



**"Serving the  
Community"**

**Quarterly report on the monitoring of  
nitrogen dioxide and  
airborne particulate matter in Albert St, Penzance**

**January 1<sup>st</sup> – March 31<sup>st</sup> 2008**

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Air Quality Unit, Cornwall College, TR15 3RD  
(CAQF@cornwall.ac.uk)

# Quarterly report on the monitoring of nitrogen dioxide and airborne particulate matter in Albert St, Penzance

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Commissioned: John Osborn, Scientific Officer, Penwith District Council, Cornwall.

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## 1.0 Introduction

Monitoring of three atmospheric pollutants has been ongoing at two sites in Penzance; sulphur dioxide (SO<sub>2</sub>) is monitored at Chyandour Cliff and is reported separately. Nitrogen dioxide (NO<sub>2</sub>) and airborne particulate matter (PM<sub>10</sub>) continuous monitoring in Albert Street began on the 12th April 2006 and stems from a long-term diffusion tube survey that indicated high concentrations of traffic-related pollution.

### 1.1 NO<sub>2</sub>

NO<sub>2</sub> is not only a health damaging pollutant but also a proxy measure for other traffic-related pollutants. The UK Government's National Air Quality Strategy (NAQS) objectives for NO<sub>2</sub> (DEFRA, 2000) are given in Table 1. As stated in the LAQM.TG(03) the NAQS annual mean objective applies to 'air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present'. The NAQS 1-hour mean objective is more specific and only applies to those locations where members of the public are regularly present for an hour or more, in locations close to heavily trafficked roads. Air Quality Consultants state that if an annual mean concentration exceeds 60 µg m<sup>-3</sup> then it is likely that the NAQS 1-hour mean objective would have been exceeded.

Table 1. NAQS objectives for nitrogen dioxide.

Nitrogen dioxide (NO <sub>2</sub> )	Measured as	Concentration
	Annual mean	40 µg m <sup>-3</sup>
	1-hour mean (18 annual exceedances)	200 µg m <sup>-3</sup>

### 1.2 PM<sub>10</sub>

Inhalable particulate matter, i.e. particulate matter with an aerodynamic diameter of less than 10 microns (PM<sub>10</sub>) is a pollutant with numerous detrimental health impacts. Like NO<sub>2</sub>, PM<sub>10</sub> is found in the vicinity of highly trafficked roads and particularly in 'canyon streets' where particulates can accumulate. The Government's National Air Quality Strategy objectives for inhalable particulate matter can be seen in Table 2.

Table 2. NAQS objectives for particulate matter.

Particulate matter (PM <sub>10</sub> )	Measured as	Concentration
	Annual mean	40 µg m <sup>-3</sup>
	24-hour mean 35 exceedances annually	50 µg m <sup>-3</sup>

## 2.0 Albert St, Penzance

A Signal continuous NO<sub>x</sub> and TEOM particulate monitor are positioned on a traffic island at the bottom of Market Jew Street at the junction with Albert Street (Figure 1). The area encompasses a busy junction surrounded by tall properties, including shops with residential properties situated above, adjacent to the road that create a 'canyon street'. As well as the canyon street effect, other characteristics including traffic lights, high traffic flow and steep inclines create an ideal environment for pollutants to accumulate.

### 3.0 Equipment

The Signal NO<sub>x</sub> box (Plate 1) monitors oxides of nitrogen and is a reference method acknowledged by regulators DEFRA. An NO<sub>2</sub> diffusion tube is collocated with the monitoring equipment in Albert Street; this records a monthly mean.

The Tapered Element Oscillating Microbalance (TEOM) particulate monitor is a DEFRA acknowledged reference method for monitoring PM<sub>10</sub>. The air intake for the TEOM monitor is heated to drive off water vapour, however this also can drive off volatile organic compounds (VOCs) and therefore DEFRA recommend applying a bias adjustment factor of 1.3 to the data.

Both monitors tag recorded data as 'valid' and 'invalid'; when the data is analysed all invalid data is removed. Invalid data is generally produced when the monitor is calibrating or when there is a temporary fault.



Figure 1. The red rectangle indicates the position of the Signal monitor in Albert Street, Penzance



Plate 1. The Signal NO<sub>x</sub> and TEOM monitors on the traffic island in Albert Street, Penzance.

## 4.0 Results

### 4.1 NO<sub>2</sub>

#### 4.1.1 3-month summary of NO<sub>2</sub> concentrations in Albert Street (1/1/2008 – 31/3/2008)

Table 3 summarises the data recorded by the Signal monitor in Albert Street between 1/1/2008 – 31/3/2008. For the 79.3 valid days monitoring period a mean NO<sub>2</sub> concentration of 32.4 µg m<sup>-3</sup> was recorded. A concentration >40 µg m<sup>-3</sup> was recorded for 37 % of the monitoring period.

Table 3. Summary of NO<sub>2</sub> data (1/1/2008 – 31/3/2008)

Start date	End date	No. of days	No. days valid data	%Data Capture	Maximum (µg m <sup>-3</sup> )	Mean (µg m <sup>-3</sup> )	Collocated Diffusion Tube Mean (µg m <sup>-3</sup> )
01/1/2008	31/3/2008	91	79.3	87.1	143.8	32.4	36.1*

\*January 2008 diffusion tube result missing.

#### 4.1.2 12-month summary of NO<sub>2</sub> concentrations in Albert Street (1/4/2007 – 31/3/2008)

Table 4 summarises the data recorded by the Signal monitor in Albert Street between 1/4/2007 – 31/3/2008. For the 326.2 valid days' monitoring period a mean NO<sub>2</sub> concentration of 35.0 µg m<sup>-3</sup> was recorded. A concentration >40 µg m<sup>-3</sup> was recorded for 38 % of the monitoring period.

Table 3. Summary of NO<sub>2</sub> data (1/4/2007 – 31/3/2008)

Start date	End date	No. of days	No. days valid data	%Data Capture	Maximum (µg m <sup>-3</sup> )	Mean (µg m <sup>-3</sup> )	Collocated Diffusion Tube Mean (µg m <sup>-3</sup> )
01/04/2007	31/3/2008	366	326.2	89.1	143.8	34.9	35.3

### 4.2 PM<sub>10</sub>

As mentioned above all values recorded by the TEOM monitor have been bias adjusted by a factor of 1.3 as recommended by DEFRA.

#### 4.2.1 3-month summary of PM<sub>10</sub> concentrations in Albert Street (1/1/2008 – 31/3/2008)

Table 5 provides a summary of data recorded by the TEOM monitor in Albert Street for the period 1/1/2008 – 31/3/2008. For the 84.6 valid days' monitoring period a mean PM<sub>10</sub> concentration of 32.3 µg m<sup>-3</sup> was recorded.

Table 5. Summary of PM<sub>10</sub> data (1/1/2008 – 31/3/2008)

Start date	End date	No. of days	No. days valid data	%Data Capture	Mean (µg m <sup>-3</sup> )
1/1/2008	31/3/2008	91	84.6	92.9	32.3

#### 4.2.2 12-month summary of PM<sub>10</sub> concentrations in Albert Street (1/4/2007 – 31/3/2008)

Table 6 provides a summary of data recorded by the TEOM monitor in Albert Street for the period 1/4/2007 – 31/3/2008. For the 343.6 valid days' monitoring period an mean NO<sub>2</sub> concentration of 29.1 µg m<sup>-3</sup> was recorded.

Table 6. Summary of PM<sub>10</sub> data (1/4/2007 – 31/3/2008)

Start date	End date	No. of days	No. days valid data	%Data Capture	Mean (µg m <sup>-3</sup> )
1/4/2007	31/3/2008	366	343.6	93.9	29.1

#### 4.2.3 24-hour exceedances of PM<sub>10</sub> concentrations

For the 12-month period ending 31/3/2008 a total of five exceedances of the NAQS 24-hour objective of 50 µg m<sup>-3</sup> were recorded of a permitted 35.

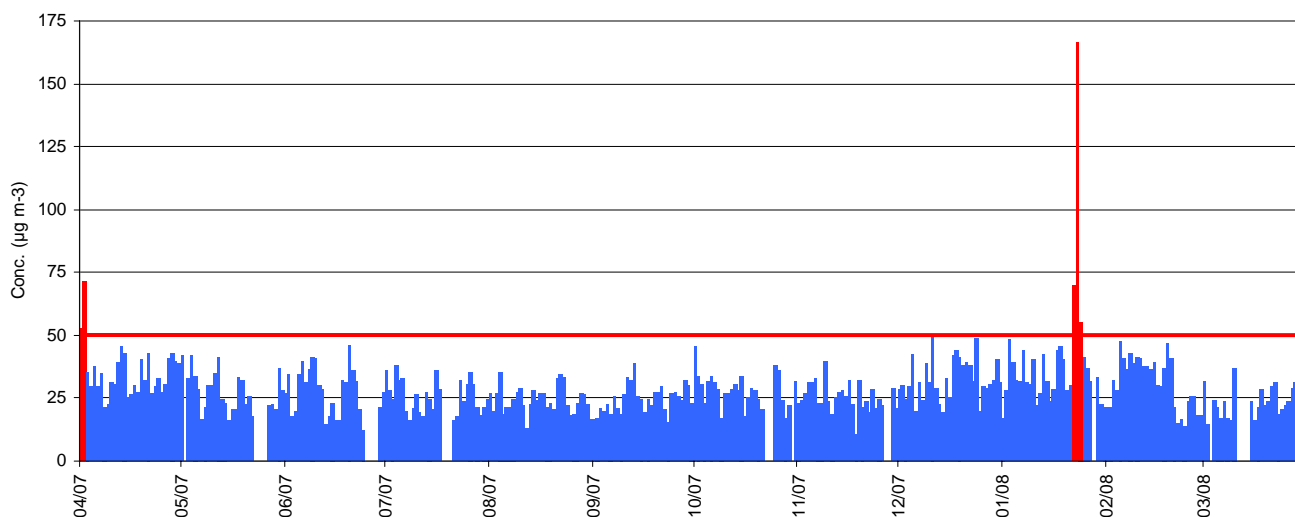


Figure 2. 24-hour mean PM<sub>10</sub> concentration recorded in Albert Street (1/4/2007 – 31/3/2008), NAQS 24-hour mean exceedances are highlighted in red.

## 5.0 Discussion

### 5.1 Exceedances

A mean NO<sub>2</sub> concentration of 32.4 µg m<sup>-3</sup> and 34.9 µg m<sup>-3</sup> was recorded in Albert Street for the 3-month and 12-month monitoring periods ending 31/3/2008 respectively. This does not exceed the NAQS annual mean objective value for NO<sub>2</sub> concentration and there were no exceedances of the NAQS 1-hour objective. The collocated diffusion tube recorded 3-month and 12-month values that also did not exceed the NAQS objectives with concentrations of 36.1 µg m<sup>-3</sup> and 35.3 µg m<sup>-3</sup> respectively. A good agreement is evident between the continuous and diffusion tube monitoring methods over the 12-months (Table 3).

A mean PM<sub>10</sub> concentration of 32.3 µg m<sup>-3</sup> and 29.1 µg m<sup>-3</sup> was recorded for the 3-month and 12-month monitoring period ending 31/3/2008; this did not exceed the NAQS annual mean objective value for PM<sub>10</sub> concentration of 40 µg m<sup>-3</sup>. There were five exceedances of the NAQS 24-hour PM<sub>10</sub> concentration mean, recorded on the 1-2 April 2007 and 22-24 January 2008, of a permitted 35 annually (Figure 2). It is suggested the source of the exceedances is national as exceedances were recorded simultaneously further along the south coast. The recorded PM<sub>10</sub> exceedances in January were as a result of a Saharan dust storm illustrated in Figure 3.

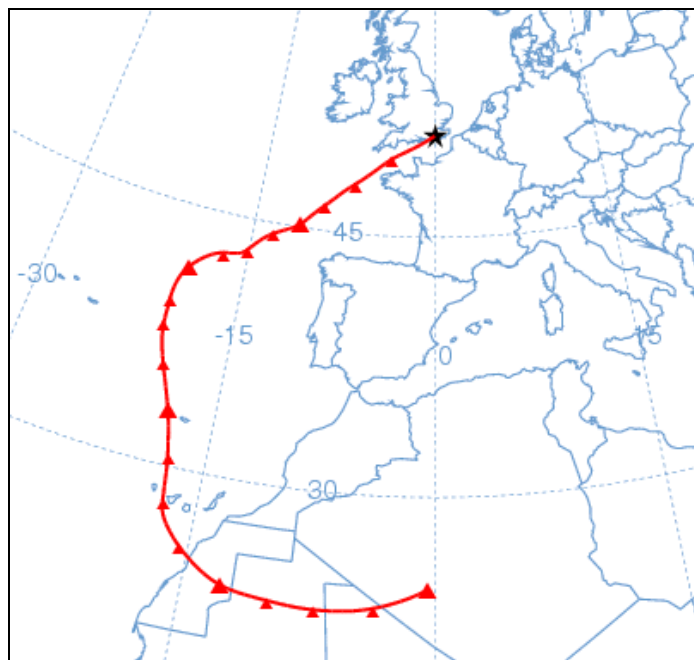


Figure 3. Trajectory of Saharan dust storm recorded on the 22-24 January 2008.

## 5.2 Data Capture

The Signal NO<sub>x</sub> monitor and TEOM had data capture values for the 3-month monitoring period ending 31/3/2008 of 87.1% and 92.9% respectively inclusive of automatic calibrations. The Signal monitor suffered data loss due to a software fault on the 11<sup>th</sup> – 17<sup>th</sup> March and resulted in the DEFRA data capture value of 90% (LAQM.TG(03)) not being met.

## 5.3 Diurnal Patterns

### 5.3.1 Diurnal NO<sub>2</sub> and PM<sub>10</sub> concentrations in Albert Street

#### Weekdays

The weekday mean NO<sub>2</sub> and PM<sub>10</sub> concentration recorded in Albert Street was 35.6 µg m<sup>-3</sup> and 33.8 µg m<sup>-3</sup> respectively for the period 1/1/2008 – 31/3/2008. Figure 3a plots the weekday diurnal NO<sub>2</sub> and PM<sub>10</sub> concentrations as a 15-minute mean.

#### Saturdays

The mean NO<sub>2</sub> and PM<sub>10</sub> concentration recorded on Saturdays in Albert Street for the period 1/1/2008 – 31/3/2008 was 37.2 µg m<sup>-3</sup> and 30.2 µg m<sup>-3</sup> respectively. Figure 3b plots the Saturday diurnal NO<sub>2</sub> and PM<sub>10</sub> concentrations as a 15-minute mean.

#### Sundays

The mean NO<sub>2</sub> and PM<sub>10</sub> concentrations recorded on Sundays in Albert Street for the period 1/1/2008 – 31/3/2008 was 29.4 µg m<sup>-3</sup> and 27.7 µg m<sup>-3</sup> respectively. Figure 3c plots the Sunday diurnal NO<sub>2</sub> and PM<sub>10</sub> concentrations as a 15-minute mean.

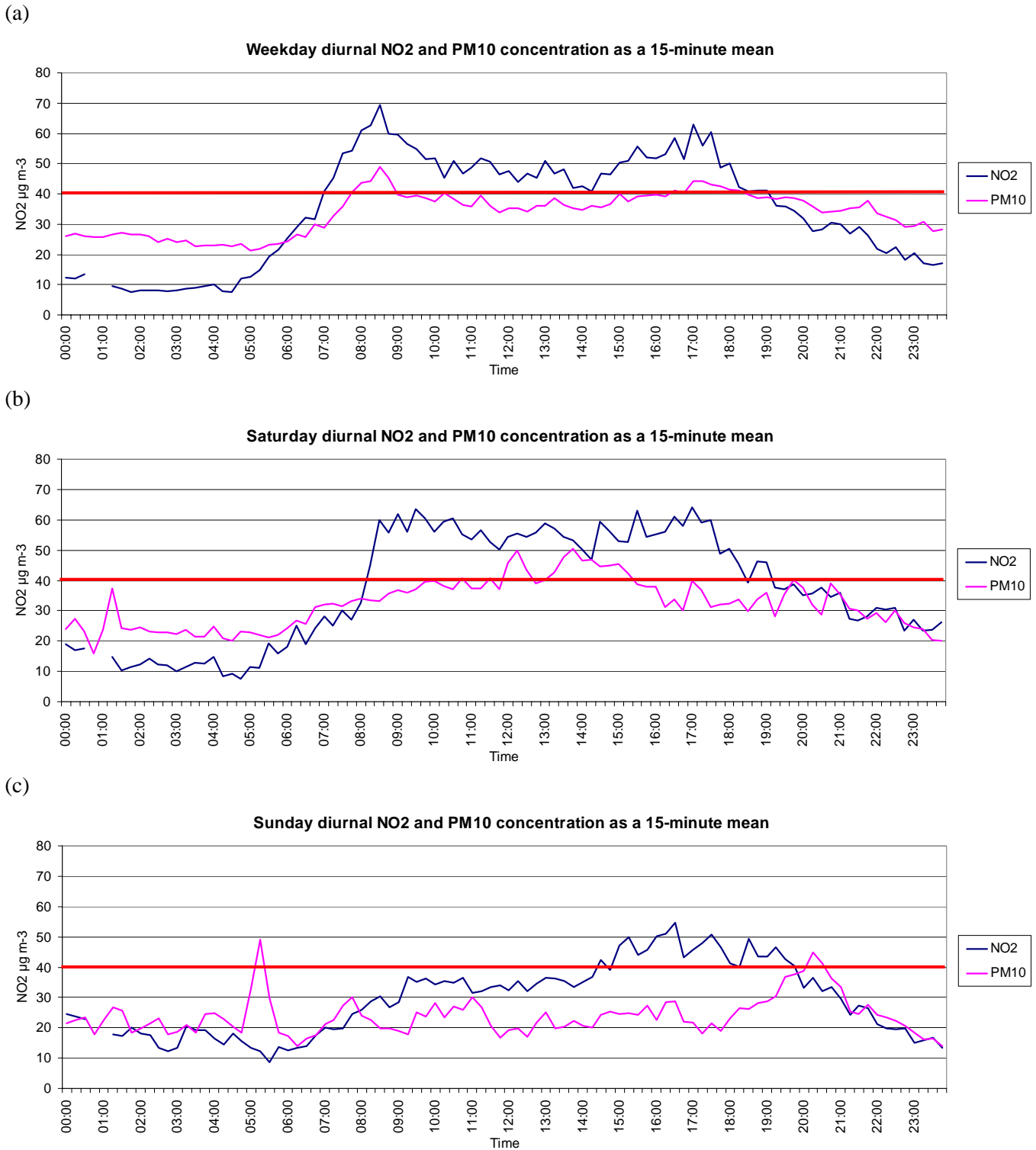


Figure 3. Diurnal NO<sub>2</sub> and PM<sub>10</sub> mean concentration recorded in Albert Street (1/1/2008 – 31/3/2008) on (a) weekdays, (b) Saturdays and (c) Sundays. The red line indicates the NAQS annual mean objective for both NO<sub>2</sub> and PM<sub>10</sub> concentration.

Diurnal patterns for NO<sub>2</sub> and PM<sub>10</sub> concentrations follow a traffic-related pollution scenario. That is, pollution increases from an overnight low to a daytime sustained period of high pollutant concentration before decreasing again in the evening, with weekday concentration amplitudes greater than that observed at weekends.

The relationship between NO<sub>2</sub> and PM<sub>10</sub> concentrations is related to the physical properties of the two pollutants; NO<sub>2</sub> is a gas and therefore disperses more rapidly than PM which is an aerosol that would accumulate and be resuspended. A large spike is evident in Figure 3c at ~05:00, this is as a result of a short-lived PM<sub>10</sub> event on the 30/3/2008 that reached maximum concentration of 121.7 µg m<sup>-3</sup> at 05:15.

## 6.0 Conclusion

- The mean NO<sub>2</sub> concentration recorded in Albert Street by the continuous monitor for the 3-month and 12-month periods ending 31/3/2008 was 32.4 µg m<sup>-3</sup> and 34.9 µg m<sup>-3</sup> respectively. These values do not exceed the NAQS annual objectives.
- The mean PM<sub>10</sub> concentration recorded in Albert Street by the continuous monitor for the 3-month and 12-month periods ending 31/3/2008 was 32.3 µg m<sup>-3</sup> and 29.1 µg m<sup>-3</sup> respectively; the NAQS annual mean objectives were not exceeded. Three exceedances of the NAQS hourly mean objective were recorded between 1/1/2008 – 31/3/2008 bringing the 12-month total hourly exceedances to five of a permitted 35.
- Data capture values for the 3-month monitoring period were 87 % and 93 % for the Signal and TEOM monitors respectively.
- A good agreement was evident between the continuous and diffusion tube monitoring methods over the 12-month monitoring periods.
- Diurnal patterns display a traffic-related pollution scenario.

### Confidentiality

All sampling results from the monitoring sites in Penwith District will be the property of Penwith District Council, and will be subject to strict confidentiality and not disclosed any third party without prior formal permission from Penwith District Council.

### Disclaimer

Cornwall College cannot accept any responsibility for the use to which the information is put nor for decisions, inferences or conclusions that are made on the basis on the information provided. No responsibility is taken for the accuracy of the sampling unless this is done under our own supervision.