Suffolk Coastal District Council

REPORT

Interim Stage 2 & 3 Air Quality Review & Assessment

June 2001

Entec UK Limited

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Report for

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Executive Summary

Entec UK were commissioned to undertake the review and assessment work on behalf of Suffolk Coastal District Council following the submission of the Stage 2 review and assessment report.

This report is an interim progress report for the Stage 3 review and assessment. The conclusions drawn so far in the project are:

- The combined impacts from the industrial processes at Sinks Pit require a PM_{10} monitoring programme (over a 3-month summer period);
- The combined emissions footprint of White Mountain Roadstone Ltd, the A12 traffic, Foxhall Four Quarry and the Foxhall landfill site has been screened out using desk based and modelling techniques to assess its potential operating impacts on PM_{10} concentrations;
- The Port of Felixstowe will require an SO_2 monitoring programme to assess the impacts of in-port shipping emissions on the local air quality;
- Stage 3 modelling is required to assess NO_2 emissions for three road sections in the District (the A14, the Lime Kiln Quay junction in Woodbridge, and the A1152 Melton crossroads), results are detailed in Entec's report 'Stage 3 local Air Quality Review & Assessment - Road Traffic Sources' (June 2001);
- A three month NO_2 monitoring programme will be carried out to validate the Stage 3 modelling at the A14 road junction near Felixstowe, results are detailed in Entec's report 'Stage 3 local Air Quality Review & Assessment - Road Traffic Sources' (June 2001).

Contents

1. Introduction

1.1 Project Background

Part IV of the Environment Act 1995 requires that local authorities in England and Wales periodically review air quality within their individual areas. This process of Local Air Quality Management (LAQM) is an integral part of delivering the Governments air quality objectives set out in the Air Quality Strategy (2000)[1].

In order to carry out an air quality review and assessment the Government recommends a three stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified as being at potential risk of exceeding the objectives.

Entec UK Ltd were commissioned by Suffolk Coastal District Council to undertake the air quality review & assessment process. The review has involved a desk based study, for industrial processes in the District, and a detailed modelling study has been carried out to accurately predict current and future levels of pollutants from the road traffic sources identified in the Stage 2 Review and Assessment report[2].

1.2 Stage 2 Review & Assessment Conclusions

Suffolk Coastal's First Stage Review and Assessment demonstrated that it is likely the air quality objectives for Benzene and 1,3-Butadiene will be met in the Suffolk Coastal District by the relevant target dates, and further review and assessment of these pollutants will not be necessary at the present time.

This Second Stage Review and Assessment has demonstrated that it is likely the air quality objectives for Lead and Carbon Monoxide will be met in the Suffolk Coastal District by the relevant target dates, and further review and assessment of these pollutants will not be necessary at the present time.

This Second Stage Review and Assessment has demonstrated, however, that there is a significant risk that air quality objectives for Nitrogen Dioxide, Sulphur Dioxide and Particulate Matter (PM_{10}) will not be met at locations within the Suffolk Coastal District by the relevant target dates. For the stated emission sources of these pollutants, further review and assessment will be necessary to determine the risk of exceedance more precisely:

[1] Air Quality Strategy for England, Scotland, Wales, and Northern Ireland, DETR 2000

[2] Stage 2 Air Quality Review & Assessment, Suffolk Coastal District Council, 2000

Nitrogen Dioxide

Traffic using the A14 trunk road.

Traffic using the A1152, including specifically the crossroads of the A1152 and B1438 at Melton, due to planned developments at the former RAF Bentwaters air-base, Rendlesham, and St Audry's, Melton. This is to include elevated levels of NO_2 seen from the current monitoring site at the Melton crossroads.

Emissions from traffic monitored at High Road West, Felixstowe and Lime Kiln Quay Road/Thoroughfare/St John's Street junction, Woodbridge using NO_2 diffusion tubes.

Sulphur Dioxide

Shipping at the Port of Felixstowe.

Particulate Matter (PM_{10})

Shipping at the Port of Felixstowe;

Future predicted levels of traffic using the A1152, including specifically the crossroads of the A1152 and B1438 at Melton due to planned developments at the former RAF Bentwaters air-base, Rendlesham and St Audry's, Melton. This is to include elevated levels of NO_2 seen from the current monitoring site at the Melton crossroads.

Emissions from traffic at High Road West, Felixstowe, and Lime Kiln Quay Road/Thoroughfare/St John's Street junction, Woodbridge.

The emission "Footprint" of White Mountain Roadstone Limited, traffic using the A12 and uncontrolled and fugitive emissions from Foxhall Four Quarry and Foxhall Landfill Site at Brightwell, Suffolk.

The emission footprint of Roadworks (1952) Limited and Sinks Pit Quarry, Kesgrave, Suffolk.

1.3 Further Review & Assessment Work

Following the conclusions from the Suffolk Coastal District Council Stage 2 conclusions, Entec UK were commissioned to carry out the following further review and assessment studies:

- Nitrogen dioxide emissions from the A14 trunk road, Lime Kiln Quay junction, and the A1152 Melton Crossroads;
- Sulphur dioxide and particulates (PM_{10}) emissions from shipping at the Port of Felixstowe;
- Particulates (PM_{10}) emissions from the combined emissions footprint from White Mountain Roadstone Ltd, A12 traffic, the Foxhall Four Quarry and the Foxhall landfill site and from activities at the Sinks Pit site.

1.4 Review & Assessment Methodology

Stage 3 screening modelling techniques have been used to predict current and future levels of nitrogen dioxide pollutant contributions from the busy A14 section of road near Felixstowe.

All modelling was carried out with regard to current DETR guidance notes on Air Quality Review and Assessment. In particular the following documents were used:

- LAQM TG4(00)[3] – Pollutant Specific Guidance
- LAQM TG3(00)[4] – Dispersion Modelling Guidance
- LAQM G1(00)[5] – Framework for Air Quality Review and Assessment

1.5 United Kingdom Air Quality Objectives

Table 1, below, details the UK Air Quality Objectives and dates of target achievement as were correct at the time of writing this document.

Table 1: United Kingdom Air Quality Objectives

Pollutant	Objective Concentration	Measured as	Date to be achieved by
Benzene	16.25µg/m^3 (5ppb)	Running annual mean	31/12/2003
1,3 Butadiene	2.25µg/m^3 (1ppb)	Running annual mean	31/12/2003
Carbon monoxide	11.6µg/m^3	Annual mean	31/12/2003
Lead	0.5µg/m^3	Annual mean	31/12/2004
	0.25µg/m^3	Annual mean	31/12/2008
Nitrogen dioxide (NO_2)	200µg/m^3 (105ppb) not to be exceeded more than 18 times a year	1 hour mean	31/12/2005
	40µg/m^3	annual mean	31/12/2005
Particles (PM_{10})	50µg/m^3 (gravimetric) not to be exceeded more than 35 times a year	24 hour mean	31/12/2004
	40µg/m^3 (gravimetric)	Annual mean	31/12/2004
Sulphur dioxide (SO_2)	350µg/m^3 (132 ppb) not to be exceeded more than 24 times a year	1 hour mean	31/12/2004
	125µg/m^3 (47 ppb) not to be exceeded more than 3 times a year	24 hour mean	31/12/2004
	266µg/m^3 (100 ppb) not to be exceeded more than 35 times a year	15 minute mean	31/12/2004

[3] LAQM TG4 (00) – Review & Assessment: Pollutant Specific Guidance, DETR, January 2000

[4] LAQM TG3 (00) - Dispersion Modelling Guidance, DETR

[5] LAQM G1(00) Framework for Air Quality Review & Assessment, DETR

1.6 Stage 2 & 3 Review & Assessment Report Structure

This report details the further review and assessment studies that Entec UK were commissioned to carry out for Suffolk Coastal District Council.

Section 2 of this report details the methodology and assessment of the continued Stage 2 review and assessment issues of the PM_{10} emissions from the Sinks Pit and Foxhall Four industrial sites in the District.

Section 3 of this report details the methodology and Stage 2 assessment of emissions relating to shipping emissions from the Port of Felixstowe.

Section 4 details the methodology and Stage 3 assessment of NO_2 emissions from the three identified road sections in the District requiring further review and assessment.

Section 5 of this report is the summary of the review and assessment findings and recommendations for the District.

2. Continued Stage 2 Review & Assessment

2.1 Stage 2 Assessment Methodology

The review and assessment work in this section of the report details the concluding Stage 2 assessments following the submission of the Stage 2 review and assessment report by Suffolk Coastal District Council. The methodology used throughout the review and assessment is in line with the DETR guidance documents LAQM TG4(00) and LAQM.TG3(00).

2.2 Stage 2 PM_{10} Assessment

The Suffolk Coastal District Council Stage 2 review and assessment report indicated that further consideration was necessary for fugitive PM_{10} releases from the Sinks Pit and Foxhall Four sites in the District. PM_{10} emissions from the in-port shipping emissions Port of Felixstowe will be addressed in section 3, emissions from shipping.

2.3 Fugitive Dust Emissions from Quarrying Operations

There is an element of uncertainty surrounding uncontrolled and fugitive PM_{10} emissions. Uncontrolled and fugitive contributions from the two quarrying operations requiring further assessment at Stage 2 and 3 will be addressed in the following two sections. The two operations are the Sinks Pit site and the Foxhall Four combined sites located in the Suffolk Coastal District.

2.4 Sinks Pit

Sinks Pit is situated in Kesgrave, to the north of the A1214. There are several processes in operation at Sinks Pit: gravel / sand extraction; stockpiling of aggregates materials; mobile crushing plant with the potential for fugitive and uncontrolled PM_{10} emissions. There is also an authorised roadstone coating plant in operation at the site and emissions from this source were assessed at Stage 2 using the ADMS-Screen modelling tool.

The nearest receptor locations to Sinks Pit are residential properties, approximately 245 metres from the working areas. There are no relevant receptors located within 200 metres of the main long-term working areas. There is a history of nuisance complaints from local residents regarding dust and other environmental nuisances from the Sinks Pit site.

The Stage 2 review and assessment report considered each of the processes and concluded that individually the processes on the site posed no significant risk of contributing to an exceedance of the PM_{10} air quality objective.

However, in view of the fact that a significant number of complaints has been received regarding dust nuisance from Sinks Pit and, considering the potential for combined impacts from the quarrying operations and roadstone coating plant, it is required that further assessment is carried out.

It is difficult to define any values for the concentrations of uncontrolled and fugitive dust emissions from the Sinks Pit site. ADMS modelling estimations for the roadstone coating plant combined with estimated background concentrations have predicted that the PM_{10} concentrations will be 24.08 $\mu g/m^3$. LAQM.TG4(00) states that for the review of PM_{10} if there are properties within 200-400 metres of the dust emissions sources, there should be no need to proceed further if the estimated 2004 background PM_{10} concentration is below 25$\mu g/m^3$, gravimetric. Professional judgement would also suggest that the contribution of PM_{10} from uncontrolled fugitive dust sources on site will not be significant enough to cause an exceedance of the air quality objective. The UK annual mean air quality objective for PM10 is 40$\mu g/m^3$.

In agreement with the site operator and Suffolk Coastal District Council it has been decided that a PM_{10} monitoring programme should be carried out at a suitable relevant receptor location to the Sinks Pit site. This will provide evidence to assist with the screening assessment of this process. In order for the assessment to provide a more useful set of indicative monitoring results the survey will be carried out during a three month period over the summer months (perceived to be the worst case scenario for likely uncontrolled fugitive dust emissions).

Nuisance dust complaints have been received from local residents about the Sinks Pit site. Nuisance dust particles are expected to be in the larger, visual, range of particle sizes than specifically PM_{10}. The types of dust associated with the operational activities at the Sinks Pit are expected to be larger particles, however, any elevated levels of nuisance dust may indicate elevated levels of PM_{10} from the emission source as well.

2.5 Foxhall Four Industrial Site

The Foxhall Four site is located by the west side of the A12, approximately 2 km to the north of the A12 junction with the A14.

The Foxhall Four site operates several processes: a quarrying and stockpiling operation; an operational landfill; and a roadstone coating plant (operated by White Mountain Roadstone Limited). The site, therefore, has the potential for PM_{10} emissions from uncontrolled fugitive sources as well as from the roadstone coating process.

An ADMS-Screen modelling assessment was carried out on the roadstone coating plant for the Stage 2 report for Suffolk Coastal District Council. Individually the roadstone coating plant is not predicted to cause an increase in PM_{10} sufficient to exceed the air quality objective.

There are no relevant receptors within 600 metres of the current operational area for the landfill, though the landfill area is planned to extend to within 300 metres of the nearest residential property in the future. The nearest receptor to the working quarry face at the Foxhall Four Quarry is approximately 250 metres away. There are three residential properties within 1 km of the Foxhall Four site, each is located on the other side of the A12 main road. There have been no logged nuisance complaints from residential properties regarding dust nuisance emissions from the Foxhall Four site.

2.5.1 Foxhall Four Site - Combined Source Impacts

The Suffolk Coastal District Stage 2 report concluded that there was an issue of concern that the combined impacts of the roadstone coating plant emissions, the contribution from road sources and fugitive emissions from the Foxhall Four Quarry and Foxhall landfill site may contribute to an exceedance of the air quality objective for PM_{10}.

The LAQM.TG4(00) methodology for assessing combined source impacts is to combine the worst case impacts to predict the 90th percentile concentration. Entec's approach to calculating the short term statistics for combined source impacts is detailed below.

It is not valid to simply add plant, roadside and background contributions in the area for averaging periods other than the long term annual mean, because peak short term (e.g. hourly maximum) concentrations from the plant will not coincide with peak background and traffic concentrations. To determine the total concentrations (vehicular, plant and background short term concentrations) a validated Entec in-house empirical method[6] was used to predict short-term statistical values of PM_{10}. The method is similar to that laid out in DETR guidance to local authorities for the assessment of emissions and also to calculations used in the DMRB method. The method is described below.

Entec method for the determination of total (vehicular contribution, roadstone coating stack emissions and background) PM_{10} concentrations.

To determine total concentrations of PM_{10} the following approach was taken:

1. Predicted annual mean PM_{10} vehicular contributions (taken from DMRB modelling) were added to annual mean background PM_{10} concentrations (taken from estimations of future background levels), and contributions from the roadstone coating plant (taken from the ADMS-Screen modelling estimations).

2. Total annual mean PM_{10} concentrations were then converted to short period PM_{10} concentrations using empirical relationships derived from the regression analysis of the UK data set of PM_{10} monitoring data.

This approach was used at the public inquiry into the Heathrow Terminal 5 proposals after agreement by all parties represented at the inquiry's Air Quality Joint Data Group.

Table 2.5.1, below, shows the figures used and results obtained for the short-term combined contribution emissions calculation to estimate the impacts from the Foxhall Four site.

The background concentrations for the Foxhall site were taken from the NETCEN[7] estimated annual mean background pollutant concentration maps of PM_{10} for 2004. Road traffic contributions of PM_{10} were taken from the DMRB modelling estimations carried out by Suffolk Coastal District Council at Stage 2 of the review and assessment. The estimated peak annual average emission from the roadstone coating plant at the Foxhall site was taken from the ADMS-Screen modelling of the plant undertaken for the Stage 2 review.

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[6] A method for calculating short period concentration statistics from annual mean concentrations. M.Pratt and H.Dalton, Clean Air and Environmental Protection, Vol 30, No 3, 2000.

[7] NETCEN estimated annual mean background pollutant concentration maps, PM_{10} (gravimetric) 2004 (http://www.aeat.co.uk/netcen/airqual)

Table 2.5.1 Short Term Statistics for Combined Source Impacts at Foxhall Four Site

All values in table in µg/m^3	**Estimated**	**Air Quality Objective (NAQS, 2000)**
Background	23.3	N/A
Road traffic contribution	1.62	N/A
*Roadstone coating plant	2.83	N/A
Annual mean (sum of emissions)	**27.8**	**40**
90th percentile of 24-hour means	**45.7**	**50**
Max number of exceedances of 90th percentile of 24-hour means	25 exceedances	35 exceedances

*Value used for roadstone coating plant was peak annual average prediction

The short term statistics model estimates that the annual mean PM_{10} contribution from all sources will be 27.8µg/m^3 for 2004. The estimated short term 90th percentile of 24-hour means is predicted to be 45.7µg/m^3.

The short term calculations are relatively conservative values. The nearest receptor (residential property) in relation to the roadstone plant stack is 250 metres away. The annual average emission from the stack was taken from the peak annual average and ADMS-Screen modelling predicts this maximum concentration to fall 60 metres from the stack. The nearest combined source impact receptor is approximately 150 metres from the roadside. The DMRB road traffic contribution was taken from a calculation run on a property 50 metres from the roadside on the same section of road. The second closest receptor for the combined source impacts is approximately 400 metres from the site boundary.

Using the evidence supported from the estimated short term calculations and using an element of professional judgement it is unlikely that the combined source impacts will cause an exceedance of the PM_{10} air quality objective for 2004. The site is well operated and it is reasonable to suggest that the contribution of uncontrolled fugitive sources of PM_{10} will not have a significant impact on the annual average PM_{10} concentration in the vicinity of the Foxhall Four site.

This report indicates that the Foxhall Four site can be screened out from further review and assessment at the current time. However, the results from the proposed monitoring programme at the Sinks Pit quarry will be seen as relevant to the dust emissions from both quarry processes due to the observed similarity of the level of uncontrolled fugitive dust sources at each site. Therefore, if a significant problem is shown to exist at Sinks Pit it may be necessary to re-assess the fugitive dust emissions from the Foxhall site.

3. Port of Felixstowe

The scope of the review and assessment of air quality in the Port of Felixstowe area was to assess the potential impacts of SO_2 and PM_{10} emissions from shipping activities. Emissions from sources other than in-port shipping have not been assessed in this report.

3.1 The Port of Felixstowe

The Port of Felixstowe is the UK's largest container Port, handling 40% of the nation's containerised freight. Around 100 shipping lines use the Port of Felixstowe, combining to service 365 ports. The Port handled approximately 2.7 Million shipping containers during 1999. It is reputed to be one of the most efficient ports in Europe, in terms of efficient usage of both quayside and land-side facilities[8].

The total developed area of the Port of Felixstowe covers 267 hectares, with future predicted development expected to extend over another 58 hectares. The largest terminal is the Trinity Terminal, which extends for over 2 km of quayside. A recent submission to the Government has been made for an application to construct a 270 metre extension to the quayside at the Trinity Terminal. The Port has a second freight terminal (the Landguard Terminal) which extends for almost 0.5 km in quayside length. Both of these freight terminals have rail terminals with capacity for 6 x 20 and 3 x 20 wagon trains respectively. The Port operates two freight ferry terminals and a dock basin area extending for over 0.5 km of quayside length. The Port also operates an oil jetty, accommodating vessels of up to 180 metres in length.

The Port has two rail terminals, with an average of 28 rail movements each day. The busy A14 road also serves the Port, this is being assessed independently as part of the review and assessment for Suffolk Coastal District Council.

The Port of Felixstowe operates an active environmental policy in respect of its operations and perceived responsibilities to the local area. The mechanised plant equipment on the Port site is maintained to meet EU emission and performance standards for operating individually[9].

3.2 Air Quality Monitoring

There has been no active monitoring of emissions from the Port of Felixstowe shipping operations. The only monitoring carried out has been an SO_2 diffusion tube survey carried out in the vicinity of the Port area.

Suffolk Coastal District Council have operated an SO_2 diffusion tube survey for 6 months. Some of the monitoring locations have been close to the Port of Felixstowe.

[8] Source: Port of Felixstowe web site (http://www.hph.com.hk)

[9] Source: Port of Felixstowe web site (http://www.hph.com.hk/pfl/environment.htm)

Results taken from background locations, used as part of the Suffolk Coastal District Council SO_2 diffusion tube survey, indicate annual mean SO_2 levels in the District to be 8-12μg/m^3. SO_2 concentrations monitored at houses near to the Port indicate a higher annual mean concentration of 16-17μg/m^3 and monitoring at houses located on the sea front show monitored annual mean concentrations to be 11-12μg/m^3.

The diffusion tube monitoring results indicate that elevated concentrations of SO_2, expressed as an annual mean, are experienced in the vicinity of the Port area. There are no air quality objective standards contained in the Air Quality Strategy to relate to the long term annual mean concentration of SO_2. The assessment of SO_2 emissions from shipping activities at the Port are most likely to impact on the short term (15-minute) SO_2 objectives. Short term impacts cannot be monitored using diffusion tubes as these are long-term passive monitoring devices. However, they do provide a cost-effective monitoring indicator to show evidence for elevated levels of pollutants in areas, and can indicate seasonal variations over an annual monitoring survey.

3.3 Emissions from Shipping - Previous Studies

One of the most detailed studies of shipping emissions in Europe was a report commissioned by the oil companies european organisation for environmental and health protection, the CONCAWE report (1994)[10]. The purpose of the study was to provide a detailed assessment of the impact of sulphur emissions from ships within the Channel and Southern North Sea. The report was an evidential review to contribute to the debate on the need to limit the sulphur content of bunker fuels. The CONCAWE report studied an area containing 80 Ports. The main Ports studied were Rotterdam, Antwerp, Europoort and Le Havre.

The study concluded that in-port emissions of SO_2 from ships contribute 26% of the total emissions from ships, therefore a significant proportion. The study also showed that in-port shipping sources near to land contribute to high atmospheric concentrations of SO_2.

From detailed analysis of the eleven largest ports in the study area, the CONCAWE report concluded that in-port fuel consumption constitutes 29% of the total fuel consumed by ships.

In-port time for freight ships can vary from between less than one day to over four days in-port. Fuel consumption figures also vary according to the size and type of ship whilst operating in port, for example the unloading of oil tankers requires about 40% of main engine-at-sea fuel consumption (in tons/day) larger ships may require up to 70%.

Emissions of SO_2 from shipping arise from the high sulphur content of the, mainly, heavy fuel-oil used in the ships engines. Information obtained from the Port of Felixstowe and from investigation into shipping in the UK also suggests that it is common practice for ships berthing and load transferring in-port to switch to a low-sulphur fuel, such as gas oil. In practice though, as the CONCAWE report discussed, emissions from shipping remain an issue from in-port movements, though emissions of SO_2 may be reduced by the use of higher grade fuels.

[10] CONCAWE – the oil companies European organisation for environmental and health protection, The contribution of sulphur dioxide emissions from ships to coastal deposition and air quality in the channel and southern north sea area, 1994. Report no. 2/94

An investigation commissioned by the European Commission into the air quality targets for heavy metals[11] contained a reference relating to expected reductions in SO_2 from shipping. For North Sea and Channel ports some improvement may be anticipated due to the limitation of sulphur in bunker fuel to 1.5%. This will be introduced in the NW Europe Special Area under Annex VI to MARPOL (UN Convention on Maritime Pollution); whilst no implementation date has been fixed yet, industry sources anticipate its introduction by 2010.

3.4 UK Shipping Emissions Studies

The most recent and relevant UK study into emission from shipping in port areas was an air quality impact assessment report[12] into the proposed Dibden terminal at the Southampton Dock.

The Southampton Dock study is the only study available, but there are a number of factors that prevent a direct comparison.

A comparison of the Southampton Dock, where the impact assessment of shipping emissions was carried out, and the Port of Felixstowe is not straightforward due to the different nature of operations. The Port of Felixstowe is estimated to receive over 7200 shipping movements as an annual average, this is a total for large container vessels and ferries that will all spend time in the port area. Figures of ship movements for Southampton Dock relate to the number of shipping movements experienced per week in the Solent Channel, which is ships using a number of ports for docking. The number of shipping movements estimated to use the Solent Channel is 35204 ships per annum, this is made up of various sized freight and ferry ships, and this figure does not represent the number of actual docking ships and in-port shipping movements at Southampton Dock. The Solent is a major shipping channel used to access a number of Ports, therefore, the annual figure does not represent in-port shipping numbers / movements at any one Port location.

At present the Port of Felixstowe has 2.7 million container movements through the port, Southampton Dock achieves approximately 1 million container movements per year. Information gathered would suggest that the Port of Felixstowe experiences a significantly larger number of container ships docking / berthing at the port than are experienced at the Southampton Dock.

The conclusions from the operational impact assessment of the proposed terminal were that emissions from shipping would cause occasional short-lived increases in SO_2 concentrations, and would cause small increases in annual SO_2 concentrations.

The Southampton Dock study also concluded that emissions from shipping from the proposed extension would cause an extremely small increase in annual mean PM_{10} concentrations in the area. Information was based on measured emission rates of PM_{10} relative to those of SO_2 from shipping, the emission rates of PM_{10} were estimated to be insignificant in comparison to the potential impacts from emissions of SO_2 from in-port shipping.

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[11] European Commision - Economic Evaluation of Air Quality Targets for Heavy Metals, January 2001, Entec UK

[12] Associated British Ports, prepared by Air Quality Consultants, Air Quality Impact Assessment - Terminal, September 2000

As part of the impact assessment at Southampton Dock a 2-month monitoring programme was carried out to assess the short-term impact of SO_2 emissions from shipping. The monitoring was taken at a distance from the in-port ships representative of the closest distance between the ships and the nearest sensitive receptor, a distance of approximately 400 metres. The monitoring concluded that emissions from ships give rise to short-lived peaks in concentration and that over the monitoring period no infringement of the air quality objective for SO_2 occurred.

3.5 Recommendations for further review and assessment

As has been highlighted in the review of the Port so far, there is potential for emissions of SO_2 and PM_{10} from in-port shipping activities at the port to influence local air quality.

LAQM.TG4(00) details that there is only the potential for a significant impact of SO_2 from shipping where there are large numbers of ships, e.g. major ports, and there is the potential for public exposure within close proximity.

On the basis of information gathered the Port of Felixstowe has a significant number of ship movements and there are properties in relatively close proximity (within 400 - 500 metres) to the in-port shipping quayside areas.

There has been no short term air quality monitoring data assessment of emissions from shipping at the Port of Felixstowe. Modelling of shipping emissions would be associated with a significant amount of uncertainty, particularly as the assessment is for short term peak SO_2 concentrations.

The proposed methodology for further review and assessment of SO_2 emissions from in-port shipping at the Port of Felixstowe is to set-up a minimum 6-month SO_2 monitoring programme. The proposed automatic SO_2 monitoring programme will be used to monitor short-term averaging periods relevant to the 15-minute, 1-hour and 24-hour SO_2 air quality objectives.

On the basis of evidence gathered from previous studies, namely those related to the CONCAWE report and from the study of in-port shipping emissions at Southampton Dock, it is not judged necessary to proceed with further assessment of PM_{10} emissions specifically from in-port shipping activities at the Port of Felixstowe. However, upon review of the SO_2 monitoring results it will be possible to assess the SO_2 concentrations and in turn to consider the potential implications for other pollutants, including PM_{10}.

4. Stage 3 Modelling for Road Traffic

The Stage 3 modelling required for the review and assessment of air quality in Suffolk Coastal District Council is for NO_2 emissions from road sources.

4.1 Stage 2 Conclusions

The stage 2 review and assessment for Suffolk Coastal District Council concluded that Stage 3 modelling was required for the A14 road section between Ipswich and Felixstowe, the Lime Kiln Quarry road junction and the A1152 Melton Crossroads.

Suffolk Coastal District Council have completed their Stage 2 NO_2 assessments for all of the road sections within the District.

4.2 A14 Road Monitoring

There has been no automatic monitoring carried out previously in the District, therefore the decision was made to operate a 3-month NOx monitoring programme at a receptor by the A14 near to Felixstowe. The results from this monitoring will be used as a validation check for the modelling study of the A14 road section.

The validation modelling will be able to be used for the other potential road sections in the District that may be requiring a Stage 3 modelling study.

4.3 Stage 3 Road Traffic Modelling

Detailed Stage 3 modelling for NO_2 from road traffic will be carried out for the following road sections:

- The A14 road section through the District
- The Lime Kiln Quay Junction at Woodbridge
- The A1152 Melton Crossroads

Results of the Stage 3 modelling are detailed in Entec's report 'Stage 3 local Air Quality Review & Assessment - Road Traffic Sources' (June 2001).

5. Review & Assessment Summary of Progress

5.1 Sinks Pit

The review and assessment of the operational activities at the Sinks Pit site has concluded that a 3-month PM_{10} monitoring should be carried out at a suitable receptor location over the summer months (June - August) to assess the impact of all emission sources from the quarry processes.

5.2 Foxhall Four Industrial Site

On the basis of the review and assessment evidence gathered the conclusion was drawn that the PM_{10} emissions from the Foxhall Four industrial site requires no further review and assessment work.

5.3 Port of Felixstowe

Review and assessment of the shipping activities at the Port of Felixstowe has concluded that it will be necessary to carry out a minimum 6-month SO_2 monitoring programme.

A further assessment of PM_{10} from in-port shipping emissions will be made after review of the initial 6-month SO_2 monitoring survey at the Port.

Upon agreement with the Port authorities a visual inspection of the Port will be made to assess the requirement for further assessment of NO_2 and PM_{10} from combined in-port shipping and non-shipping sources at the Port of Felixstowe. It is expected that this will form part of the next phase of review and assessments for Suffolk Coastal District Council. The assessment of NO_2 and PM_{10} emissions from non-shipping activities at the Port will require an investigative visit to the Port. Further review in the form of monitoring may be required after this initial assessment.

5.4 A14 Road Traffic Monitoring

The NOx monitoring at the receptor located on the A14 is progressing, the results will be used to validate the NO_2 road traffic modelling predictions along the A14.

Results of the NOx monitoring are detailed in Entec's report 'Stage 3 local Air Quality Review & Assessment - Road Traffic Sources' (June 2001).

5.5 Further Review and Assessment

The following review and assessment work is still in progress for Suffolk Coastal District Council:

- NO_2 monitoring on the A14 road section near Felixstowe
- PM_{10} monitoring at Sinks Pit
- SO_2 monitoring at the Port of Felixstowe
- Stage 3 NO_2 modelling for the A14
- Stage 3 NO_2 modelling for the Lime kiln Quay junction in Woodbridge
- Stage 3 NO_2 modelling for the A1152 Melton Crossroads

Results of the NOx monitoring and Stage 3 road traffic modelling are detailed in Entec's report 'Stage 3 local Air Quality Review & Assessment - Road Traffic Sources' (June 2001).

Appendix 1
Method for Calculating Short Period Concentration Statistics

7 Pages


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• Major Stationary Sources & the AQ Strategy
• Secondary Air Pollutants
• Calculating Short Period Concentration Statistics
• Priority Pollutants in Renfrewshire
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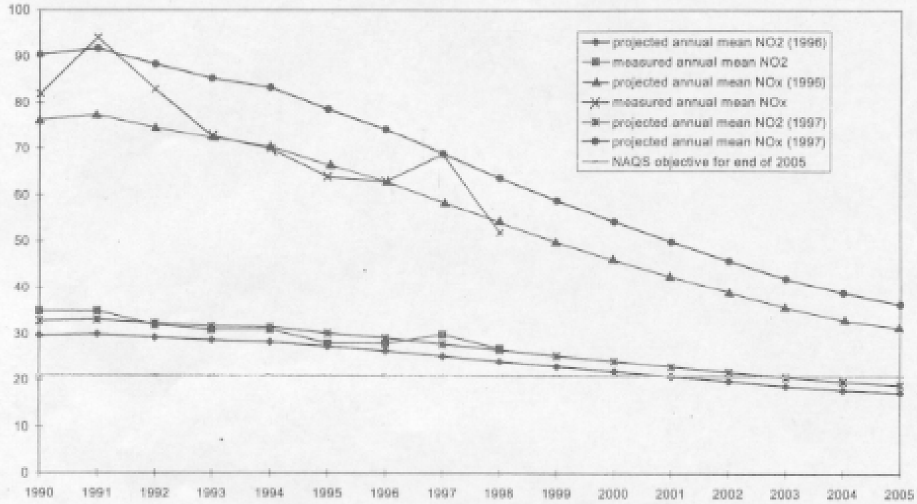
John R Stedman, AEA Technology Environment, National Environmental Technology Centre, E5 Culham, Abingdon, OX14 4ED

Figure 1: Comparison of measured NO_2 and NO_x concentrations at West London with projections based on both 1996 and 1997 monitoring data (ppb)



A Method For Calculating Short Period Concentration Statistics From Annual Mean Concentrations

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Background

Over the last few years there have been great improvements in the advice and techniques available for assessing air quality. There are however three areas which consistently cause difficulties when assessing ambient air concentrations namely the:

- determination of the short period term statistic concentrations which are required for comparison to the Air Quality Strategy standards or objectives;
- combination of predicted contributions from a specific scheme to existing background concentrations; and
- determination of nitrogen dioxide (rather that total nitrogen oxides) concentrations.

Whilst methods are available to address all three areas, these can often involve complicated and expensive modelling or monitoring work. In many cases the modelling techniques have not been extensively validated and the methods of calculation involved are not transparent.

The new generation of dispersion models can generally calculate short-period statistics for direct comparison to air quality objectives. Some modelling methods, however, only provide data for long period means (typically annual means) and these data cannot be compared directly with the standards or objectives for short period statistics. The calculation of short period concentrations is straightforward when only a limited number of sources are being considered and there are few, if any, other significant sources in the area. It is less straightforward to assess the total ambient concentration resulting from the combination of local, national and international sources. To achieve this, very detailed modelling is required that includes total emissions from regional, national and international sources. These emissions ideally need to be correlated with the hour of day in which they occur and the corresponding meteorological conditions. Such modelling may be appropriate in some cases but there are many cases where a simpler, cheaper and equally robust method is appropriate, for example Stage 2 Local Air Quality Management (LAQM) reviews can be used.

The combination of predicted short period contributions from a specific scheme with background concentrations is difficult because peak short-term concentrations from a particular scheme (e.g. road or industrial plant) are unlikely to occur at the same time as peak background concentrations. Moreover, concentrations expressed in statistical terms cannot be combined without returning to the original hourly values. It is only valid to combine modelled long-term average concentrations with equivalent background concentrations for a given period (usually a year).

One approach for the determination of short period concentrations resulting from multiple sources, including "background" is to calculate the combined annual mean concentration by simple addition of the annual mean contribution from each source and then use empirically derived fixed ratios or conversion factors to determine short period statistics. This method is used in several Government guidance documents, including DMRB[2], and the pollutant specific guidance[3]. For example, for road sources, DMRB suggests a factor of 5 for converting an annual mean nitrogen dioxide concentration to the equivalent maximum hourly mean concentrations.

Another area of difficulty is the determination of nitrogen dioxide concentrations resulting from emissions comprising mainly nitrogen oxides (e.g. combustion sources). Again, this can be done from knowledge of plume and ambient chemistry but simpler techniques can sometimes be appropriate. None of the commonly used dispersion models (including new ones) attempt to deal with this complex chemistry in anything other than a rudimentary way.

Development Of A Simple Method To Calculate Short Period Concentrations

The method presented here was developed during the public inquiry into the Heathrow Terminal 5 proposals, which began in 1995 and continued for four years. The air quality evidence was based on annual mean concentrations calculated from Heathrow, regional and national emission sources combined with simple ratios to give the limited number of statistics required for comparison with the Air Quality Standards[4] that were current at the time. The introduction of the new short-period statistics in the Air Quality Strategy published in 1997[1] required a different approach.

Examination of monitoring data from a range of sites suggests a broad correlation between annual mean concentrations and a number of short-term statistics. To explore this further a regression analysis of measured annual mean concentrations and shorter period statistics from a UK data set provided by NETCEN was carried out. The data set covered the period 1973 to 1996 where available (although some of the statistics included 1997 data) at a range of rural, urban and road sites in the UK. This analysis also examined the correlation of nitrogen dioxide concentrations with nitrogen oxide concentrations. The result of this work was a series of equations describing the relationship between annual mean and short period statistics. An example of such a correlation is given in Figure 1. This shows the relationship between annual mean NO_x and NO_2 concentrations.

The monitoring sites around Heathrow[a] were excluded for the regression analysis so that the efficacy of the estimation procedure could be tested. This test involved the calculation of the short period concentrations from ***measured*** annual mean concentrations and comparing the results with ***measured*** short period concentrations. On the basis of this test it was agreed, by all parties represented at the inquiry's Air Quality Joint Data Group, that the regression methodology (as set out in inquiry document BAA/818) would be used for the calculation of short period statistics from the modelled annual mean concentrations. A summary of these comparisons for the current strategy (and some other) objectives is given in Table 1.

The results in Table 1 show that the short period concentrations estimated from measured annual concentrations using the best-fit equations could be both over and underestimates of the measured values as might be expected. The calculated short period concentrations in the Heathrow area were, generally, over estimated compared with the measured value. As might be expected over and under estimates were largest for very short period concentrations, e.g. maximum hourly values. This observation is consistent with that found when attempting to model short period concentrations; the shorter the period the greater the uncertainty in the calculated concentration. The ranges of values are better in many cases than would be expected from equivalent dispersion model derived values and many are comparable to the normal uncertainty associated with measured values.

If the relationship between background and source contributions was to change with time the relationship between annual mean and shorter period concentrations may also change. This aspect was examined during the development of the method and no discernible variation was identified from historical data. From this examination it was concluded that these relationships were therefore likely to be valid for future years. To maintain the confidence in the methodology in the future it will become necessary to repeat the analysis using more recent data, as these become available.

The Method

The relationships between short period and annual mean concentrations determined from the UK data set are given in Table 2. It is important to remember that the method was developed when the objectives and air quality data were reported in volume/volume units. Accordingly all concentrations are in parts per billion (ppb), except for carbon monoxide (CO) and PM_{10} which are in parts per million (ppm) and micrograms per cubic metre ($\mu g/m^3$) respectively. The equations are not valid for concentrations expressed in other units. If the available data are expressed in mass units they should be converted before the application of the methodology using the factors given in Table 3. It should also be noted that the correlation for nitrogen oxides converts annual mean nitrogen oxides (NO_X) concentrations to annual mean and short period nitrogen dioxide (NO_2) concentrations.

Application of the Method

Use of the best-fit equations is simple. To calculate short period concentrations, the annual mean concentration is inserted into the equation type specified in the last column of Table 2, together with coefficients b_1 to b_3 as appropriate. The regression coefficient (R^2) is an indication of the closeness of fit of the data to the regression curve. If all the data fall on the regression curve, R^2 will be 1. If the curve explains little of the range of variation of the data, R^2 will tend towards zero.

Whether the methodology is likely to over or underestimate concentrations in a given area can be assessed by repeating the "test" procedure outlined above using monitoring data from the nearest appropriate Automatic Urban Network or other equivalent site.

The method has been used in other studies and was found to be a straightforward, reliable method for calculating the necessary short period concentrations. It is simple in its application, does not require the purchase of additional expensive modelling packages and yet tests show that it is at least as accurate as dispersion modelling.

References

1. Malcolm Pratt was the air quality witness for BAA plc at the Terminal 5 inquiry.

2. The Design Manual for Roads and Bridges, Volume 11 Environmental Assesssment, Section 3 Environmental Assessment Techniques, Part 1 Air Quality, May 1999.

3. Review and Assessment: Pollutant Specific Guidance, LAQM.TG4(00). Consultation Draft, December 1999.

4. Air Quality Standards Regulations 1989 (SI 1989 No. 817) HMSO.

5. The United Kingdom National Air Quality Strategy March 1997, The Stationery Office.

6. Calculation of Short Period Concentration Statistics from Annual Mean Concentrationss – BAA/818 December 1997 Entec.

A simple spreadsheet to undertake all the above calculations including unit conversion is available, free of charge from Entec by contacting Malcolm Pratt (01606 354848, pratm@entecuk.co.uk) or Gwyn Jones (0207 843 1419, joneg@entecuk.co.uk).

Table 1 Short period statistics determined from measured annual mean data [a]

Pollutant	Short period statistic	Range of over or underestimate
Nitrogen oxides	***Annual mean nitrogen dioxide***	***+15 to - 6%***
Nitrogen oxides	98th percentile of hourly mean nitrogen dioxide (equivalent to 175 exceedences)	+18 to -13%
Nitrogen oxides	***99.8th percentile of hourly mean nitrogen dioxide (equivalent to 18 exceedences)***	***+21 to -20%***
Nitrogen oxides	Maximum 1 hour mean nitrogen dioxide	+72 to -15%
Nitrogen oxides	***Number of exceedences of 104.6ppb (nitrogen dioxide) as the 1 hour mean***	***+1200 to -29%b***
Nitrogen oxides	Maximum 24 hour nitrogen dioxide	+51 to -28%
Carbon monoxide	Maximum 1 hour mean	+45 to - 31%
Carbon monoxide	***Maximum 8 hour running mean***	***+55 to - 36%***
Sulphur dioxide	***99.9th percentile of 15 minute mean (equivalent to 35 exceedences)***	***No monitoring data available including 15 minute means***
Sulphur dioxide	Maximum 15 minute mean	No monitoring data available including 15 minute means
Sulphur dioxide	98th percentile of daily mean (equivalent to 7 exceedences)	+35 to +16%
Sulphur dioxide	Maximum 24 hour mean	+114 to +30
PM_{10}	***90th percentile of 24 hour means (equivalent to 35 exceedences)***	***+4 to -3%***
PM_{10}	94th percentile of 24 hour means (equivalent to 20 exceedences)[c]	+3 to -8%
PM_{10}	98th percentile of 24 hour means (equivalent to 7 exceedences)[c]	+19 to -8%
PM_{10}	99th percentile of 24 hour means (equivalent to 4 exceedences)[c]	+31 to -15%
PM_{10}	99.7th percentile of 24 hour means (equivalent to 1 exceedence)[c]	+31 to -7%
PM_{10}	99th percentile of daily maximum running 24 hour means equivalent to 4 exceedences)	+16 to -10%
PM_{10}	Maximum running 24 hour mean	+22 to -7%
PM_{10}	***Number of exceedences of 50 μg/m³ as the 24 hour mean***	***+30 to -15%***

Notes

a Those statistics in ***bold*** represent the objectives included in the January 2000 Air Quality Strategy

b The range of under or overestimate as a percentage is large for this statistic since it relates to the number of exceedences occurring. Where the numbers are small (e.g. 1 exceedence) any small overestimate (e.g. 10 exceedences) results in a large percentage overestimate.

c These statistics represent the TEOM equivalent concentrations to the gravimetric values given in the EU daughter directive for 2005 and 2010.

Table 2 Best Fit Equation Coefficients

Annual mean concentration	Units	Short period or other statistic	Coefficients				
			b_1	b_2	b_3	R^2	Equation type
Nitrogen Oxides	ppb	Nitrogen dioxide					
		Annual mean	***1.0741***	***-0.1581***		***0.999***	***E***
		98th percentile of 1 hour means (equivalent to 175 exceedences)	1.4005	-0.0080	1.57E-5	0.972	A
		99.8th percentile of 1 hour means (equivalent to 18 exceedences)[b]	***12.8365***	***0.4604***		***0.746***	***B***
		Maximum 1 hour mean	3.6452	-0.0203	3.90E-5	0.872	A
		Number of exceedances of 104.6ppb as the 1 hour mean[b]	***-9.1033***	***0.3079***	***0.0007***	***0.462***	***F***
		Maximum 24 hour mean	8.6226	0.5110		0.688	B
Carbon monoxide	ppm	Carbon monoxide					
		Maximum 1 hour mean	14.9898	-3.9233	0.4148	0.909	A
		Maximum 8 hour running mean	***10.4244***	***-2.4052***	***0.2288***	***0.902***	***A***
Sulphur dioxide[a]	ppb	Sulphur dioxide					
		99.9th percentile of 15 minute means (equivalent to 35 exceedences)	***13.6818***			***0.941***	***C***
		Maximum 15 minute mean	39.3111	-1.7866	0.0426	0.925	A
		98th percentile of daily means (equivalent to 7 exceedences)	3.5733	-0.0112		0.9701	D
		Maximum 24 hour mean	7.5146	-0.0445		0.931	D
PM_{10}	µg/m³	PM_{10}					
		90th percentile of 24 hour means (equivalent to 35 exceedences)[b]	***1.4991***	***1.0281***		***0.931***	***B***
		94th percentile of 24 hour means (equivalent to 20 exceedences)[b]	1.7898	1.0131		0.851	B
		98th percentile of 24 hour means (equivalent to 7 exceedences)[b]	1.8961	1.0752		0.743	B
		99th percentile of 24 hour means (equivalent to 4 exceedences)[b]	1.8133	1.1261		0.647	B
		99.7th percentile of 24 hour means (equivalent to 1 exceedence)[b]	2.0925	1.1339		0.393	B
		99th percentile of daily maximum running 24 hour means (equivalent to 4 exceedences)	1.8213	-0.3372		0.999	E
		Maximum running 24 hour mean	2.2911	-0.6220		0.996	E
		Number of exceedences of 50µg/m³ as the 24 hour mean[b]	***14.1699***	***-2.5723***	***0.1069***	***0.795***	***F***

Notes

a Unfortunately the correlations for the new sulphur dioxide objectives are not yet available.

b These equation coefficients were not included in document BAA/818, they were derived subsequently.

The statistics in ***bold*** represent the objectives included in the January 2000 Air Quality Strategy.

Form of best-fit equations

A [short period statistic] = ([b_1*(annual mean)] + [b_2*(annual mean)^2] + [b_3*(annual mean)^3])

B [short period statistic] = [b_1*(annual mean)^{b_2}]

C [short period statistic] = [b_1*(annual mean)]

D [short period statistic] = ([b_1*(annual mean)] + [b_2*(annual mean)^2])

E [short period statistic] = [(annual mean)^{b_1}*[(annual mean)^{b_2}]$^{\log(\text{annual mean})}$]

F [short period statistic] = [b_1 + b_2(annual mean) + b_3(annual mean)^2]

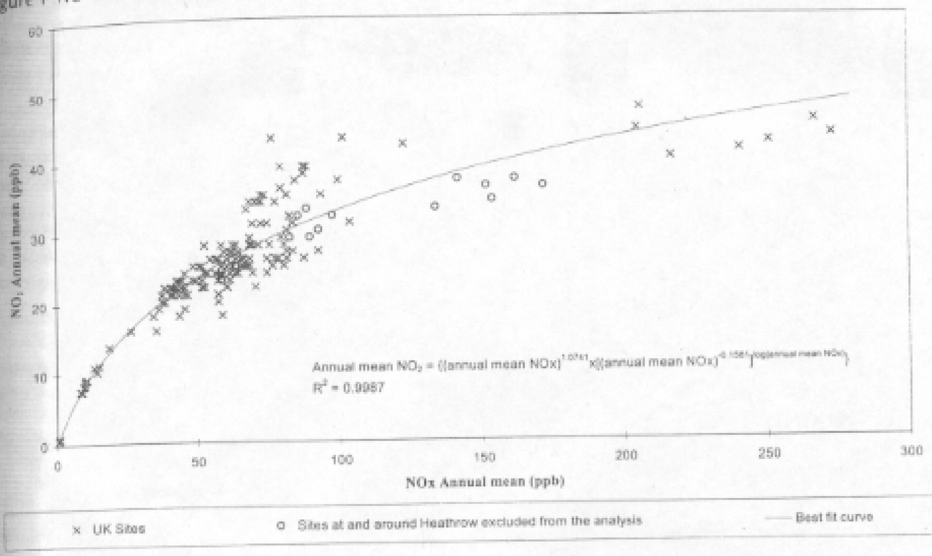
Example

(Annual mean NO_2) = [(annual mean NO_2)$^{1.0741}$ x [(annual mean NO_2)$^{-0.1581 \cdot \log(\text{annual mean } NO_2)}$]

Table 3 Unit Conversions

Pollutant	ppb to µg/m³ multiply by	µg/m³ to ppb multiply by
Nitrogen dioxide	1.91	0.52
Carbon monoxide	1.16	0.86
Sulphur dioxide	2.66	0.37

Figure 1 NO- Annual mean regression with annual mean NOx concentration for 1973-1996



Benzene, Particulate Matter And Associated Priority Pollutants In Renfrewshire, Scotland – Experience From Enhancing Local Air Quality Monitoring

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To support the first stage air quality review of Renfrewshire, a collaborative research project between the University of Paisley and Renfrewshire Council was established to develop a monitoring programme for benzene, particulate matter, lead and polycyclic aromatic hydrocarbons (PAHs). Generally, the district complied with target air quality levels. In the case of benzene a diffusion-based monitoring network highlighted the significance of vehicle movement and the broader impact of a significant traffic intervention event on air quality. Gravimetrically determined particle levels (PM_{10}, $PM_{2.5}$, TSP), and those of associated pollutants, varied widely at sites studied, and included potential exceedences of PM_{10} standards. Some variation in the data was attributed to the varied influence of vehicle and natural background sources in response to environmental factors.

Background and Introduction

This article summarises the results and preliminary conclusions from a three-year, collaborative research project, jointly between the University of Paisley and Renfrewshire Council during the period October 1995 to July 1998. The aim of the project was to enhance the monitoring of local air quality in the district, focussing on the priority pollutants: benzene, fine particles (mainly PM_{10}), and particle-associated lead and polycyclic aromatic hydrocarbons (PAHs). The data was then used in the first stage review and assessment of local air quality (DETR 1997, 1998a, 1998b).

A further aim of the work was to assess the applicability of a range of monitoring techniques for the various pollutants and also to generate baseline data directly comparable, where possible, to other studies. A detailed assessment of a number of other atmospheric components was also undertaken and forms part of a PhD thesis being submitted by one of us (RM).