



Ambient Air Monitoring

In

Wexford

10th March 2005 – 31st March 2006



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Summary

An air quality assessment was carried out in Wexford town from 10th March 2005 until 31st March 2006. No limit values were exceeded during the assessment.

Concentrations of carbon monoxide, sulphur dioxide, nitrogen dioxide, benzene and lead were below their respective lower assessment thresholds. Levels of PM₁₀ exceeded the upper assessment threshold for this parameter.

| | Below Lower Assessment Threshold | Below Upper Assessment Threshold | Above Upper Assessment Threshold | Above Limit |
|------------------------|---|---|---|--------------------|
| PM₁₀ | | | | |
| NO₂ | | | | |
| CO | | | | |
| SO₂ | | | | |
| Benzene | | | | |
| Pb | | | | |

Wexford 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)

- PM₁₀ will need to be monitored continuously
- Levels of CO, SO₂, NO₂, 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 question 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 SO₂, NO_x, particulate matter and lead. The second daughter directive was adopted in November 2000 (2000/69/EC) and covers CO and Benzene. The third daughter directive relates to ozone (2002/3/EC) and came out in 2002 while the fourth daughter directive (heavy metals and PAH, 2004/107/EC) was published in 2004. The first three directives have been transposed into Irish law as the Air Quality Standard Regulations 2002 (S.I No. 271 of 2002) and the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004).

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:

- Monitoring instruments which continuously measure and record concentrations of the pollutants sulphur dioxide, nitrogen oxides, carbon monoxide and PM₁₀.
- Instrument which continuously measures and records the levels of particulate matter.
- Gas chromatograph which measures levels of benzene and toluene.
- Sampler for lead and other metals in air (collection on filter for determination in the laboratory).

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 Wexford on 10th March 2005. Monitoring continued until 31st March 2006.

Siting

The monitoring unit was sited in the premises of Wexford County Council on Hill Street, Wexford. The site was within 500m of the centre of Wexford town.

Fig. 1: Map of site location (courtesy of OSI)



Site Location

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 4.7 μ m.

Sulphur Dioxide

Sulphur dioxide was monitored using an Advanced Pollution Instrumentation SO₂ Fluorescent Analyser - Model 100A. This is a continuous analyser which measures the fluorescence of SO₂ molecules after excitation by ultraviolet radiation.

Nitrogen Dioxide and Oxides of Nitrogen

NO_x species were monitored using an Advanced Pollution Instrumentation Chemiluminescent NO/NO₂/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 NO₂ present is then reduced to NO by a molybdenum converter giving a second value for total NO_x concentration. The amount of NO₂ present is found by subtraction.

Particulate Matter

Concentrations of PM₁₀ were measured using an instrument which uses tapered element oscillating microbalance technology (TEOM, Rupprecht & Patashnick Co. Inc., 25 Corporate Circle, Albany, New York). This is a continuous method in which the air from the sampling head is passed through a filter placed on a tapered element. A mass transducer relates changes in the frequency of the tapered element to changes in particulate matter on the filter, the difference between the filter's current weight and its initial weight gives the total mass of collected particulate matter. An inertial impactor sampling head restricted the sampled particles to those with a diameter less than 10 μ m. PM₁₀ concentrations measured by the TEOM were multiplied by a correction factor of 1.3 to compensate for the loss of volatile matter as recommended by the EC working group on particulate matter.

Particulate matter was also measured using an OSIRIS Environmental Dust Monitor (Turnkey Instruments, 1&2 Dalby Court, Gadbrook Business Centre, Northwich, 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, PM₁₀, PM_{2.5} and PM₁.

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 Metrical membrane filter (Gelman, 37mm, 0.8 μ m) situated in a calming chamber. The filters were changed every 3-4 weeks. They were digested in conc. HNO₃ 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

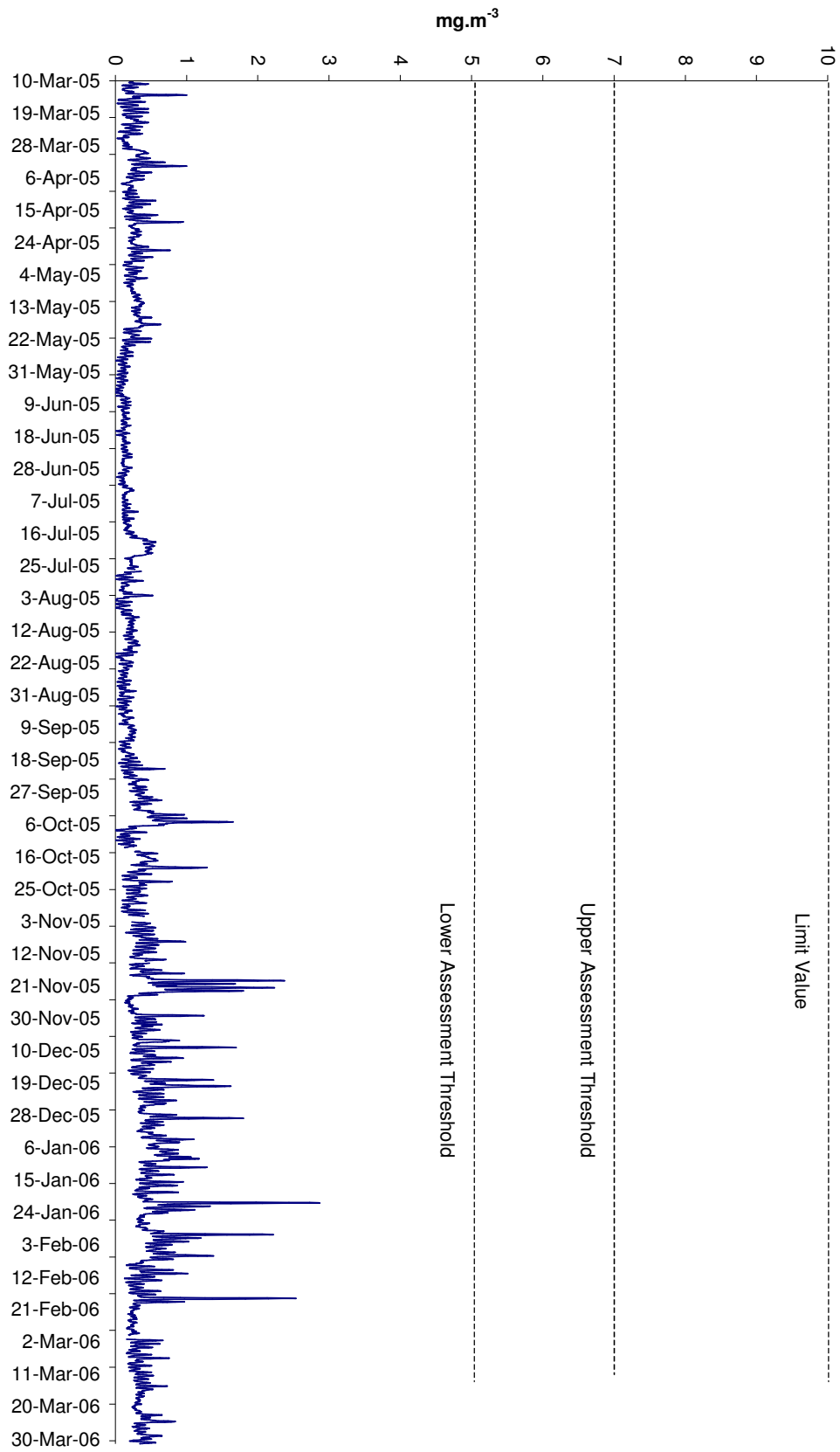
| | | |
|---|---------|--------------------|
| No. of hours | 9271 | |
| Missing values (including routine maintenance) | 88 7 | |
| No. of measured values | 9183 | |
| Percentage covered | 99.1 | |
| Maximum hourly value | 4.4 | mg.m ⁻³ |
| 98 percentile for hourly values | 1.2 | mg.m ⁻³ |
| Mean hourly value | 0.3 | mg.m ⁻³ |
| Maximum 8-hour mean | 2.9 | mg.m ⁻³ |
| 98 percentile for 8-hour mean | 1.0 | mg.m ⁻³ |

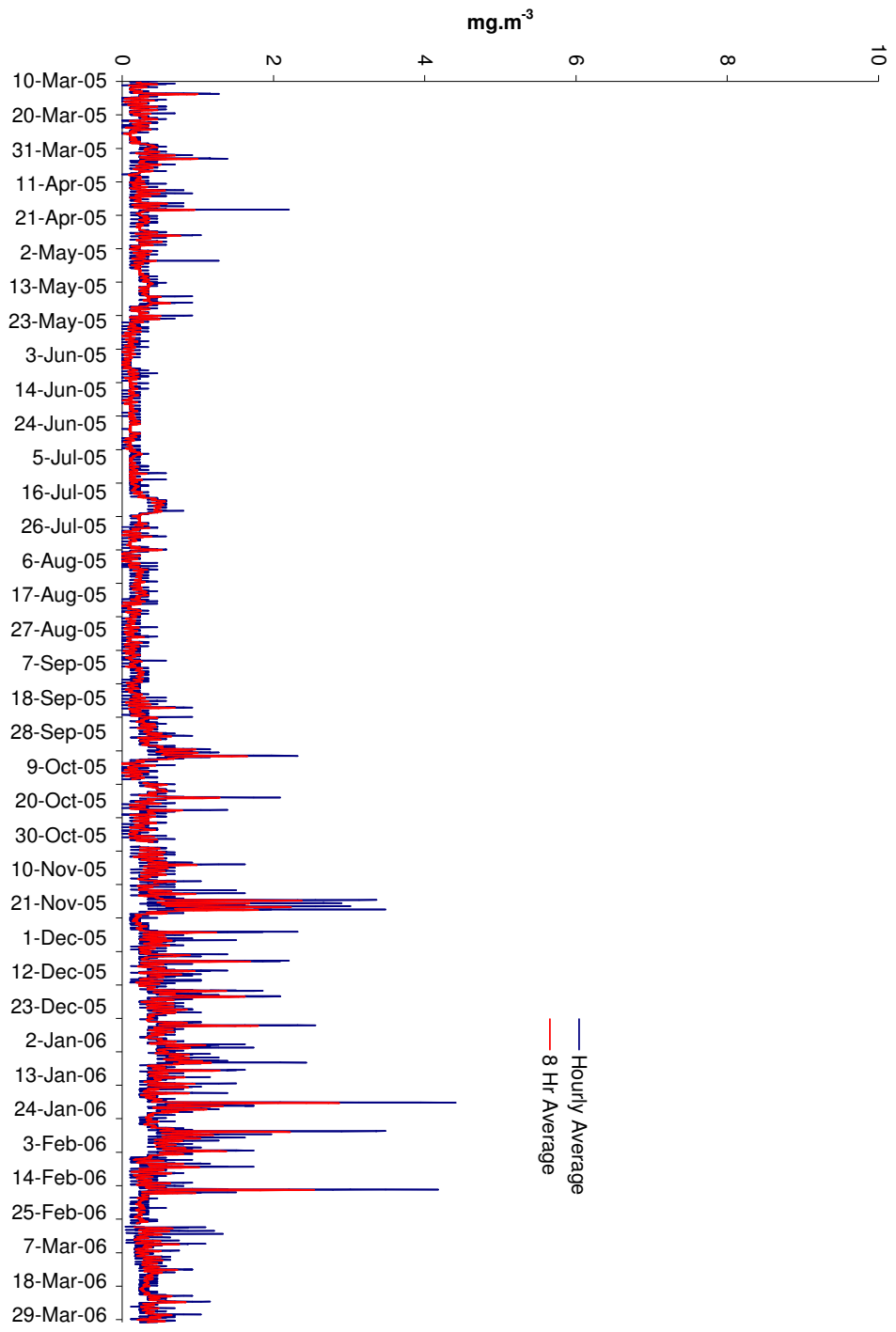
Directive Limits (2000/69/EC)

| | 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 (Figure 2).

**Fig. 2 Carbon Monoxide 8-hour Running Average
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**





**Fig.3 Carbon Monoxide
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**

Sulphur Dioxide

| | |
|---|----------------------------|
| No. of hours | 9271 |
| Missing values (including routine maintenance) | 105 4 |
| No. of measured values | 9166 |
| Percentage covered | 98.9 |
| Maximum hourly value | 213.6 $\mu\text{g.m}^{-3}$ |
| 98 percentile for hourly values | 53.2 $\mu\text{g.m}^{-3}$ |
| Mean hourly value | 10.0 $\mu\text{g.m}^{-3}$ |
| Maximum 24-hour value | 50.6 $\mu\text{g.m}^{-3}$ |
| 98 percentile for 24-hour values | 31.9 $\mu\text{g.m}^{-3}$ |

Directive Limits (1999/30/EC)

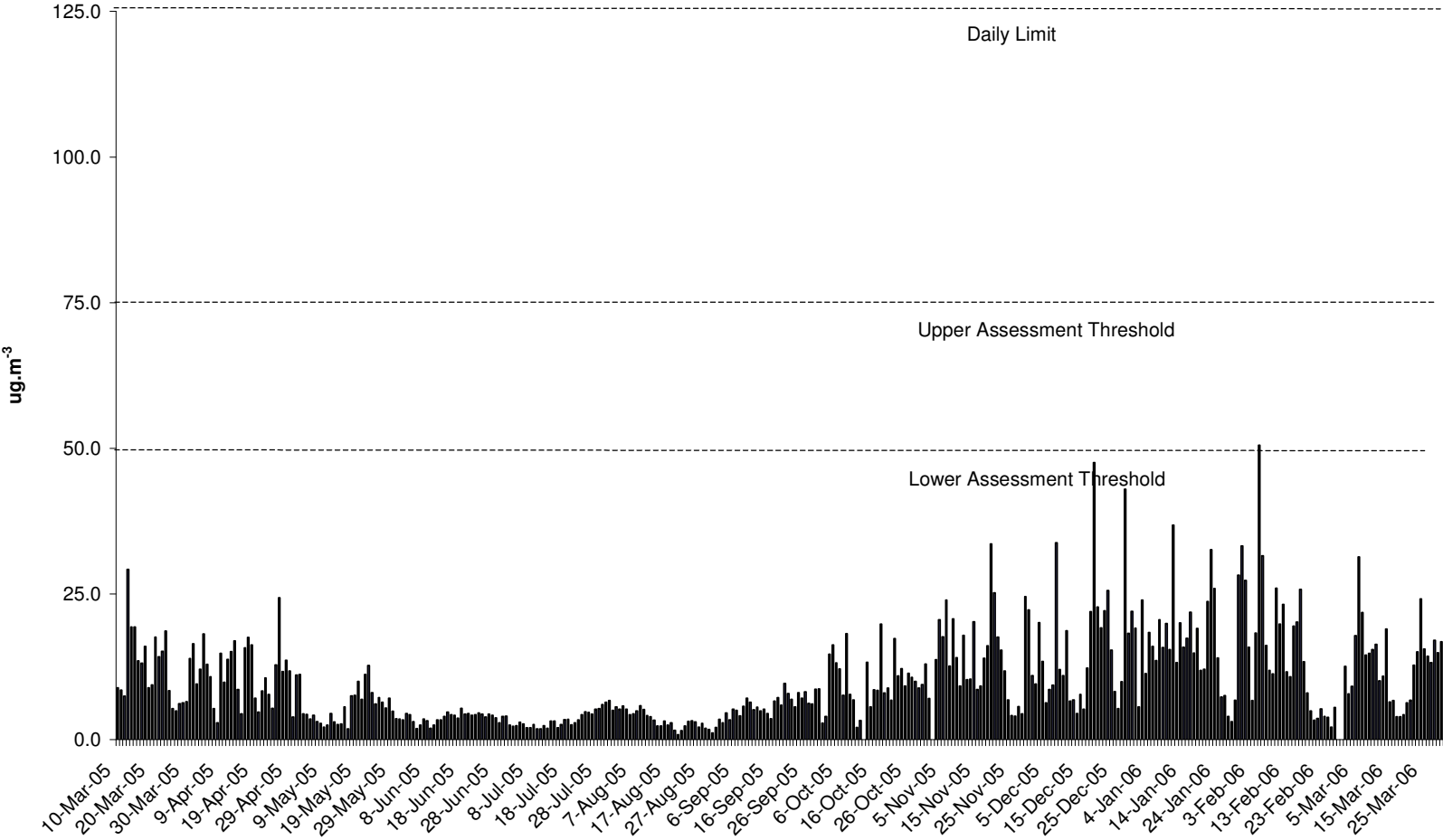
| | Averaging Period | Limit Value | Date by which limit value is to be met |
|---|--|--|--|
| Hourly limit value for the protection of human health | 1 hour | 350 $\mu\text{g m}^{-3}$ not to be exceeded more than 24 times a calendar year | 1 January 2005 |
| Daily limit value for the protection of human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

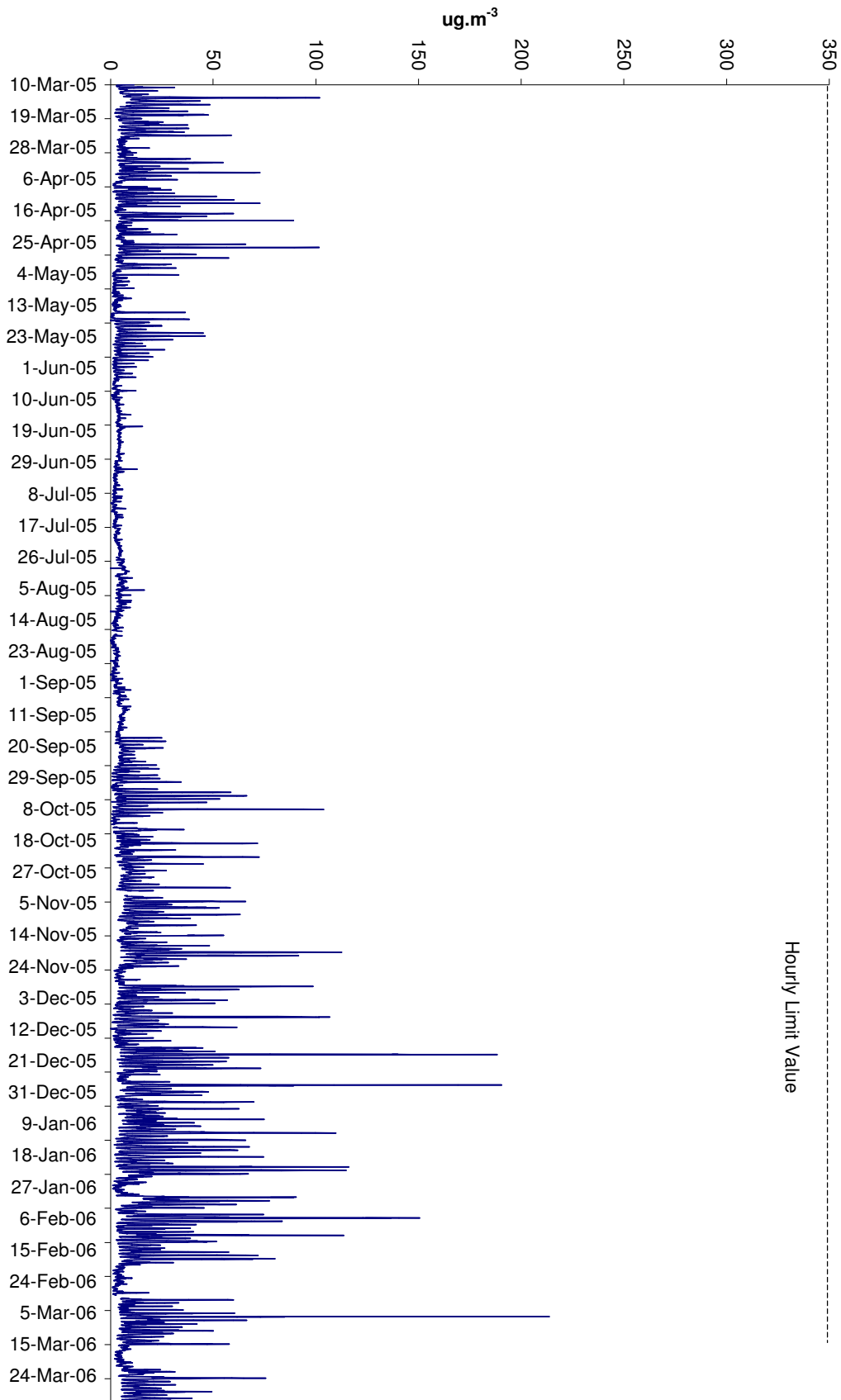
Directive Limits (1999/30/EC) continued

| | 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 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times a calendar year | |
| Lower assessment threshold for the protection of human health | 24 hours | 50 $\mu\text{g m}^{-3}$ 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 $\mu\text{g m}^{-3}$ | |
| Lower assessment threshold for the protection of ecosystems | Calendar year and winter (1 October to 31 March) | 8 $\mu\text{g m}^{-3}$ | |

The lower assessment threshold for the protection of human health was exceeded on one occasion during the twelve and a half month measurement period (Figure 4). However, Wexford is classified as being below the lower assessment threshold for sulphur dioxide as three exceedences of the threshold are permitted in a calendar year. The lower assessment threshold for the protection of ecosystems was exceeded during the measurement period. However, the standards for the protection of ecosystems were designed for rural areas and are not particularly relevant for urban air quality monitoring.

**Fig. 4 Sulphur Dioxide 24 Hour Averages
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**





**Fig 5 Sulphur Dioxide Hourly Averages
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**

Hourly Limit Value

Nitrogen Dioxide and Oxides of Nitrogen

| | |
|--|--|
| No. of hours | 9271 |
| Missing values (including routine maintenance) | 649 2 |
| No. of measured values | 8622 |
| Percentage covered | 93.0 |
| Maximum hourly value (NO ₂) | 89.2 $\mu\text{g}\cdot\text{m}^{-3}$ |
| 98 percentile for hourly values (NO ₂) | 47.6 $\mu\text{g}\cdot\text{m}^{-3}$ |
| Mean hourly value (NO ₂) | 12.6 $\mu\text{g}\cdot\text{m}^{-3}$ |
| Mean hourly value (NO _x) | 19.1 $\mu\text{g}\cdot\text{m}^{-3}$ 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 $\mu\text{g m}^{-3}$ 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 $\mu\text{g m}^{-3}$ NO ₂ | 1 January 2010 |
| Annual limit value for the protection of vegetation | Calendar year | 30 $\mu\text{g m}^{-3}$ NO _x | 19 July 2001 |
| Alert threshold | | 400 $\mu\text{g m}^{-3}$ NO ₂ over three consecutive hours | |

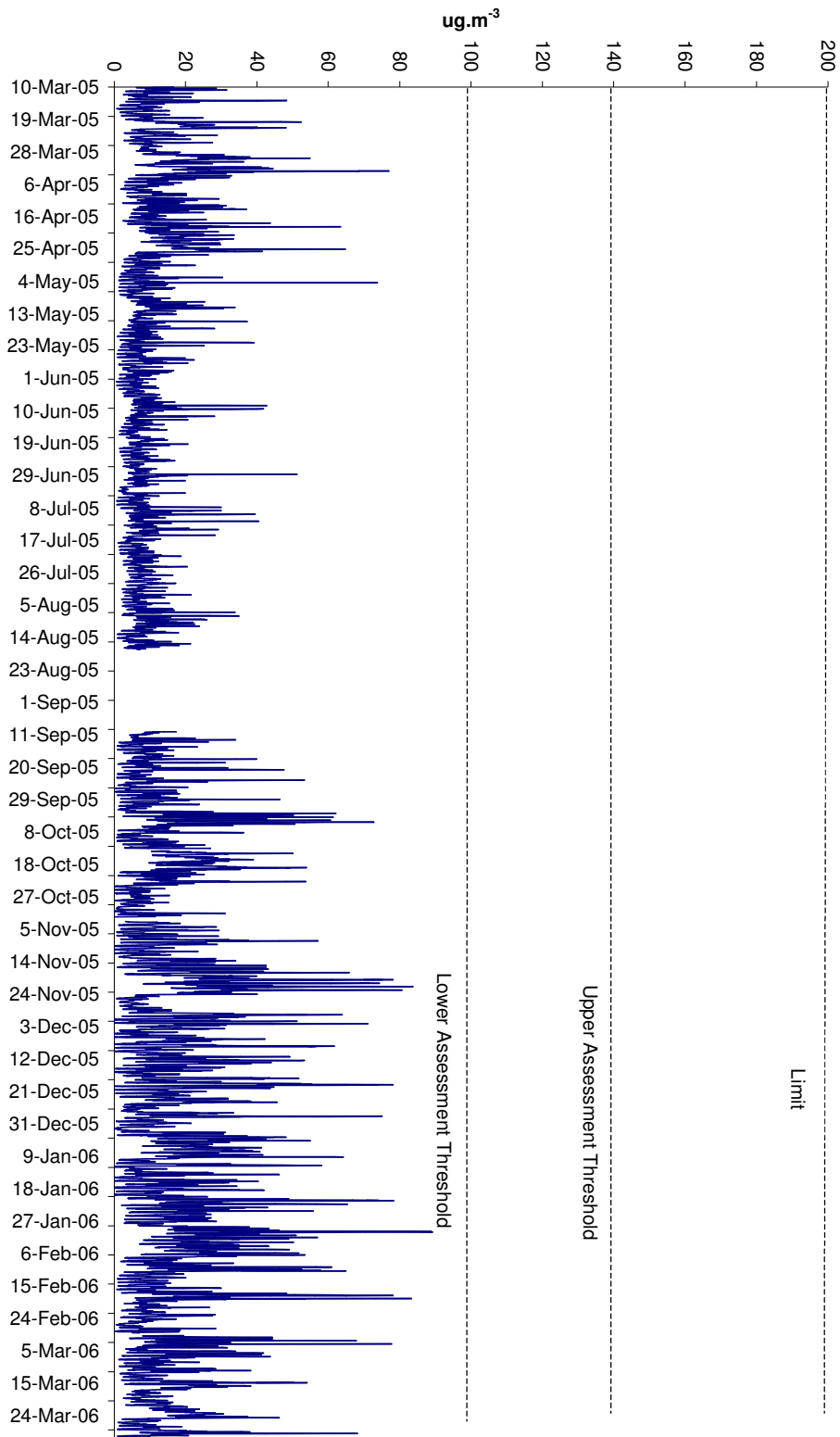
Directive Limits (1999/30/EC) continued

| | 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 $\mu\text{g m}^{-3}$ 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 $\mu\text{g m}^{-3}$ NO ₂ | |
| Lower assessment threshold for the protection of human health | 1 hour | 100 $\mu\text{g m}^{-3}$ 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 $\mu\text{g m}^{-3}$ NO ₂ | |
| Upper assessment threshold for the protection of vegetation | Calendar year | 24 $\mu\text{g m}^{-3}$ NO _x | |
| Lower assessment threshold for the protection of vegetation | Calendar year | 19.5 $\mu\text{g m}^{-3}$ NO _x | |

NO, NO₂ and NO_x are measured as ppb (parts per billion) by volume. To convert to μg.m⁻³, a factor (1.25 for NO, 1.91 for NO₂) is used. No formula is specified for NO_x, the directive requires it to be expressed as NO₂ (i.e. ppb*1.91). This applies even when most of the NO_x is present as NO.

The lower assessment thresholds for the protection of human health were not exceeded during the measurement period. Similarly, the lower assessment threshold for the protection of vegetation was not exceeded.

**Fig. 6 NO₂ Hourly Values
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**



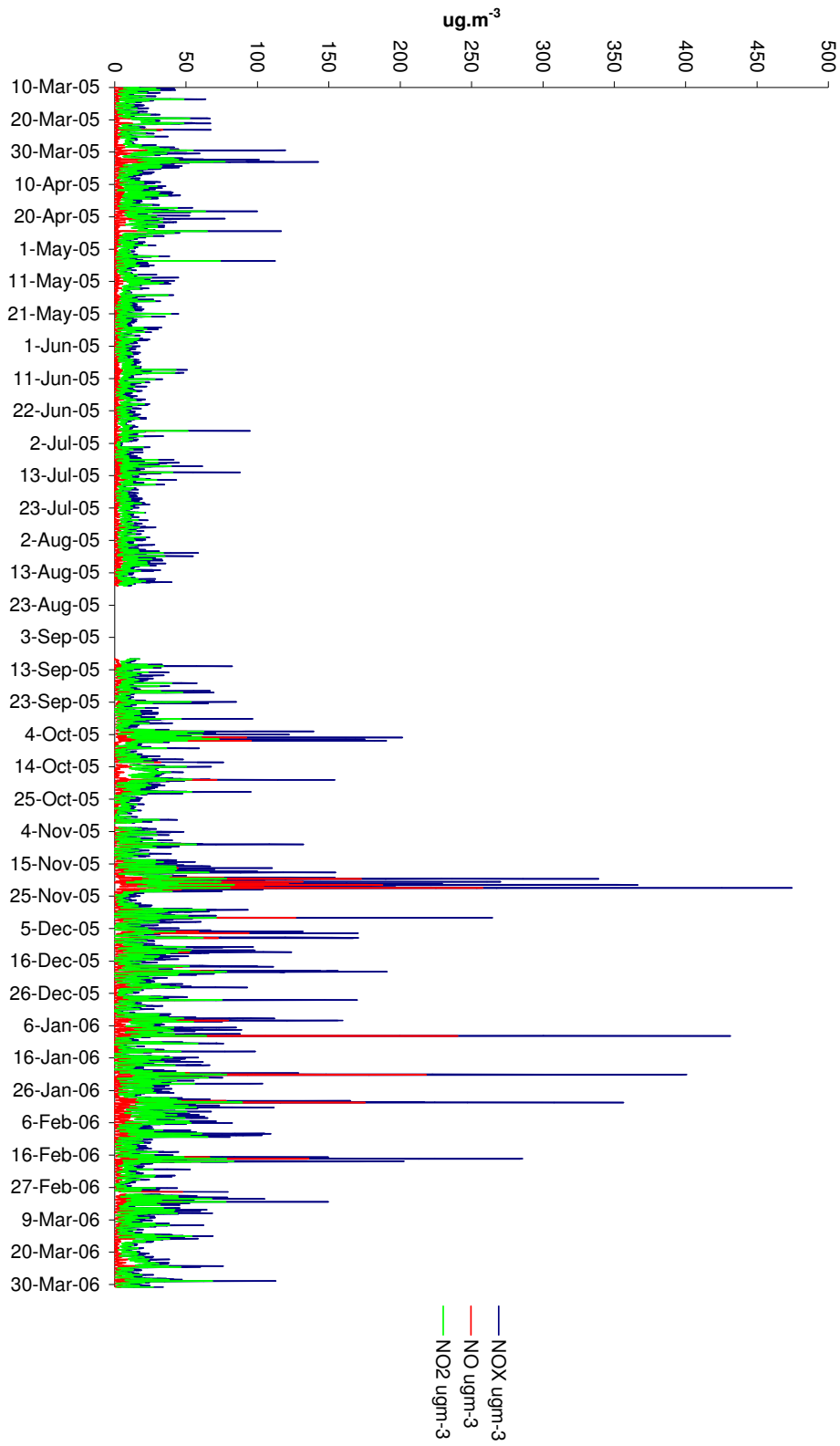


Fig. 7 NO_x Hourly Values
Trailer 1 in Wexford 10th March 2005 - 31st March 2006

Particulate Matter

PM₁₀ : gravimetric method

| | |
|---|---------------------------|
| No. of days | 386 |
| Missing values (including routine maintenance) | 66 0 |
| No. of measured values | 320 |
| Percentage covered | 82.9 |
| Maximum daily value | 98.3 $\mu\text{g.m}^{-3}$ |
| 98 percentile for daily values | 58.2 $\mu\text{g.m}^{-3}$ |
| Mean daily value | 25.3 $\mu\text{g.m}^{-3}$ |

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 $\mu\text{g m}^{-3}$ 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 $\mu\text{g m}^{-3}$ PM ₁₀ | 1 January 2005 |
| Upper assessment threshold for the protection of human health | 24 hour | 30 $\mu\text{g m}^{-3}$ PM ₁₀ not to be exceeded more than 7 times a calendar year | <i>based on the indicative limit values for 1 January 2010</i> |
| Upper assessment threshold for the protection of human health | Calendar year | 14 $\mu\text{g m}^{-3}$ PM ₁₀ | <i>based on the indicative limit values for 1 January 2010</i> |

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 $\mu\text{g m}^{-3}$ PM ₁₀ not to be exceeded more than 7 times a calendar year | <i>based on the indicative limit values for 1 January 2010</i> |
| Lower assessment threshold for the protection of human health | Calendar year | 10 $\mu\text{g m}^{-3}$ PM ₁₀ | <i>based on the indicative limit values for 1 January 2010</i> |

The daily limit value for the protection of human health was exceeded on 15 occasions during the measurement period. However, the daily PM₁₀ limit was not exceeded in Wexford as the directive permits the limit value to be exceeded 35 times in a calendar year. Similarly, the annual limit value for PM₁₀ was not exceeded. The daily upper assessment threshold was exceeded on 83 days while the daily lower assessment threshold was exceeded on 193 days, the directive states that the daily assessment thresholds may only be exceeded on seven occasions in a calendar year. The annual upper and lower assessment thresholds were both exceeded. Wexford is thus classified as being above the upper assessment threshold for PM₁₀.

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), PM₁₀ and PM₁. All measurements were hourly values.

The concentration of PM₁₀ measured by the OSIRIS and that measured using the TEOM were compared to give a daily correction factor. The correction factor was used to estimate the concentration of PM_{2.5} using the formula:

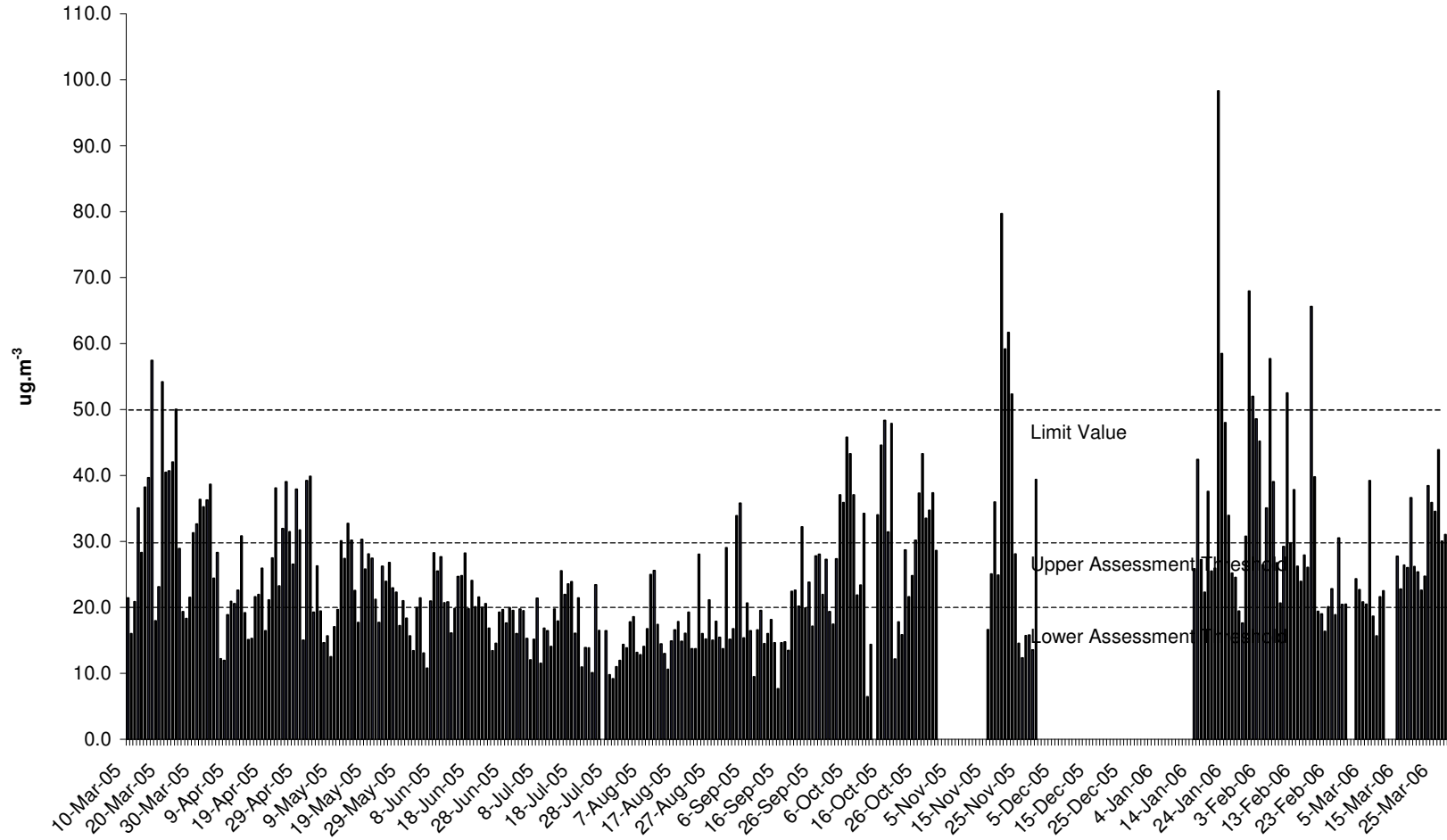
$$\begin{array}{l} \text{24-hour average} \\ \text{concentration} \\ \text{of PM}_{2.5} \end{array} = \begin{array}{l} \text{OSIRIS 24-hour} \\ \text{average concentration} \\ \text{of PM}_{2.5} \end{array} \times \frac{\text{TEOM 24-hour average PM}_{10}}{\text{OSIRIS 24-hour average PM}_{10}}$$

Results:

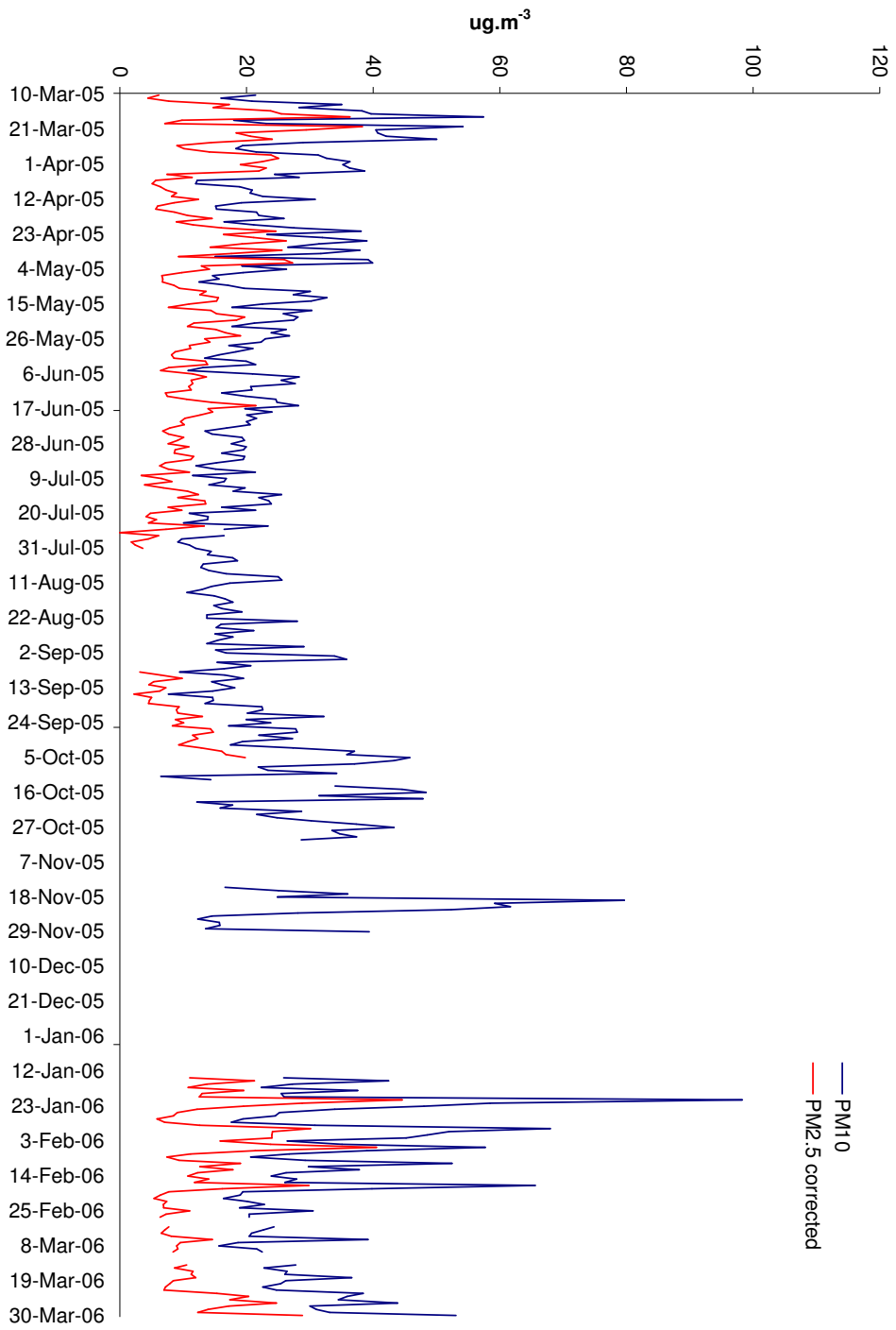
| | |
|---|---------------------------|
| No. of days | 386 |
| Missing values (including routine maintenance) | 143 0 |
| No. of measured values* | 243 |
| Percentage covered | 62.9 |
| Maximum daily value | 44.6 $\mu\text{g.m}^{-3}$ |
| 98 percentile for daily values | 29.9 $\mu\text{g.m}^{-3}$ |
| Mean daily value | 12.5 $\mu\text{g.m}^{-3}$ |
| Median daily value | 10.9 $\mu\text{g.m}^{-3}$ |

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

Fig. 8 PM₁₀ Daily Values
Trailer 1 in Wexford 10th March 2005 - 31st March 2006



**Fig. 9 PM₁₀ and PM_{2.5} Daily Values
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**



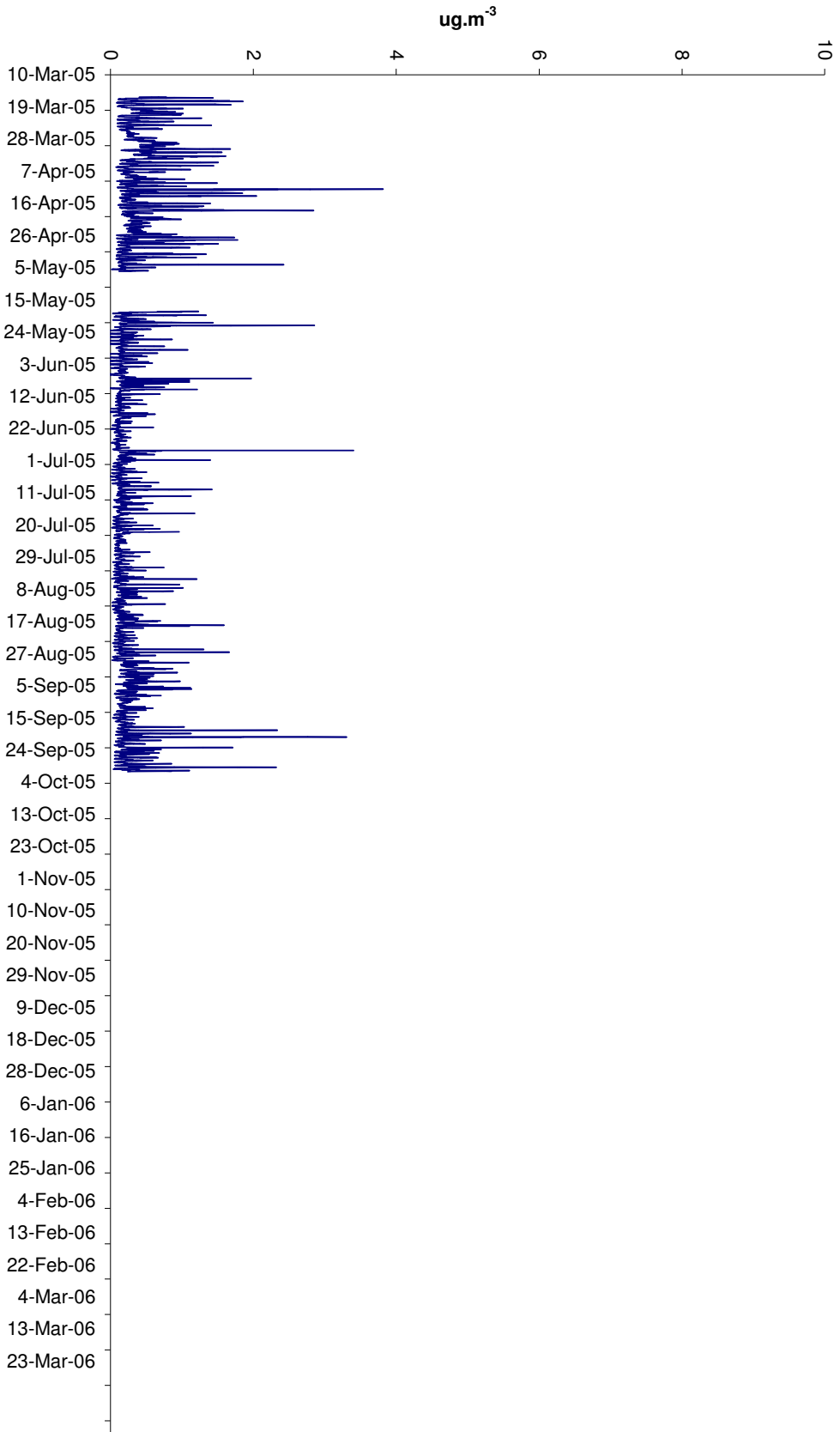
Benzene

| | |
|---|--------------------------|
| No. of hours | 9271 |
| Missing values (including routine maintenance) | 4815 11 |
| No. of measured values | 4456 |
| Percentage covered | 48.2 |
| Maximum hourly value | 3.8 $\mu\text{g.m}^{-3}$ |
| 98 percentile for hourly values | 1.2 $\mu\text{g.m}^{-3}$ |
| Mean hourly value | 0.3 $\mu\text{g.m}^{-3}$ |

Directive Limits (2000/69/EC)

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

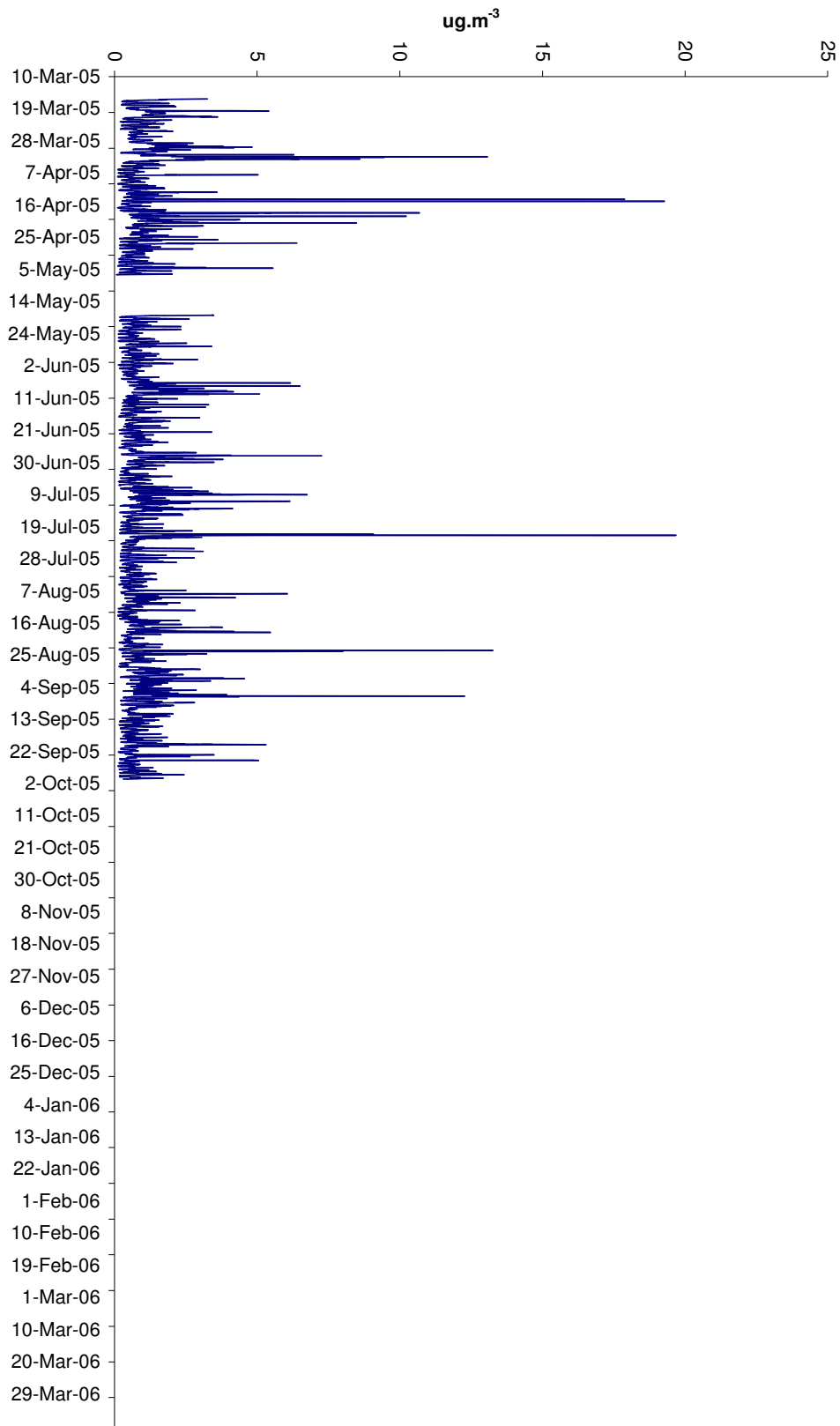
The lower assessment threshold was not exceeded.



**Fig. 10 Benzene Hourly Values
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**

Toluene

| | | |
|---|------|----------------------|
| No. of hours | 9271 | |
| Missing values (including routine maintenance) | 4815 | |
| | 11 | |
| No. of measured values | 4456 | |
| Percentage covered | 48.2 | |
| Maximum hourly value | 19.7 | $\mu\text{g.m}^{-3}$ |
| 98 percentile for hourly values | 3.5 | $\mu\text{g.m}^{-3}$ |
| Mean hourly value | 0.9 | $\mu\text{g.m}^{-3}$ |



**Fig. 11 Toluene Hourly Values
Trailer 1 in Wexford 10th March 2005 - 31st March 2006**

Lead

| | |
|---|--------------------------------------|
| No. of days | 387 |
| Missing days (including routine maintenance) | 0 |
| No. of measured days | 387 |
| Percentage covered | 0 |
| Concentration of Pb | 0.01 $\mu\text{g}\cdot\text{m}^{-3}$ |

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 $\mu\text{g m}^{-3}$ | 1 January 2005 |
| Upper assessment threshold | Calendar year | 0.35 $\mu\text{g m}^{-3}$ | |
| Lower assessment threshold | Calendar year | 0.25 $\mu\text{g m}^{-3}$ | |

The lower assessment threshold was not exceeded.

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 arsenic in air was lower than trace levels of arsenic known to exist on the filter papers.

The maximum concentration of cadmium in air was lower than trace levels of cadmium known to exist on the filter papers.

The maximum concentration of nickel in air was lower than trace levels of nickel known to exist on the filter papers.

