NEPG

The Norfolk Environmental Protection Group [NEPG] is an apolitical group of district council environmental health staff whose duties include the monitoring and enforcement of pollution matters.

The grouping comes together to share expertise and knowledge across these functions and to work towards providing consistent enforcement standards across Norfolk.

The work covers pollution of air [including that by noise], water in all its forms and contaminated land.

Whilst much of the group's discussions are technical, views on policy matters are also discussed and often presented to the Norfolk Chief Environmental Health Officers as a professional view of field officers.

The group meets quarterly for ordinary meetings and subgroups meet more regularly to research and prepare special reports.

This report is the second of its kind produced by the NEPG the first being a review of Norfolk air quality produced for 1996.

Norfolk and air quality

Norfolk is the home to more than 765,000 people and includes an historic city, two historic industrial ports, many market towns and swathes of some of England's most arable lands. The area totals some 536,953 hectares, contains 90 miles of fine coastline and is predominantly very rural.

The county contains some particularly precious environmental areas of heritage coast, wildlife reserves, many Sites of Special Scientific Interest (SSSI), the Brecks and the Broads. There are also important and historical parts of the built environment in the county, especially in the provincial capital city of Norwich.

In terms of sources of air pollution, road transport is probably the dominant large scale source as elsewhere in the country. In the industrial context there are, in the county, approximately 240 polluting processes registered as part B processes authorised by district council environmental health departments. There are a further 19 Part A processes dealt with by the Environment Agency which tend to be large industrial plant.

These processes are expected to form an important part of the emission inventory for the county as are road transport emissions, especially but not exclusively, in the urban centres. There are, in the county, over 9000 kilometres of roadway.

The geography of the region and its proximity to Europe causes it to suffer from some of the worst ozone episodes in the country - damaging health and crops. Ozone is reported to exacerbate respiratory ill-health.

Apart from the ozone imported into the region in the summer months it is possible that there are widespread PM_{10} [particulate matter less than 10 microns aerodynamic diameter] breaches (see Appendix 1 for standards and objectives). Monitoring of PM_{10} began in Norwich during the summer of 1997.

At the present time there are a variety of air pollutants monitored across the districts of Norfolk and there are some areas where there is no regular ambient monitoring taking place. Pollutants monitored include smoke, sulphur dioxide, nitrogen dioxide, benzene, lead and ozone. A variety of measurement techniques are used, from real time analysers to monthly diffusion tubes.

This is the second report produced by NEPG covering air quality within the Norfolk Area.

Air Pollutants - Sources Sinks and behaviour

A wide range of activities, industrial, transport and domestic, large and small scale emit pollutants to the atmosphere. Each activity produces its own mixture of pollutants over its own area of effect. The resultant ambient air quality is dependant upon the current weather and geography of the region.

In general weather conditions throughout most of the year are such that pollutants are mixed and dispersed sufficiently to retain pollution levels below those considered by experts to be harmful to health. Occasionally, weather systems can suppress dispersion or promote chemical reaction in the atmosphere giving rise to pollution episodes lasting from a number of hours to a number of days. It is during these episodes that health guidelines may be breached.
Pollutants remain in the atmosphere until they are removed either by precipitation (rain, snow, fog etc.), chemical reaction or surface impact. Their distribution is dependant on the weather and the height at which they are emitted. Some pollutants may be transported across entire continents before being taken back down to ground level. Air pollution respects no political boundaries and is global problem as well as a local one.

Generally pollutants can be described as primary or secondary. Primary pollutants are those which are directly emitted from a source, e.g. carbon monoxide from car exhausts. Secondary pollutants , such as ozone, are those which form as a result of reaction with other chemicals present in the atmosphere. The major pollutants, both primary and secondary, are described below.

NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) and nitric oxide (NO) are both oxides of nitrogen and together they are referred to as NO_x. All combustion processes in air produce NO_x, though the colourless gas NO usually predominates. The conversion of NO to the red brown gas NO_2 takes place in the atmosphere by a reaction with chemically active species such as ozone. Generally in remote, unpolluted areas nitric oxide concentrations are only a small fraction of those of nitrogen dioxide. However, in polluted areas where the oxidising capacity of the atmosphere may be limited, nitric oxide concentrations often exceed those of nitrogen dioxide. Elevated levels of nitrogen oxides are generally observed in urban environments under stable meteorological conditions, when the air mass is unable to disperse (e.g. calm, damp winter days). Together with hydrocarbons, they play an important role in the formation of ozone in the atmosphere. Nitrogen oxides have a lifetime of approximately 1 day with before being converted to nitric acid, which is removed from the atmosphere by direct deposition to the ground or transfer to aqueous droplets (e.g. cloud or rainwater), thereby contributing to acid deposition.

Nitrogen dioxide is associated with adverse affects on human health, particularly with regard to the exacerbation of symptoms associated with respiratory illness. Nitrogen oxides are also indirect greenhouse gases which influence the atmospheric chemistry cycle.

Current estimates show that, on the national scale, road transport accounts for 46% of the total UK emissions of nitrogen oxides. The electricity supply industry accounts for approximately 22%, the industrial and commercial sectors for 12% and domestic sources for 3%.

There are presently national air quality standards and EC limits and guide values for nitrogen dioxides in the atmosphere. These, together with the provisional UK National Air Quality objectives are shown in Appendix (1).

OZONE

Ozone (O_3) is found in the stratosphere (stratospheric ozone) and in the troposphere (ground level ozone), it is not emitted directly from any man-made source in any significant quantities, but arises from chemical reactions in the atmosphere caused by sunlight.

In the stratosphere, where ozone plays a beneficial role by shielding the earth from harmful ultraviolet radiation, ozone is produced by sunlight acting on oxygen molecules. The balance between ozone and oxygen is currently being disturbed by migration upwards of chemicals such as chloroflurocarbons, which destroy ozone therefore increasing the amount of ultra-violet light reaching the earth's surface.

The formation of ground level ozone requires the presence of three ingredients: hydrocarbons, nitrogen oxides and sunlight. Sunlight provides the energy for the whole process, leading to the formation of reactive species known as free radicals. In the presence of nitrogen oxides, these free radicals catalyse the oxidisation of hydrocarbons to carbon dioxide and water vapour. Partially oxidised organic species and carbon monoxide are intermediate oxidation products and ozone is generated as a by-product. Ozone also catalyses its own formation. Consequently, high levels of ozone are generally observed under sunny, summertime conditions in locations where the air mass has previously collected emissions of hydrocarbons and nitrogen oxides. Because of the time required for chemical processing, ozone formation tends to be down wind of pollution centres (i.e. it is usual for the highest ozone levels to be in suburban or rural locations).

Depending on the concentration, ozone causes short term acute effects on the respiratory system especially to sensitive individuals. Ozone also has an adverse impact on plant life.

There are presently no statutory standards Appendix (1) shows the objective in the National Air Quality Strategy.

SULPHUR DIOXIDE

Sulphur Dioxide is a gas at normal temperature and pressure. It dissolves in water to give an acidic solution which is readily oxidised to sulphuric acid. In the United Kingdom the predominant source of sulphur dioxide is from the combustion of sulphur containing fossil fuels, principally coal and heavy fuel oils.

It is an irritant when it is inhaled, and because of its acidic nature, high concentrations may cause breathing difficulties in people exposed to it. Recent studies have shown that people suffering from asthma may be especially susceptible to the adverse effects of sulphur dioxide and that, within the range of concentrations that occur in pollution episodes, it may provoke some attacks of asthma. Sulphur dioxide can also lead to direct adverse effects in vegetation, with trees, crops and other native flora all known to be affected by the concentrations that are sometimes found in the UK.

For the first half of this century, emissions of sulphur dioxide were dominated by the combustion of coal, not only in the domestic sector, but also in commercial and industrial premises and in power stations which were situated predominantly within towns and cities. Following the smogs of the 1950s and the Clean Air Act 1956, this pattern changed as cleaner fuels replaced coal in the domestic, commercial and industrial sectors, and power generation was concentrated in much larger, more efficient stations situated in rural areas.

As a result national emissions of sulphur dioxide have decreased by 63% since 1970, and by 52% since 1980. Urban smogs like those in the 1950s are now a thing of the past, and average levels of sulphur dioxide have decreased by around 5 fold since the 1960s. Emissions are now dominated by fossil fuel power stations which currently account for 67% of the national total. Although the use of solid fuel outside the power generation sector is small overall there are still some areas of the UK, especially in areas associated with coal mining where domestic coal and smokeless solid fuel is burned in significant quantities.

In contrast to other pollutants, transport emissions of sulphur dioxide are relatively unimportant nationally, but the combustion of diesel fuel can make a significant contribution to background levels in urban areas.

There are presently National and EC standards for sulphur dioxide in air. There are also provisional objectives within the NAQS, these can be seen in Appendix (1)

CARBON MONOXIDE

Carbon Monoxide (CO) is a gas formed by the incomplete combustion of carbon containing fuels. In general, the more efficient the combustion process, the lower the carbon monoxide emissions. At very high levels, prolonged exposure to carbon monoxide can result in death. At lower levels, the reduction in the oxygen carrying capacity of the blood may increase the risk of heart problems in predisposed individuals.

Although the major concern over carbon monoxide in the UK relates to very high indoor concentrations arising from faulty combustion appliances causing fatalities, there are also potentially adverse affects on health from high levels in the outdoor environment.

The main source of carbon monoxide in the UK is road transport which currently accounts for almost 75% of emissions (some 4,000,000 tons per year). Of this road transport emission, the predominant source is petrol vehicles which account for approximately 70% of the UK total and 95% of road transport emissions.

Emissions of carbon monoxide in the UK have increased significantly from 6.5 million tons in 1970 to 7.4 million tons in 1990, an increase of approximately 13%. Emissions have, however, been decreasing since 1990 due to the introduction of catalytic converters on petrol vehicles.

Since the main source of carbon monoxide is motor traffic, concentrations are highest near to heavily trafficked roads. Concentrations fall fairly rapidly with distance away from roads so that carbon monoxide is a local, rather than a trans-boundary pollutant. Carbon monoxide is also an indirect greenhouse gas which influences atmospheric chemistry cycles.

There are presently no air quality standards laid down in law for carbon monoxide in ambient air. The National Air Quality Strategy however has a proposed objective which is shown in Appendix (1).

FINE PARTICLES (PM_{10})

Unlike the individual gaseous pollutants which are single, well defined substances, particulate matter in the atmosphere is composed of a wide range of materials arising from a variety of sources. Examples of man-made sources are: carbon particles from incomplete combustion; ash; recondensed metallic vapours; and so called secondary particles, or aerosols, formed by chemical reactions in the atmosphere. As well as being emitted directly from combustion sources, man-made particles can arise from: mining; quarrying and construction operations; brake and tyre wear in motor vehicles; and from road dust lifted by moving traffic or strong winds. Natural sources of particles include wind blown dust from agricultural activity and sea salt, and biological particles such as pollens and fungal spores.

Average levels of particles in the air in UK towns and cities derived from domestic coal burning have decreased at some locations by as much as 10 fold in the past 25-30 years following the Clean Air Acts and subsequent restrictions of coal burning in the domestic sector. Over this period, measurements of particles in the air have been made by measuring “black smoke”. This is a relatively crude and simple technique which is now being superseded by direct weighing (gravimetric) techniques which give a more direct measurement of particle concentrations in the atmosphere.

Although many of the obvious effects of air pollution disappeared with the earlier smogs, research over the last few years has suggested that, even at the much lower levels now found in the UK, particulate air pollution appears to be associated with a range of ill-health, including effects on respiratory and cardio-vascular systems; asthma and mortality.

PM_{10} is sometimes referred to as "fine" particulate matter. Larger particles are not readily inhaled and are removed comparatively efficiently from the air by sedimentation. PM_{10} is defined as the total mass (per unit volume of air) of particles of medium aerodynamic diameter less than 10 μm (1/10,000,000 metre) and these have the greatest likelihood of reaching the lung. It is for this reason that they are of concern.

Increasingly interest is being focused on smaller particles and, in the US, and more recently in UK, research is being carried out into the presence and effects of $PM_{2.5.}$

At present there are no standards for PM_{10} although the National Air Quality Strategy has a provisional objective which can be seen in Appendix(1).

LEAD

Lead is the most widely used non-ferrous metal and has a large number of industrial applications, both in its elemental form and in alloys and compounds. The single largest use globally is in the manufacturer of batteries but other uses are as pigments in paints and glazes, etc. As the compound tetraethyl lead, it has been used as a petrol additive. With the recognition of the adverse affects of lead on human health and the growing use of catalytic converters, which are poisoned by lead, this use is declining rapidly.

Most of the air borne emissions of lead in the UK arise from petrol engine motor vehicles. Most of the lead in the air is in the form of fine particles.

Direct human exposure to lead occurs through food, water, dust and soil and air. Most people receive the largest portion of their daily lead intake via food, although other sources may be important in specific populations.

During the 1970s and early 1980s the lead content of petrol was gradually reduced, maintaining total emissions from vehicles broadly constant. At the end of 1985, the maximum permitted lead content of petrol was reduced significantly and in 1987 unleaded petrol was introduced.

Consequently lead emissions from motor vehicles have halved since 1987. It is arguable that the decline in air borne lead levels have been one of the most dramatic change in pollutant levels in the UK in recent years.

The objective in the National Air Quality Standard for lead in air is shown in Appendix (1).

BENZENE

Benzene is known to be a human carcinogen. The effect of long term exposure which is of most concern is leukaemia. It has not been possible to demonstrate a level at which there is zero risk from exposure to benzene. Therefore policies to control benzene concentrations in the ambient air adopt a risk management approach, aiming at attaining levels where the risk to health is very small.

In the UK the main atmospheric source is the combustion, distribution and storage of petrol. Diesel fuel is a relatively small source. The amount of benzene in petrol is regulated to an upper limit of 5% by volume by EC legislation, although currently it comprises, on average, about 2% by volume in the UK. Motor vehicle exhaust gases contain some unburned benzene, but they also contain benzene formed from the combustion of other aromatic components of petrol.

Motor vehicles are the most important single source on a national basis, which in 1995 have accounted for 67% of total emissions, with 66% of the total arising from petrol vehicles. The emissions from the evaporation of petrol and other mobile sources account for about 13% of total emissions in 1995.

Since the main sources of benzene are motor vehicles, and primary emissions are dispersed and diluted, benzene is a local rather than a trains-boundary pollutant.

At present there is no statutory standard for benzene levels in ambient air although the National Air Quality Strategy proposes an objective as shown in Appendix (1).

1,3 - BUTADIENE

1,3 - butadiene is a gas at normal temperature and pressure and trace amounts are present in the atmosphere, deriving mainly from the combustion of petrol and of other materials. 1,3 - butadiene is used in industry, mainly in the production of synthetic rubber for tyres.

It is thus a chemical to which workers have been exposed and there is evidence that such groups of workers have had slightly higher than expected risks of cancers. It is a Genoa-toxic carcinogen and, in theory, it is not possible to determine an absolutely safe level for human exposure.

Although neither petrol nor diesel fuel contain 1,3-butadiene it is formed in the combustion process from components in the fuel known as olefins. The proportions of these olefins in petrol have been increasing over the last decade and it is likely that the amounts of 1,3-butadiene emitted into the atmosphere from road traffic have also been rising. 1,3-butadiene is also an important industrial chemical. It is handled in bulk at a small number of industrial locations in the UK. Other than in the vicinity of such locations, the dominant source of 1,3-butadiene in the UK atmosphere is the motor vehicle. In 1995 petrol vehicles contributed 67% of national emissions.

1,3-butadiene is a reactive gas whose atmospheric measurement is difficult and requires sophisticated instrumentation.

There are presently no statutory standards for 1,3 - butadiene in ambient air although the National Air Quality Strategy propose an objective .

Health Effects of vehicle pollution

Pollutant	Source	Health Effect
Nitrogen Dioxide (NO_2)	One of the nitrogen oxides emitted in vehicle exhausts Conversion from NO	May exacerbate asthma and possibly increase susceptibility to infections.
Sulphur Dioxide (SO_2)	Mostly produced by burning coal, some SO_2 is emitted by diesel vehicles.	May provoke wheezing and exacerbate asthma. It is also associated with chronic bronchitis.
Particulates (PM_{10}) Total suspended Particulates Black Smoke	Includes a wide range of solid and liquid particles in air. Those less than 10 μm in diameter (PM_{10}) penetrate the lung fairly efficiently and are most hazardous to health.	Associated with a wide range of respiratory symptoms. Long term exposure is associated with an increased risk of death from heart and lung disease. Particulates can carry carcinogenic materials into the lungs.
Carbon Monoxide (CO)	Comes mainly from petrol car exhaust.	Lethal at high doses. At low doses can impair concentration and neuro behavioural function. Increases the likelihood of exercise related heart pain in people with coronary heart disease. May present a risk to the foetus.
Ozone (0_3)	Secondary pollutant produced from nitrogen oxides and volatile organic compounds in the air.	Irritates the eyes and air passages. Increases the sensitivity of the airways to allergic triggers in people with asthma. May increase susceptibility to infection.

Volatile organic compounds (including benzene & 1.3 butadiene	A group of chemicals emitted from the evaporation of solvents and distribution of petrol fuel. Also present in vehicle exhaust.	Benzene has given most cause for concern in this group of chemicals. It is a cancer causing agent which can cause leukaemia at higher doses than are present in the normal environment.
Lead (pb)	Compound present in leaded petrol to help the engine run smoothly.	Impairs the normal intellectual development and learning ability of children.

AIR QUALITY MONITORING

Air Quality Monitoring has been carried out in this country for many years. The purpose of monitoring is to obtain measurements of the pollutant levels in air and so provide the necessary information to make informed decisions on how to improve air quality. As technology advances new and more accurate methods have evolved.

RESEARCH

With analysis and interpretation, measurements can be used to provide information for research into the extent and behaviour of pollutants. Assessments can be made as to the effects of various pollutants, how pollution levels vary with time and location, whether air quality is getting better or worse.

PUBLIC INFORMATION

As public awareness of air pollution increases, the demand for readily available information increases. The reports by the Norfolk Environmental Protection Group help to meet some of these requirements. Another good source of national information is that supplied on behalf of the DETR.

MONITORING METHODS.

There are two distinct types of air pollution monitoring in use in Norfolk - automatic continuous samplers and non-automatic passive diffusion tubes. Non-automatic methods are cheaper and easier to install and maintain but do not give such accuracy or resolution as automatic methods.

PASSIVE SAMPLING BY DIFFUSION TUBE

These tubes provide a simple and inexpensive method of screening air quality in an area, giving an indication of average pollution levels over a period of weeks or months. The sampler consists of a small plastic tube with an absorbent material packed at one end. Different absorbent materials are used for measuring different gases and the level of pollution can be found by analysing the material after the tube has been exposed for the desired period.
The low cost per tube permits sampling at a number of positions in the area of interest. Comparisons of NO_2 diffusion tube measurements with simultaneous measurements from an automatic analyser found that the diffusion tubes tended to overestimate ambient NO_2 by approximately 10%. The relationship is not linear and is dependant upon location and meteorology.

AUTOMATIC REAL-TIME CONTINUOUS ANALYSERS.

These produce high resolution measurements for pollutants such as Ozone, oxides of nitrogen, sulphur dioxide, carbon monoxide and particles. Methods used include a variety of spectroscopic methods such as infra-red or ultra-violet absorption, ultra-violet fluorescence, chemiluminescence, or for particles, a variety of sophisticated filtration techniques. Gas Chromatography analysers also provide high resolution data on benzene, 1,3-butadiene and other hydrocarbons The sample is drawn in and analysed on-line and in real-time. Data may be downloaded from the analyser remotely by modem.

This is the most expensive method of air quality monitoring routinely employed. It requires strict maintenance, operational and quality control procedures.

Air Pollution - What is being done

NATIONAL AND INTERNATIONAL ACTION TO REDUCE AIR POLLUTION.

Different sources of pollution are more important in some areas than others. Pollutants have the capacity to travel over large distances between towns and between countries and continents. Actions to reduce emissions must reflect this. In the UK the action that is being taken is summarised in the UK National Air Quality Strategy (NAQS). European protocols intended to reduce emissions of Long Range Transboundary Pollutants such as sulphur dioxide, hydrocarbons and nitrogen oxides have been brought into European Law. Other European standards have been set to reduce the emissions from new vehicles sold within the EU. This includes not only the installation of catalytic converters on all new petrol vehicles sold since the start of 1993, but also a range of other measures affecting petrol vehicles and their fuels.

Nationally controls are exerted on industry by both local authorities and the Environment Agency under the Environmental Protection Act 1990. This brings about the principle of integrated pollution control where all pollutants from an industrial source are considered together and the requirement to control emissions using the best available technology not entailing excessive cost (BATNEEC)

LOCAL ACTION

The National Air Quality Strategy lays down a set of objectives for air pollution which should be achieved in areas by 2005. Local Authorities are now required to review and assess air quality in their area. If national and international measures are not thought to be sufficient to meet the agreed objective by 2005, the local authority must declare an air quality management area and devise an air quality management plan following local consultation.

INDIVIDUAL ACTION

Decisions that we take about the way we use energy and other products have a direct impact on air pollution. Since energy costs money reducing pollution can save money.

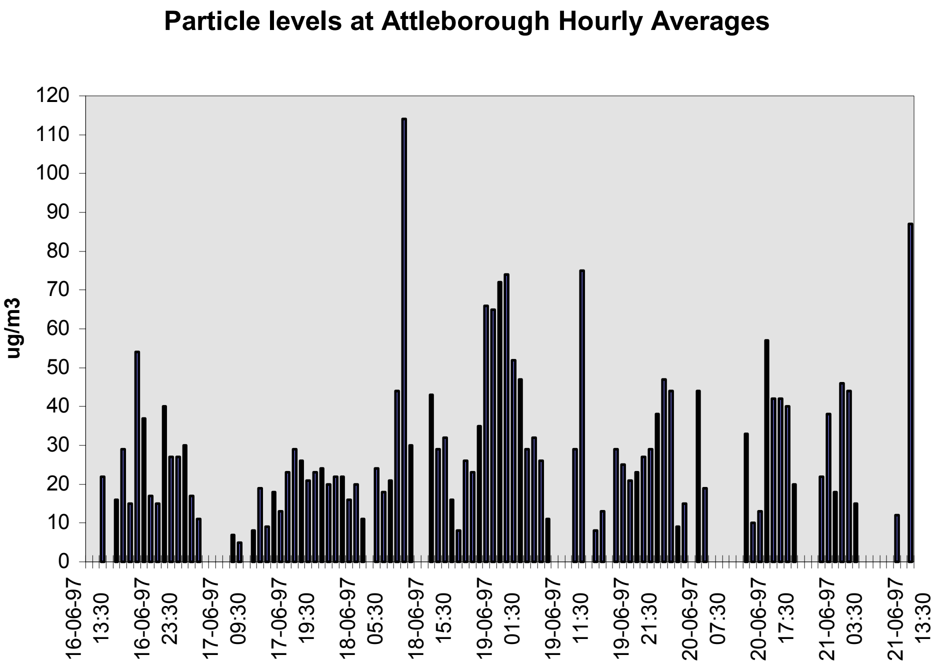
Results summarised

The results of monitoring within the County of Norfolk generally show that air quality is quite good. Locally there are some hot spots and Ozone levels do exceed the 50ppb level on some hot still days. Little monitoring has been done on PM_{10} levels within Norfolk, although guidance from the DETR suggests that there is likely to be a problem in Eastern England.

The reviews being undertaken by each local authority of air quality within their areas will look in more detail at the whole issue of individual pollutants.

Results in detail

The following pages give detailed results of monitoring carried out within each local authority area.


Particle levels at Attleborough Hourly Averages
ug/m3
0
10
20
30
40
50
60
70
80
90
100
110
120
16-06-97 13:30
16-06-97 23:30
17-06-97 09:30
17-06-97 19:30
18-06-97 05:30
18-06-97 15:30
19-06-97 01:30
19-06-97 11:30
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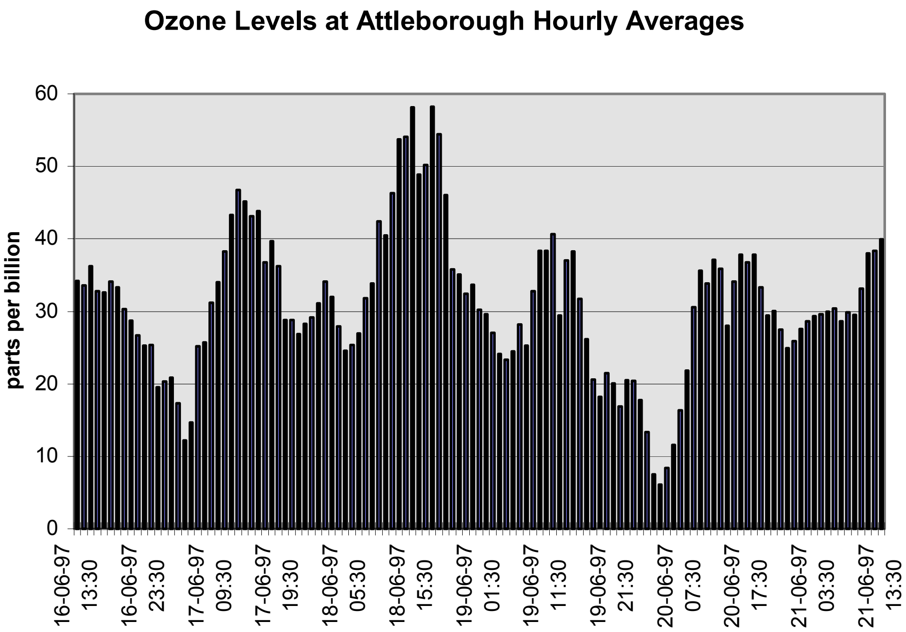
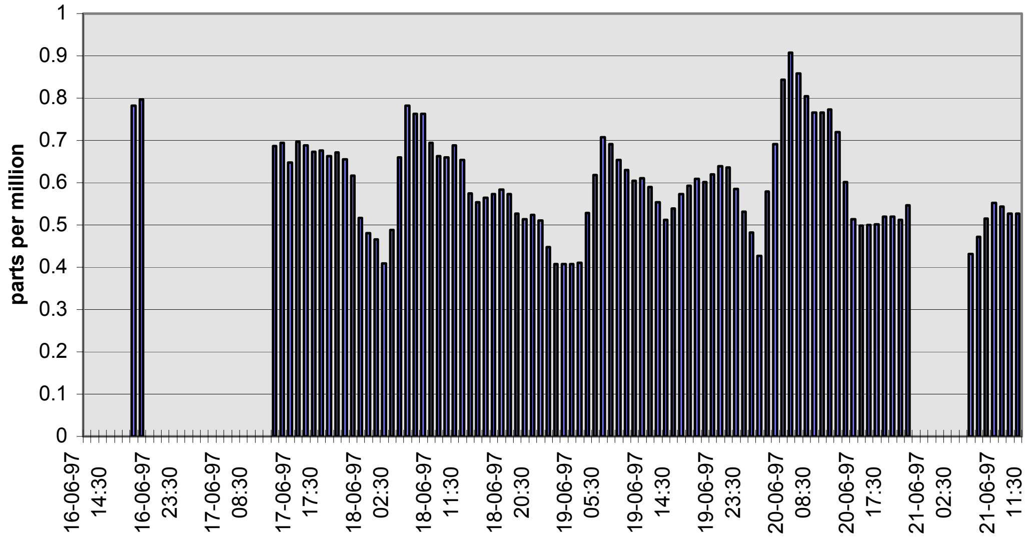
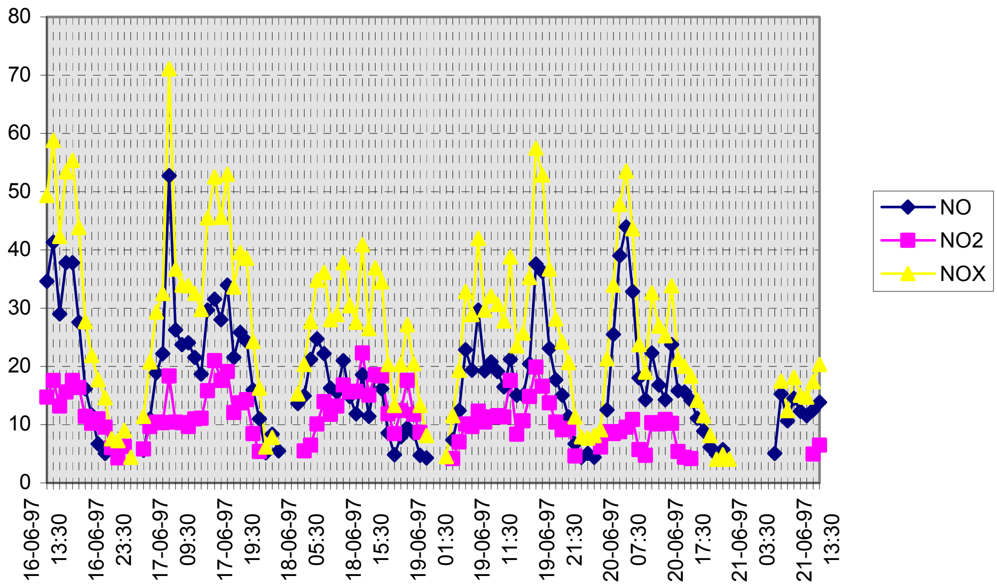
20-06-97 17:30
21-06-97 03:30
21-06-97 13:30

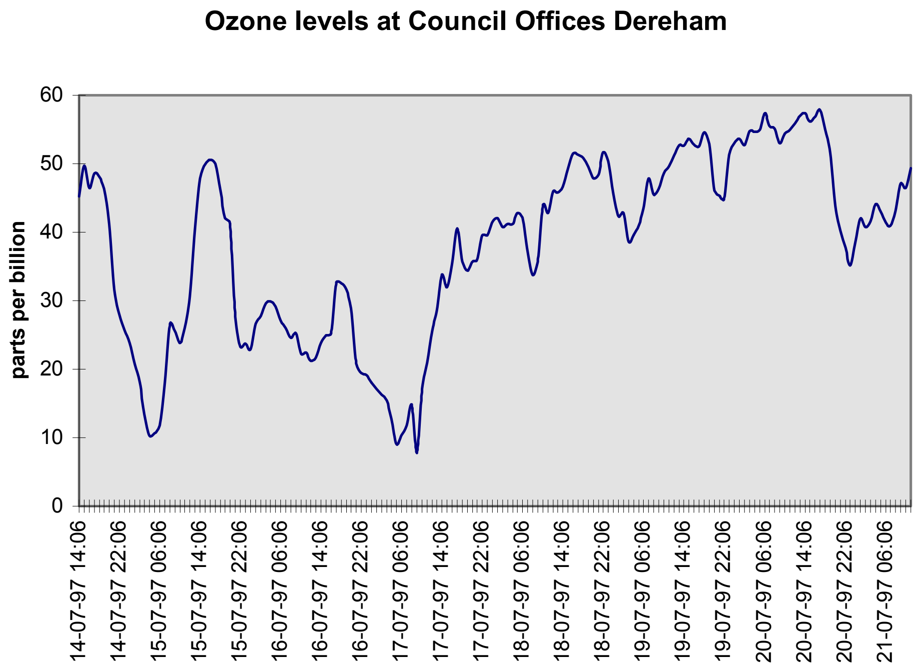

Ozone Levels at Attleborough Hourly Averages
parts per billion
0
10
20
30
40
50
60
16-06-97 13:30
16-06-97 23:30
17-06-97 09:30
17-06-97 19:30
18-06-97 05:30
18-06-97 15:30
19-06-97 01:30
19-06-97 11:30
19-06-97 21:30
20-06-97 07:30
20-06-97 17:30
21-06-97 03:30
21-06-97 13:30

Carbon Monoxide levels at Attleborough 8 hour running averages



Nox, NO2, NO at Attleborough Hourly Averages




Ozone levels at Council Offices Dereham
parts per billion
60
50
40
30
20
10
0
14-07-97 14:06
14-07-97 22:06
15-07-97 06:06
15-07-97 14:06
15-07-97 22:06
16-07-97 06:06
16-07-97 14:06
16-07-97 22:06
17-07-97 06:06
17-07-97 14:06
17-07-97 22:06
18-07-97 06:06
18-07-97 14:06
18-07-97 22:06
19-07-97 06:06
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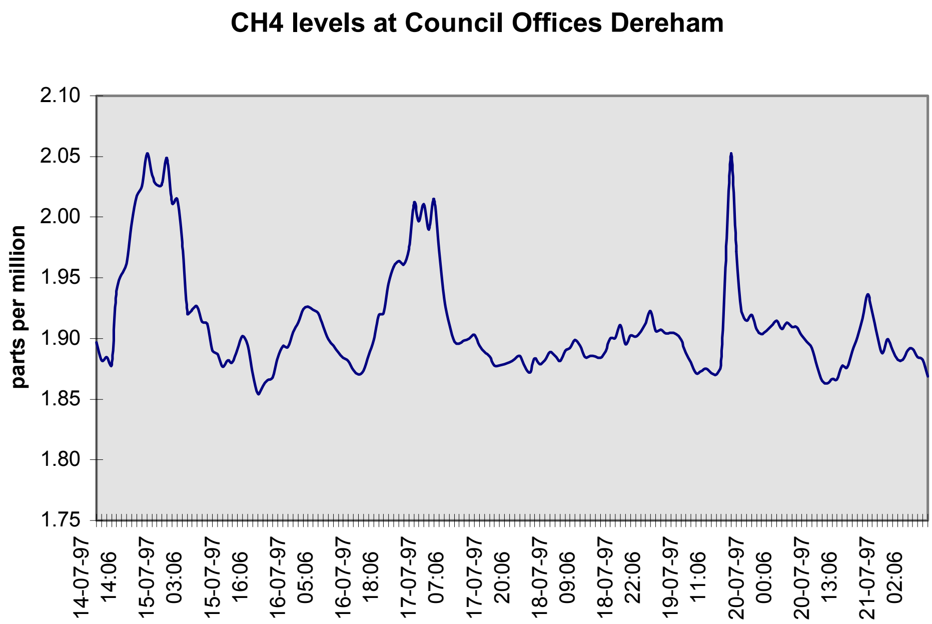
21-07-97 06:06


CH4 levels at Council Offices Dereham
parts per million
2.10
2.05
2.00
1.95
1.90
1.85
1.80
1.75
14-07-97 14:06
15-07-97 03:06
15-07-97 16:06
16-07-97 05:06
16-07-97 18:06
17-07-97 07:06
17-07-97 20:06
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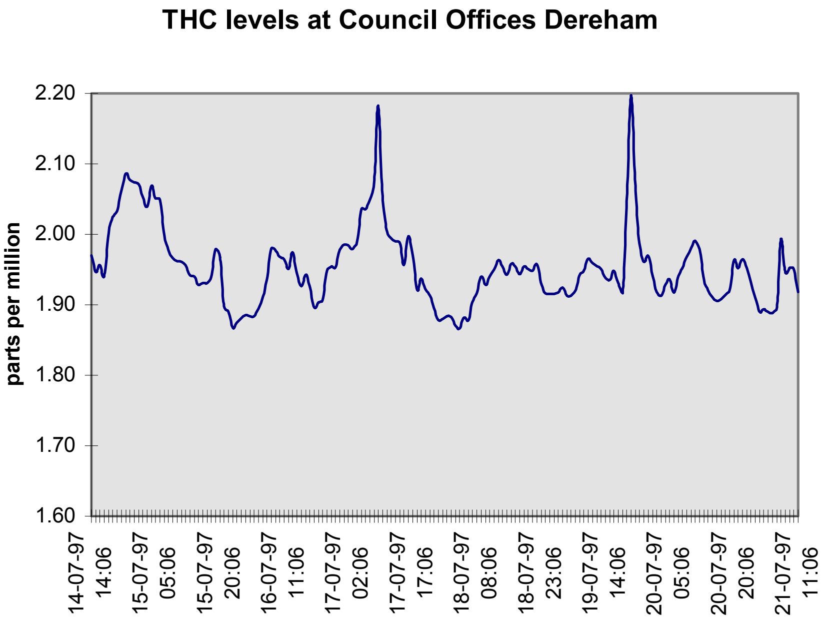
21-07-97 02:06


THC levels at Council Offices Dereham
parts per million
2.20
2.10
2.00
1.90
1.80
1.70
1.60
14-07-97
14:06
15-07-97
05:06
15-07-97
20:06
16-07-97
11:06
17-07-97
02:06
17-07-97
17:06
18-07-97
08:06
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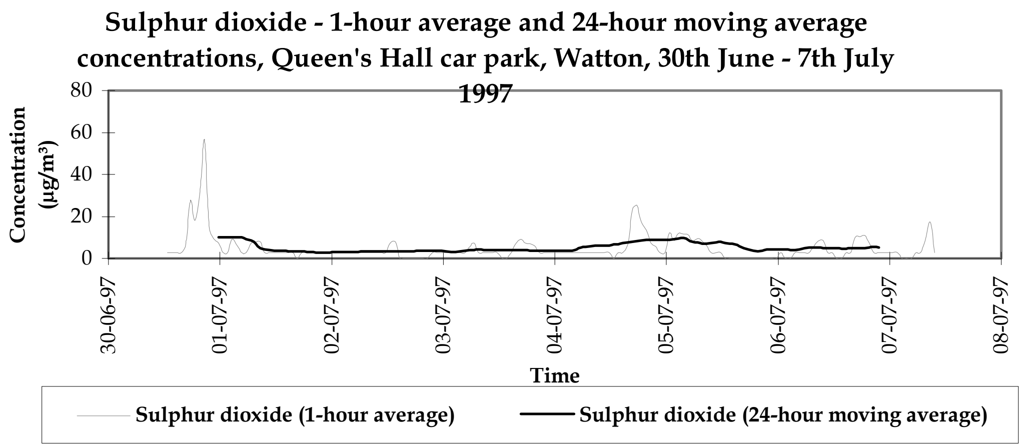
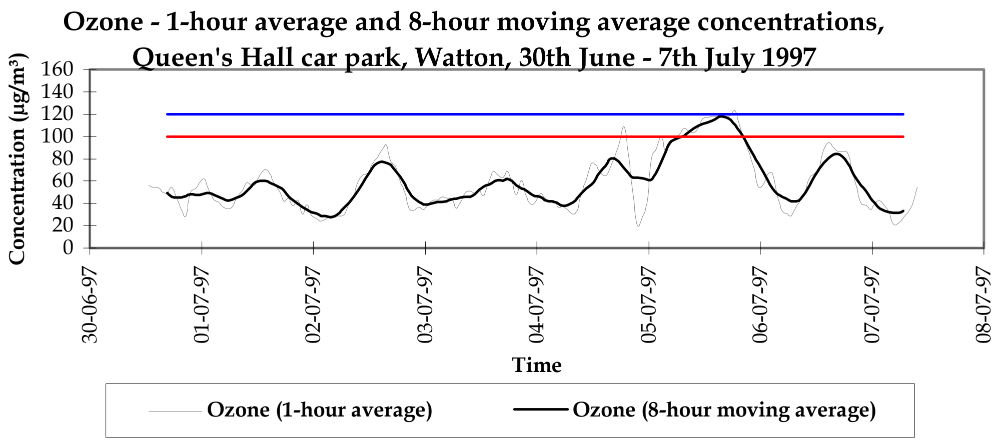
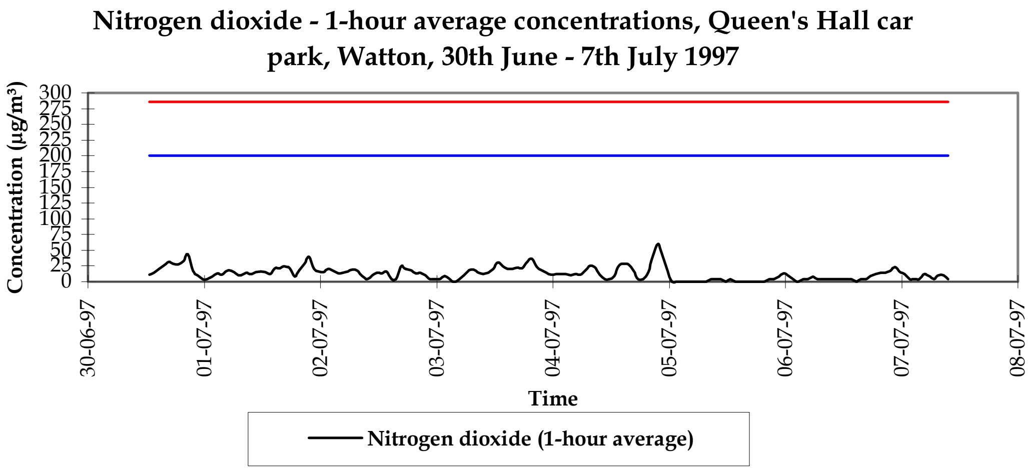
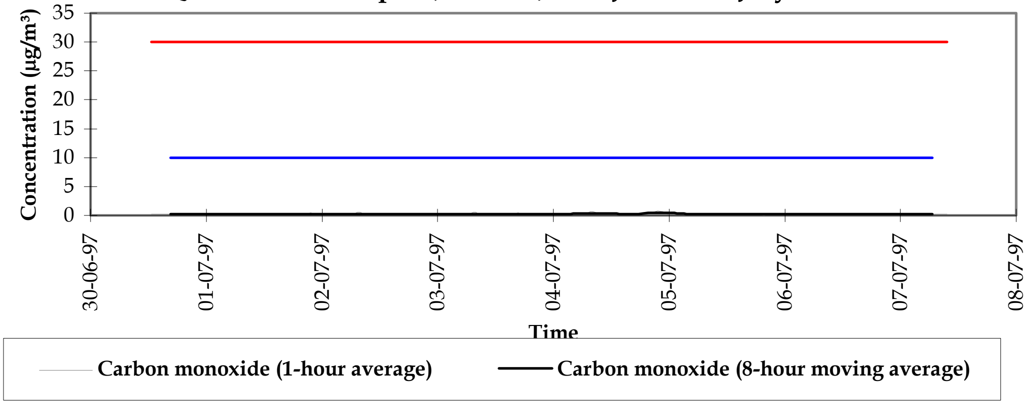
20:06
21-07-97
11:06


Sulphur dioxide - 1-hour average and 24-hour moving average concentrations, Queen's Hall car park, Watton, 30th June - 7th July 1997
Concentration (µg/m³)
80
60
40
20
0
30-06-97
01-07-97
02-07-97
03-07-97
04-07-97
05-07-97
06-07-97
07-07-97
08-07-97
Time
Sulphur dioxide (1-hour average)
Sulphur dioxide (24-hour moving average)

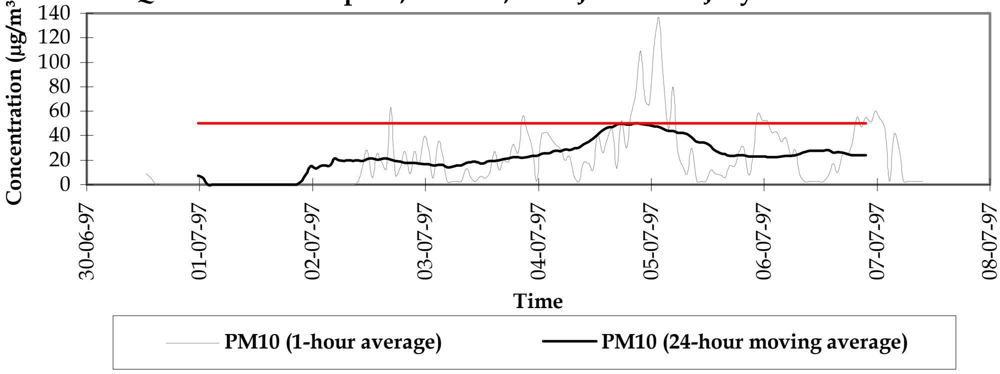

Ozone - 1-hour average and 8-hour moving average concentrations, Queen's Hall car park, Watton, 30th June - 7th July 1997
Concentration (µg/m³)
160
140
120
100
80
60
40
20
0
30-06-97
01-07-97
02-07-97
03-07-97
04-07-97
05-07-97
06-07-97
07-07-97
08-07-97
Time
Ozone (1-hour average)
Ozone (8-hour moving average)


Nitrogen dioxide - 1-hour average concentrations, Queen's Hall car park, Watton, 30th June - 7th July 1997
Concentration (µg/m³)
300
275
250
225
200
175
150
125
100
75
50
25
0
30-06-97
01-07-97
02-07-97
03-07-97
04-07-97
05-07-97
06-07-97
07-07-97
08-07-97
Time
Nitrogen dioxide (1-hour average)

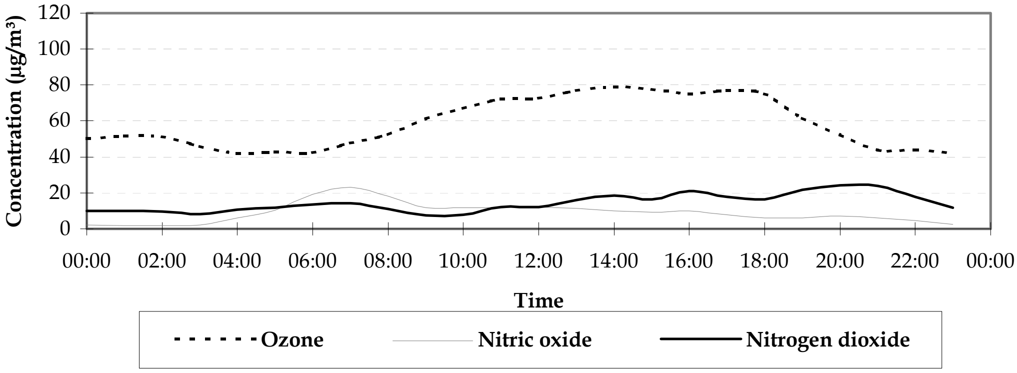
Carbon monoxide - 1-hour average and 8-hour average concentrations, Queen's Hall car park, Watton, 30th June - 7th July 1997



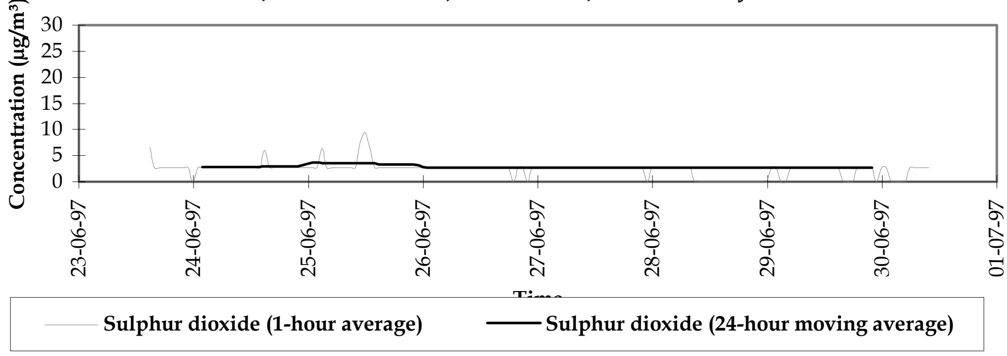
PM10 - 1-hour average and 24-hour moving average concentrations, Queen's Hall car park, Watton, 30th June - 7th July 1997



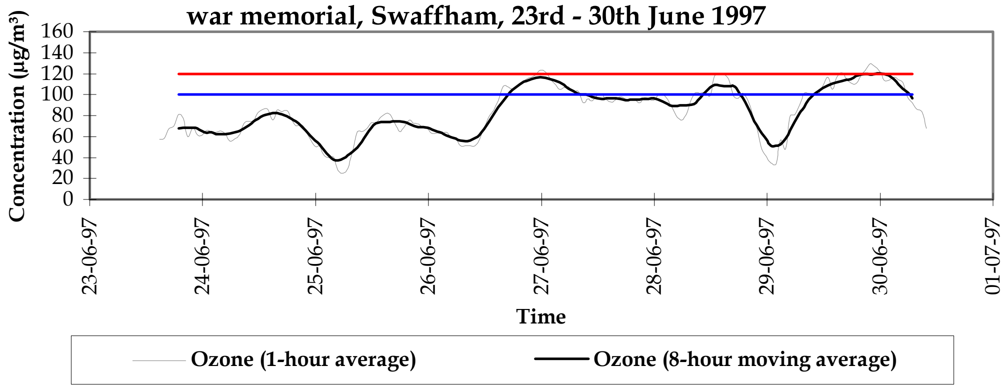
Mean diurnal concentrations of ozone, nitric oxide and nitrogen dioxide, Queen's Hall car park, Watton, 30th June - 7th July 1997



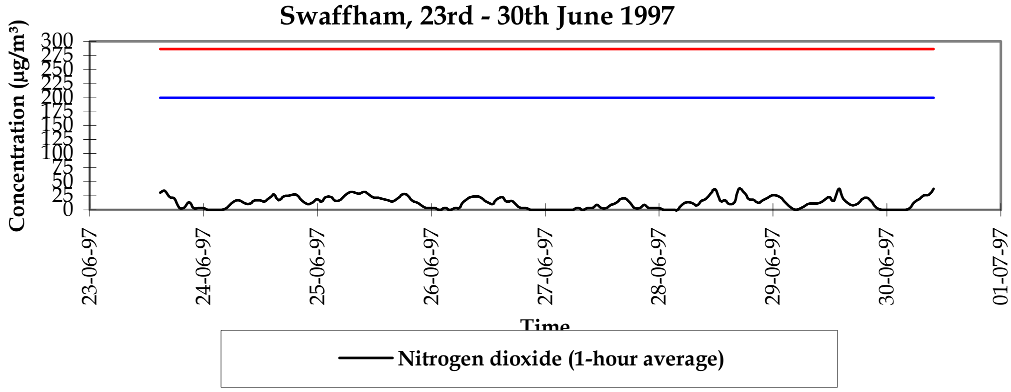
Sulphur dioxide - 1-hour average and 24-hour moving average concentrations, war memorial, Swaffham, 23rd - 30th June 1997



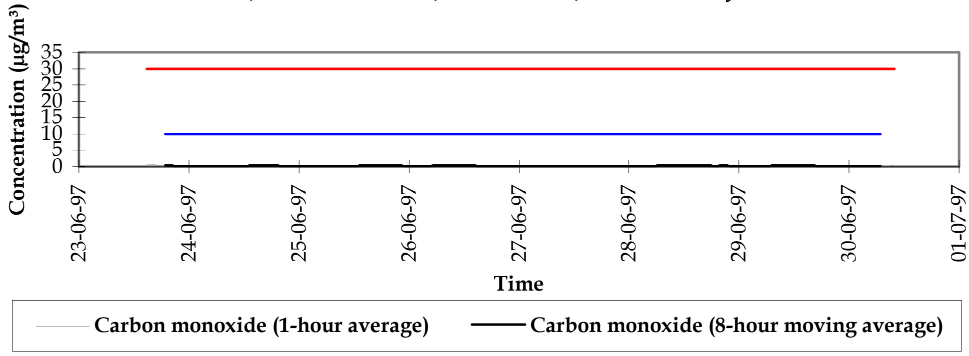
Ozone - 1-hour average and 8-hour moving average concentrations, war memorial, Swaffham, 23rd - 30th June 1997



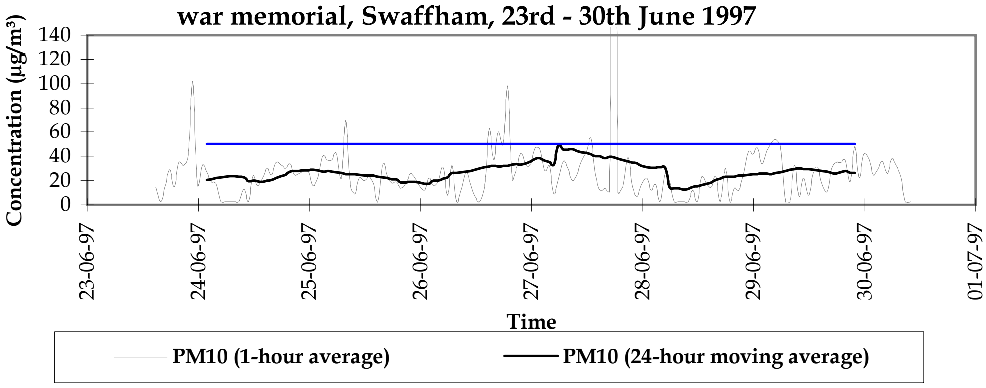
Nitrogen dioxide - 1-hour average concentrations, war memorial, Swaffham, 23rd - 30th June 1997



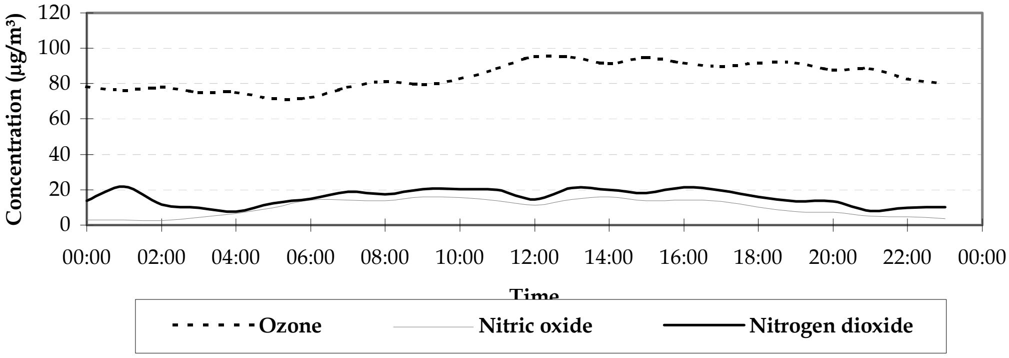
Carbon monoxide - 1-hour average and 8-hour moving average concentrations, war memorial, Swaffham, 23rd - 30th June 1997



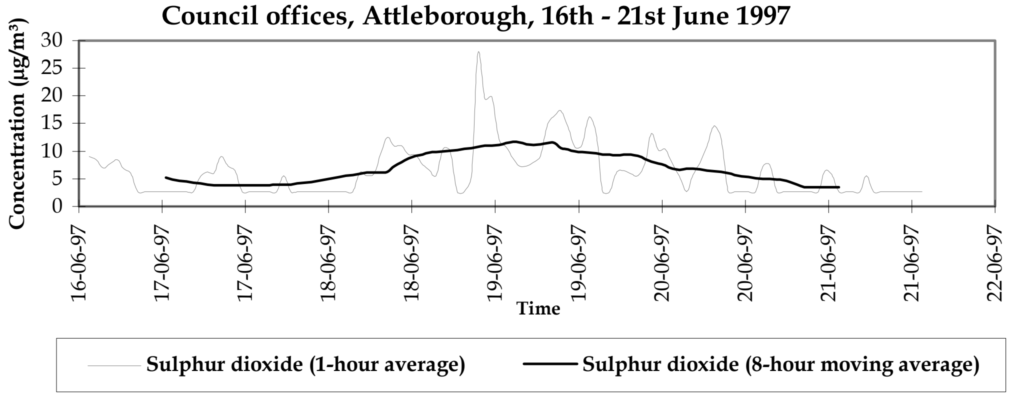
PM10 - 1-hour average and 24-hour moving average concentrations, war memorial, Swaffham, 23rd - 30th June 1997



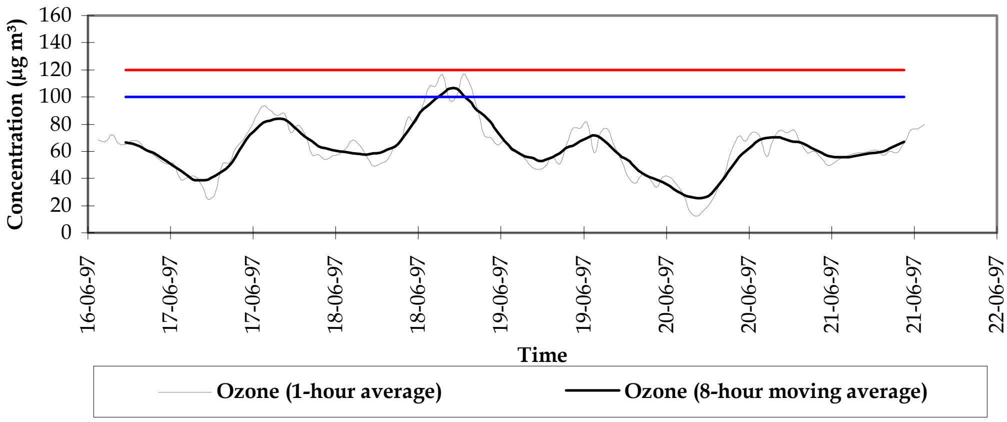
Mean diurnal concentrations of ozone, nitric oxide and nitrogen dioxide, war memorial, Swaffham, 23rd - 30th June 1997



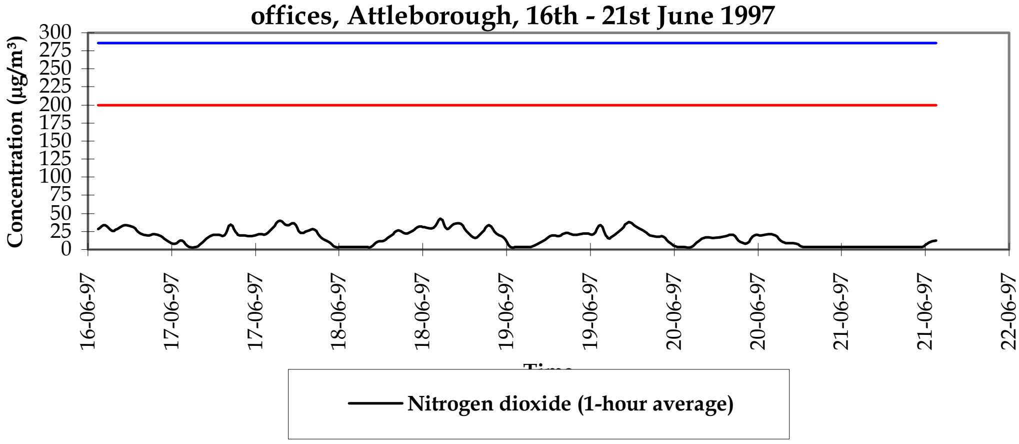
Sulphur dioxide - 1-hour average and 24-hour moving average, former Council offices, Attleborough, 16th - 21st June 1997

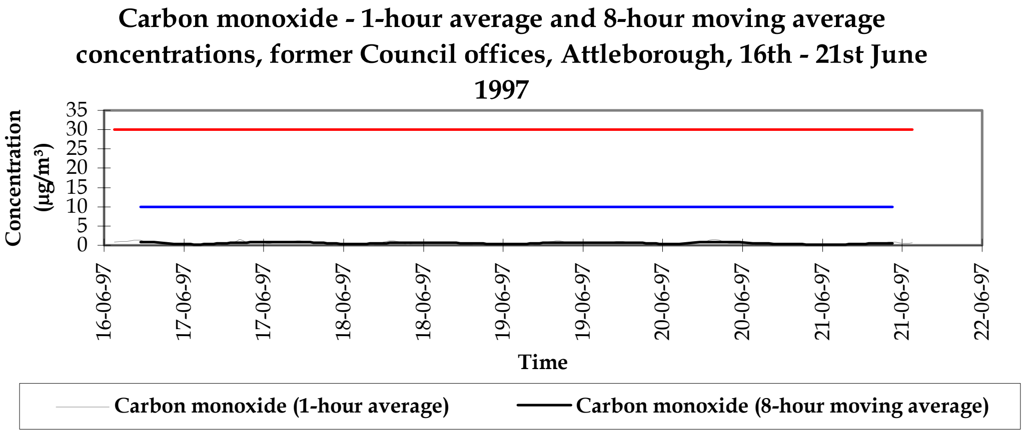


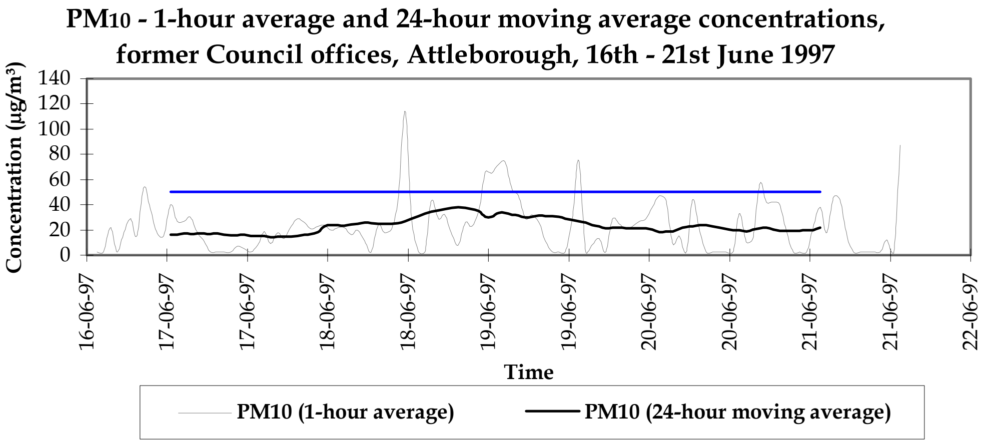
Ozone - 1-hour average and 8-hour moving average concentrations, former Council offices, Attleborough, 16th - 21st June 1997

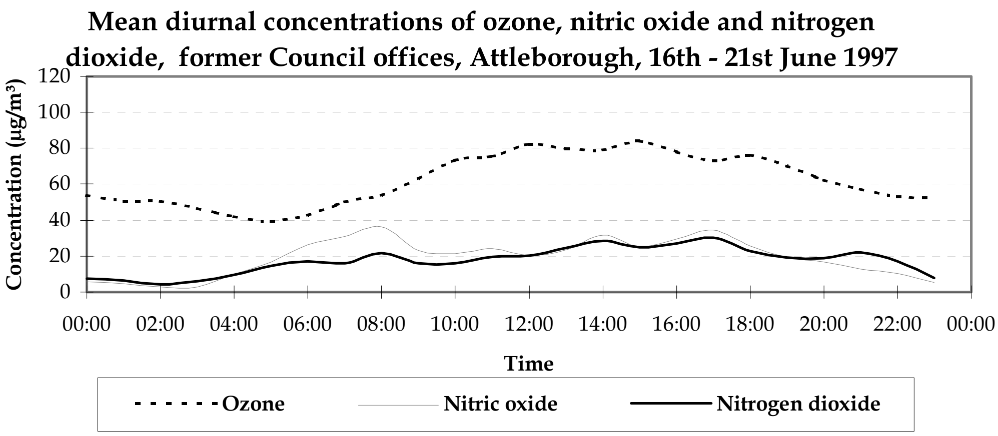


Nitrogen dioxide - 1-hour average concentrations, former Council offices, Attleborough, 16th - 21st June 1997

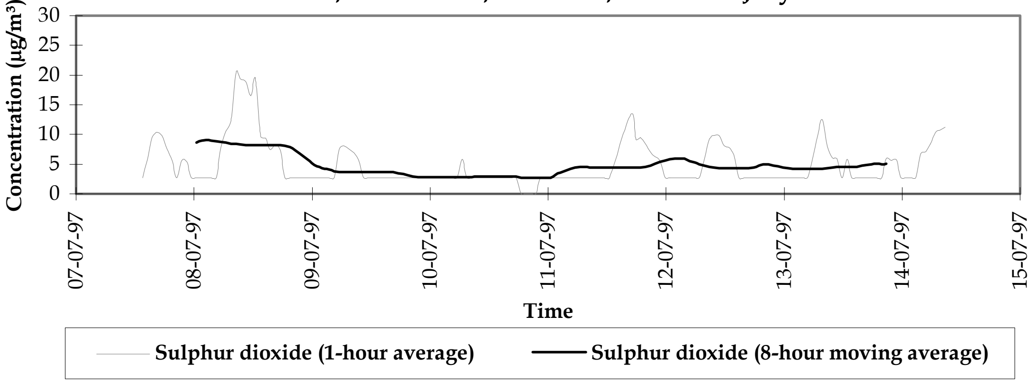



Carbon monoxide - 1-hour average and 8-hour moving average concentrations, former Council offices, Attleborough, 16th - 21st June 1997
Concentration (µg/m³)
35
30
25
20
15
10
5
0
16-06-97
17-06-97
17-06-97
18-06-97
18-06-97
19-06-97
19-06-97
20-06-97
20-06-97
21-06-97
21-06-97
22-06-97
Time
Carbon monoxide (1-hour average)
Carbon monoxide (8-hour moving average)

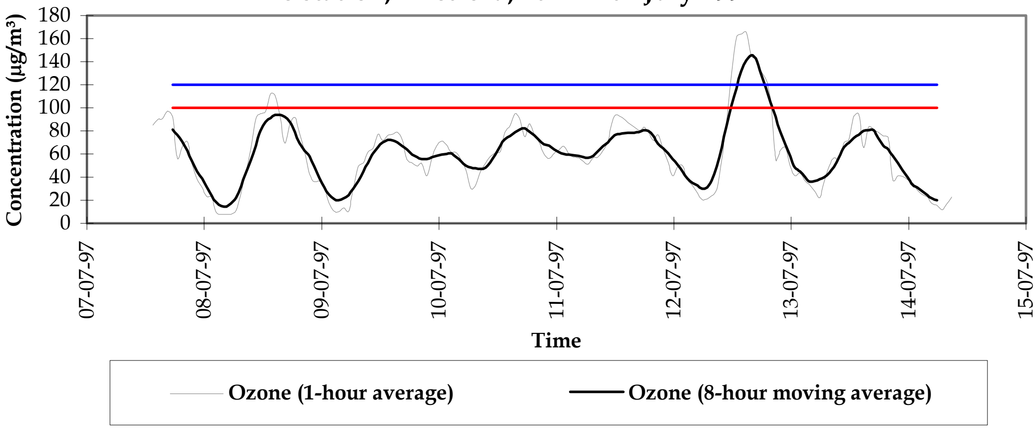

PM10 - 1-hour average and 24-hour moving average concentrations, former Council offices, Attleborough, 16th - 21st June 1997
Concentration (µg/m³)
140
120
100
80
60
40
20
0
16-06-97
17-06-97
17-06-97
18-06-97
18-06-97
19-06-97
19-06-97
20-06-97
20-06-97
21-06-97
21-06-97
22-06-97
Time
PM10 (1-hour average)
PM10 (24-hour moving average)


Mean diurnal concentrations of ozone, nitric oxide and nitrogen dioxide, former Council offices, Attleborough, 16th - 21st June 1997
Concentration (µg/m³)
120
100
80
60
40
20
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
Time
Ozone
Nitric oxide
Nitrogen dioxide

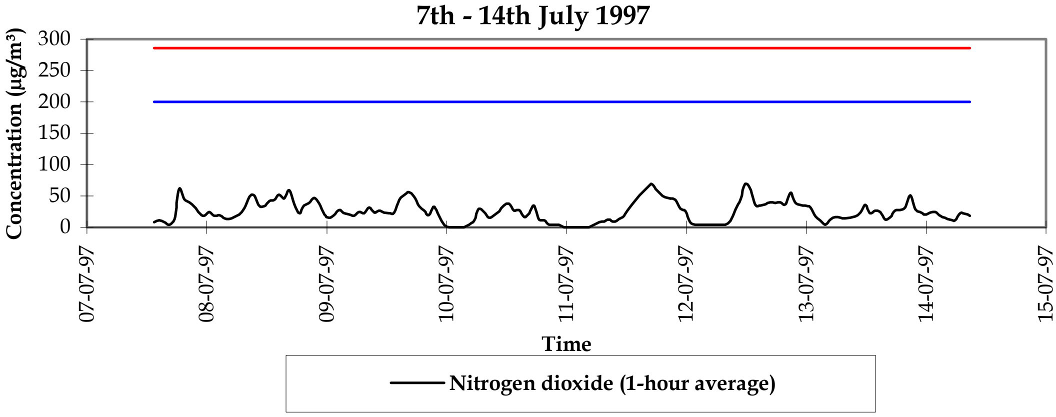
Sulphur dioxide - 1-hour average and 24-hour moving average concentrations, fire station, Thetford, 7th - 14th July 1997

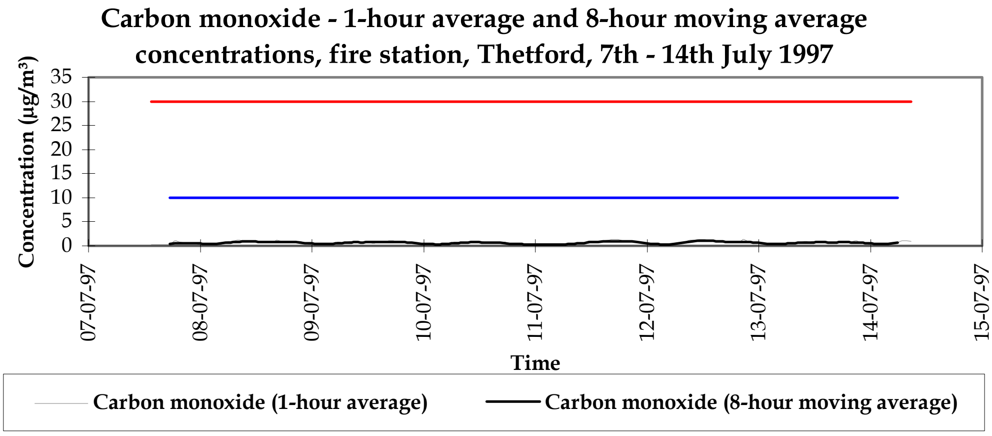


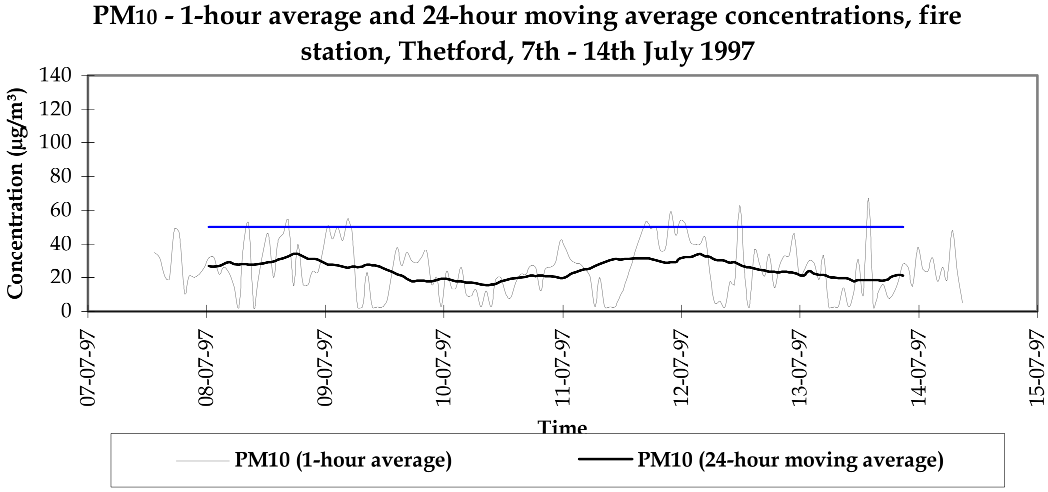
Ozone - 1-hour average and 8-hour moving average concentrations, fire station, Thetford, 7th - 14th July 1997

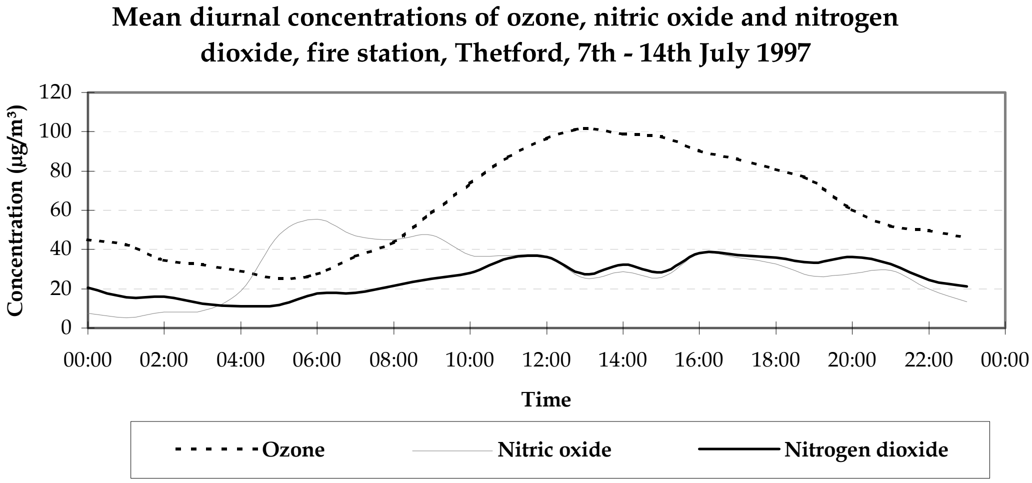


Nitrogen dioxide - 1-hour average concentrations, fire station, Thetford, 7th - 14th July 1997



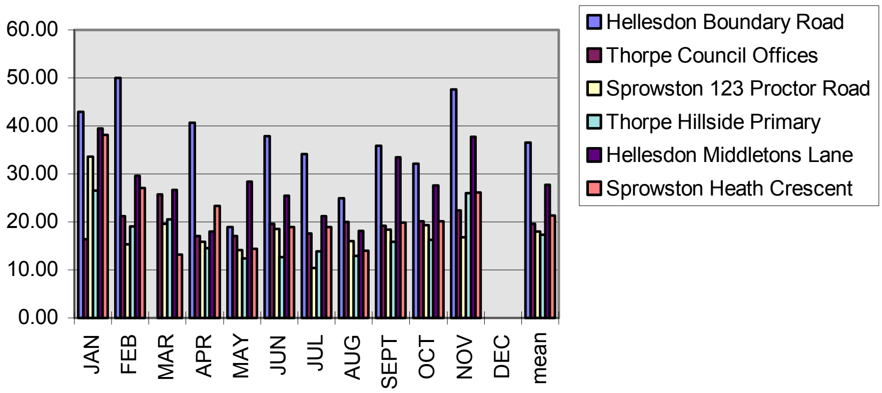

Carbon monoxide - 1-hour average and 8-hour moving average concentrations, fire station, Thetford, 7th - 14th July 1997
Concentration (µg/m³)
35
30
25
20
15
10
5
0
07-07-97
08-07-97
09-07-97
10-07-97
11-07-97
12-07-97
13-07-97
14-07-97
15-07-97
Time
Carbon monoxide (1-hour average)
Carbon monoxide (8-hour moving average)

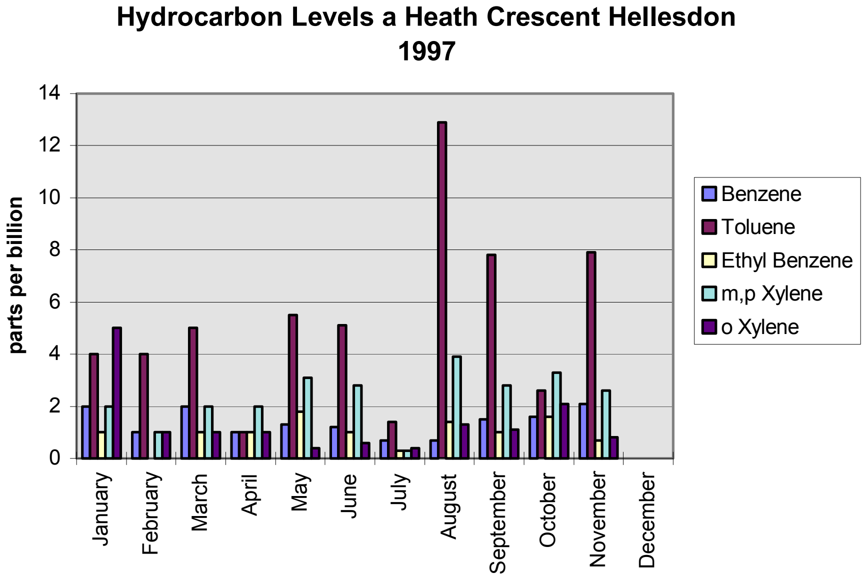

PM10 - 1-hour average and 24-hour moving average concentrations, fire station, Thetford, 7th - 14th July 1997
Concentration (µg/m³)
140
120
100
80
60
40
20
0
07-07-97
08-07-97
09-07-97
10-07-97
11-07-97
12-07-97
13-07-97
14-07-97
15-07-97
Time
PM10 (1-hour average)
PM10 (24-hour moving average)


Mean diurnal concentrations of ozone, nitric oxide and nitrogen dioxide, fire station, Thetford, 7th - 14th July 1997
Concentration (µg/m³)
120
100
80
60
40
20
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
Time
Ozone
Nitric oxide
Nitrogen dioxide

Broad land DC

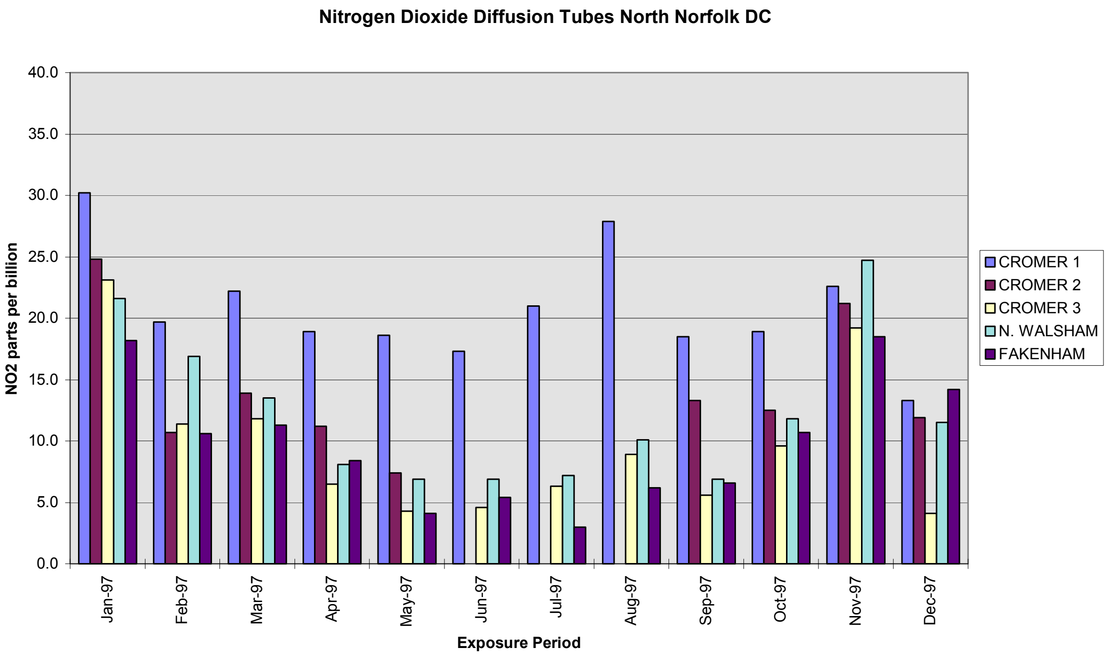
Nitrogen Dioxide

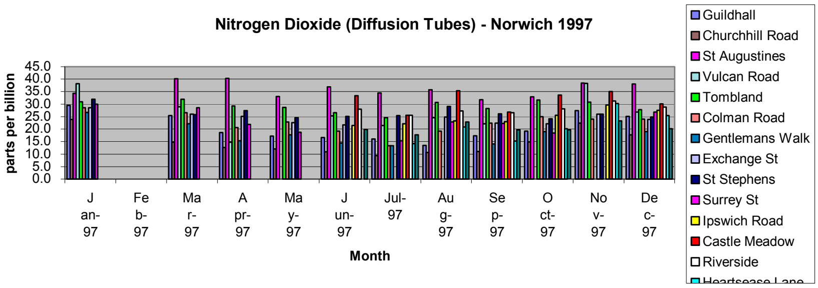


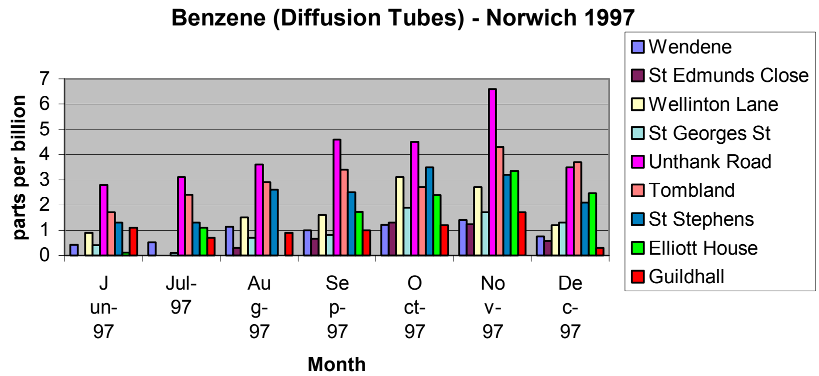


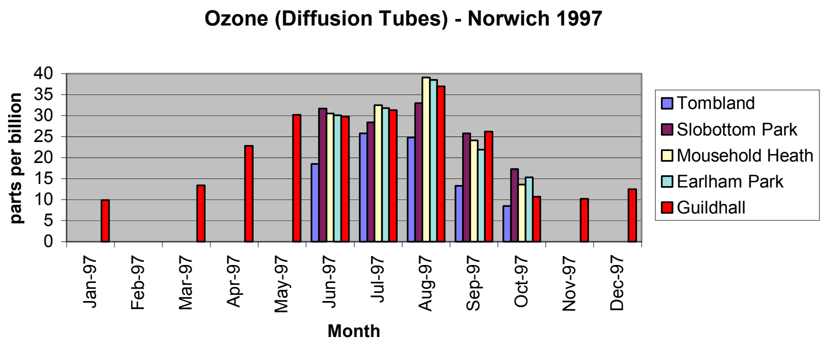
North Norfolk DC

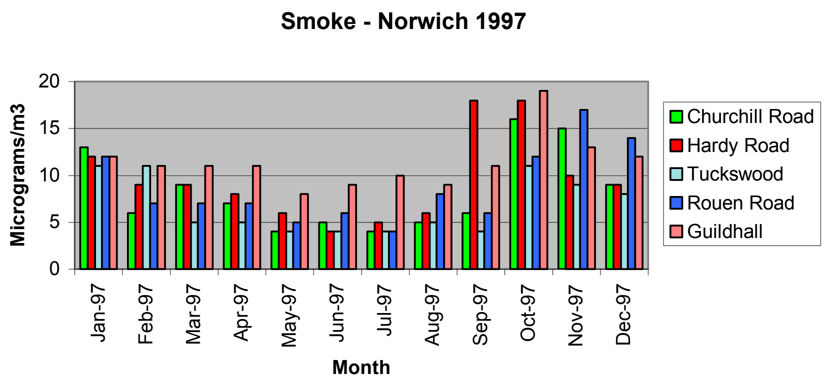
Nitrogen Dioxide levels

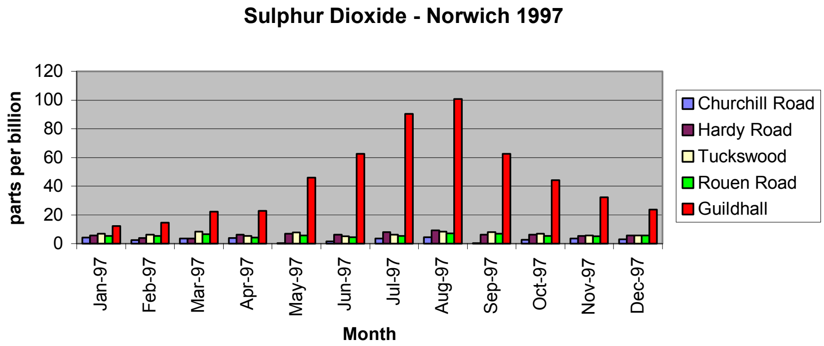



Nitrogen Dioxide (Diffusion Tubes) - Norwich 1997
parts per billion
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Sep-97
Oct-97
Nov-97
Dec-97
Month
Guildhall
Churchhill Road
St Augustines
Vulcan Road
Tombland
Colman Road
Gentlemans Walk
Exchange St
St Stephens
Surrey St
Ipswich Road
Castle Meadow
Riverside

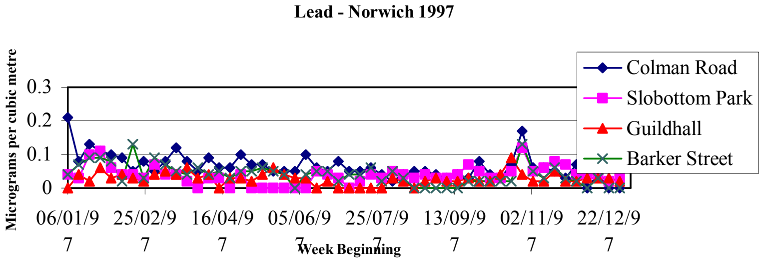

Benzene (Diffusion Tubes) - Norwich 1997
parts per billion
7
6
5
4
3
2
1
0
Jun-97
Jul-97
Aug-97
Sep-97
Oct-97
Nov-97
Dec-97
Month
Wendene
St Edmunds Close
Wellinton Lane
St Georges St
Unthank Road
Tombland
St Stephens
Elliott House
Guildhall


Ozone (Diffusion Tubes) - Norwich 1997
parts per billion
40
35
30
25
20
15
10
5
0
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Sep-97
Oct-97
Nov-97
Dec-97
Month
Tombland
Slobottom Park
Mousehold Heath
Earlham Park
Guildhall


Smoke - Norwich 1997
Micrograms/m3
20
15
10
5
0
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Sep-97
Oct-97
Nov-97
Dec-97
Month
Churchill Road
Hardy Road
Tuckswood
Rouen Road
Guildhall

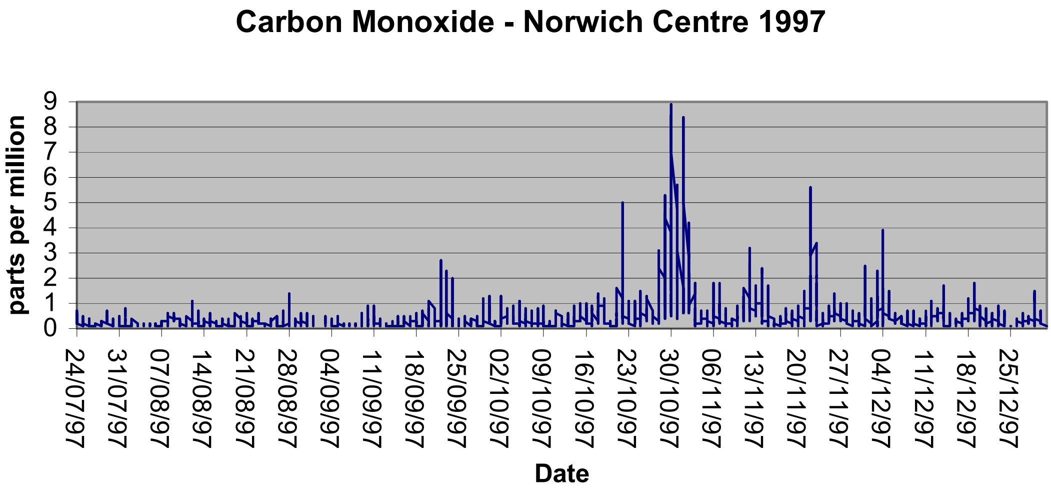


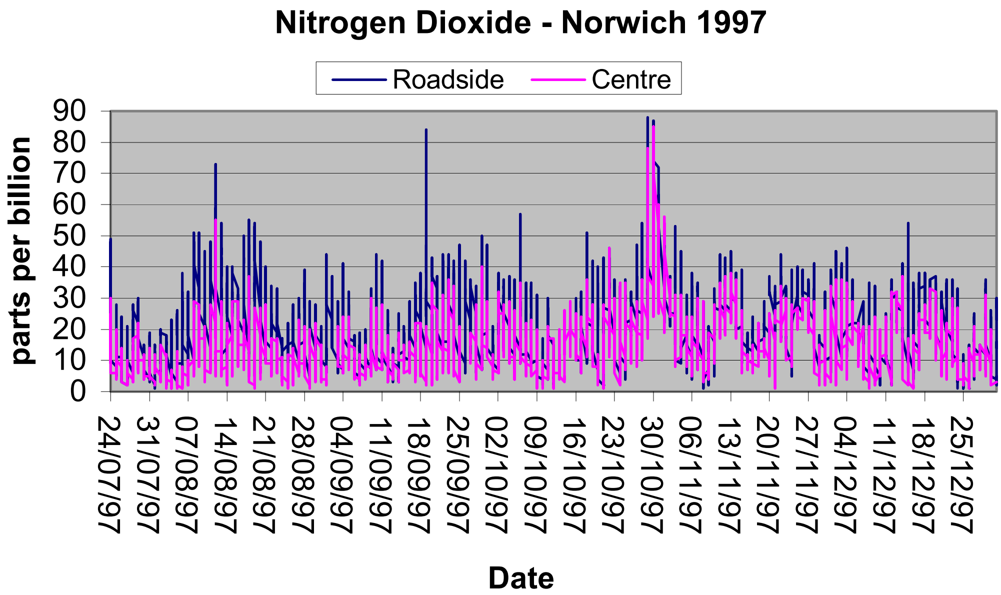
Sulphur Dioxide - Norwich 1997
parts per billion
0
20
40
60
80
100
120
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Sep-97
Oct-97
Nov-97
Dec-97
Month
Churchill Road
Hardy Road
Tuckswood
Rouen Road
Guildhall

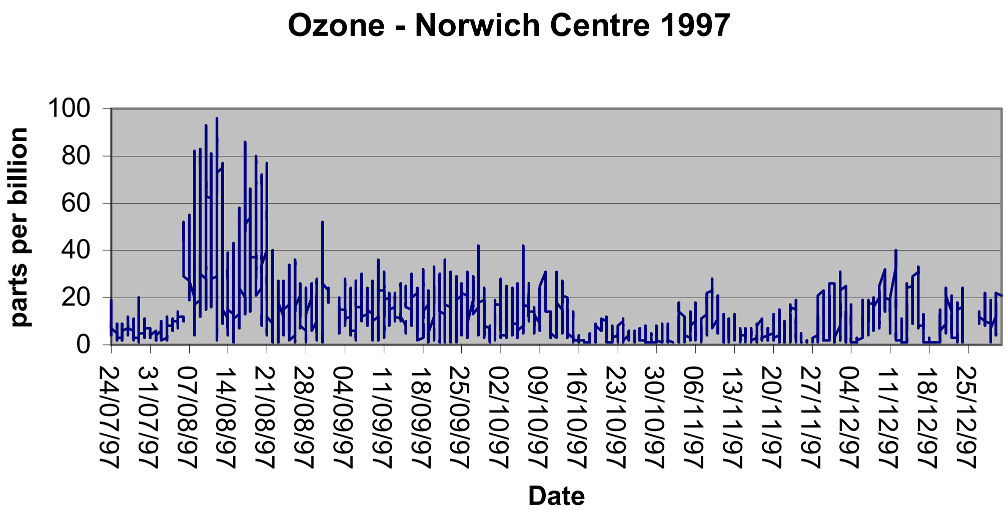


Lead - Norwich 1997
Micrograms per cubic metre
0
0.1
0.2
0.3
06/01/97
25/02/97
16/04/97
05/06/97
25/07/97
13/09/97
02/11/97
22/12/97
Week Beginning
Colman Road
Slobottom Park
Guildhall
Barker Street

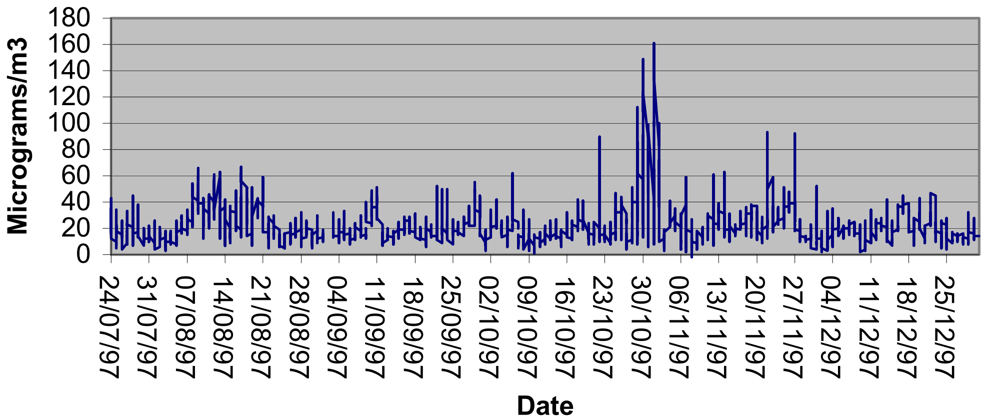
Norwich City Council Auto sites



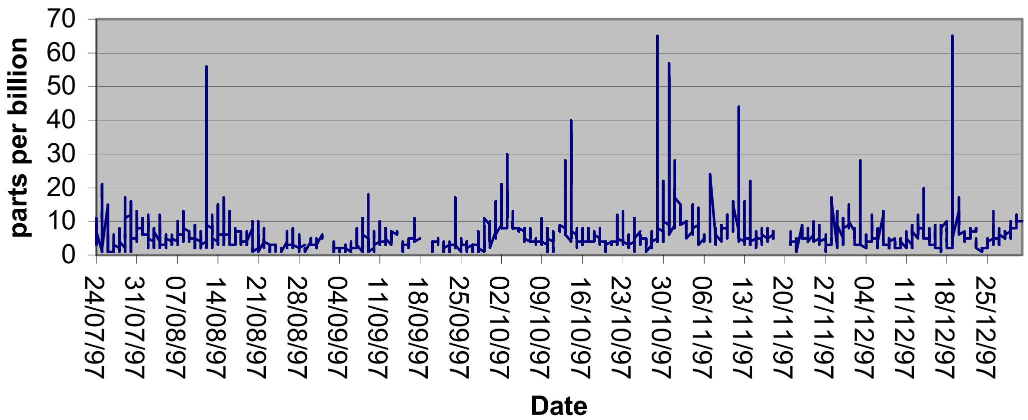


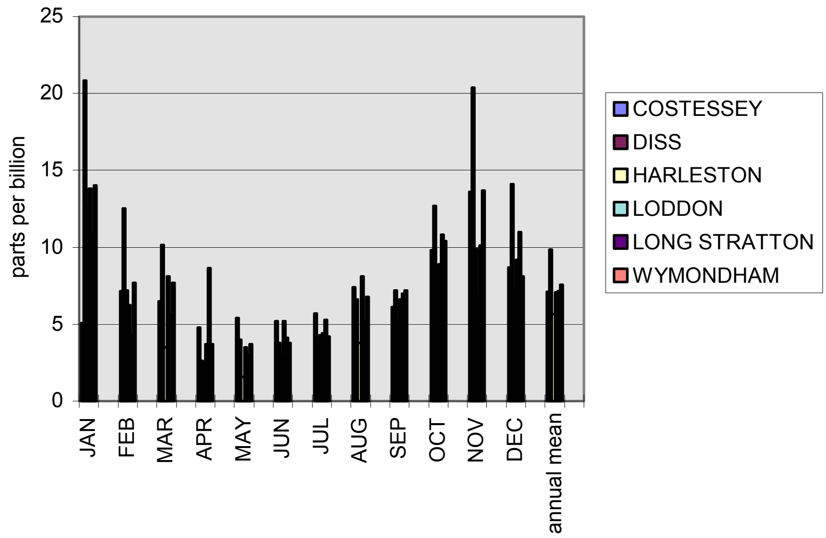


Fine Particles (PM10) - Norwich Centre 1997

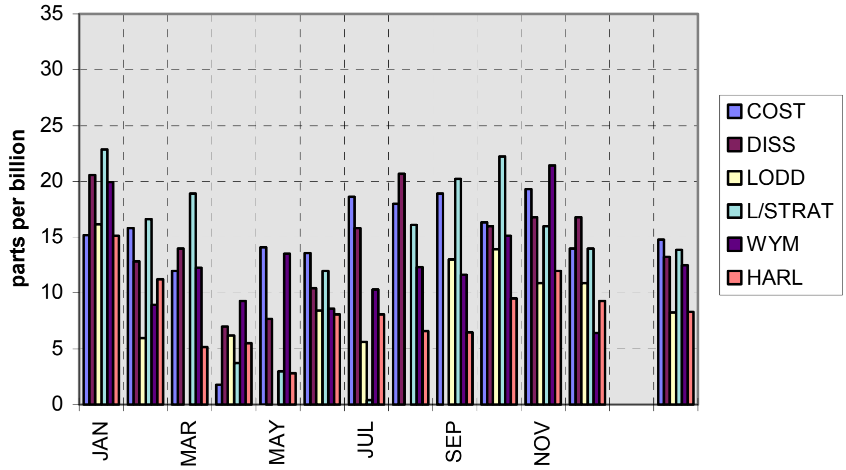


Sulphur Dioxide - Norwich Centre 1997

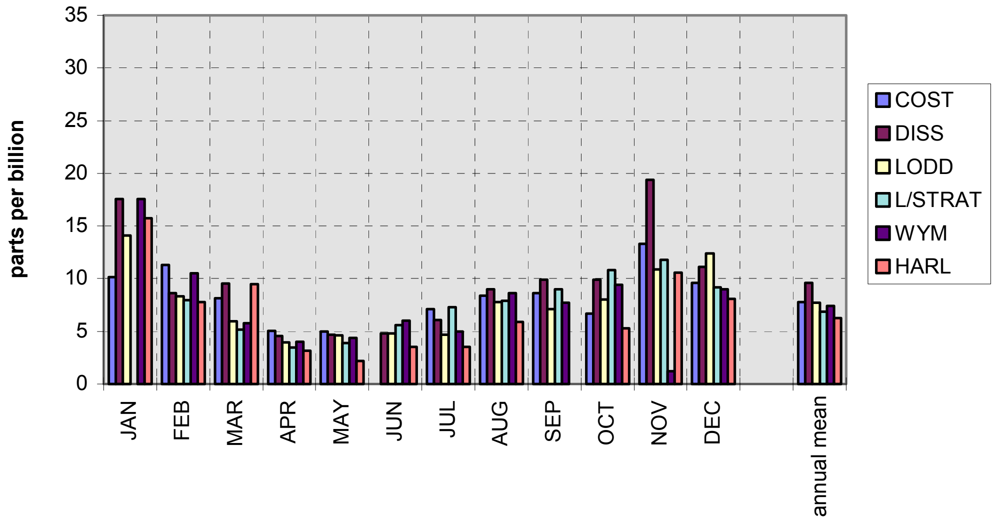




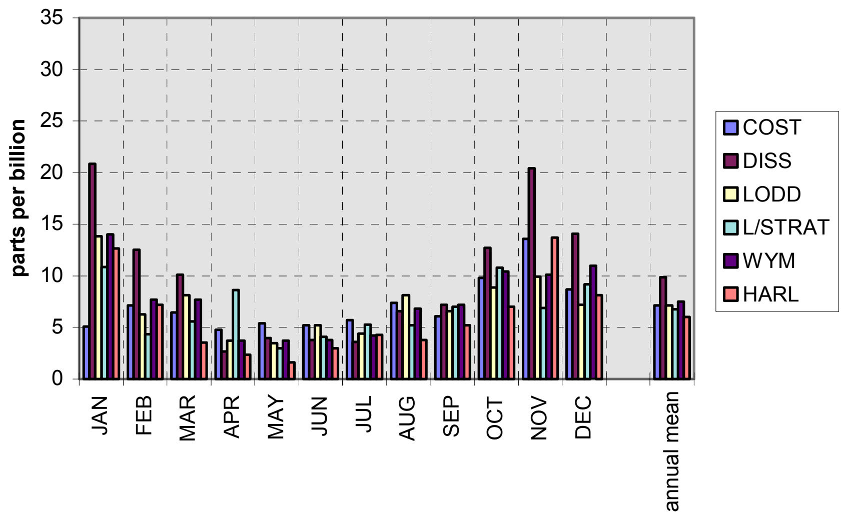
NO2 Diffusion tube results 1997 Near road sites (see key)



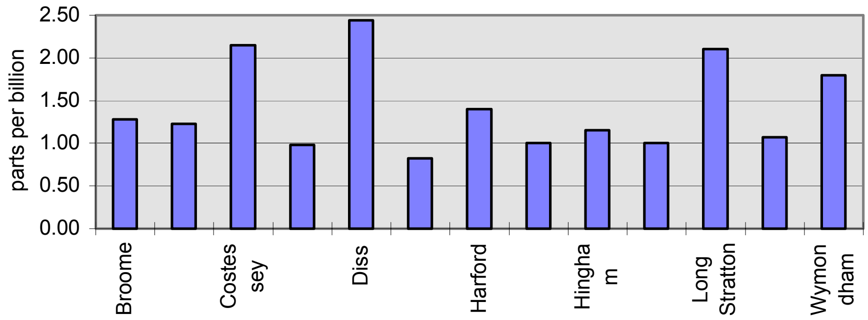
NO2 Diffusion tube results 1997 Intermediate sites (see key)

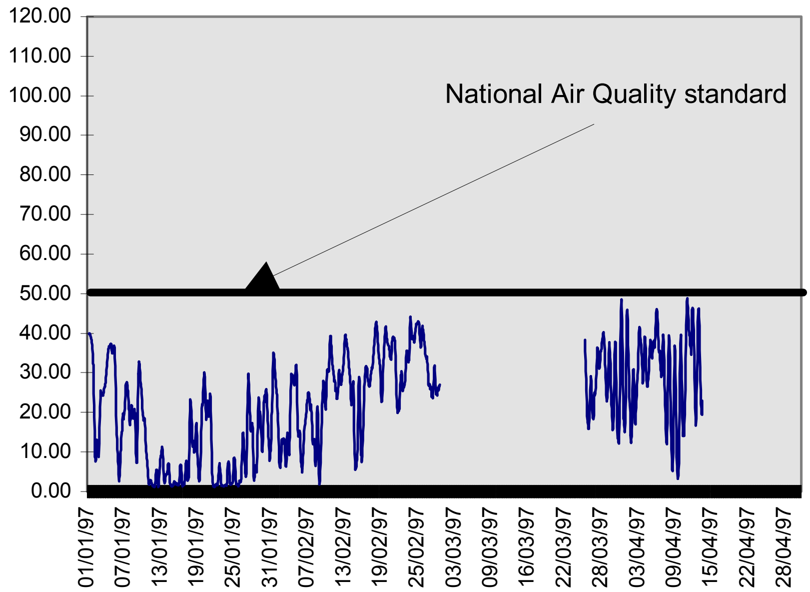


NO2 Diffusion tube results 1997 Remote sites (see key)



Annual average levels of Benzene 1997 in South Norfolk





120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
National Air Quality standard
01/01/97
07/01/97
13/01/97
19/01/97
25/01/97
31/01/97
07/02/97
13/02/97
19/02/97
25/02/97
03/03/97
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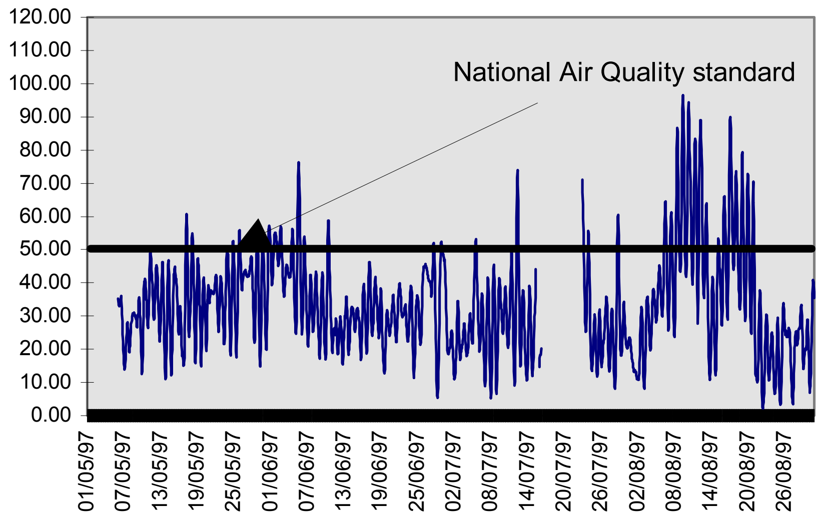
15/04/97
22/04/97
28/04/97



120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
National Air Quality standard
01/05/97
07/05/97
13/05/97
19/05/97
25/05/97
01/06/97
07/06/97
13/06/97
19/06/97
25/06/97
02/07/97
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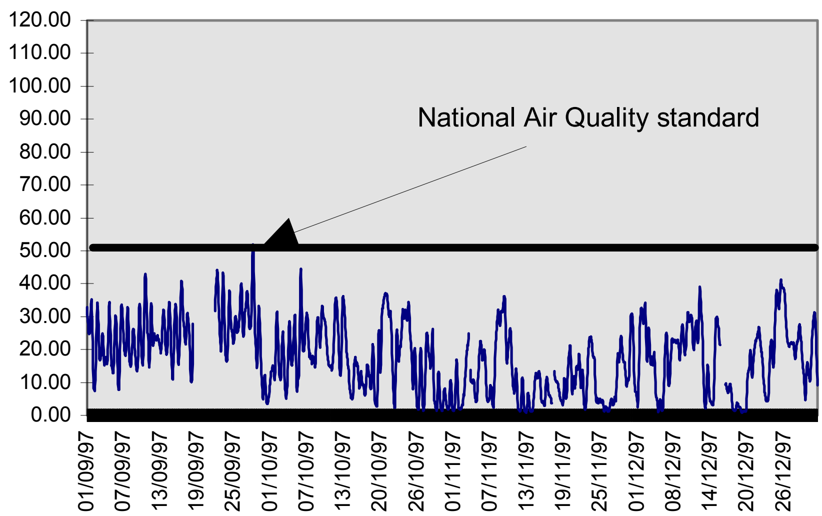
20/08/97
26/08/97



120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
National Air Quality standard
01/09/97
07/09/97
13/09/97
19/09/97
25/09/97
01/10/97
07/10/97
13/10/97
20/10/97
26/10/97
01/11/97
07/11/97
13/11/97
19/11/97
25/11/97
01/12/97
08/12/97
14/12/97
20/12/97
26/12/97

King's Lynn & West Norfolk BC