

Nitrogen Dioxide Diffusion Tube Summary Report: Treliske, Truro

1st November 2008 to 30th October 2009

Prepared for Cornwall Council by;

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Commissioned by Mark Hitchens, Environmental Protection Officer, Cornwall Council

1.0. Introduction

1.1. History

As part of the National Air Quality Strategy (NAQS) the UK Government has set guidelines and objectives for local authorities defined under the Environment Act (1995) in regards to monitoring and management of ambient air quality. Under this framework, the Carrick District Council, which has now become part of Cornwall Council (CC), employed the Air Quality Unit (AQU) to undertake a series of nitrogen dioxide (NO₂) monitoring regimes to survey the area of Treliske along the A390 corridor into Truro. Contemporary surveys and reports of the area had indicated exceedences of traffic-related pollution standards (AQU 2009: AQU 2008) in the NO₂ levels defined by the Department for Environment, Food and Rural Affairs (Defra). This was then confirmed by the three month pilot survey carried out by the AQU by sampling undertaken between August and October, 2008.

On the 1st of November, 2008, the AQU started the Treliske survey along the A390 with a series of eight sampling sites located in the vicinity of Treliske. This 12-month survey continued till the end of October, 2009. Since the survey started, CC has initiated the installation of a permanent traffic-related pollution monitoring system at Treliske. This is scheduled to become operational in 2010.

In the area of Treliske there is little to no industrial output of NO₂, this suggests that most, if not all NO₂ detected in the immediate region is the result of traffic. Also, urban development of the Highertown area of Truro has been outlined in the 'Truro and Threemilestone Area Action Plan' - this proposal has set in place the goals towards the upgrade of infrastructure, and development of housing within the region, making the A390 route a potential 'hotspot' for traffic-related pollution, now and into the future.

With these plans for development comes the need to keep in place a scheme of monitoring to ensure good air quality for the area, and this report, and subsequent reports, will provide a foundation for the monitoring of changes in air in the region of Treliske, Truro.

1.2. The National Air Quality Strategy

Traffic pollution has been recognised as having the potential to be detrimental to health (RCEP 1994: BMA 1997), and one commonly found traffic pollutant is NO₂. As a gaseous compound, NO₂ is not only health damaging, but it can also be used as a proxy measurement for other traffic-related pollutants. The UK Government, through Defra, published the NAQS which set parameters for NO₂ (Table 1) to monitor and manage traffic-related pollution. This is in reference to the Environment Act Regulations, where it states that likely exceedences of the objectives should be assessed in relation to; "the quality of the 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". This has also been expressed in the *Local Air Quality Management Technical Guidance* (2009), or LAQM.TG (09), published by Defra.

Table 1. National Air Quality Strategy limit values for NO₂, taken from the LAQM.TG (09)

NO ₂	Concentration	Measured as
	200 µg m ⁻³	I-hour mean (not to be exceeded more than 18 times a year)
	40 µg m ⁻³	Annual mean

The annual and hourly mean objectives only apply to those locations where members of the public are regularly present for an hour or more. LAQM.TG (09) has clarified this by stating that if an annual mean concentration exceeds 60 µg m⁻³, then it is likely that the NAQS I-hour objective will have been exceeded.

1.3. Survey Location

Located to the west of Truro, the area of Treliske is found along the A390 (Figure 1) which is one of the primary access route into the city along with the A39 which enters from the east. The area of Treliske, and the A390 in general, has a high traffic volume with a Annual Average Daily Traffic (AADT) volume of about 27,428 (2009 figure). The Treliske area is also the location of the Royal Cornwall Hospital, County Hall, Richard Lander School, Truro College, a retail park and a supermarket. Treliske, as well as the Hightertown and Threemilestone areas, has additional housing development in-place within the area of the Gloweth Housing Estate. There is also pre-existing private housing and business offices/sites in the area, some of which are bordering the A390. This stretch of road also has many road junctions and road management infrastructure, such as traffic-lights, roundabouts, road safety control measures and pedestrian crossings all of which will filter and restrict traffic flow.

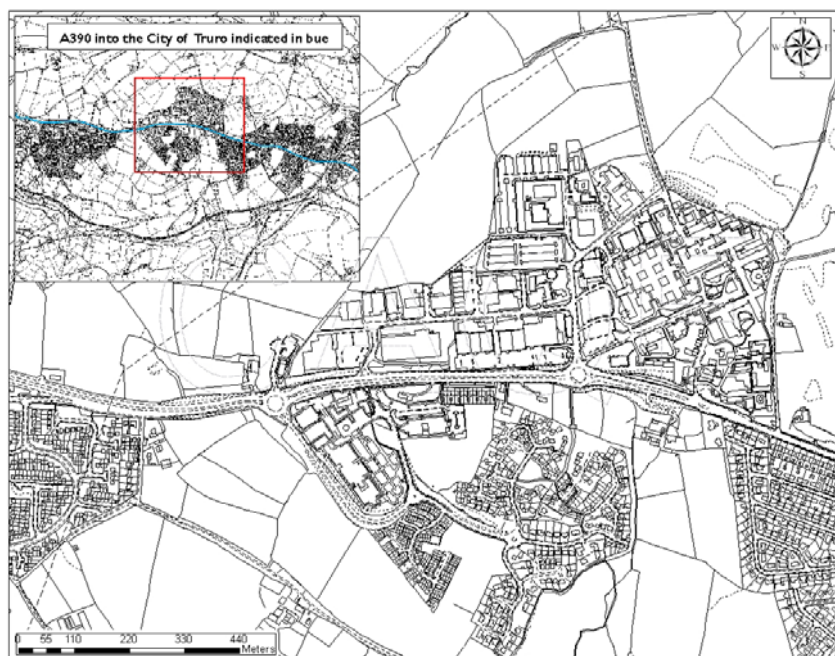


Figure 1. Map of Treliske (main), showing the A390 route through the area

2.0. Monitoring Equipment and Analysis

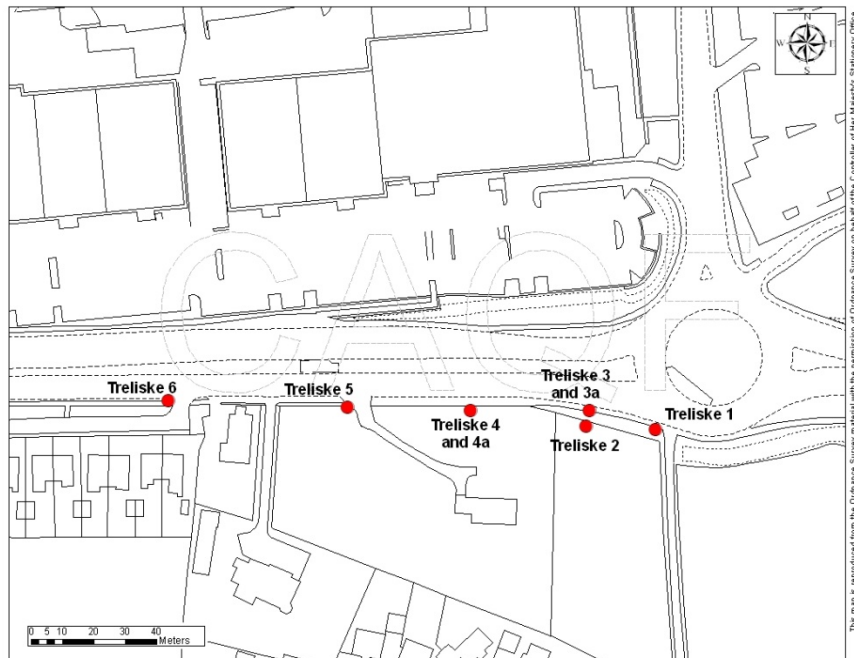


Figure 2. Locations of sampling sites in Treliske. Note: sites 3 and 4 are two samples at each site

The monitoring technique used was passive sampling using (Palmer) diffusion tubes. The tubes are deployed at selected sites around the Treliske area beside the heavily-trafficked A390 road (see Figure 2). Each tube gives NO₂ concentrations for the monthly period.

Sampling tubes are prepared and supplied by Gradko International, using 20% triethanolamine (TEA) in water as the sorbent. As laboratories perform differently (Laxen & Wilson 2002), Gradko was chosen as in a comparison exercise undertaken by the Workplace Analysis Scheme for Proficiency (WASP) programme, Gradko was awarded with a performance score of “Good” in 2009.

Passive diffusion samplers are a simple and cost effective form of indicative monitoring. However, diffusion tubes are known to equate a certain amount of inaccuracy when compared to active sampling techniques such as an automatic chemiluminescent monitor (which is stated by the European Union (EU) as the reference method for measurement of NO₂). Research (Defra 2003) has shown that diffusion tubes have exhibited both positive bias (defined as over-reading) and negative bias (defined as under-reading). Quality Assurance/Quality control (QA/QC) therefore requires a bias adjustment figure to be applied to all passive sampling data.

QA/QC national bias adjustment figures are derived by co-location studies between tube surveys and automatic analysis data from local authorities. Defra, and the devolved administrations as part of the LAQM process, have established a QA/QC support¹ system to allow for the calculation of the bias figure. In subsequent air quality reports, both the adjusted and non-adjusted figure can then be commented on to ensure QA/QC.

I. Available to download from <http://www.uwe.ac.uk/aqm/review/R&Asupport/diffusiontube050509.xls>

For Cornwall, triplicate tubes have been co-located with continuous monitors in a variety of locations around the County as part of CC's QA/QC, and the AEA Group's Diffusion Tube Precision, Accuracy and Bias spreadsheet¹ has been used to provide a local bias adjustment factor using data from these co-location studies. This can then be applied to tube results throughout Cornwall to give a more QA/QC guaranteed result. However, poor data capture has prevented Cornwall from calculating its own local factor figure for 2009 - therefore, the national 2008-09 figure of 0.91 was used for Treliske to ensure a good and adequate QA/QC in the reporting system. Subsequently, the 2008-09 National factor will be applied throughout this report, and this figure will be updated for future 2010 reports.

3.0. Results

As the results are based on a year's survey that does not follow the whole calendar year (i.e. 2009, January to December), data will be reviewed firstly by the year within 2008 and 2009's results, before an individual Annual 2008 and 2009 review and assessment.

3.1. Diffusion Tube Data for the One Year Period, November 2008, to October 2009

3.1.1. Monthly Results, non-bias Adjusted

The NO₂ concentrations for the Treliske survey are demonstrated in Table 2 and Figure 3.

Table 2. Results in micrograms per metre cubed ($\mu\text{g m}^{-3}$) for the 1-year survey, Treliske (red figures denoted those above the NAQS objective)

Location	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09
	$\mu\text{g m}^{-3}$											
TSK1	52.32	51.55	41.41	46.89	21.59	39.12	36.11	38.52	-	-	24.97	40.2
TSK2	30.38	29.09	28.59	36.92	14.25	28.71	22.92	21.27	22.99	19.88	31.55	26.84
TSK3	53.92	49.08	50.32	58.96	24.78	45.49	48.06	50.24	53.25	42.13	42.2	45.15
TSK3a	44.4	47.07	43.73	52.72	21.89	48.15	47.55	36.34	55.27	43.98	45.42	49.97
TSK4	57.39	55.59	53.74	52.62	29.48	48.62	47.55	53.39	54.75	42.03	50.45	59.51
TSK4a	60.16	60.87	52.57	59.62	-	55.67	56.7	49.23	53.68	41.52	54.19	52.98
TSK5	38.68	44.55	36.35	43.75	17.34	23.88	31.68	27.64	28.45	30.68	39.39	33.9
TSK6	40.59	54.18	37.78	45.91	22.97	35.28	-	35.71	-	-	40.91	36.61

Prior to bias adjustment, the objective figure for the NAQS annual mean of 40 $\mu\text{g m}^{-3}$ has been exceeded 54 times (56% of provided results). Data capture is 94% for the 12-month period. Confidence intervals for non-bias adjusted monthly NO₂ readings can be seen in Appendix One.

I. Available to download from www.airquality.co.uk/laqm/tools/AEA_DifTPAB_v03.xls

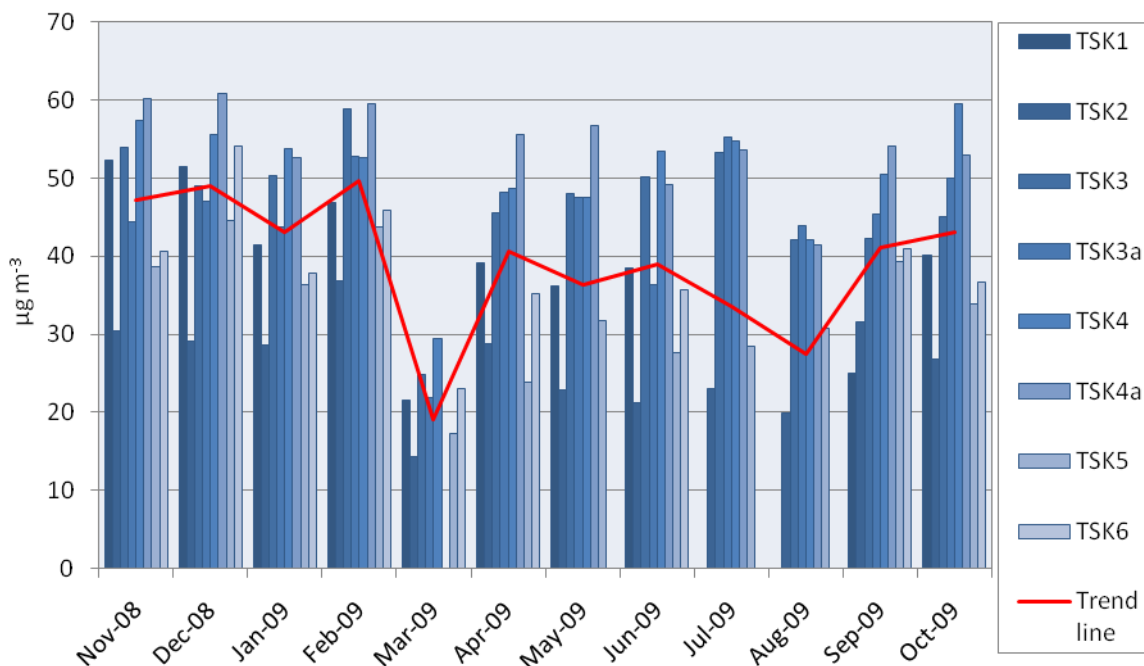


Figure 3. Bar Chart of the monthly NO₂ readings for all tubes, November, 2008, to October, 2009

Monthly characteristics of the collected data show a small amount of typical variation from each monthly readings with a slight lowering of NO₂ over the periods of March to August. March has shown to be the overall lowest month for NO₂ concentrations, whilst February has the highest monthly reading.

3.1.2. Monthly Results, Bias Adjusted

The bias adjusted NO₂ concentrations for the Treliske survey are demonstrated in Table 3 and Figure 4

Table 3. Bias adjusted results in micrograms per metre cubed for the 1-year survey, Treliske (red figures denoted those above the NAQS objective)

Location	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09
	$\mu\text{g m}^{-3}$											
TSK1	47.61	46.91	37.69	42.67	19.65	35.6	32.86	35.05	-	-	22.72	36.58
TSK2	27.65	26.47	26.02	33.59	12.97	26.12	20.86	19.35	20.92	18.09	28.71	24.43
TSK3	49.07	44.66	45.79	53.65	22.55	41.4	43.74	45.72	48.46	38.34	38.4	41.08
TSK3a	40.4	42.84	39.79	47.98	19.92	43.81	43.27	33.07	50.3	40.02	41.33	45.48
TSK4	52.23	50.59	48.9	47.88	26.83	44.25	43.27	48.58	49.82	38.25	45.91	54.15
TSK4a	54.75	55.39	47.84	54.25	-	50.66	51.59	44.8	48.85	37.78	49.31	48.21
TSK5	35.2	40.54	33.08	39.81	15.78	21.73	28.83	25.16	25.89	27.92	35.85	30.85
TSK6	36.94	49.31	34.38	41.78	20.9	32.1	-	32.49	-	-	37.23	33.32

The objective figure for the NAQS annual mean of 40 $\mu\text{g m}^{-3}$ has been exceeded 41 times (42% of provided results). Data capture is 94% for the 12-month period. Confidence intervals can be seen in Appendix One.

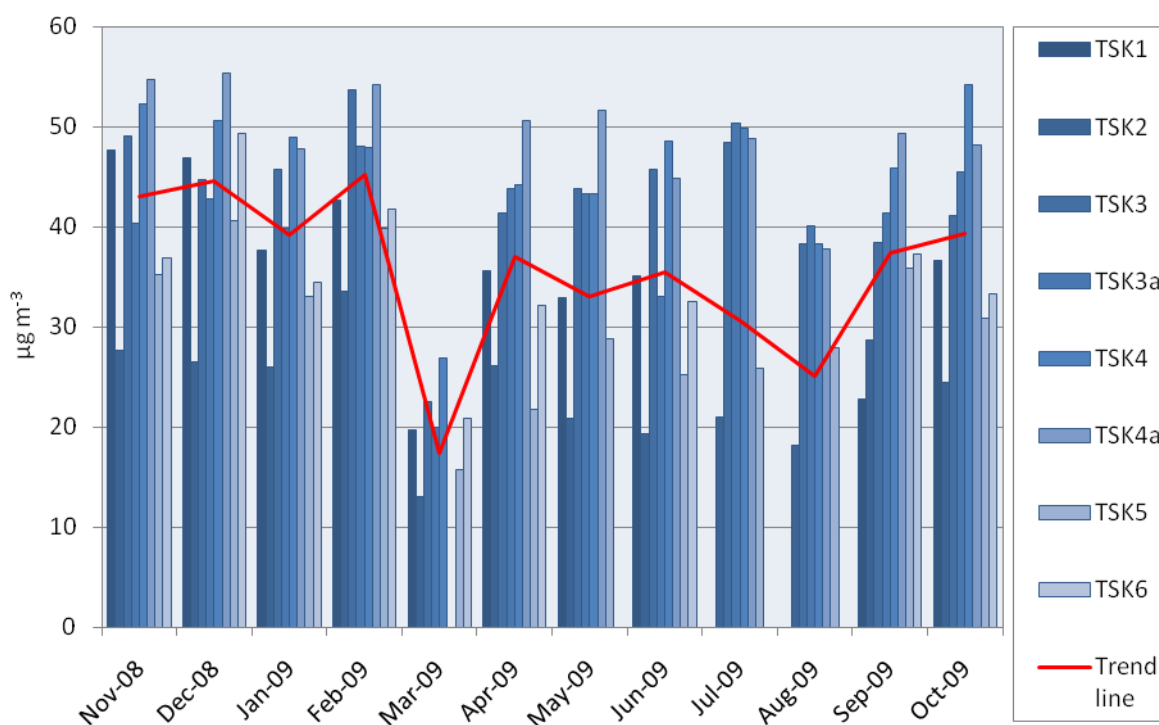


Figure 4. Bar Chart of the monthly NO₂ readings for all tubes, November, 2008, to October, 2009

Monthly characteristics of the bias adjusted data show a small amount of typical variation from each monthly readings. As with the non-bias adjusted data, March has shown to be the overall lowest month for NO₂ concentrations, whilst February has given the highest monthly reading.

3.2. Annual Survey

3.2.1. Yearly Results

Mean results of the 1-year survey can be seen in Table 4. The first year’s data has shown that in 2008, based on two month’s results (November and December, 2008), the NAQS objective of 40 µg m⁻³ has been exceeded five out of six months on the non-bias adjusted figures, and four out of six on the adjusted 2008 figures. 2009 data, based on ten month’s results (January to October, 2009), has shown the same objective has been exceeded twice on the non-bias adjusted figures, and twice on the adjusted figures.

Table 4. Yearly means in µg m⁻³ from diffusion tube readings for the Treliske survey

Location	2008		2009	
	µg m ⁻³			
	non-bias adjusted	bias adjusted	non-bias adjusted	bias adjusted
TSK1	51.93	47.26	36.1	32.85
TSK2	29.73	27.06	25.39	23.11
TSK3*	48.62	44.24	45.28	41.21
TSK4*	58.5	53.24	50.96	46.38
TSK5	41.61	37.87	31.31	28.49
TSK6	47.39	43.12	36.45	33.17

Taken as a one year survey, data from 2008 and 2009 a more representative assessment can be made. Table 5 demonstrates that the NAQS annual objective of $40 \mu\text{g m}^{-3}$ for NO_2 has been exceeded in locations Treliske 3 and Treliske 4 over the yearly period.

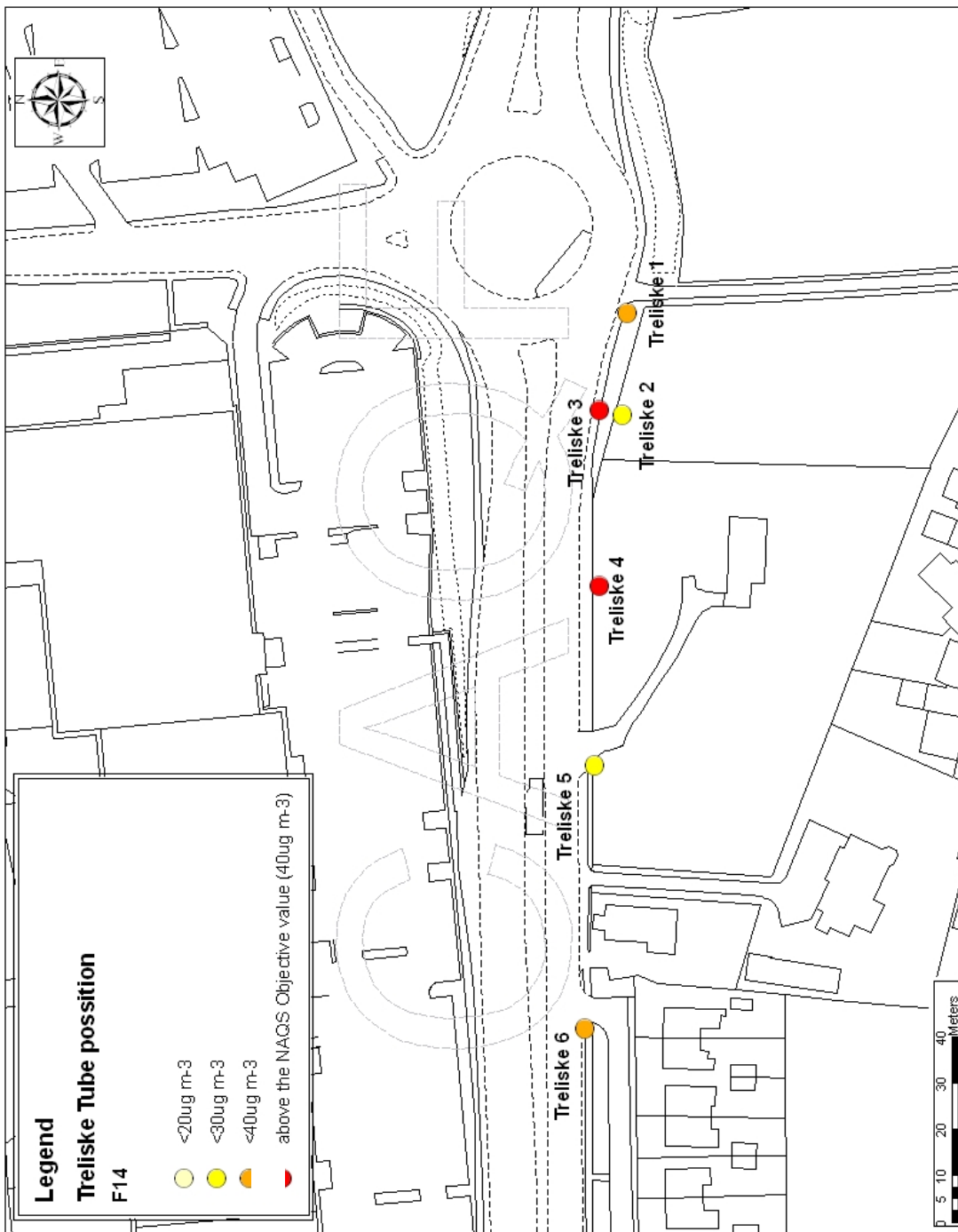
Table 5. NO_2 results in $\mu\text{g m}^{-3}$ for the yearly period from November, 2008, to October, 2009

Location	2008 & 2009 data as a 12- month total	
	$\mu\text{g m}^{-3}$	
	non-bias adjusted	bias adjusted
TSK1	39.27	35.73
TSK2	26.12	23.76
TSK3*	45.84	41.71
TSK4*	52.27	47.57
TSK5	33.02	30.05
TSK6	38.88	35.38

On both bias adjusted and un-adjusted mean readings, Treliske 4 has been shown to have high levels of NO_2 . Treliske 4 has the highest recorded levels of NO_2 over the whole monitoring period ($52.3 \mu\text{g m}^{-3}$ for non-bias adjusted and $47.6 \mu\text{g m}^{-3}$ for bias adjusted).

Figure 5 shows the first year's average NO_2 readings within Treliske, illustrating the relationship between location and pollutant levels.

*locations Treliske 3 and 4 are co-located sites, therefore a mean is calculated from the pair and shown as the single location result



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Figure 5. Tube positions and the first year's (November, 2008, to October, 2009) NO₂ levels, as a comparison against the NAQS Objective annual mean of 40 µg m⁻³

4.0. Conclusions

4.1. Exceedences

For the Treliske area, the roundabout between the Gloweth Estate, the industrial estate and the Royal Cornwall Hospital has shown an exceedence of the NAQS objective in two locations out of the six monitored for the sampling period November, 2008, to October, 2009. These have been one of $41.71 \mu\text{g m}^{-3}$ for Treliske 3, and the other of $47.57 \mu\text{g m}^{-3}$ for Treliske 4 (both bias adjusted).

2009's readings from the same six locations show that, to October, 2009, there have been two NAQS objective exceedences in the same locations. These were $41.21 \mu\text{g m}^{-3}$ at Treliske 3 and $46.38 \mu\text{g m}^{-3}$ at Treliske 4 (both bias adjusted).

4.2. National Air Quality Objective

Bias adjusted mean NO_2 readings for Treliske sites for 2008 and 2009, and 2009 are given in Figure 6.

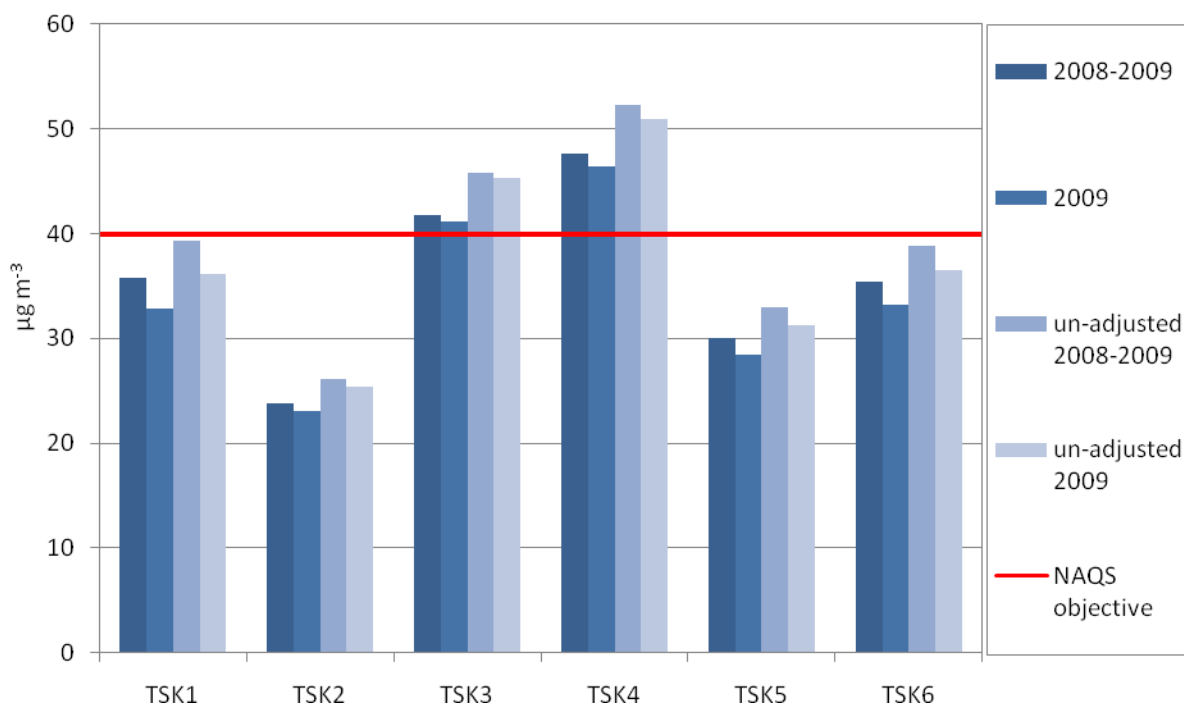


Figure 6. Bias adjusted mean NO_2 values for Treliske, by date

Figure 6 demonstrates that difference between 2008 and 2009's data combined, against 2009's singular data collection, is marginal at $\sim 1.5 \mu\text{g m}^{-3}$ for adjusted data and $\sim 1.65 \mu\text{g m}^{-3}$ for the non-bias adjusted data. Test sites Treliske 3 and 4 are both above the NAQS objective figure. Both Treliske 1 and Treliske 6 are coming close to this measurement of $40 \mu\text{g m}^{-3}$ also.

The trend shows a reduction in NO_2 , however, until the completion of the 2009 survey (January to December) a true assessment of 2009 values cannot be made. With the increase of infrastructure and associated passageway and constraints on the region, it is suggested that levels in NO_2 will increase in line with development.

5.0. Summary

- NO₂ concentrations in the Treliske area show that traffic related pollution has a significant impact on air quality.
- NO₂ levels have exceeded the NAQS objective figure at two of the six sites. Two other sites are noted as being of 'concern'
- Future reports will have to take into account the changes to the volume of traffic brought on by the development plans to the region. This may, require the possible expansion of the survey's data capture perimeters to accommodate this.

6.0. References

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Confidentiality

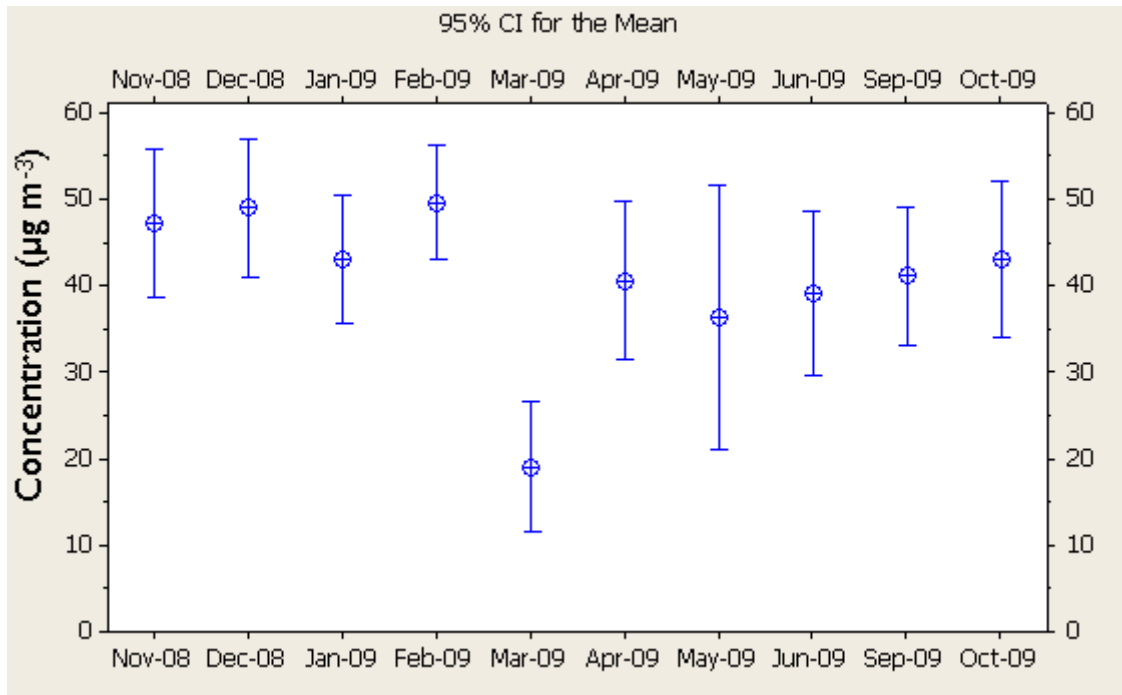
All sampling results from the monitoring sites in the Treliske survey will be the property of Cornwall Council, and will be subject to strict confidentiality with no disclosure to any third party without prior and formal permission from the appropriate council bodies.

Disclaimer

Neither the Air Quality Unit, nor its employees, can accept any responsibility for where decision making, inferences or conclusions are based on information gained from this report. No responsibility is taken for the accuracy of the sampling unless this is done under our own supervision.

Appendix I

1. 95% confidence interval for the monthly means of Treliske, November 2008 to October, 2009



2. 95% confidence interval for the monthly bias adjusted means of Treliske, November 2008 to October, 2009

