniques are taken into account, one additional monitoring station is required in the Swansea Urban Area agglomeration to characterise the local background levels. This monitoring station will operate in tandem with the existing industrial monitoring station located downwind of the Port Talbot steelworks. A list of monitoring stations included in the 2005 BaP monitoring network is presented in Appendix 5.

4.2.2 Requirements within non-agglomeration zones

Table 2 presents the monitoring requirements in non-agglomeration zones in the UK taking account the assumptions presented in Section 3.

Figure 2 shows that the Upper Assessment Threshold is exceeded in two locations within the Yorkshire & Humberside zone in England. These exceedences are associated with industrial point sources, one of which already has upwind background monitoring close by. As a result, three further monitoring stations are required; one downwind station to be paired with the existing background station and a further set of up and downwind monitors for the second point source.

Concentrations between the Lower and Upper Assessment Thresholds in the South Wales zone are associated with the industrial source located in the nearby Swansea Urban Area agglomeration. Additional monitoring has already been identified for this source in section 4.2.1 and therefore no further monitoring is required.

Within the Northern Ireland zone, exceedence of the Lower and Upper Assessments Thresholds is wide spread in urban areas. As with the Belfast Metropolitan Urban Area agglomeration these exceedences have been linked to diffuse sources related to domestic solid fuel combustion. All current monitoring in Northern Ireland is located in the Belfast Metropolitan Urban Area agglomeration. As a result, a further two monitoring stations are required in the Northern Ireland zone to assess compliance with the Target Values.

Table 1 Benzo-a-pyrene monitoring requirements in UK agglomerations**1. England**

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Roadside	Urban Background	
Greater London Urban Area	8278251	Below LAT	n/a	-	0	2	2	0
West Midlands Urban Area	2284093	Below LAT	n/a	-	0	0	1	0
Greater Manchester Urban Area	2244931	Below LAT	n/a	-	0	0	1	0
West Yorkshire Urban Area	1499465	Below LAT	n/a	-	0	0	1	0
Tyneside	879996	Below LAT	n/a	-	0	0	1	0
Liverpool Urban Area	816216	Below LAT	n/a	-	0	0	1	0
Sheffield Urban Area	640720	Below LAT	n/a	-	0	0	0	0
Nottingham Urban Area	666358	Below LAT	n/a	-	0	0	0	0
Bristol Urban Area	551066	Below LAT	n/a	-	0	0	0	0
Brighton/Worthing/Littlehampton	461181	Below LAT	n/a	-	0	0	1	0
Leicester Urban Area	441213	Below LAT	n/a	-	0	0	0	0
Portsmouth Urban Area	442252	Below LAT	n/a	-	0	0	0	0
Teesside Urban Area	365323	Below LAT	n/a	-	0	0	1	0
The Potteries	362403	Below LAT	n/a	-	0	0	0	0
Bournemouth Urban Area	383713	Below LAT	n/a	-	0	0	0	0
Reading/Wokingham Urban Area	369804	Below LAT	n/a	-	0	0	0	0
Coventry/Bedworth	336452	Below LAT	n/a	-	0	0	0	0
Kingston upon Hull	301416	Below LAT	n/a	-	0	0	0	0
Southampton Urban Area	304400	Below LAT	n/a	-	0	0	0	0
Birkenhead Urban Area	319675	Below LAT	n/a	-	0	0	0	0
Southend Urban Area	269415	Below LAT	n/a	-	0	0	0	0
Blackpool Urban Area	261088	Below LAT	n/a	-	0	0	0	0
Preston Urban Area	264601	Below LAT	n/a	-	0	0	0	0

Additional monitoring requirements in agglomerations in England:

0

(Table1 continued)

2. Wales

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Roadside	Urban Background	
Swansea Urban Area	270506	LAT-UAT	1 point source	2	1	0	0	1
Cardiff Urban Area	327706	Below LAT	n/a	-	0	0	1	0

Additional monitoring requirements in agglomerations in Wales:

1

3. Scotland

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Roadside	Urban Background	
Edinburgh Urban Area	452194	Below LAT	n/a	-	0	0	1	0
Glasgow Urban Area	1168270	Below LAT	n/a	-	0	0	1	0

Additional monitoring requirements in agglomerations in Scotland:

0

4. Northern Ireland

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Roadside	Urban Background	
Belfast Metropolitan Urban Area	580276	Above UAT	Diffuse source	1	0	0	2	0

Additional monitoring requirements in agglomerations in Northern Ireland:

0

Table 2 Benzo-a-pyrene monitoring requirements in UK zones**1. England**

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Urban Background	Rural Background	
North East	1269803	Below LAT	n/a	0	1	0	0	0
North West & Merseyside	2826622	Below LAT	n/a	-	0	0	1	0
Yorkshire & Humberside	2514947	Above UAT	Point source(s)	4	0	1 a	1	3
East Midlands	3084598	Below LAT	n/a	-	0	1	0	0
West Midlands	2271650	Below LAT	n/a	-	0	0	0	0
Eastern	4850132	Below LAT	n/a	-	0	0	1	0
South East	6016677	Below LAT	n/a	-	0	0	0	0
South West	3980991	Below LAT	n/a	-	0	0	0	0

Additional monitoring requirements in zones in England:

3

2. Wales

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Urban Background	Rural Background	
South Wales	1578773	Above UAT	Point source	0 b	0	1	0	0
North Wales	720022	Below LAT	n/a	-	0	0	0	0

Additional monitoring requirements in zones in Wales:

0

Note:

a - indicates that of the 2 point sources causing exceedence of the UAT in the Yorkshire & Humberside zone, 1 point source already has downwind monitoring associated with it and therefore requires a further upwind monitor. The second source requires a pair of up and downwind monitors.

b - indicates that the point source responsible for levels between the Lower & Upper Assessment Threshold in this zone is actually located in the Swansea Urban Area agglomeration and already has monitoring associated with it, hence it requires no additional monitoring

(Table 2 continued)

3. Scotland

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Urban Background	Rural Background	
Scottish Borders	254690	Below LAT	n/a	-	0	0	0	0
Central Scotland	1813314	Below LAT	n/a	-	0	0	0	0
North East Scotland	1001499	LAT-UAT	n/a	0 c	0	0	0	0
Highland	380062	Below LAT	n/a	-	0	1	0	0

Additional monitoring requirements in zones in Scotland:

0

4. Northern Ireland

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Industrial	Urban Background	Rural Background	
Northern Ireland	1104991	Above UAT	Diffuse source	2	0	0	0	2

Additional monitoring requirements in zones in Northern Ireland:

2

Note:

c - Indicates that 1 monitoring station is required in this zone, although a diffuse source has been also identified these data are sufficiently anomolous to warrant exclusion as a vaild prediction. See Section 4.2

5 Heavy metals

5.1 Methodology

Annual mean concentrations for Arsenic (As), Cadmium (Cd) and Nickel (Ni) have been assessed at background locations and in the vicinity of industrial point sources throughout the UK. Estimates of pollutant concentrations have been derived using a dispersion model method (Vincent K and Passant N, 2006) to derive an estimate of the annual mean concentrations of heavy metals. Using this approach model estimates with and without a fugitive emission component have been made. Exceedence statistics for Upper and Lower Assessment Thresholds (UAT and LAT) have been calculated for both model outputs in order to identify appropriate monitoring requirements and locations. In addition, measured data have been compared with the UAT and LAT to provide a check that the model outputs do not systematically underestimate concentrations. Measured and modelled exceedence statistics are presented in Appendix 4.

Figures 3a, 4a and 5a present maps of estimated annual mean concentrations of arsenic, cadmium and nickel at urban background locations in the UK. In Figures 3b, 4b and 5b a fugitive emission component has been included in the model estimates. Colour coding indicates exceedences of the Target Value, Upper Assessment Threshold and Lower Assessment Threshold for each pollutant. Full details of the Target Values and Assessment Thresholds set by the Directive are given in Appendix 2.

Tables A4.2 – A4.4 in Appendix 4 show that the measured and modelled exceedences of the Lower and Upper Assessment Thresholds for arsenic, cadmium and nickel generally correlate well at the locations of national networks of heavy metals monitoring stations. At a number of locations where a limited measurement campaign was conducted in 2000, measured concentrations were above the Lower or Upper Assessment Thresholds for arsenic and cadmium whereas the model outputs predict lower concentrations. These exceedences correlate well with metal refining and foundry activities in the Birmingham and Sheffield and monitoring has continued at the stations measuring highest concentrations.

As for BaP, the preliminary assessment exceedence category is also presented in Tables A4.2-A4.4, is the criterion that will be declared for the zone or agglomeration within which the monitoring station is located. This metric shows, that when all modelled exceedences zones or agglomerations are considered, rather than just those at the monitoring stations, our assessment approach using modelled data is precautionary, capturing a more realistic estimate of the scale of exceedences than would otherwise be possible with measurements alone.

Guidance on determining the minimum number of monitoring stations required for assessment of diffuse sources and point sources is provided by Annex III of the Daughter Directive (see Appendix 3). Where sources of information other than fixed measurements are available, the number of monitoring stations for fixed measurements may be reduced (see Article 4 (11) of the Directive). For the assessment of releases from point sources, we have assumed a minimum of two monitoring stations is required; one downwind from the source in the nearest residential area and one upwind of the source to characterise the local background. Information on heavy metal distribution patterns and potential human exposures will be provided from modelled outputs and emission inventories.

In addition to the measurements of particulate phase Arsenic, Cadmium and Nickel concentrations, at the 17 urban heavy metals network presented in Appendix 5, particulate phase mercury measurements are also made. Measurements of vapour-phase mercury are carried at 13 of the 17 network sites.

5.2 Observations and proposals

Figures 3a, 4a and 5a show that annual mean concentrations of arsenic, cadmium and nickel at urban and rural background locations were generally below the Lower Assessment Thresholds for emission releases without a non-fugitive component. Conversely, for the model outputs including a fugitive

component shown in Figures 3b, 4b and 5b, there are a number of areas with concentrations in excess of the Lower and Upper Assessment Thresholds for the respective metals. By comparing the areas exceeding with the location of authorised industrial processes provided by the NAEI it can be shown that there is a good correlation with major metal refining processes, coking works and smokeless fuel production facilities. This indicates that the majority of exceedences are related to industrial point sources emissions.

In order to provide a conservative estimate of heavy metal concentrations at background locations, particularly those close to industrial sources, modelled estimates with the fugitive component included have been used in this assessment. A detailed examination of the model outputs has also highlighted the presence of anomalous areas of high emission in the area sources emissions inventory. These features are visible in the model output as small areas of elevated concentrations, generally limited to 1 km², and which do not correlate with the geographical location of a point source. Concentrations are generally limited to between the LAT and UAT. A check of the method used to generate the area source emission maps used in this modelling indicates that these areas had substantially more of the UK's national total emission distributed to them for an unspecified reason. This method has been updated since this modelling work took place and the current 2004 NAEI emission maps do not show the same pattern of emissions. It has been assumed, therefore, that the area source emissions driving the elevated predicted concentrations in the 2003 model outputs are erroneous and the exceedence statistics relating to these areas have been excluded from further analysis.

The following sections present additional monitoring required in agglomeration and non-agglomeration zones for compliance with the 4th Daughter Directive. Where additional monitoring stations are recommended for any of the metals, measurements of all arsenic, cadmium and nickel will be made.

5.2.1 Requirements within agglomerations

The number of monitoring stations required in UK agglomerations to measure arsenic, cadmium and nickel, based on the threshold exceedences presented in Figures 3a-5c is shown in Table 3.

Table 3 indicates that when the current (2005) network of heavy metals monitoring stations and the supplementary assessment techniques are taken into account, a total of seven additional monitoring stations are required in the UK agglomerations.

The majority of this monitoring is targeted at point sources. The Sheffield Urban Area agglomeration requires an additional upwind background monitoring station to pair with an existing downwind industrial station and in the Cardiff Urban Area agglomeration a downwind industrial station is required to pair with an existing upwind station. In Teesside Urban Area agglomeration, exceedences of the Lower Assessment Threshold arising from emissions from the steelworks require both downwind industrial and upwind background stations. Within the Swansea agglomeration, an upwind background monitoring station is required to pair with an existing downwind industrial station close to a nickel refining process to the west of the agglomeration and a downwind industrial station is needed close to the iron and steel works to the east of the agglomeration. Because of the proximity of the two processes (approximately 16 km separation) and the footprint of the exceedences areas it is proposed that one upwind background monitoring station is capable of characterising the local background levels for both processes.

The remaining areas of the UK exceeding the Lower Assessment Threshold are found in the Belfast Metropolitan Urban Area, and have been identified as diffuse sources related to domestic solid fuel combustion. There is currently no heavy metals monitoring in this agglomeration and a further monitoring station is required as a result.

5.2.2 Requirements within non-agglomerations zones

Table 4 presents the monitoring requirements in non-agglomeration zones in the UK. Figures 3a-5c show that the Lower or Upper Assessment Threshold for arsenic, cadmium and Nickel is exceeded in eight non-agglomeration zones in the UK. The majority of these exceedences arise from point sources located in agglomeration zones which either already have monitoring associated with them or have been targeted for additional monitoring in section 5.2.1. Of the areas with predicted

exceedences in England, one process in the Yorkshire & Humberside and one in the Eastern zone do not have either upwind or downwind monitoring. As a result a further four monitors are required in England for assessment relative to the Target Values.

In the South Wales zone, exceedences of the Lower or Upper Assessment Threshold for Cadmium and Nickel are predicted but these arise from point source releases in the Swansea agglomeration. As above, these processes either already have monitoring associated with them or have been targeted for additional monitoring in section 5.2.1.

Table 3 Heavy metal monitoring requirements in UK agglomerations**1. England**

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Roadside	Industrial	Urban Background	
Greater London Urban Area	8278251	Below LAT	n/a	0	1	0	3	0
West Midlands Urban Area	2284093	Above UAT	Point source	2	0	2	1	0
Greater Manchester Urban Area	2244931	Below LAT	n/a	0	0	0	1	0
West Yorkshire Urban Area	1499465	Below LAT	n/a	0	0	0	1	0
Tyneside	879996	Below LAT	n/a	0	0	1	0	0
Liverpool Urban Area	816216	Below LAT	n/a	0	0	0	0	0
Sheffield Urban Area	640720	Above UAT	Point source	2	0	1	0	1
Nottingham Urban Area	666358	Below LAT	n/a	0	0	0	0	0
Bristol Urban Area	551066	Above UAT	Point source	2 a	0	1	0	0
Brighton/Worthing/Littlehampton	461181	Below LAT	n/a	0	0	0	0	0
Leicester Urban Area	441213	Below LAT	n/a	0	0	0	0	0
Portsmouth Urban Area	442252	Below LAT	n/a	0	0	0	0	0
Teesside Urban Area	365323	LAT-UAT	Point source	2	0	0	0	2
The Potteries	362403	Below LAT	n/a	0	0	0	0	0
Bournemouth Urban Area	383713	Below LAT	n/a	0	0	0	0	0
Reading/Wokingham Urban Area	369804	Below LAT	n/a	0	0	0	0	0
Coventry/Bedworth	336452	Below LAT	n/a	0	0	0	0	0
Kingston upon Hull	301416	Below LAT	n/a	0	0	0	0	0
Southampton Urban Area	304400	Below LAT	n/a	0	0	0	0	0
Birkenhead Urban Area	319675	Below LAT	n/a	0	0	0	0	0
Southend Urban Area	269415	Below LAT	n/a	0	0	0	0	0
Blackpool Urban Area	261088	Below LAT	n/a	0	0	0	0	0
Preston Urban Area	264601	Below LAT	n/a	0	0	0	0	0

Additional monitoring requirements in agglomerations in England:

3

Note:

a - indicates that down-wind industrial and upwind background monitoring is already located in close vicinity to this point source. The industrial monitoring station being located in the Bristol Urban Area agglomeration zone, background monitoring in the South West non-agglomeration zone.

(Table 3 continued)

2. Wales

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Roadside	Industrial	Urban Background	
Swansea Urban Area	270506	Above UAT	Point source	3		1	0	2
Cardiff Urban Area	327706	Above UAT	Point source	2		0	1	1

Additional monitoring requirements in agglomerations in Wales:

3

3. Scotland

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Roadside	Industrial	Urban Background	
Edinburgh Urban Area	452194	Below LAT	n/a	0		0	0	0
Glasgow Urban Area	1168270	Below LAT	n/a	0		0	2	0

Additional monitoring requirements in agglomerations in Scotland:

0

4. Northern Ireland

Agglomeration	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Roadside	Industrial	Urban Background	
Belfast Metropolitan Urban Area	580276	LAT-UAT	Diffuse source	1		0	0	1

Additional monitoring requirements in agglomerations in Northern Ireland:

1

Table 4 Heavy metals monitoring requirements in UK zones**1. England**

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Roadside	Industrial	Urban Background	
North East	1269803	LAT-UAT	Point source	2	0	0	0	0 a
North West & Merseyside	2826622	Below LAT	n/a	n/a	n/a	n/a	n/a	1
Yorkshire & Humberside	2514947	Above UAT	Point source	4	0	0	0	0
East Midlands	3084598	Above UAT	Point source	2	0	0	0	1
West Midlands	2271650	Above UAT	Point source	2	0	0	0	0
Eastern	4850132	Above UAT	Point source	2	0	0	0	2
South East	6016677	Above UAT	Point source	2	0	0	0	1
South West	3980991	Above UAT	Point source	2	0	1	0	1

Additional monitoring requirements in zones in England:

4

2. Wales

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement
					Roadside	Industrial	Urban Background	
South Wales	1578773	Above UAT	Point source	2	0	0	0	1
North Wales	720022	Below LAT	n/a	n/a		0	0	0

Additional monitoring requirements in zones in Wales:

0

Note:

a – Indicates that the point source responsible for levels between the Lower & Upper Assessment Threshold in this zone is located in the Teesside agglomeration and has been targeted for additional monitoring (see Table 3), hence no further monitoring required in the zone

b – Indicates that one of the point source(s) responsible for levels above the Upper Assessment Threshold is located in the Sheffield Urban Area agglomeration and targeted for additional monitoring. The other source does not have monitoring and hence both upwind and downwind monitors are required.

c – Indicates that the point source responsible for levels above the Upper Assessment Threshold in this zone is located in the Sheffield Urban Area agglomeration and already has monitoring associated with it, hence no further monitoring required in the zone

d - Indicates that the point source responsible for levels above the Upper Assessment Threshold in this zone is located in the West Midlands Urban Area agglomeration and already has monitoring associated with it, hence no further monitoring required in the zone

e - Indicates that the point source responsible for levels above the Upper Assessment Threshold in this zone is located in the South East zone adjacent to the Thames estuary, the exceedence has already been targeted for additional monitoring downwind of the source in the Eastern zone, hence no further monitoring required in the zone

f – Indicates that the point source responsible for levels above the Upper Assessment Threshold in this zone is located in the Swansea Urban Area agglomeration and targeted for additional monitoring (see Table 3), hence no further monitoring required in the zone

(Table 4 continued)

3. Scotland

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement	
					Roadside	Industrial	Urban Background		
Scottish Borders	254690	Below LAT	n/a	n/a	0	0	0	1	0
Central Scotland	1813314	Below LAT	n/a	n/a	0	0	0	1	0
North East Scotland	1001499	Below LAT	n/a	n/a	0	0	0	1	0
Highland	380062	Below LAT	n/a	n/a	0	0	0	0	0

Additional monitoring requirements in zones in Scotland:

0

4. Northern Ireland

Zone	Population	Exceedence Category	Cause of Exceedence	Minimum Monitoring Requirement	Existing Monitoring			Additional Monitoring Requirement	
					Roadside	Industrial	Urban Background		
Northern Ireland	1104991	Below LAT	n/a	n/a	0	0	0	0	0

Additional monitoring requirements in zones in Northern Ireland:

0

6 Rural background levels and deposition rates

Article 4 (9) of the 4th Daughter Directive stipulates that, irrespective of concentration levels, one rural background sampling point shall be installed every 100,000 km² for the indicative measurement of arsenic, cadmium, nickel, total gaseous mercury, benzo-*a*-pyrene and the other PAH compounds referred to in Section 4.2 of this report. In addition to the ambient levels of these pollutants their deposition rates will also be measured.

The Directive indicates that each Member State shall have at least one monitoring station of this type, and in the case of the UK, which has a land mass area of approximately 244,800 km², 2 rural background monitoring stations are required (Personal communication between AEQ Division Defra with the European Commission, 2004). A further recommendation is made for the monitoring to be coordinated with EMEP monitoring stations where appropriate. On this basis, 2 monitoring stations measuring ambient levels and deposition rates for the pollutants outlined above are to be commissioned at the UK's Harwell and Auchencorth Moss EMEP monitoring locations.

It should be noted however, that due to the limits of detection of the sampling and analysis techniques and the likely levels at rural background locations, separate sampling and analysis of PAH and heavy metals will be required. In addition, heavy metals and vapour phase mercury are already measured at Auchencorth Moss and at a further 9 rural monitoring stations throughout the UK (see Appendix 5)

7 Achieving compliance

BaP and heavy metals levels have been assessed throughout the UK. On the basis of the assessments and analyses presented in this report, the number of additional monitoring stations required to provide coverage of areas with high estimated pollutant concentrations have been identified. The recommendations for additional monitoring are summarised in Table 5. Fixed monitoring in the vicinity of areas exceeding the Lower and Upper Assessment Thresholds for diffuse and point sources will be supplemented by information from model outputs to inform on the overall footprint of exceedences and the likely population exposure. Monitoring stations already available in the current monitoring network have been taken into account.

Table 5 Summary of the minimum additional number of monitoring sites required in the UK for compliance with the 4th Daughter Directive

1. PAH (as benzo-a-pyrene)					
	England	Wales	Scotland	Northern Ireland	Total
Agglomerations	0	1	0	0	1
Other Zones	3	0	0	2	5
Total	3	1	0	2	6
2. Heavy metals (Arsenic, Cadmium, Nickel)					
	England	Wales	Scotland	Northern Ireland	Total
Agglomerations	3	3	0	1	7
Other Zones	4	0	0	0	4
Total	7	3	0	1	11
3. Vapour phase mercury					
	England	Wales	Scotland	Northern Ireland	Total
Agglomerations	0	0	0	0	0
Other Zones	1	0	0	0	1
Total	1	0	0	0	1
4. Deposition (extended PAH compounds, heavy metals & mercury)					
	England	Wales	Scotland	Northern Ireland	Total
Agglomerations	0	0	0	0	0
Other Zones	1	0	0	0	1
Total	1*	0	0*	0	1*

* denotes that separate deposition samplers will be needed to measure deposition rates for heavy metals and BaP owing to the detection limits of the analytical techniques used.

The additional monitoring needed for formal compliance with the 4th Daughter Directive will be achieved by a process of affiliation of existing local authority monitoring stations and direct funding of new monitoring sites from the UK Government. From 2006, the UK PAH sampler network will be upgraded with sampler and analysis systems which are compliant with the draft CEN standard specified by Annex V (II) of the Directive.

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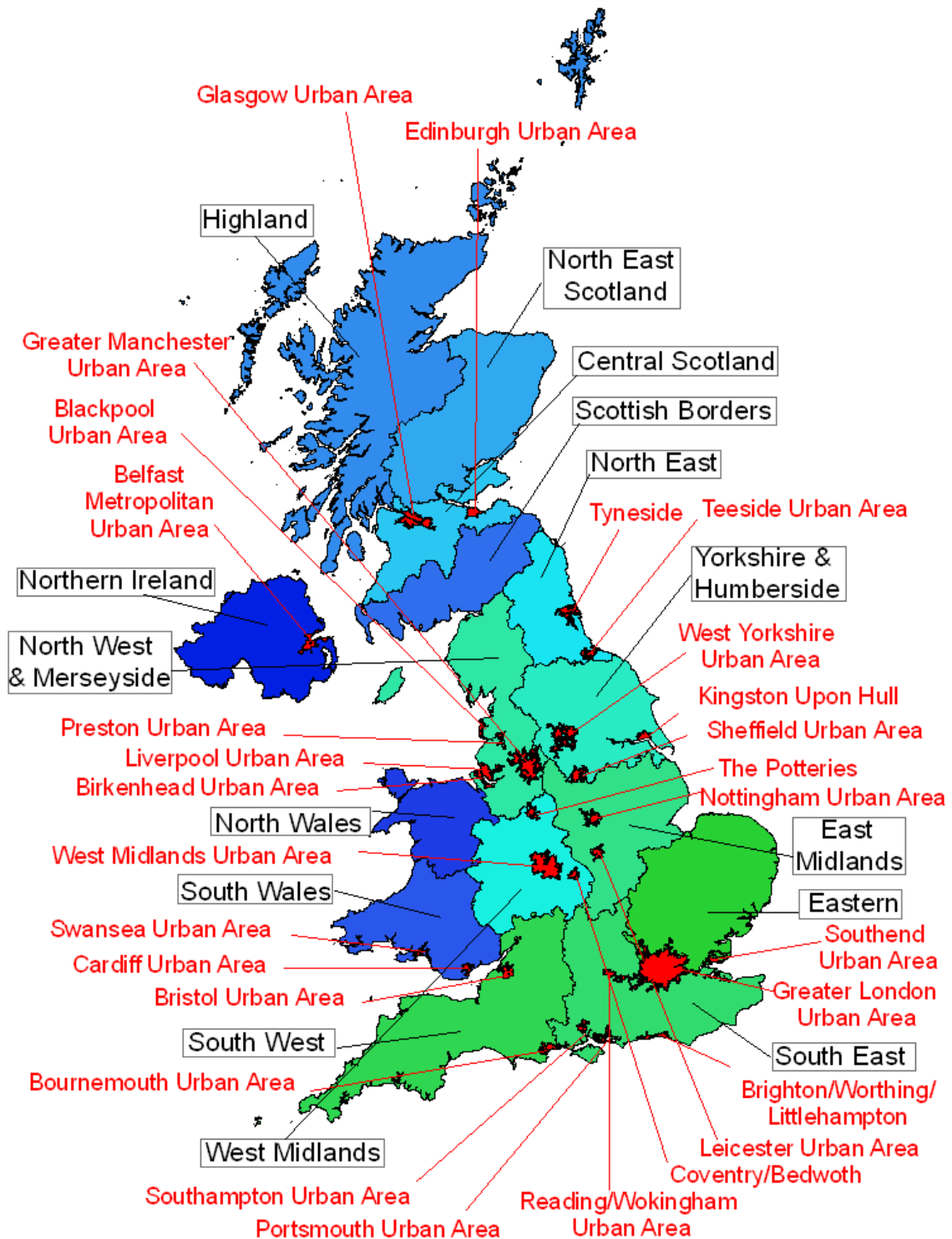
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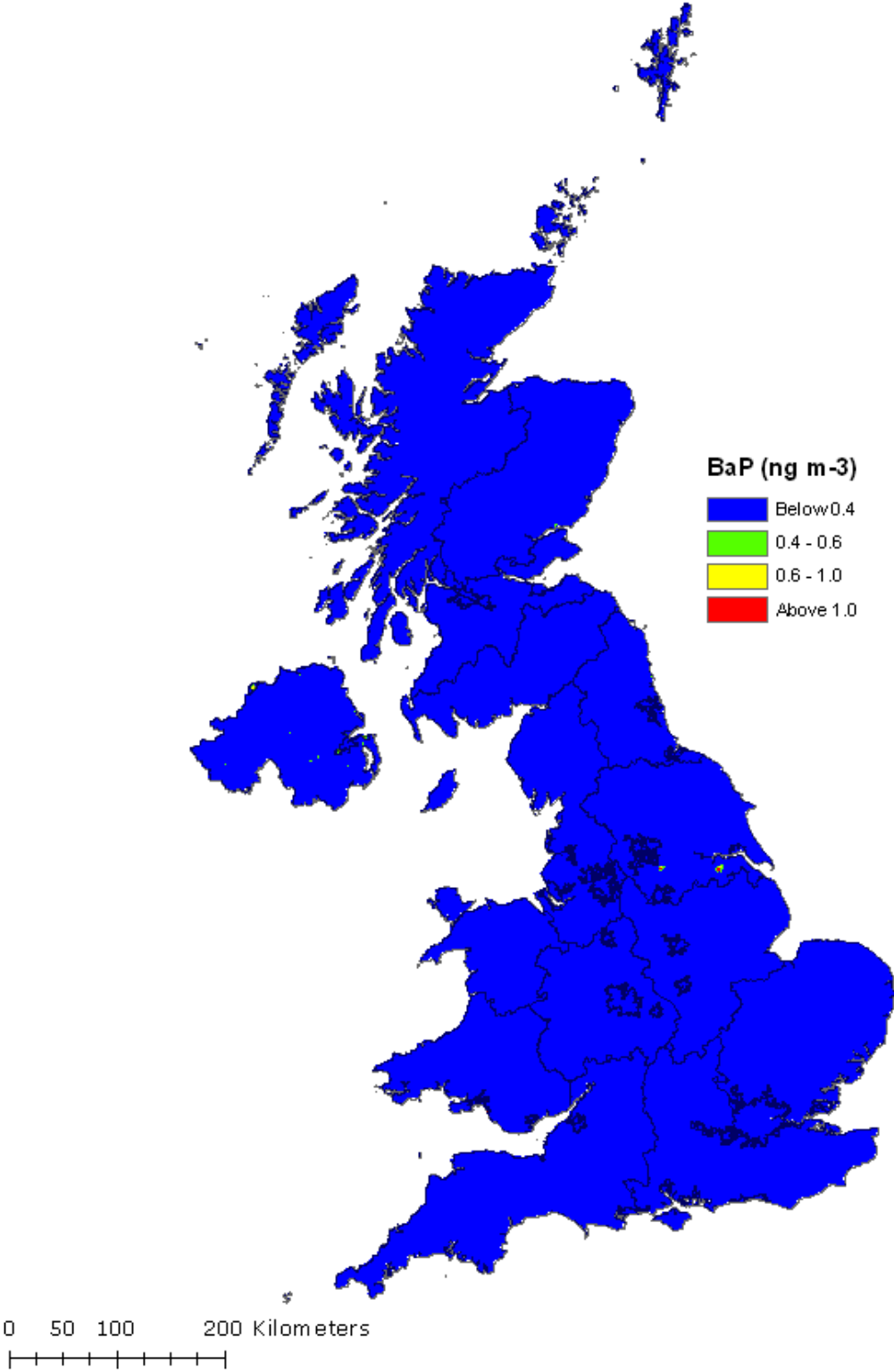
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Figure 1 Preliminary Assessment zones and agglomerations in the UK
 UK agglomeration zones shown in red, nonm-agglomeration zones in black



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Figure 2 Estimated annual average BaP concentrations at background locations in the UK, 2005. (ng m⁻³)



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Figure 3 a. Annual mean arsenic concentration 2003 (ng m^{-3}).

b. Annual mean arsenic concentration 2003 with fugitive component included (ng m^{-3}).

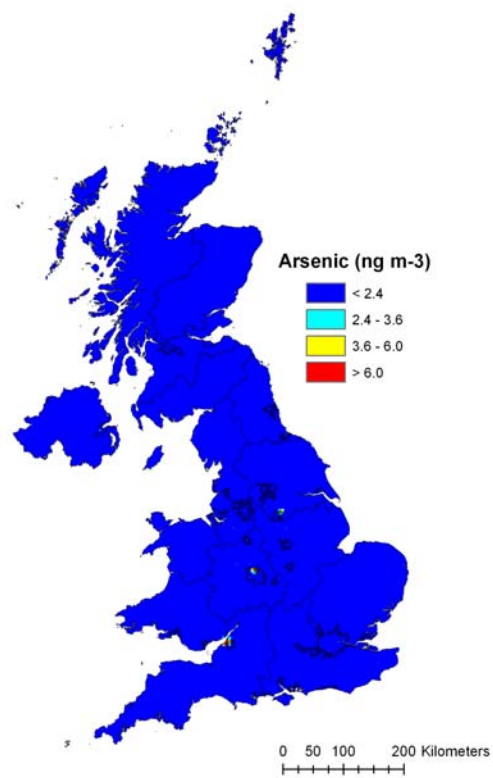
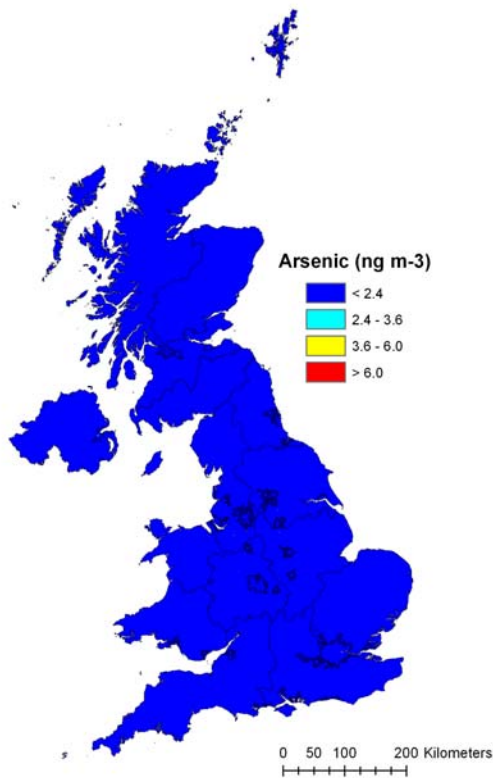
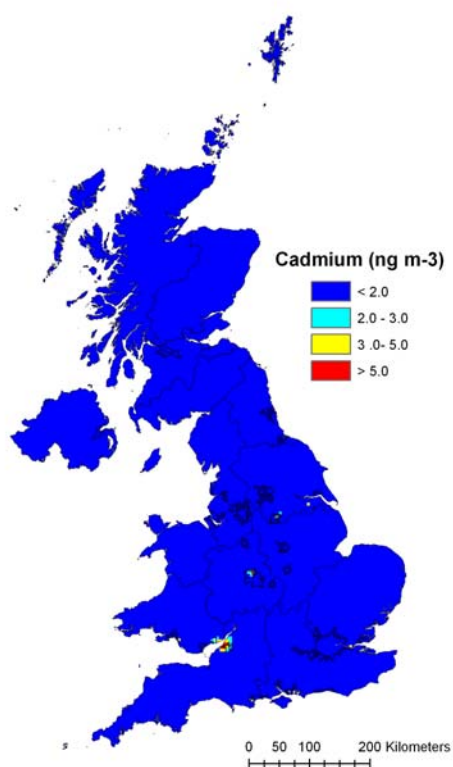
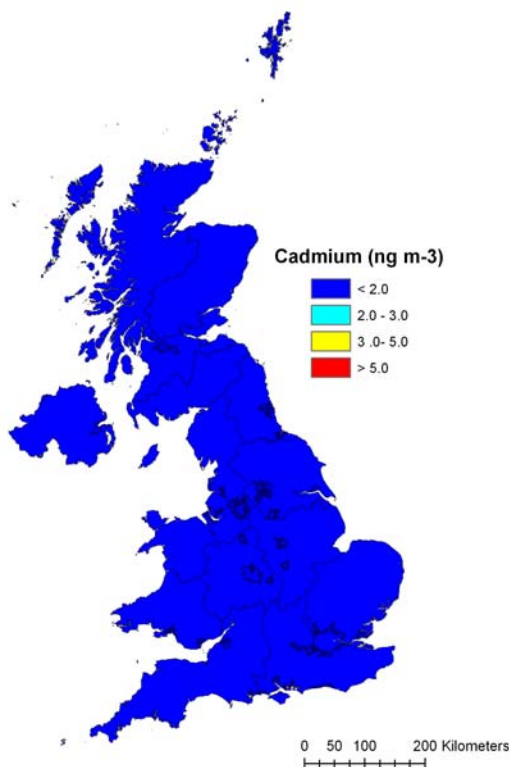


Figure 4 a. Annual mean cadmium concentration 2003 (ng m^{-3}).

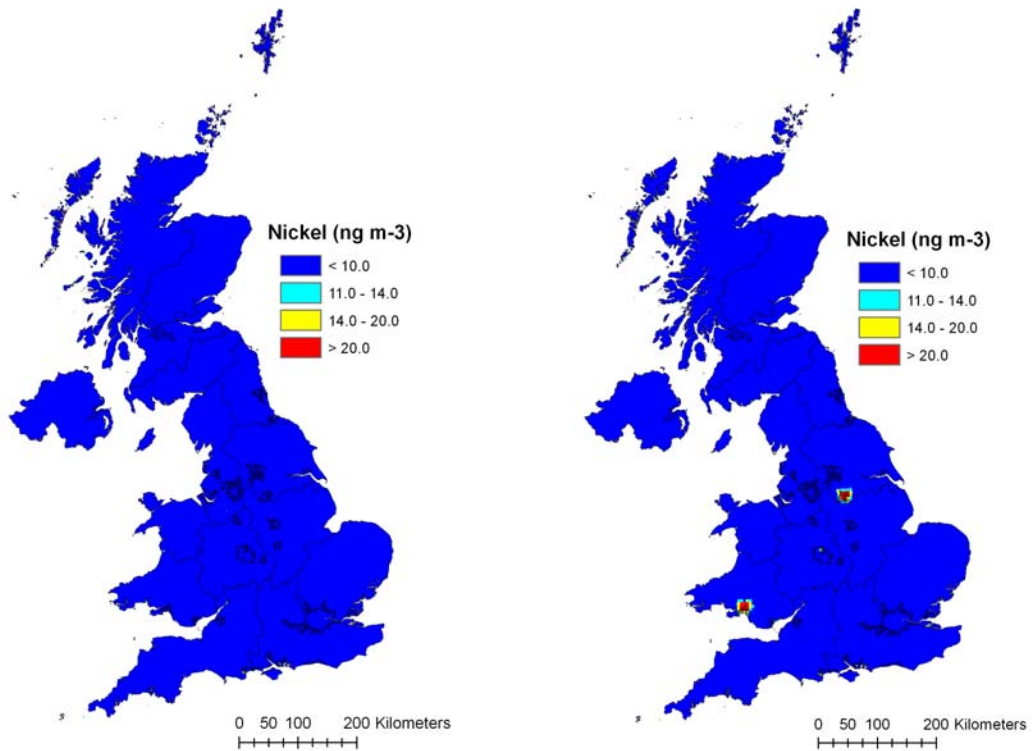
b. Annual mean cadmium concentration 2003 with fugitive component included (ng m^{-3}).



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Figure 5 a. Annual mean nickel concentration 2003 (ng m^{-3}).

b. Annual mean nickel concentration 2003 with fugitive component included (ng m^{-3}).



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Appendices

Appendix 1: Article 5 of the Framework Directive

Appendix 2: Annex I and II of the 4th Daughter Directive; Daughter Directive Target Values and Assessment Thresholds

Appendix 3: Annex III of the 4th Daughter Directive;
Location and minimum number of sampling points for the measurement of concentrations in ambient air and deposition rates

Appendix 4: Comparison of measured and modelled exceedance statistics

Appendix 1

Framework Directive: Article 5

Article 5, Preliminary assessment of ambient air quality

Member States which do not have representative measurements of the levels of pollutants for all zones and agglomerations shall undertake series of representative measurements, surveys or assessments to have data available in time for the implementation of the legislation referred to in Article 4 (1).

Source: Council Directive 2000/69/EC

Appendix 2

Annex I and II of the 4th Daughter Directive

Daughter Directive Target Values and Assessment Thresholds

ANNEX I

Target values for arsenic, cadmium, nickel and benzo(a)pyrene

Pollutant	Target value ⁽¹⁾
Arsenic	6 ng/m ³
Cadmium	5 ng/m ³
Nickel	20 ng/m ³
Benzo(a)pyrene	1 ng/m ³

⁽¹⁾ For the total content in the PM₁₀ fraction averaged over a calendar year.

ANNEX II

Determination of requirements for assessment of concentrations of arsenic, cadmium, nickel and benzo(a)pyrene in ambient air within a zone or agglomeration**I. Upper and lower assessment thresholds**

The following upper and lower assessment thresholds will apply:

	Arsenic	Cadmium	Nickel	B(a)P
Upper assessment threshold in percent of the target value	60 % (3,6 ng/m ³)	60 % (3 ng/m ³)	70 % (14 ng/m ³)	60 % (0,6 ng/m ³)
Lower assessment threshold in percent of the target value	40 % (2,4 ng/m ³)	40 % (2 ng/m ³)	50 % (10 ng/m ³)	40 % (0,4 ng/m ³)

II. Determination of exceedances of upper and lower assessment thresholds

Exceedances of upper and lower assessment thresholds must be determined on the basis of concentrations during the previous five years where sufficient data are available. An assessment threshold will be deemed to have been exceeded if it has been exceeded during at least three calendar years out of those previous five years.

Where fewer than five years' data are available, Member States may combine measurement campaigns of short duration during the period of the year and at locations likely to be typical of the highest pollution levels with results obtained from information from emission inventories and modelling to determine exceedances of the upper and lower assessment thresholds.

Appendix 3

Annex III of the Daughter Directive

Location and minimum number of sampling points for the measurement of concentrations in ambient air and deposition rates.

ANNEX III

Location and minimum number of sampling points for the measurement of concentrations in ambient air and deposition rates**I. Macroscale siting**

The sites of sampling points should be selected in such a way as to:

- provide data on the areas within zones and agglomerations where the population is likely to be directly or indirectly exposed to the highest concentrations averaged over a calendar year;
- provide data on levels in other areas within zones and agglomerations which are representative of the exposure of the general population;
- provide data on deposition rates representing the indirect exposure of the population through the food chain.

Sampling points should in general be sited so as to avoid measuring very small micro-environments in their immediate vicinity. As a guideline, a sampling point should be representative of air quality in surrounding areas of no less than 200 m² at traffic-orientated sites, at least 250 m × 250 m at industrial sites, where feasible, and several square kilometres at urban-background sites.

Where the objective is to assess background levels the sampling site should not be influenced by agglomerations or industrial sites in its vicinity, i.e. sites closer than a few kilometres.

Where contributions from industrial sources are to be assessed, at least one sampling point shall be installed downwind of the source in the nearest residential area. Where the background concentration is not known, an additional sampling point shall be situated within the main wind direction. In particular where Article 3(3) applies, the sampling points should be sited such that the application of BAT can be monitored.

Sampling points should also, where possible, be representative of similar locations not in their immediate vicinity. Where appropriate they should be co-located with sampling points for PM₁₀.

II. Microscale siting

The following guidelines should be met as far as practicable:

- the flow around the inlet sampling probe should 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 0,5 m from the nearest building in the case of sampling points representing air quality at the building line);
- in general, the inlet sampling point should be between 1,5 m (the breathing zone) and 4 m above the ground. Higher positions (up to 8 m) may be necessary in some circumstances. Higher siting may also be appropriate if the station is representative of a large area;
- the inlet probe should not be positioned in the immediate vicinity of sources in order to avoid direct intake of emissions unmixed with ambient air;
- the sampler's exhaust outlet should be positioned so that recirculation of exhaust air to the sample inlet is avoided;
- traffic-orientated sampling points should be at least 25 metres from the edge of major junctions and at least 4 m from the centre of the nearest traffic lane; inlets should be sited so as to be representative of air quality near the building line;

Source: Council Directive 2004/107/EC

The following factors may also be taken into account:

- 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
- the desirability of co-locating sampling points for different pollutants
- planning requirements.

III. Documentation and review of site selection

The site selection procedures should be fully documented at the classification stage by such means as compass-point photographs of the surrounding area and a detailed map. Sites should be reviewed at regular intervals with repeated documentation to ensure that selection criteria remain valid over time.

IV. Criteria for determining numbers of sampling points for fixed measurement of concentrations of arsenic, cadmium, nickel and benzo(a)pyrene in ambient air

Minimum number of sampling points for fixed measurement to assess compliance with target values for the protection of human health in zones and agglomerations where fixed measurement is the sole source of information.

(a) Diffuse sources

Population of agglomeration or zone (thousands)	If maximum concentrations exceed the upper assessment threshold ⁽¹⁾		If maximum concentrations are between the upper and lower assessment thresholds	
	As, Cd, Ni	B(a)P	As, Cd, Ni	B(a)P
0–749	1	1	1	1
750–1 999	2	2	1	1
2 000–3 749	2	3	1	1
3 750–4 749	3	4	2	2
4 750–5 999	4	5	2	2
≥ 6 000	5	5	2	2

⁽¹⁾ To include at least one urban-background station and for benzo(a)pyrene also one traffic-oriented station provided this does not increase the number of sampling points.

(b) Point sources

For the assessment of pollution in the vicinity of point sources, the number of sampling points for fixed measurement should be determined taking into account emission densities, the likely distribution patterns of ambient air pollution and potential exposure of the population.

The sampling points should be sited such that the application of BAT as defined by Article 2(11) of Directive 96/61/EC can be monitored.

Source: Council Directive 2004/107/EC

Appendix 4

Comparison of measured and modelled exceedence statistics

Table A4.1 Identified exceedences of the Lower and Upper Assessment Thresholds for BaP based upon measured data (2001-2005) and modelled data (2005) for UK. (concentration units, ng m⁻³)

Zone/agglomeration	Site	Measured annual mean BaP (ng m ⁻³)					Modelled 2005	Exceedences		Preliminary Assessment Category (a)
		2001	2002	2003	2004	2005		Measured	Modelled	
Belfast Metropolitan Urban Area	Belfast	0.37	0.13	0.08	0.15	0.27	0.21	-	-	> UAT
Belfast Metropolitan Urban Area	Lisburn	0.96	0.66	0.95	0.62	0.61	0.45	UAT	LAT-UAT	> UAT
Cardiff Urban Area	Cardiff				0.07	0.09	0.12	-	-	< LAT
East Midlands	Bolsover	0.28	0.24	0.46	0.22	0.23	0.12	-	-	< LAT
Eastern	StokeFerry	0.09	0.08	0.08	0.04	0.06	0.07	-	-	< LAT
Edinburgh Urban Area	Edinburgh				0.04	0.05	0.08	-	-	< LAT
Glasgow Urban Area	Glasgow	0.12	0.12	0.06	0.07	0.10	0.10	-	-	< LAT
Greater London Urban Area	Brent			0.14	0.09	0.11	0.10	-	-	< LAT
Greater London Urban Area	Bromley		0.25	0.21	0.19	0.17	0.09	-	-	< LAT
Greater London Urban Area	London	0.14	0.13	0.12	0.08	0.08	0.12	-	-	< LAT
Greater Manchester Urban Area	Manchester	0.34	0.17	0.24	0.11	0.10	0.10	-	-	< LAT
Highland	Kinlochleven	0.34	0.38	0.21	0.32	0.31	0.10	-	-	< LAT
Liverpool Urban Area	Speke		0.14	0.14	0.10	0.10	0.10	-	-	< LAT
North East	Ashington	0.20		0.19	0.15	0.16	0.14	-	-	< LAT
North West & Merseyside	Hazelrigg	0.08	0.05	0.04	0.02	0.02	0.08	-	-	< LAT
South East	Hove			0.10	0.09	0.10	0.08	-	-	< LAT
South Wales	Newport	0.36	0.19	0.11	0.10	0.10	0.11	-	-	> UAT
Swansea Urban Area	PortTalbot	0.40	0.34	0.47	0.29	0.41	0.15	LAT-UAT	-	> UAT
Teesside Urban Area	Middlesbrough	0.37	0.21	0.24	0.14	0.18	0.12	-	-	< LAT
Tyneside	Newcastle	0.11	0.12	0.16	0.06	0.08	0.11	-	-	< LAT
West Midlands Urban Area	Birmingham					0.12	0.10	-	-	< LAT
West Yorkshire Urban Area	Leeds					0.17	0.15	-	-	< LAT
Yorkshire & Humberside	HighMuffles	0.05	0.04	0.05	0.03	0.03	0.07	-	-	> UAT
Yorkshire & Humberside	Scunthorpe				0.56	0.95	0.70	UAT	UAT	> UAT

Table A4.2 Identified exceedences of the Lower and Upper Assessment Thresholds for arsenic based upon measured data (2000, 2002-2005) and modelled data (2003) for UK. (concentration units, ng m⁻³)

Zone/agglomeration	Site	Measured annual mean concentration					Modelled 2003	Exceedences		Preliminary Assessment Category (a)
		2000	2002	2003	2004	2005		Measured	Modelled	
Belfast Metropolitan Urban Area	NIGEN Ltd. - Kilroot	0.47					0.00	< LAT (1)	< LAT	LAT-UAT
Belfast Metropolitan Urban Area	Belfast Harbour Estate	1.01					1.07	< LAT (1)	< LAT	LAT-UAT
Bristol Urban Area	BZL Avonmouth	1.89				1.09	5.44	< LAT (1)	> UAT	> UAT
Cardiff Urban Area	Cardiff				1.05	1.22	0.00	< LAT (1)	< LAT	> UAT
Central Scotland	Auchencorth Moss			0.43			0.45	< LAT (1)	< LAT	< LAT
Central Scotland	Scottish Power - Longannet	0.70					0.48	< LAT (1)	< LAT	< LAT
Central Scotland	Glacier Vandervell Ltd.	0.54					0.47	< LAT (1)	< LAT	< LAT
East Midlands	Beacon Hill			1.50			0.59	< LAT (1)	< LAT	> UAT
East Midlands	Midland Lead Refiners	1.78					1.06	< LAT (1)	< LAT	> UAT
East Midlands	Tungsten Batteries Ltd.	1.08					0.58	< LAT (1)	< LAT	> UAT
Eastern	Heigham Holmes			1.30			0.42	< LAT (1)	< LAT	> UAT
Eastern	Monkswood			0.93			0.44	< LAT (1)	< LAT	> UAT
Glasgow Urban Area	Glasgow			1.20	0.82	0.81	0.54	< LAT (2)	< LAT	< LAT
Glasgow Urban Area	Motherwell			0.80	0.55	0.81	0.54	< LAT (2)	< LAT	< LAT
Greater London Urban Area	Central London Metals			1.50	1.38	1.26	0.55	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Brent Metals			1.80	1.53	1.41	0.56	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Cromwell Road Metals			1.50	1.15	1.14	0.52	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Marylebone Road Metals					1.73	0.52	< LAT (1)	< LAT	< LAT
Greater London Urban Area	A Cohen & Co Ltd.	1.59					0.76	< LAT (1)	< LAT	< LAT
Greater London Urban Area	Britannia Refined Metals	1.31					0.67	< LAT (1)	< LAT	< LAT
Greater Manchester Urban Area	Manchester			1.50	1.12	1.01	0.58	< LAT (2)	< LAT	< LAT
North East Scotland	Banchory			0.45			0.41	< LAT (1)	< LAT	LAT-UAT
North Wales	Castle Cement	1.03					0.59	< LAT (1)	< LAT	< LAT
North West & Merseyside	Runcorn Weston Point	1.00				0.73	1.71	< LAT (1)	< LAT	> UAT
North West & Merseyside	Cockley Beck			0.63			0.41	< LAT (1)	< LAT	> UAT
North West & Merseyside	FE Mottram Ltd Congleton	1.19					0.70	< LAT (1)	< LAT	> UAT
Northern Ireland	Coolkeeragh Power Station	0.72					1.86	< LAT (1)	< LAT	> UAT
Scottish Borders	Eskdalemuir			0.30	0.14	0.15	0.41	< LAT (2)	< LAT	< LAT
Sheffield Urban Area	Sheffield		2.37	2.11	1.67	1.53	2.53	< LAT (2)	LAT-UAT	> UAT
Sheffield Urban Area	British Steel Engineering	3.01					4.74	LAT-UAT (1)	> UAT	> UAT
Sheffield Urban Area	Associated Octel Company Ltd.	0.95					4.74	< LAT (1)	> UAT	> UAT
South East	Wytham Wood			0.92			0.47	< LAT (1)	< LAT	> UAT
South East	Esso Petroleum Company Ltd.	0.90					0.55	< LAT (1)	< LAT	> UAT
South East	Cliffe Hill Quarry	1.28					0.50	< LAT (1)	< LAT	> UAT
South Wales	Cwmystwyth			0.38			0.41	< LAT (1)	< LAT	> UAT
South Wales	British Steel Llanwern	1.70					1.66	< LAT (1)	< LAT	> UAT
South West	Hallen		4.79	2.71	1.53	0.97	14.41	< LAT (2)	> UAT	> UAT
South West	Yarner Wood Metals			0.71			0.44	< LAT (1)	< LAT	> UAT
Swansea Urban Area	INCO Europe	1.18				1.18	0.79	< LAT (1)	< LAT	> UAT
Swansea Urban Area	Pontardawe			0.70			1.06	< LAT (1)	< LAT	> UAT
Tyneside	Elswick 6		1.74	1.37	1.10	0.75	0.58	< LAT (2)	< LAT	< LAT
West Midlands	Sutton Coldfield Crematorium	1.15					0.88	< LAT (1)	< LAT	> UAT
West Midlands Urban Area	IMI 2	8.36	1.92	3.16	1.54	1.18	6.38	< LAT (2)	> UAT	> UAT
West Midlands Urban Area	Brookside Bilston Lane		1.82	2.11	1.84	1.26	3.82	< LAT (2)	> UAT	> UAT
West Midlands Urban Area	Cerro Extruded Metals	1.84					3.24	< LAT (1)	LAT-UAT	> UAT
West Midlands Urban Area	Walkers Galvanizing	4.22					6.39	> UAT (1)	> UAT	> UAT
West Midlands Urban Area	Bruhl UK Ltd.	2.67					2.08	LAT-UAT (1)	< LAT	> UAT
West Midlands Urban Area	Sidney Smith	2.30					1.13	< LAT (1)	< LAT	> UAT
West Midlands Urban Area	Wolverhampton MWI	3.11					1.98	LAT-UAT (1)	< LAT	> UAT
West Yorkshire Urban Area	Leeds Market Building			1.30	1.05	1.15	0.75	< LAT (2)	< LAT	< LAT
West Yorkshire Urban Area	White Rose Environmental	3.31					0.92	LAT-UAT (1)	< LAT	< LAT
Yorkshire & Humberside	British Steel Plc.	1.70					1.42	< LAT (1)	< LAT	> UAT
Yorkshire & Humberside	Paramount Batteries	2.91					1.88	LAT-UAT (1)	< LAT	> UAT
Yorkshire & Humberside	National Power Plc. - Drax	1.16					0.59	< LAT (1)	< LAT	> UAT

Note;

a - indicates the preliminary assessment criteria assigned to the zone or agglomeration identified based on modelled concentrations throughout the zone or agglomeration.

1 - indicates exceedence category based on less than 3 years of measured data

2 - indicates exceedence category based on 3 or more years of measured data

Modelled data for 2003 includes a fugitive emission component

Table A4.3 Identified exceedences of the Lower and Upper Assessment Thresholds for cadmium based upon measured data (2000, 2002-2005) and modelled data (2003) for UK. (concentration units, ng m⁻³)

Zone/agglomeration	Site	Measured annual mean concentration					Modelled 2003	Exceedences		Preliminary Assessment Category (a)
		2000	2002	2003	2004	2005		Measured	Modelled	
Belfast Metropolitan Urban Area	NIGEN Ltd. - Kilroot	0.13					0.04	< LAT (1)	< LAT	LAT-UAT
Belfast Metropolitan Urban Area	Belfast Harbour Estate	0.14					0.04	< LAT (1)	< LAT	LAT-UAT
Bristol Urban Area	BZL Avonmouth	7.73	8.26	1.84	0.71	0.48	8.73	< LAT (2)	> UAT	> UAT
Cardiff Urban Area	Cardiff				0.27	0.50		< LAT (1)	< LAT	> UAT
Central Scotland	Auchencorth Moss			0.07			0.01	< LAT (1)	< LAT	< LAT
Central Scotland	Scottish Power - Longannet	0.12					0.01	< LAT (1)	< LAT	< LAT
Central Scotland	Glacier Vandervell Ltd.	0.53					0.01	< LAT (1)	< LAT	< LAT
East Midlands	Beacon Hill			0.21			0.08	< LAT (1)	< LAT	> UAT
East Midlands	Midland Lead Refiners	0.52					0.16	< LAT (1)	< LAT	> UAT
East Midlands	Tungsten Batteries Ltd.	0.24					0.02	< LAT (1)	< LAT	> UAT
Eastern	Heigham Holmes			0.18			0.01	< LAT (1)	< LAT	> UAT
Eastern	Monkswood			0.18			0.01	< LAT (1)	< LAT	> UAT
Glasgow Urban Area	Glasgow			0.30	0.18	0.21	0.02	< LAT (2)	< LAT	< LAT
Glasgow Urban Area	Motherwell			0.20	0.14	0.28	0.02	< LAT (2)	< LAT	< LAT
Greater London Urban Area	Central London Metals			0.40	0.26	0.37	0.23	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Brent Metals			0.40	0.33	0.55	0.11	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Cromwell Road Metals			0.40	0.29	0.36	0.12	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Marylebone Road Metals			0.47			0.12	< LAT (1)	< LAT	< LAT
Greater London Urban Area	A Cohen & Co Ltd.	0.55					0.22	< LAT (1)	< LAT	< LAT
Greater London Urban Area	Britannia Refined Metals	0.47					1.65	< LAT (1)	< LAT	< LAT
Greater Manchester Urban Area	Manchester			0.30	0.21	0.31	0.05	< LAT (2)	< LAT	< LAT
North East Scotland	Banchory			0.06			0.01	< LAT (1)	< LAT	LAT-UAT
North Wales	Castle Cement	0.22					0.02	< LAT (1)	< LAT	< LAT
North West & Merseyside	Runcorn Weston Point	0.23				0.28	0.05	< LAT (1)	< LAT	> UAT
North West & Merseyside	Cockley Beck			0.07			0.01	< LAT (1)	< LAT	> UAT
North West & Merseyside	FE Mottram Ltd Congleton	0.34					0.31	< LAT (1)	< LAT	> UAT
Northern Ireland	Coolkeeragh Power Station	0.13					0.03	< LAT (1)	< LAT	> UAT
Scottish Borders	Eskdalemuir			0.10	0.04	0.09	0.01	< LAT (2)	< LAT	< LAT
Sheffield Urban Area	Sheffield		0.94	0.94	0.67	0.63	3.66	< LAT (2)	> UAT	> UAT
Sheffield Urban Area	British Steel Engineering	0.81					2.27	< LAT (1)	< LAT	> UAT
Sheffield Urban Area	Associated Octel Company Ltd.	0.17					2.27	< LAT (1)	< LAT	> UAT
South East	Wytham Wood			0.15			0.01	< LAT (1)	< LAT	> UAT
South East	Esso Petroleum Company Ltd.	0.20					0.02	< LAT (1)	< LAT	> UAT
South East	Cliffe Hill Quarry	0.26					0.01	< LAT (1)	< LAT	> UAT
South Wales	Cwmystwyth			0.09			0.01	< LAT (1)	< LAT	> UAT
South Wales	British Steel Llanwern	1.40					3.33	< LAT (1)	LAT-UAT	> UAT
South West	Hellen		13.05	3.60	1.44	1.06	29.58	< LAT (2)	> UAT	> UAT
South West	Yarner Wood Metals			0.12			0.01	< LAT (1)	< LAT	> UAT
Swansea Urban Area	INCO Europe	0.27				0.38	0.20	< LAT (1)	< LAT	> UAT
Swansea Urban Area	Pontardawe			0.14			0.13	< LAT (1)	< LAT	> UAT
Tyneside	Elswick 6		3.70	0.19	0.21	0.23	0.10	< LAT (2)	< LAT	< LAT
West Midlands	Sutton Coldfield Crematorium	0.38					0.33	< LAT (1)	< LAT	> UAT
West Midlands Urban Area	IMI 2	7.37	2.16	1.40	0.89	0.64	3.73	< LAT (2)	> UAT	> UAT
West Midlands Urban Area	Brookside Bilston Lane		5.08	4.29	4.72	3.33	2.79	> UAT (2)	LAT-UAT	> UAT
West Midlands Urban Area	Cerro Extruded Metals	0.76					2.67	< LAT (1)	LAT-UAT	> UAT
West Midlands Urban Area	Walkers Galvanizing	1.94					3.73	< LAT (1)	> UAT	> UAT
West Midlands Urban Area	Bruhl UK Ltd.	1.18					1.05	< LAT (1)	< LAT	> UAT
West Midlands Urban Area	Sidney Smith	3.50					0.30	LAT-UAT (1)	< LAT	> UAT
West Midlands Urban Area	Wolverhampton MWI	0.82					2.03	< LAT (1)	< LAT	> UAT
West Yorkshire Urban Area	Leeds Market Building			0.30	0.21	0.38	0.27	< LAT (2)	< LAT	< LAT
West Yorkshire Urban Area	White Rose Environmental	0.57					0.22	< LAT (1)	< LAT	< LAT
Yorkshire & Humberside	British Steel Plc.	0.62					3.40	< LAT (1)	LAT-UAT	> UAT
Yorkshire & Humberside	Paramount Batteries	0.59					0.55	< LAT (1)	< LAT	> UAT
Yorkshire & Humberside	National Power Plc. - Drax	0.25					0.16	< LAT (1)	< LAT	> UAT

Note:

a - indicates the preliminary assessment criteria assigned to the zone or agglomeration identified based on modelled concentrations throughout the zone or agglomeration.

1 - indicates exceedence category based on less than 3 years of measured data

2 - indicates exceedence category based on 3 or more years of measured data

Modelled data for 2003 includes a fugitive emission component

Table A4.4 Identified exceedences of the Lower and Upper Assessment Thresholds for nickle based upon measured data (2000, 2002-2005) and modelled data (2003) for UK. (concentration units, ng m⁻³)

Zone/agglomeration	Site	Measured annual mean concentration					Modelled 2003	Exceedences		Preliminary Assessment Category (a)
		2000	2002	2003	2004	2005		Measured	Modelled	
Belfast Metropolitan Urban Area	NIGEN Ltd. - Kilroot	1.25						< LAT (1)	< LAT	LAT-UAT
Belfast Metropolitan Urban Area	Belfast Harbour Estate	3.59					1.48	< LAT (1)	< LAT	LAT-UAT
Bristol Urban Area	BZL Avonmouth	2.67				4.13	3.81	< LAT (1)	> UAT	> UAT
Cardiff Urban Area	Cardiff				2.70	1.89		< LAT (1)	< LAT	> UAT
Central Scotland	Auchencorth Moss			1.80			0.47	< LAT (1)	< LAT	< LAT
Central Scotland	Scottish Power - Longannet	1.21					0.69	< LAT (1)	< LAT	< LAT
Central Scotland	Glacier Vandervell Ltd.	0.85					0.52	< LAT (1)	< LAT	< LAT
East Midlands	Beacon Hill			1.50			0.73	< LAT (1)	< LAT	> UAT
East Midlands	Midland Lead Refiners	1.72					1.78	< LAT (1)	< LAT	> UAT
East Midlands	Tungsten Batteries Ltd.	1.03					0.66	< LAT (1)	< LAT	> UAT
Eastern	Heigham Holmes			1.90			0.37	< LAT (1)	< LAT	> UAT
Eastern	Monkswood			1.90			0.40	< LAT (1)	< LAT	> UAT
Glasgow Urban Area	Glasgow			1.50	1.31	2.11	0.69	< LAT (2)	< LAT	< LAT
Glasgow Urban Area	Motherwell			0.90	0.70	3.34	0.69	< LAT (2)	< LAT	< LAT
Greater London Urban Area	Central London Metals			2.90	1.90	3.47	0.79	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Brent Metals			2.60	4.26	3.45	0.70	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Cromwell Road Metals			3.10	2.97	4.46	0.63	< LAT (2)	< LAT	< LAT
Greater London Urban Area	London Marylebone Road Metals			4.26			0.65	< LAT (1)	< LAT	< LAT
Greater London Urban Area	A Cohen & Co Ltd.	2.61					1.13	< LAT (1)	< LAT	< LAT
Greater London Urban Area	Britannia Refined Metals	2.92					1.15	< LAT (1)	< LAT	< LAT
Greater Manchester Urban Area	Manchester			1.70	1.51	3.86	0.85	< LAT (2)	< LAT	< LAT
North East Scotland	Banchory			1.00			0.35	< LAT (1)	< LAT	LAT-UAT
North Wales	Castle Cement	0.71					0.85	< LAT (1)	< LAT	< LAT
North West & Merseyside	Runcorn Weston Point	1.78				2.36	2.56	< LAT (1)	LAT-UAT	> UAT
North West & Merseyside	Cockley Beck			0.95			0.33	< LAT (1)	< LAT	> UAT
North West & Merseyside	FE Mottram Ltd Congleton	1.34					1.91	< LAT (1)	< LAT	> UAT
Northern Ireland	Coolkeeragh Power Station	2.05					2.19	< LAT (1)	< LAT	> UAT
Scottish Borders	Eskdalemuir			2.60	1.77	1.53	0.32	< LAT (2)	< LAT	< LAT
Sheffield Urban Area	Sheffield		16.20	19.37	20.47	14.26	130.50	> UAT (2)	> UAT	> UAT
Sheffield Urban Area	British Steel Engineering	8.25					45.95	< LAT (1)	> UAT	> UAT
Sheffield Urban Area	Associated Octel Company Ltd.	1.41					45.95	< LAT (1)	> UAT	> UAT
South East	Wytham Wood			1.40			0.48	< LAT (1)	< LAT	> UAT
South East	Esso Petroleum Company Ltd.	2.40					1.88	< LAT (1)	< LAT	> UAT
South East	Cliffe Hill Quarry	1.33					0.55	< LAT (1)	< LAT	> UAT
South Wales	Cwmystwyth			1.20			0.33	< LAT (1)	< LAT	> UAT
South Wales	British Steel Llanwern	3.43					2.20	< LAT (1)	< LAT	> UAT
South West	Hellen		1.96	2.48	2.12	3.51	5.58	< LAT (2)	> UAT	> UAT
South West	Yarner Wood Metals			2.10			0.39	< LAT (1)	< LAT	> UAT
Swansea Urban Area	INCO Europe	20.64	28.91	18.14	33.83	19.62	93.42	> UAT (2)	> UAT	> UAT
Swansea Urban Area	Pontardawe			42.70			197.26	< LAT (1)	> UAT	> UAT
Tyneside	Elswick 6		1.91	0.96	1.84	2.75	0.72	< LAT (2)	< LAT	< LAT
West Midlands	Sutton Coldfield Crematorium	1.15					1.52	< LAT (1)	< LAT	> UAT
West Midlands Urban Area	IMI 2	7.44	2.13	3.57	2.02	2.82	13.85	< LAT (2)	> UAT	> UAT
West Midlands Urban Area	Brookside Bilston Lane		2.03	2.81	2.51	5.51	9.04	< LAT (2)	> UAT	> UAT
West Midlands Urban Area	Cerro Extruded Metals	1.93					7.90	< LAT (1)	> UAT	> UAT
West Midlands Urban Area	Walkers Galvanizing	2.61					13.85	< LAT (1)	> UAT	> UAT
West Midlands Urban Area	Bruhl UK Ltd.	13.39					4.12	LAT-UAT (1)	> UAT	> UAT
West Midlands Urban Area	Sidney Smith	1.71					2.28	< LAT (1)	< LAT	> UAT
West Midlands Urban Area	Wolverhampton MWI	1.78					5.70	< LAT (1)	> UAT	> UAT
West Yorkshire Urban Area	Leeds Market Building			1.70	0.98	2.61	1.84	< LAT (2)	< LAT	< LAT
West Yorkshire Urban Area	White Rose Environmental	2.48					2.20	< LAT (1)	< LAT	< LAT
Yorkshire & Humberside	British Steel Plc.	2.28					2.13	< LAT (1)	< LAT	> UAT
Yorkshire & Humberside	Paramount Batteries	3.69					13.79	< LAT (1)	> UAT	> UAT
Yorkshire & Humberside	National Power Plc. - Drax	1.88					2.56	< LAT (1)	LAT-UAT	> UAT

Note;

- a - indicates the preliminary assessment criteria assigned to the zone or agglomeration identified based on modelled concentrations throughout the zone or agglomeration.
 - 1 - indicates exceedence category based on less than 3 years of measured data
 - 2 - indicates exceedence category based on 3 or more years of measured data
- Modelled data for 2003 includes a fugitive emission component

Appendix 5

National PAH and heavy metals networks 2005

Table A5.1 The UK PAH monitoring network 2005

Site name	Agglomeration	Zone	Site type
Ashington		North East	Industrial/Urban
Belfast	Belfast Metropolitan Urban Area		Urban
Birmingham 2	West Midlands Urban Area		Urban
Bolsover		East Midlands	Industrial
Brent	Greater London Urban Area		Urban
Bromley	Greater London Urban Area		Urban
Glasgow	Glasgow Urban Area		Urban
Hazelrigg		North West & Merseyside	Rural
High Muffles		Yorkshire & Humberside	Rural
Hove	Brighton/Worthing/Littlehampton		Urban
Kinlochleven		Highland	Urban Industrial
Leeds 2	West Yorkshire Urban Area		Urban
Lisburn	Belfast Metropolitan Urban Area		Urban
London 2a	Greater London Urban Area		Urban
London 2b	Greater London Urban Area		Urban
Manchester	Greater Manchester Urban Area		Urban
Middlesbrough	Teesside Urban Area		Urban
Newcastle	Tyneside		Urban
Newport		South Wales	Urban
Port Talbot	Swansea Urban Area		Urban Industrial
Scunthorpe 2		Yorkshire & Humberside	Urban Industrial
Speke	Liverpool Urban Area		Urban
Stoke Ferry		Eastern	Rural

Table A5.2 UK Heavy metals monitoring networks 2005

Site name	Agglomeration	Zone	Site type	Network
Auchencorth Moss		Scottish Borders	Rural	Rural Heavy Metals Deposition
Banchory		North East Scotland	Rural	Rural Heavy Metals Deposition
Beacon Hill		East Midlands	Rural	Rural Heavy Metals Deposition
Brookside 2 69	West Midlands Urban Area		Industrial	Heavy Metals
BZL Avonmouth 47	Bristol Urban Area		Industrial	Heavy Metals
Cardiff 68		South West	Urban	Heavy Metals
Cockley Beck		North West & Merseyside	Rural	Rural Heavy Metals Deposition
Cwmystwyth		South Wales	Rural	Rural Heavy Metals Deposition
Detling		South East	Rural	Rural Heavy Metals Deposition
Eskdalemuir 65		Scottish Borders	Rural	Rural Heavy Metals Deposition
Glasgow 64	Glasgow Urban Area		Urban	Heavy Metals
Hallen Village 56		South West	Industrial	Heavy Metals
Heigham Holmes		Eastern	Rural	Rural Heavy Metals Deposition
IMI Walsall 46	West Midlands Urban Area		Industrial	Heavy Metals
Leeds 63	West Yorkshire Urban Area		Urban	Heavy Metals
London Brent 60	Greater London Urban Area		Urban	Heavy Metals
London Cromwell Road 61	Greater London Urban Area		Urban	Heavy Metals
London Horseferry 62	Greater London Urban Area		Urban	Heavy Metals
Manchester 67	Greater Manchester Urban Area		Urban	Heavy Metals
Monkswood		Eastern	Rural	Rural Heavy Metals Deposition
Motherwell 66	Glasgow Urban Area		Urban	Heavy Metals
Newcastle 70	Tyneside		Industrial	Heavy Metals
Sheffield 58	Sheffield Urban Area		Industrial	Heavy Metals
Swansea 49	Swansea Urban Area		Industrial	Heavy Metals
Weston Point 59		North West & Merseyside	Industrial	Heavy Metals
Wytham Wood		South East	Rural	Rural Heavy Metals Deposition
Yarner Wood		South West	Rural	Rural Heavy Metals Deposition
Auchencorth Moss		Scottish Borders	Rural	Rural Heavy Metals Deposition

