Ambient Air Monitoring

In

Drogheda

19th Febuary 2002 – 3rd January 2003

Contents

List of Figures

Summary

An assessment of air quality was carried out in Drogheda, Co. Louth from 19th Febuary 2002 until 3rd January 2003. Concentrations of carbon monoxide, nitrogen dioxide, sulphur dioxide, benzene and lead were below their respective lower assessment thresholds. The limit value for PM_{10} was not exceeded when the allowed margin of tolerance was taken into account. The limit value does not come into force until 2005. The directive allows the limit value for PM_{10} to be exceeded by a margin of tolerance which is defined as a percentage of the limit value which reduces at twelve monthly intervals to reach 0% on 1 January 2005.

	Below Lower Assessment Threshold	**Below Upper Assessment Threshold**	**Above Upper Assessment Threshold**	**Above Limit**
PM_{10}				
NO_2				
CO				
SO_2				
Benzene				
Pb				

Drogheda is in Zone C of the country. The implications of this assessment are that within Zone C (specified urban centres with populations in excess of 15,000).

- Levels of PM_{10} will need to be monitored continuously
- Levels of CO, SO_2, NO_2, benzene and lead can be assessed using modelling or objective estimation techniques.

The directive states that modelling or objective estimation techniques may be used to assess ambient air quality if levels of the pollutant in that zone are below the lower assessment threshold. Continuous monitoring is required if levels exceed the upper assessment threshold.

Introduction

The European Union introduced a new approach to the monitoring, assessment and management of air quality in 1996 when it introduced a framework directive on air quality (96/62/EC, 2nd September 1996). The basic principle of the framework directive is that each country should be divided into zones and that the monitoring, assessment, management and reporting of air quality will be undertaken in relation to these zones. For the purposes of the directive, Ireland has been divided into four zones; Dublin (Zone A), Cork Urban Area (Zone B), specified population centres > 15,000 inhabitants (Zone C) and non-urban areas (Zone D).

Limit values are set for each individual pollutant which need to be met by a specific attainment date. Upper and lower assessment thresholds are also set for each pollutant, assessment thresholds are levels below the limit value, used solely in the determination of the level of monitoring needed for that pollutant in a particular zone. The extent of monitoring in any zone is determined by population size and air quality status. Measurement is mandatory in agglomerations (population >250,000) and where concentrations are above the lower assessment threshold. The greatest monitoring effort applies if concentrations are above the upper assessment threshold. Less intensive monitoring is required when concentrations are between the two assessment thresholds.

Limit values, assessment thresholds, measurement techniques and other specifics for each pollutant are defined in a series of daughter directives. The first daughter directive was adopted in April 1999 (1999/30/EC) and covered SO_2, NO_X, particulate matter and lead. The second daughter directive was adopted in November 2000 (2000/69/EC) and covers CO and Benzene. The directives were transposed into Irish law as the Air Quality Standard Regulations 2002 (S.I. No. 271 of 2002).

To comply with the directive the Environmental Protection Agency uses mobile laboratories to carry out assessments in areas with no history of air pollution measurements. These trailers contained the following instruments:

- Dedicated monitoring instruments which continuously measure and record concentrations of the pollutants sulphur dioxide, nitrogen oxides and carbon monoxide.
- Particulate monitor which continuously measures and records the levels of particulate matter.
- Gas chromatograph which measures levels of benzene, toluene and xylene
- Sampler for particulate matter (the official method specified for this parameter by the EU commission involves collection of the particulate matter on a filter on site followed by laboratory determination of the filter's increase in weight).
- Sampler for lead and other metals in air (collection on filter for determination in the laboratory).
- Mini meteorological station for measuring and recording temperature, relative humidity, wind speed and direction.

The sample inlets are at a height of ~3m.

For further information please contact

John Finnan, Barbara O' Leary or Ciaran O' Donnell.

Time Period

The mobile laboratory was brought to Dundalk on 19th Febuary 2002. Monitoring continued until 3rd January 2003 when the trailer was removed.

Siting

The trailer was sited in the carpark of Drogheda Borough Council adjacent to Bolton Square. The offices are located less than 200m from the centre of the town and less than 200m from the busy N1 road in a mixed commercial/ residential district of the town.

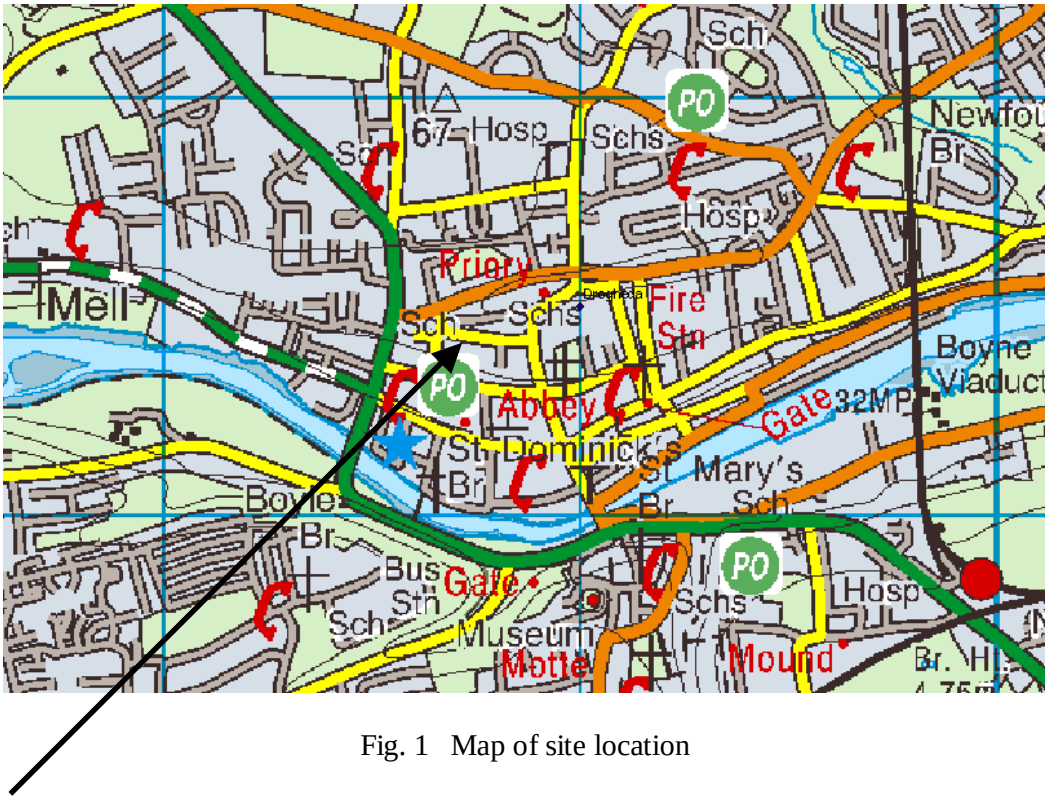


Fig. 1 Map of site location

Location of trailer

Monitoring Methods

Carbon Monoxide

Carbon monoxide was monitored using a Gas Filter Correlation CO Analyser (Model 300, Advanced Pollution Instrumentation, 6565 Nancy Ridge Drive, San Diego, California). This is a continuous analyser whose measurement technique is based on the absorption of infrared radiation by CO molecules at wavelengths near 4.7μm.

Sulphur Dioxide

Sulphur dioxide was monitored using an Advanced Pollution Instrumentation SO_2 Fluorescent Analyser - Model 100A. This is a continuous analyser which measures the fluorescence of SO_2 molecules after excitation by ultraviolet radiation.

Nitrogen Dioxide and Oxides of Nitrogen

NO_x species were monitored using an Advanced Pollution Instrumentation Chemiluminescent $NO/NO_2/NO_x$ Analyser - Model 200A. This is a continuous analyser which utilises the chemiluminescent reaction between nitric oxide in the sample and ozone to measure NO concentrations. Any NO_2 present is then reduced to NO by a molybdenum converter giving a second value for total NO_x concentration. The amount of NO_2 present is found by subtraction.

Particulate Matter

A gravimetric method was used to monitor PM_{10} particles (as defined in European Standard, prEN12341, July 1998, Central Secretariat, rue de Stassart, 36, B-1050 Brussels). An inertial impactor sampling head restricted the sampled particles to those with a diameter less than 10μm. The particles were collected on preweighed glassfibre filters (Whatman GF/A, 47mm). The filters were equilibrated at constant temperature and humidity (T = 293±1°K, R.H. = 50±3%) for at least 48 hours in a WTB Binder APT.Line KBF115 Climatic Chamber prior to weighing. An Ambient Dust Automatic Monitor (Model SM200CD with β source removed, OPSIS, S-24402, Furulund, Sweden) was used to control the airflow and change the filters daily at midnight.

Particulate matter was also measured using an OSIRIS Environmental Dust Monitor (Turnkey Instruments, 1&2 Dalby Court, Gadbrook Business Centre, Northwitch, Cheshire CW9 7TN). This instrument uses a light scattering technique to determine the concentration of airborne particles and dust; it is not an approved method. Results are given for total suspended particulates, PM_{10}, $PM_{2.5}$ and PM_1.

Benzene

Benzene was measured using a gas chromatograph (BTX Analyser GC855 supplied by Syntech Spectras, G. Meirstraat 11, 9728 TB Groningen, Nederland). This gas chromatograph samples automatically over a fifteen minute cycle and is equipped with a photoionisation detector.

Lead and Other Metals

Ambient air was pumped through a Metricel membrane filter (Gelman, 37mm, 0.8µm) situated in a calming chamber. The filters were changed every 3-4 weeks. They were digested in conc. HNO_3 and analysed for lead and other metals using ICP-MS (Inductively Coupled Plasma-Mass Spectrometry).

All results for CO, SO2, NO_X and the continuous particulate monitor were integrated to give 1-hour average values as required for comparison with the Directive limit values.

Results

Carbon Monoxide

No. of hours	7602	
Missing values	2328	
(including routine maintenance)	46	
No. of measured values	5274	
Percentage covered	69.7	
Maximum hourly value	5.4	$mg.m^{-3}$
98 percentile for hourly values	1.3	$mg.m^{-3}$
Mean hourly value	0.4	$mg.m^{-3}$
Maximum 8-hour mean	2.8	$mg.m^{-3}$
98 percentile for 8-hour mean	1.1	$mg.m^{-3}$

Proposed Directive Limits

	Averaging Period	Limit Value	Date by which limit value is to be met
Limit Value for the protection of human health	8-hour running average	10 mg m^{-3}	1 January 2005
Upper assessment threshold	8-hour running average	7 mg m^{-3}	
Lower assessment threshold	8-hour running average	5 mg m^{-3}	

The lower assessment threshold was not exceeded during the monitoring period (Figure 2).

Fig. 2 Carbon Monoxide 8-hour Running Average
Trailer 1 in Drogheda 19/2/02 - 3/1/03

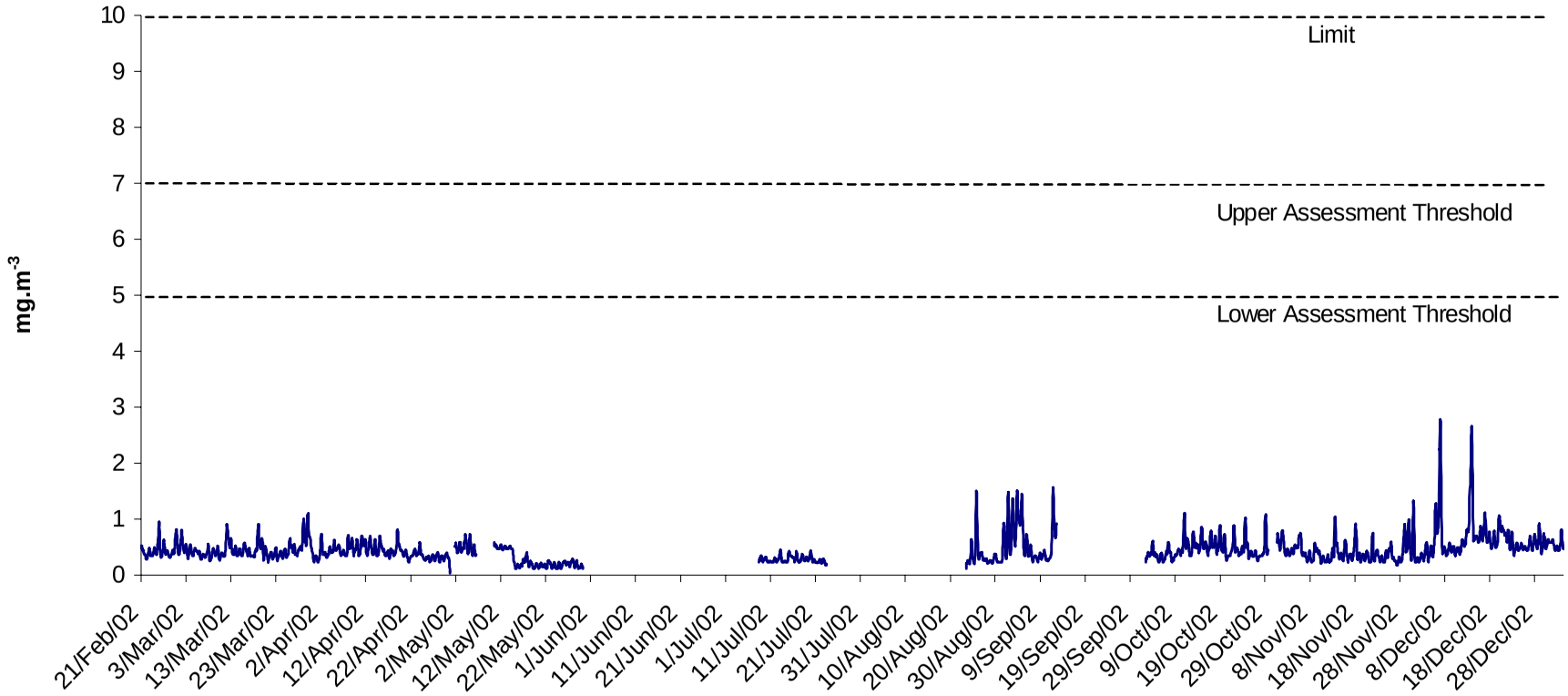
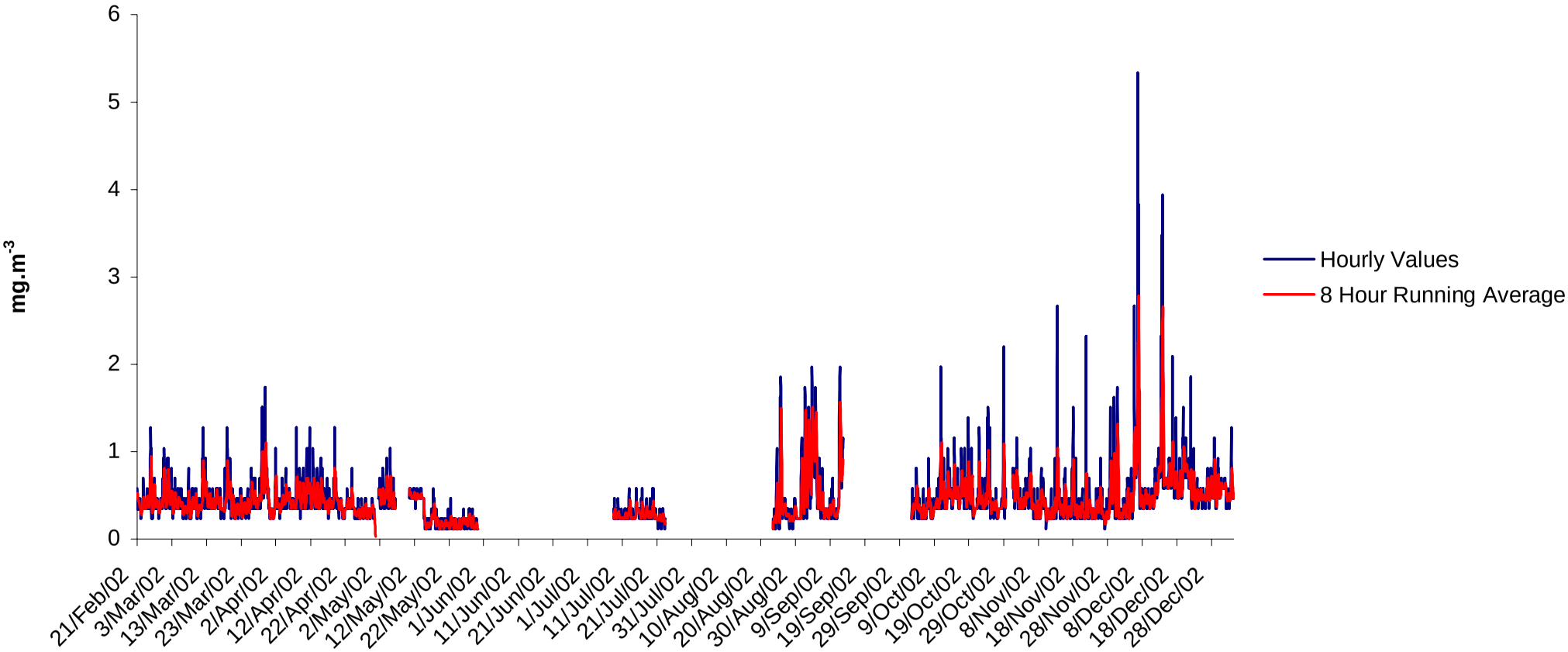


Fig. 3 Carbon Monoxide
Trailer 1 in Drogheda 19/2/02 - 3/1/03



Sulphur Dioxide

No. of hours	7602	
Missing values	2727	
(including routine maintenance)	49	
No. of measured values	4875	
Percentage covered	64.1	
Maximum hourly value	288.3	$\mu g.m^{-3}$
98 percentile for hourly values	58.4	$\mu g.m^{-3}$
Mean hourly value	13.8	$\mu g.m^{-3}$
Maximum 24-hour value	56.8	$\mu g.m^{-3}$
98 percentile for 24-hour values	33.6	$\mu g.m^{-3}$

Directive Limits (1999/30/EC)

	Averaging Period	Limit Value	Date by which limit value is to be met
Hourly limit value for the protection of human health	1 hour	350 $\mu g\ m^{-3}$ not to be exceeded more than 24 times a calendar year	1 January 2005
Daily limit value for the protection of human health	24 hours	125 $\mu g\ m^{-3}$ not to be exceeded more than 3 times a calendar year	1 January 2005
Limit value for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	20 $\mu g\ m^{-3}$	19 July 2001
Alert threshold		500 $\mu g\ m^{-3}$ over three consecutive hours	

Directive Limits (1999/30/EC) continued

	Averaging Period	Limit Value	Date by which limit value is to be met
Upper assessment threshold for the protection of human health	24 hours	75 $\mu g\ m^{-3}$ not to be exceeded more than 3 times a calendar year	
Lower assessment threshold for the protection of human health	24 hours	50 $\mu g\ m^{-3}$ not to be exceeded more than 3 times a calendar year	
Upper assessment threshold for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	12 $\mu g\ m^{-3}$	
Lower assessment threshold for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	8 $\mu g\ m^{-3}$	

The hourly and daily limit values for the protection of human health were not exceeded during the measurement period. The lower assessment threshold for the protection of human health was exceeded on two occasions during the six month measurement period (Figure 4). A break in operations occurred during the summer months of the assessment when levels of emissions from domestic heating can be expected to be lower than at other times. Consequently, it is assumed that the two exceedences recorded during the winter months are unlikely to have been repeated during the summer months. The directive stipulates that the assessment thresholds should not be exceeded more than three times in a calendar year. The mean hourly value of 13.8 $\mu g.m^{-3}$ exceeds the upper assessment threshold for the protection of vegetation. However, this threshold may not be relevant to monitoring in an urban area.

Fig. 4 Sulphur Dioxide 24 Hour Averages
Trailer 1 in Drogheda 19/2/02 - 3/1/03

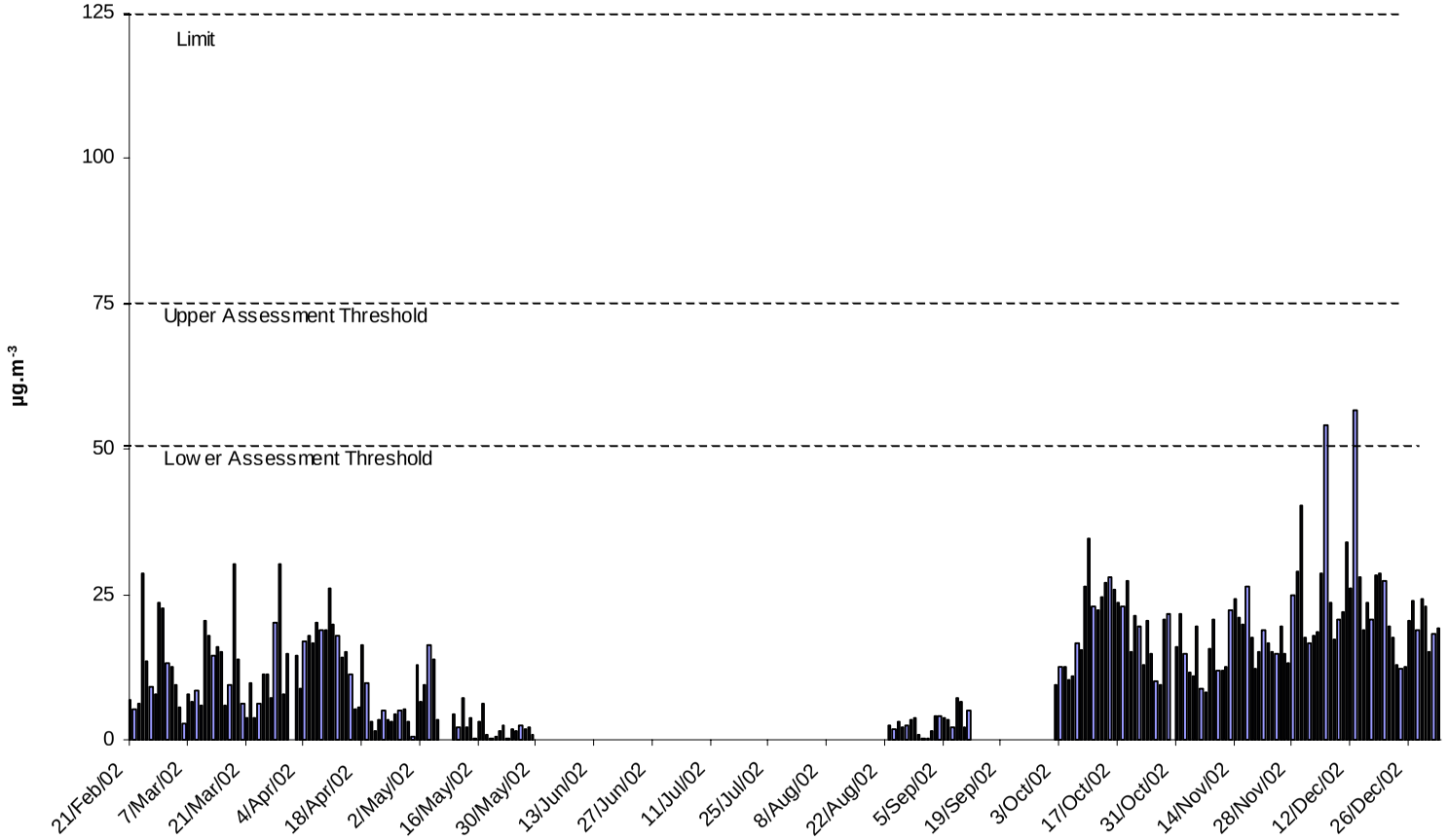
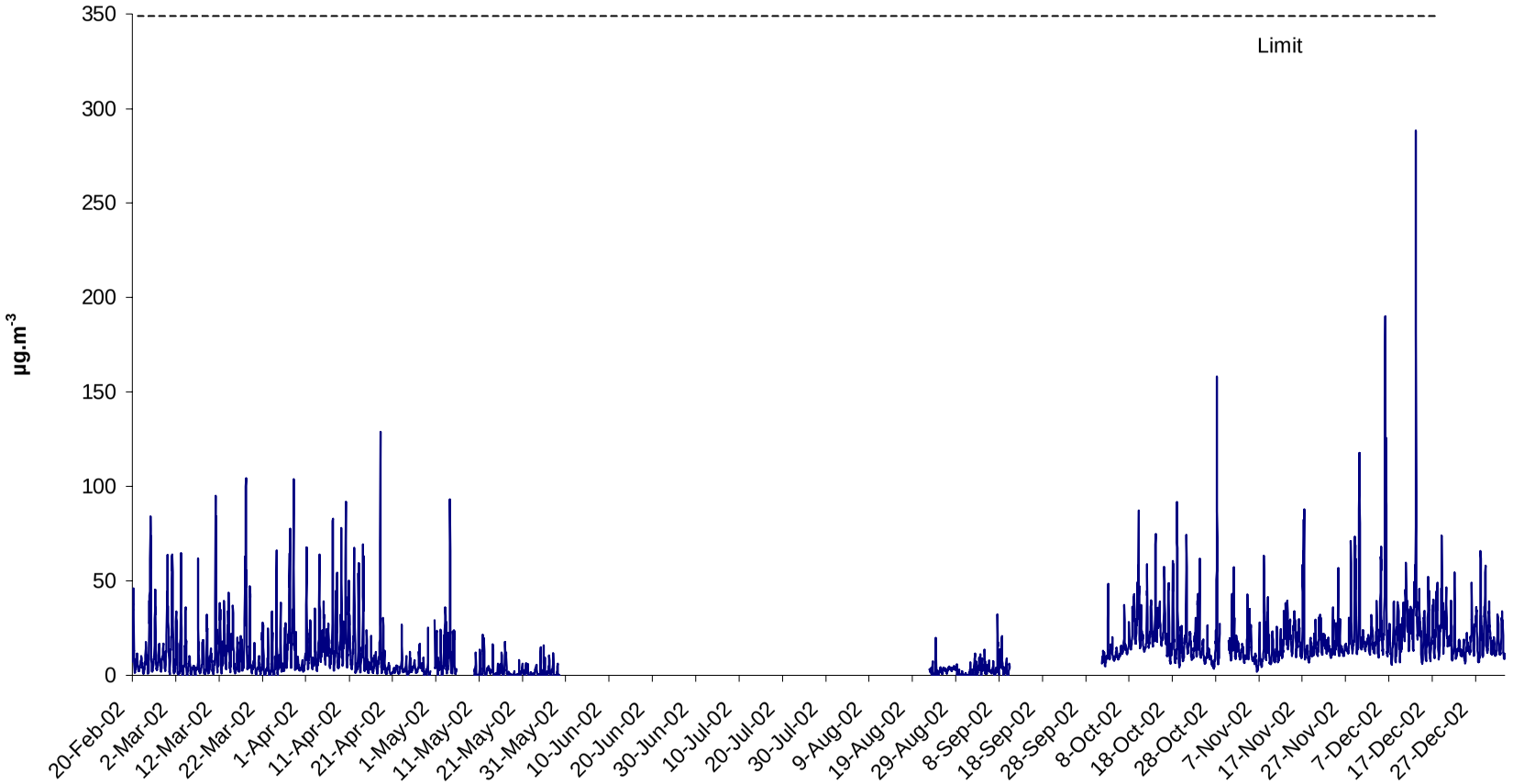


Fig. 5 Sulphur Dioxide Hourly Averages
Trailer 1 in Drogheda 19/2/02-3/1/03



Nitrogen Dioxide and Oxides of Nitrogen

No. of hours	7602	
Missing values	3170	
(including routine maintenance)	53	
No. of measured values	4432	
Percentage covered	71.5	
Maximum hourly value (NO_2)	123.4	$\mu g.m^{-3}$
98 percentile for hourly values (NO_2)	64.2	$\mu g.m^{-3}$
Mean hourly value (NO_2)	22.7	$\mu g.m^{-3}$
Mean hourly value (NO_x)	37.1	$\mu g.m^{-3}$ NO_2

Directive Limits (1999/30/EC)

	Averaging Period	Limit Value	Date by which limit value is to be met
Hourly limit value for the protection of human health	1 hour	200 $\mu g\ m^{-3}$ NO_2 not to be exceeded more than 18 times a calendar year	1 January 2010
Annual limit value for the protection of human health	Calendar year	40 $\mu g\ m^{-3}$ NO_2	1 January 2010
Annual limit value for the protection of vegetation	Calendar year	30 $\mu g\ m^{-3}$ NO_x	19 July 2001
Alert threshold		400 $\mu g\ m^{-3}$ NO_2 over three consecutive hours	

Directive Limits (1999/30/EC) continued

	Averaging Period	Limit Value	Date by which limit value is to be met
Upper assessment threshold for the protection of human health	1 hour	140 μg m^{-3} NO_2 not to be exceeded more than 18 times a calendar year	
Upper assessment threshold for the protection of human health	Calendar year	32 μg m^{-3} NO_2	
Lower assessment threshold for the protection of human health	1 hour	100 μg m^{-3} NO_2 not to be exceeded more than 18 times a calendar year	
Lower assessment threshold for the protection of human health	Calendar year	26 μg m^{-3} NO_2	
Upper assessment threshold for the protection of vegetation	Calendar year	24 μg m^{-3} NO_x	
Lower assessment threshold for the protection of vegetation	Calendar year	19.5 μg m^{-3} NO_x	

The hourly limit value for the protection of human health was not exceeded during the measurement period (Figure 6). The hourly lower assessment threshold was exceeded on four occasions during the six months of the assessment for which monitoring data is

available. The directive stipulates that the lower assessment threshold is deemed to be exceeded if there are more than 18 exceedences in a calendar year. Thus, there would have had to be over nine exceedences in the six month period to exceed the lower assessment threshold. The average NO_2 (22.7 $\mu g.m^{-3}$) value for the period of the assessment did not exceed the lower assessment threshold based on an averaging period of a calendar year (26 $\mu g.m^{-3}$).

NO, NO_2 and NO_X are measured as ppb (parts per billion) by volume. To convert to $\mu g.m^{-3}$, a factor (1.25 for NO, 1.91 for NO_2) is used. No formula is specified for NO_X, the directive requires it to be expressed as NO_2 (i.e. ppb*1.91). This applies even when most of the NO_X is present as NO.

The mean hourly value of NO_X during the measurement period (37.0 $\mu g.m^{-3}$) exceeds the annual limit value for the protection of vegetation.

Fig. 6 NO_2 Hourly Values
Trailer 1 in Drogheda 19/2/02-3/1/03

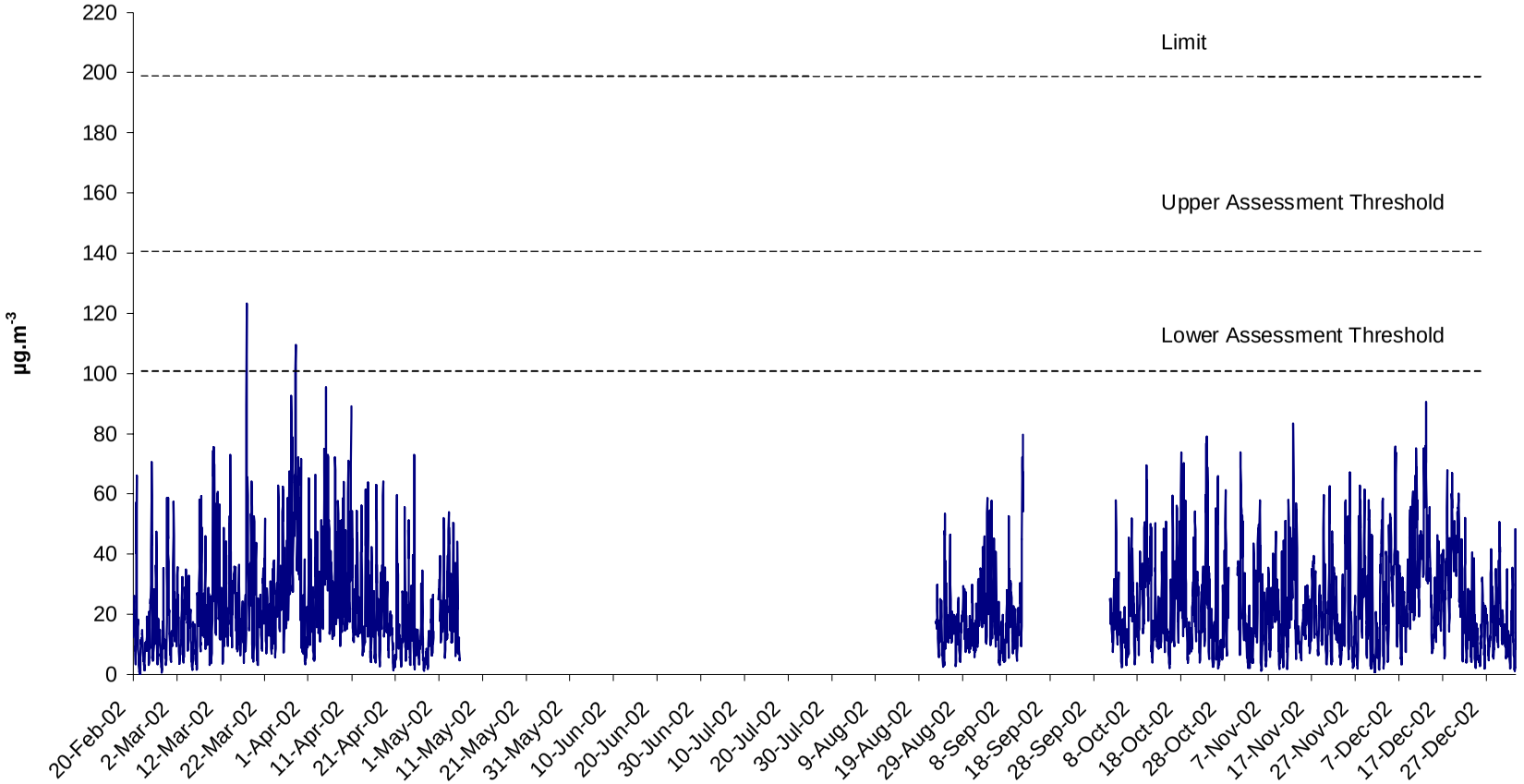
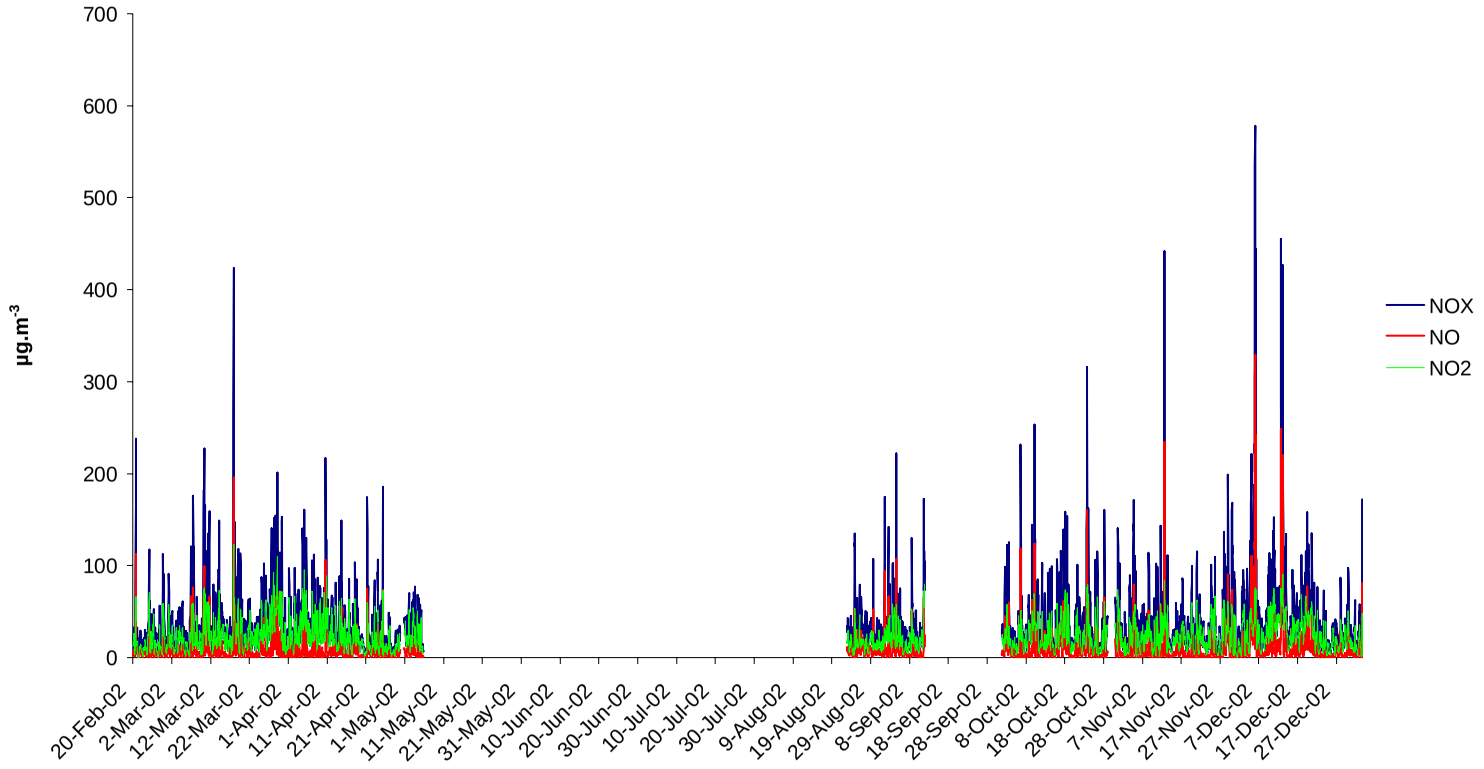


Fig. 7 NO_X Hourly Values
Trailer 1 in Drogheda 19/2/02-3/1/03



Particulate Matter

PM_{10} : gravimetric method

No. of days	317	
Missing values (including routine maintenance)	217	
No. of measured values	100	
Percentage covered	31.5	
Maximum daily value	112.6	$\mu g.m^{-3}$
98 percentile for daily values	65.0	$\mu g.m^{-3}$
Mean daily value	32.4	$\mu g.m^{-3}$

Directive Limits (1999/30/EC)

STAGE I

	Averaging Period	Limit Value	Date by which limit value is to be met
24-hour limit value for the protection of human health	24 hour	50 $\mu g\ m^{-3}$ PM_{10} not to be exceeded more than 35 times a calendar year	1 January 2005
Annual limit value for the protection of human health	Calendar year	40 $\mu g\ m^{-3}$ PM_{10}	1 January 2005
Upper assessment threshold for the protection of human health	24 hour	30 $\mu g\ m^{-3}$ PM_{10} not to be exceeded more than 7 times a calendar year	*based on the indicative limit values for 1 January 2010*
Upper assessment threshold for the protection of human health	Calendar year	14 $\mu g\ m^{-3}$ PM_{10}	*based on the indicative limit values for 1 January 2010*

Directive Limits (1999/30/EC) Stage I continued

	Averaging Period	Limit Value	Date by which limit value is to be met
Lower assessment threshold for the protection of human health	24 hour	20 µg m^{-3} PM_{10} not to be exceeded more than 7 times a calendar year	*based on the indicative limit values for 1 January 2010*
Lower assessment threshold for the protection of human health	Calendar year	10 µg m^{-3} PM_{10}	*based on the indicative limit values for 1 January 2010*

STAGE II

	Averaging Period	Limit Value	Date by which limit value is to be met
24-hour limit value for the protection of human health	24 hour	50 µg m^{-3} PM_{10} not to be exceeded more than 7 times a calendar year	1 January 2010
Annual limit value for the protection of human health	Calendar year	20 µg m^{-3} PM_{10}	1 January 2010

There were 11 exceedences of the 24 hour hour limit value for the protection of human health during the 100 days of the assessment period for which results are available (Figure 8). The directive stipulates that the limit value must not be exceeded more than 35 times in a calendar year. Thus, the limit (50 µg.m^{-3}) would have been exceeded if these results are extrapolated for the entire year. However, the limit value plus margin of tolerance (65 µg.m^{-3}) would not have been exceeded. During the assessment period, the upper assessment threshold was exceeded on 51 days (51% of measured values)

while the lower assessment threshold was exceeded on 82 days (82% of measured values). Both assessment thresholds were exceeded as the directive stipulates that each assessment threshold must not be exceeded more than 7 times in a calendar year. The mean of the daily values during the measurement period (32.4 $\mu g.m^{-3}$) exceeds the upper assessment threshold based on an averaging period of one calendar year.

Particulate Matter : $PM_{2.5}$

Article 5 of Council Directive 1999/30/EC of 22 April 1999 states that

"Member States shall ensure that measuring stations to supply data on concentration of $PM_{2.5}$ are installed."

The concentration of $PM_{2.5}$ was measured with an OSIRIS Environmental Dust Monitor in the mobile laboratory. This also measured total suspended particles (TSP), PM_{10} and PM_1. All measurements were hourly values.

The concentration of PM_{10} measured by the OSIRIS and that measured using the gravimetric method were compared to give a daily correction factor. The correction factor was used to estimate the concentration of $PM_{2.5}$ using the formula:

$$\text{24-hour average concentration of } PM_{2.5} = \text{OSIRIS 24-hour average concentration of } PM_{2.5} \times \frac{\text{gravimetric 24-hour average } PM_{10}}{\text{OSIRIS 24-hour average } PM_{10}}$$

Results:

No. of days	317	
Missing values (including routine maintenance)	252	
No. of measured values*	65	
Percentage covered	20.5	
Maximum daily value	77.5	$\mu g.m^{-3}$
98 percentile for daily values	25.6	$\mu g.m^{-3}$
Mean daily value	12.1	$\mu g.m^{-3}$
Median daily value	10.5	$\mu g.m^{-3}$

* no. of days with measurements from both the OSIRIS monitor and the gravimetric metho

Fig. 8 PM_{10} Daily Values
Trailer 1 in Drogheda 19/2/02-3/1/03

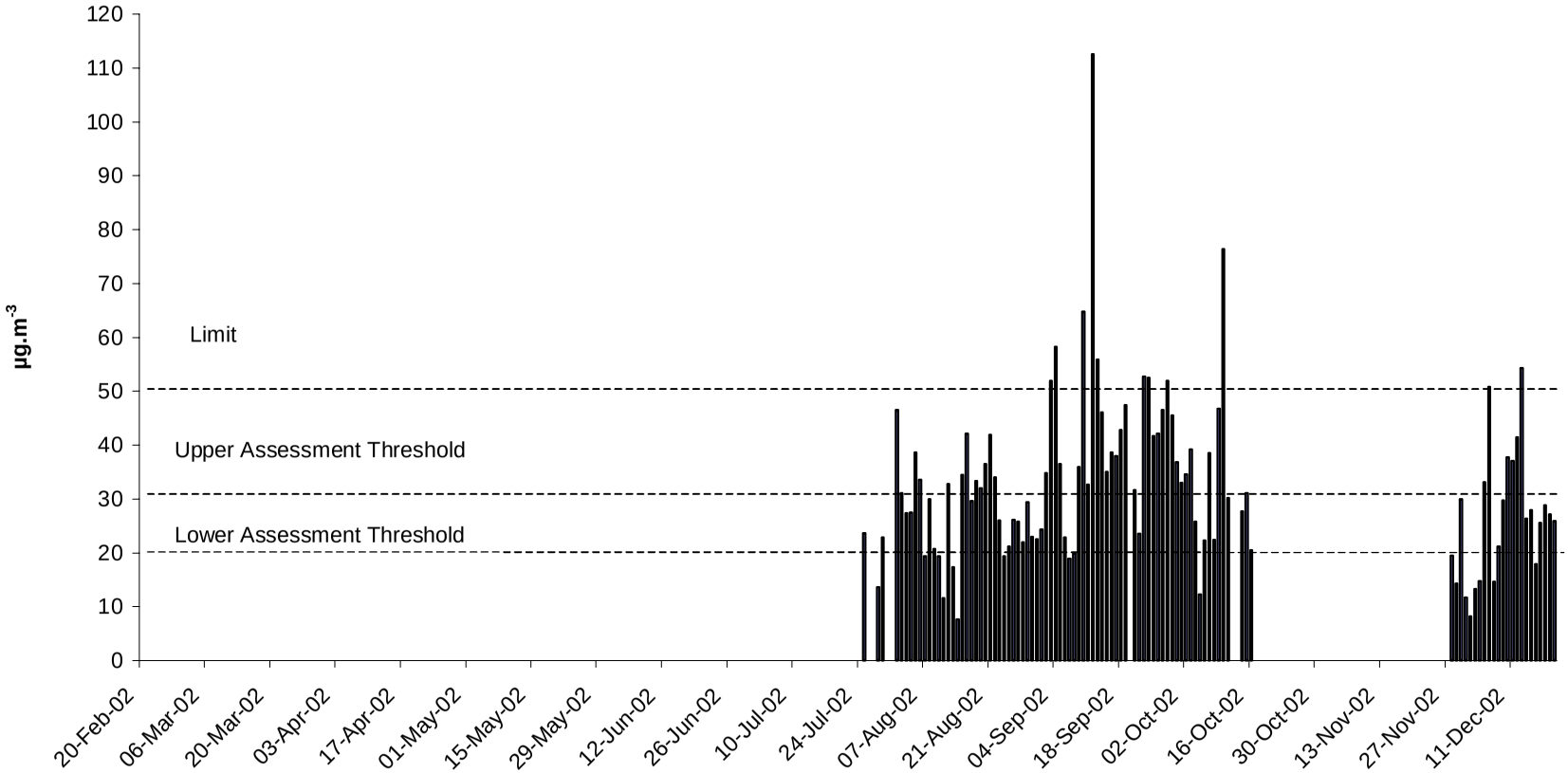
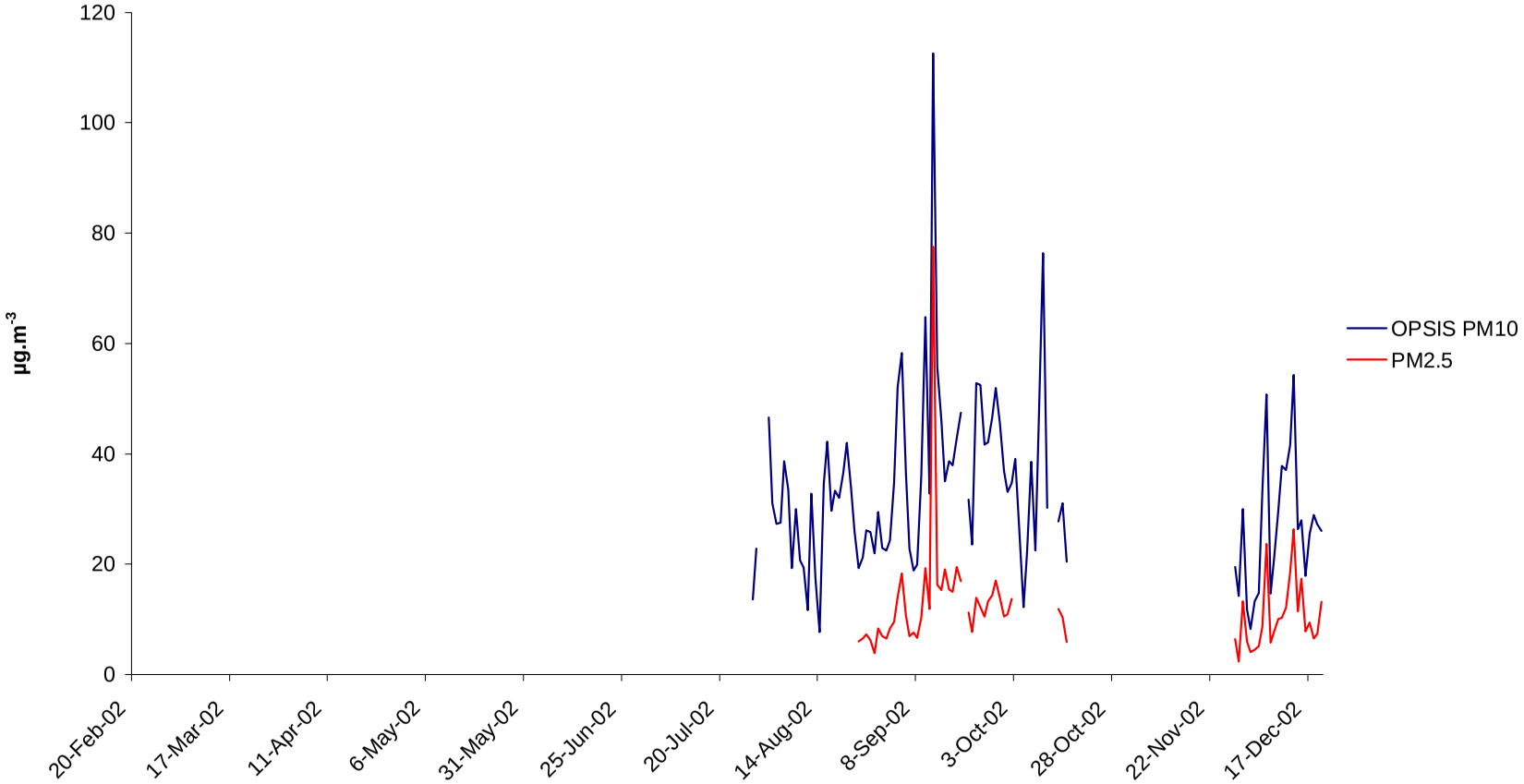


Fig. 9 PM_{10} and $PM_{2.5}$ Daily Values
Trailer 1 in Drogheda 19/2/02-3/1/03



Benzene

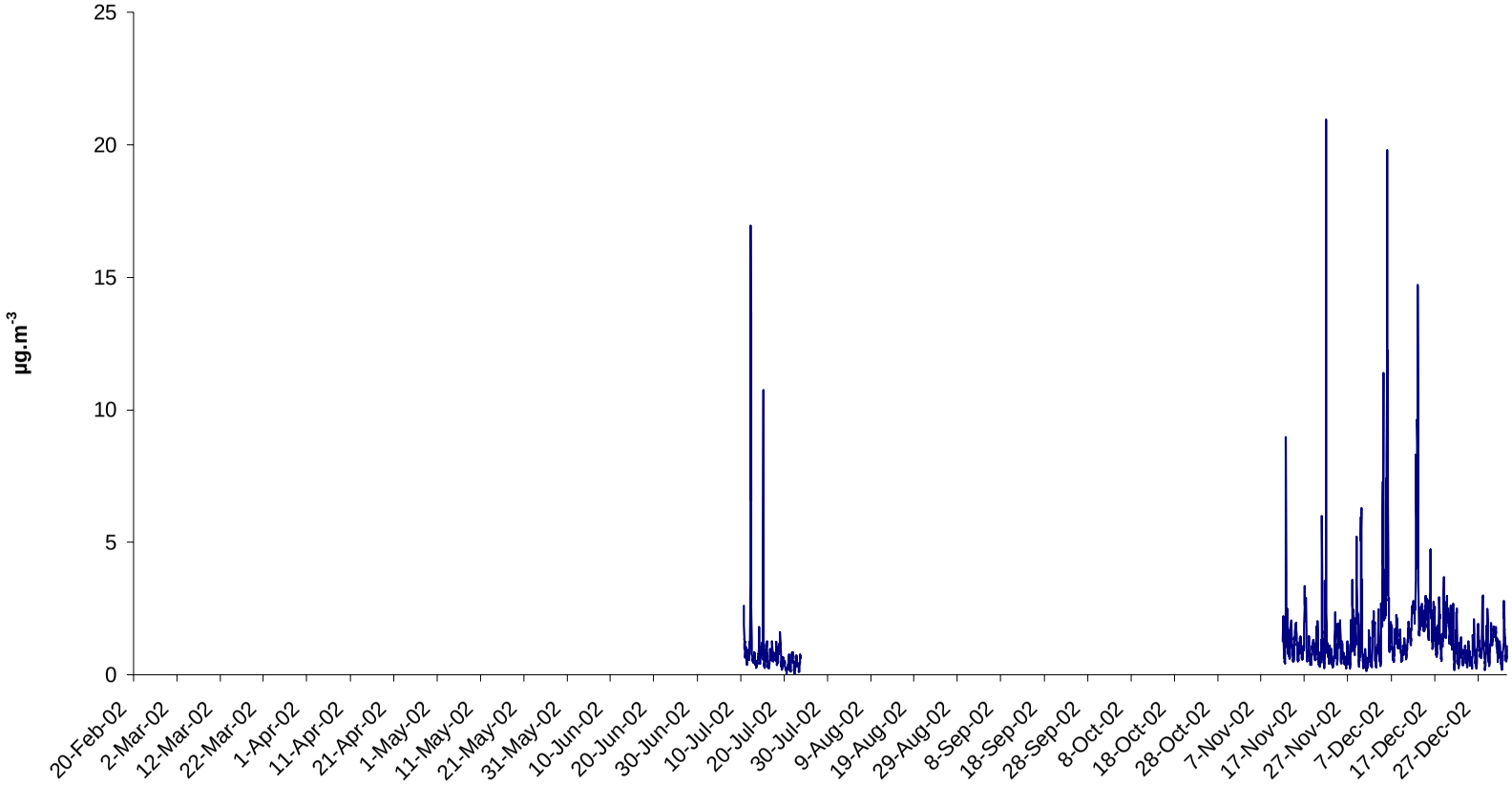
No. of hours	7602	
Missing values (including routine maintenance)	6046	
No. of measured values	1556	
Percentage covered	20.5	
Maximum hourly value	20.9	$\mu g.m^{-3}$
98 percentile for hourly values	6.0	$\mu g.m^{-3}$
Mean hourly value	1.3	$\mu g.m^{-3}$

Proposed Directive Limits

	Averaging Period	Limit Value	Date by which limit value is to be met
Limit value for the protection of human health	Calendar year	5 $\mu g\ m^{-3}$	1 January 2010
Upper assessment threshold for the protection of human health	Calendar year	3.5 $\mu g\ m^{-3}$	
Lower assessment threshold for the protection of human health	Calendar year	2 $\mu g\ m^{-3}$	

The mean hourly value for the measurement period is below the lower assessment threshold for the protection of human health (Figure 10).

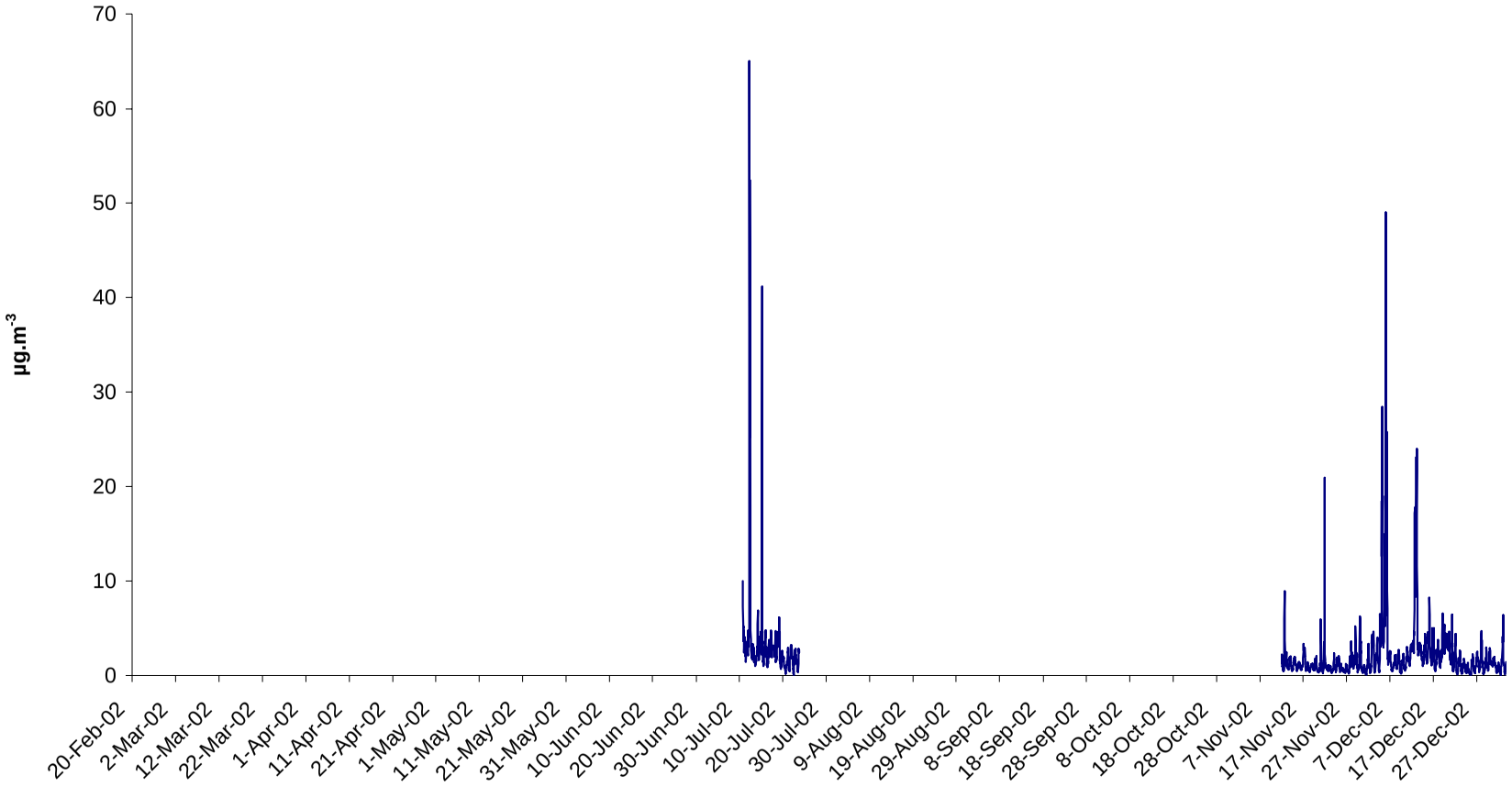
Fig. 10 Benzene Hourly Values
Trailer 1 in Drogheda 19/2/02-3/1/03



Toluene

No. of hours	7602	
Missing values (including routine maintenance)	6046	
No. of measured values	1556	
Percentage covered	20.5	
Maximum hourly value	65.0	$\mu g.m^{-3}$
98 percentile for hourly values	13.3	$\mu g.m^{-3}$
Mean hourly value	2.3	$\mu g.m^{-3}$

Fig. 11 Toluene Hourly Values
Trailer 1 in Drogheda 19/2/02-3/1/03



Lead

No. of days	318	
Missing days (including routine maintenance)		
No. of measured days	318	
Percentage covered	100	
Concentration of Pb	0.02	$\mu g.m^{-3}$

Directive Limits (1999/30/EC)

	Averaging Period	Limit Value	Date by which limit value is to be met
Annual limit value for the protection of human health	Calendar year	0.5 $\mu g\ m^{-3}$	1 January 2005
Upper assessment threshold	Calendar year	0.35 $\mu g\ m^{-3}$	
Lower assessment threshold	Calendar year	0.25 $\mu g\ m^{-3}$	

The concentration of lead during the measurement period was below the lower assessment threshold.

Other Metals:

Annex I of council directive 96/62/EC (Air Framework Directive) lists four metals other than lead to be taken into consideration in the assessment and management of ambient air quality. These are cadmium, arsenic, nickel and mercury. Limit values and measurement methods for these metals as well as certain polycyclic aromatic hydrocarbons will be set out in the fourth daughter directive.

An indicative method was used during this assessment to measure prevailing concentrations of cadmium, nickel and arsenic in air. This method is detailed above and essentially involves pumping air through a filter for several weeks before digesting the filter and analysing the digest for lead and other metals using ICP-MS. The problem with this method is that the detection limit is influenced by any traces of metal in the filter paper as well as by the volume of air passed through the filter.
The results, although indicative, do provide some indication of the concentrations of these metals in air.

During this assessment

The maximum concentration of cadmium in air was found to be 2.7 $ng.m^{-3}$
The maximum concentration of nickel in air was found to be 5 $ng.m^{-3}$
The levels of arsenic in air were lower than trace levels of arsenic known to exist on the filters