
Nitrogen Dioxide Diffusion Tube Survey in Dublin: 2016 - 2017



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ASSESSMENT OF THE VARIATION OF NITROGEN DIOXIDE LEVELS AT VARIOUS SITES IN DUBLIN

INTRODUCTION

Nitrogen dioxide is an air pollutant that belongs to a group of gases known as the oxides of nitrogen (NO_x). These are produced during combustion at high temperature and the typical sources of NO_x include electricity generation and traffic fumes. Most NO_x emissions are comprised of nitric oxide (NO) with 5 – 10% comprising nitrogen dioxide (NO₂). Elevated nitrogen dioxide affects human health, as it is an irritant to the respiratory system. Diesel engines tend to emit a higher percentage of nitrogen dioxide than petrol engines.

The concentrations of nitrogen dioxide within urban areas can vary dramatically over the course of a short distance. The concentrations depend on several factors including traffic levels, types and ages of vehicles, direction of traffic flow, topography, street canyons etc.

The purpose of this study is to gain a better understanding of nitrogen dioxide levels at various locations in Dublin city centre which are impacted heavily by traffic levels. These sites were chosen in conjunction with Dublin City Council.

The assessment techniques applied are indicative only, giving an estimate of longer term average NO₂ concentrations within the vicinity of the points monitored. Any exceedances of the EU annual limit value of 40µg/m³ are indicative only and suggest the need for investigation such as additional monitoring / modelling studies to assess the extent of exceedance.

Legislative requirements

The Clean Air for Europe Directive, (CAFE, 2008/50/EC), details the legislative requirements of member states with regards to assessment of air quality across air quality zones. Within Ireland, there are four air quality assessment zones – Zones A(Dublin), B(Cork), C (cities / towns >15,000), D (remainder of the country). For more information on the national ambient air quality monitoring network and details on recent annual air quality reports please access www.epa.ie/air .

The EPA are in the process of coordinating an expansion of the ambient air monitoring network in Ireland. The results from indicative tubes studies provide additional information on the concentration of NO₂ at locations beyond the fixed monitoring network, and is assisting in plans to locate future monitoring sites. Details concerning the National Ambient Air Monitoring Programme 2017 – 2022 can be accessed at the following link <http://www.epa.ie/pubs/reports/air/quality/> .

METHOD: DIFFUSION TUBE SAMPLING

Indicative NO₂ concentrations were determined using passive diffusion tube samplers throughout this survey. The diffusion tubes consist of a small plastic tube which contains a chemical reagent to absorb NO₂ directly



FIGURE 1 NO₂ DIFFUSION TUBE

from air. Diffusion tubes are inexpensive and can be positioned over a wider area to get a greater picture of NO₂ levels within a local area. Results from diffusion tubes have a higher level of uncertainty than concentrations measured using the CEN approved standard reference method, and for this reason they are categorised as an ‘indicative’ monitoring technique.

The diffusion tube method entails deploying small passive samplers (Figure 1) at various sampling points. The tubes are then returned to the laboratory for analysis after approximately 1 month of exposure. The diffusion tubes for this survey were supplied and analysed by Gradko International Ltd. The tubes were prepared using the 50% TEA in acetone preparation method.

All results have been corrected and converted to an annual average where required before being presented. For quality control purposes, co-located tubes were deployed at the sample inlet locations at 3 existing air quality monitoring sites.

SAMPLING LOCATIONS

Figure 2 displays the sampling locations used in 2016 in Dublin. Monthly samples were taken for a period of 7 months.

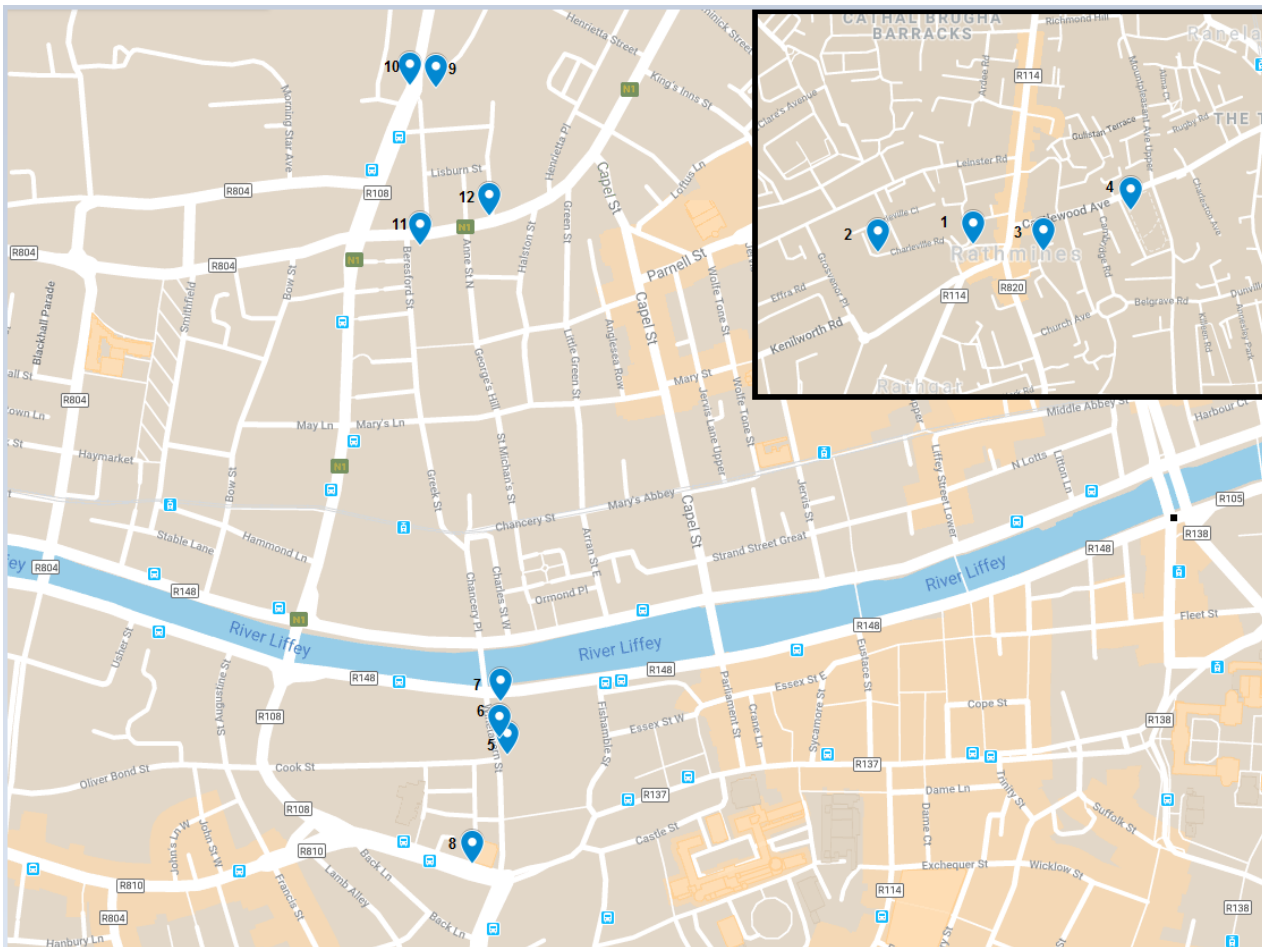


FIGURE 2 2016 DIFFUSION TUBE LOCATIONS IN DUBLIN CITY CENTRE AND RATHMINES(INSET)

Figure 3 displays the location of tubes in Dublin for 2017. Monthly samples were taken for a period of 10 months.

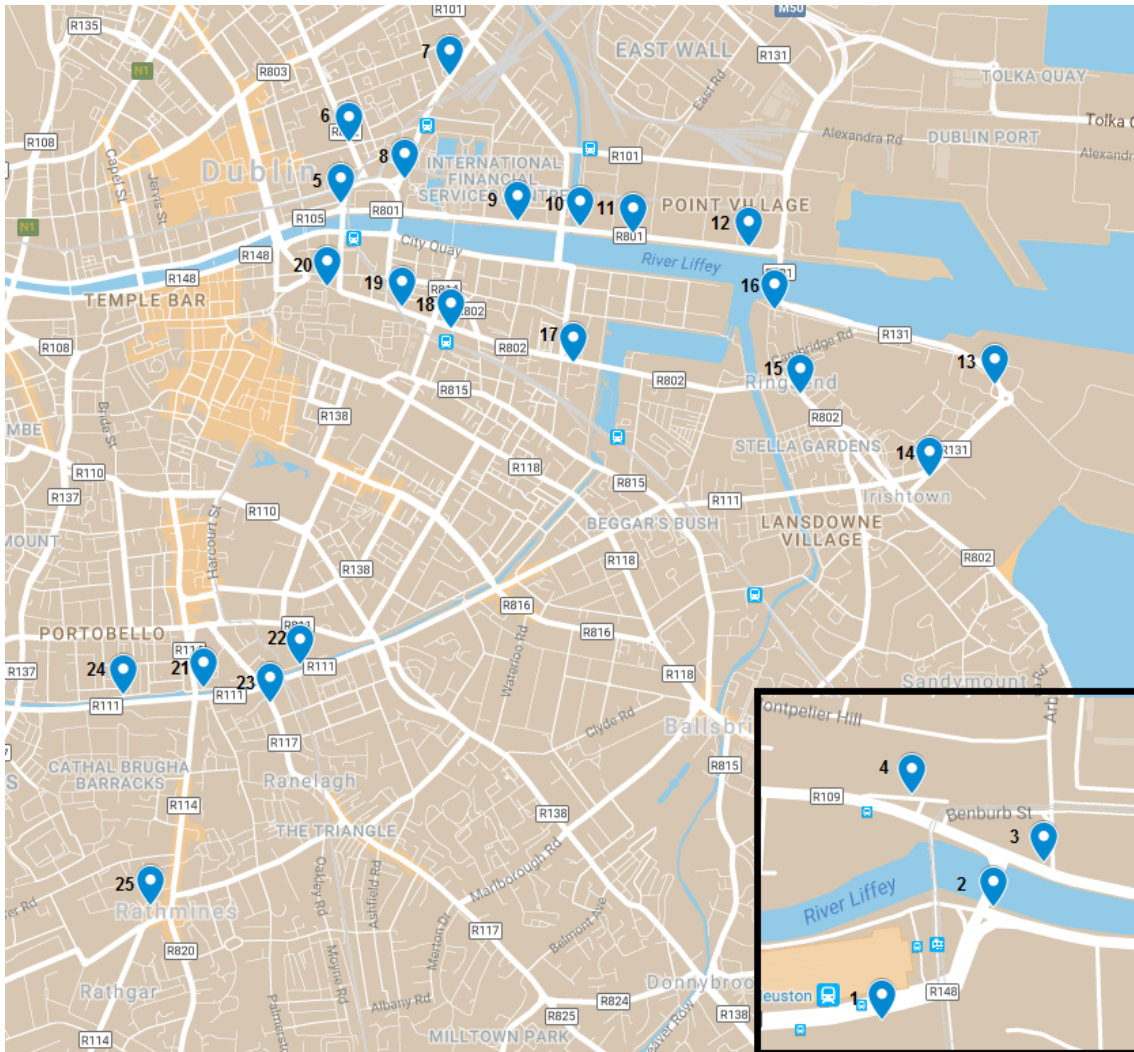


FIGURE 3 2017 DIFFUSION TUBE LOCATIONS IN DUBLIN CITY CENTRE AND ISLANDBRIDGE(INSET)

Data handling and quality control

Tubes were collocated at several existing air monitoring sites to provide a comparison to a CEN approved standard reference method. The CEN method used for NO₂ measurement is chemiluminescence. Each monthly batch of tubes also contained 3 blank samples that were returned with the tubes and analysed. The purpose of this was to identify any issues with the transport of tubes from user to laboratory.

Bias adjustment and annualisation of results have been done in accordance with UK Local Air Quality Management Guidance TG16.

Site Classification

The classification of different sampling sites into three broad categories are detailed in Table 1 below. These classification descriptions are based on siting criteria as listed in Annex VII of the CAFE Directive¹. These classifications allow the observed concentrations from different locations to be compared to each other.

TABLE 1 STATION CLASSIFICATION DESCRIPTION

Type	Definition
Urban Traffic	<10m from the kerbside. Representative of 100m section of roadway and >25m from traffic junction
Urban Background	Places in urban areas where levels are representative of the exposure of the general urban population
Suburban Background	Places in the outskirts of agglomerations where levels are representative of the exposure of the general population

RESULTS AND DISCUSSION

The following section details the results observed for each year during the survey. Summary statistics and graphical representations are also provided.

Table 2 details the annualised mean NO₂ concentrations for the locations assessed in 2016. The lowest data capture (percentage of monthly tubes samples recovered) observed was at the Rathmines Suburban background station – unfortunately the November and December tubes at the site were missing. The Belgrave Square location was missing one monthly tube, while all other locations had a data capture of 100%.

With regards to the 2016 results, the annualised average concentrations ranged from 19.0ug/m³ (Castlewood Place, Dublin 6) to 49.1ug/m³ (Woodquay, Dublin 2). In general, the lower concentrations were observed at suburban background locations while the urban centre locations and traffic classified sites showed higher levels. When compared to the legislative limit value, only Woodquay showed an indicative value higher than the annual NO₂ limit value of 40ug/m³ requiring further investigation. For illustrative purposes, Figure 4 presents a bar chart of the mean annualised bias corrected concentrations for each location in 2016.

¹ CAFE Directive <https://www.epa.ie/pubs/legislation/air/quality/airqualitycleanairforeuropedirective200850ec.html>

TABLE 2 2016 NITROGEN DIOXIDE DIFFUSION TUBE RESULTS

Location	Classification Type	Method	Data Capture (%)	Result ($\mu\text{g}/\text{m}^3$)
1 Rathmines Station	Suburban Background	Diffusion Tube (CEN monitor)*	71 (100)	20.6 (20.0)
2 Charleville Road	Suburban Background	Diffusion Tube	100	21.7
3 Castlewood Place	Suburban Background	Diffusion Tube	100	19.0
4 Belgrave Square	Suburban Background	Diffusion Tube	86	24.6
5 Winetavern Station*	Urban Traffic	Diffusion Tube (CEN monitor)	100 (100)	30.2 (33.0)
6 Winetavern Recycling	Urban Traffic	Diffusion Tube	100	38.9
7 Woodquay	Urban Traffic	Diffusion Tube	100	49.1
8 High Street	Urban Traffic	Diffusion Tube	100	38.2
9 Coleraine Street Station	Urban Background	Diffusion Tube (CEN monitor)	100 (100)	28.7 (27.6)
10 Catherine Lane	Urban Traffic	Diffusion Tube	100	35.5
11 Bolton Street South	Urban Traffic	Diffusion Tube	100	34.5
12 Bolton Street North	Urban Traffic	Diffusion Tube	100	34.7

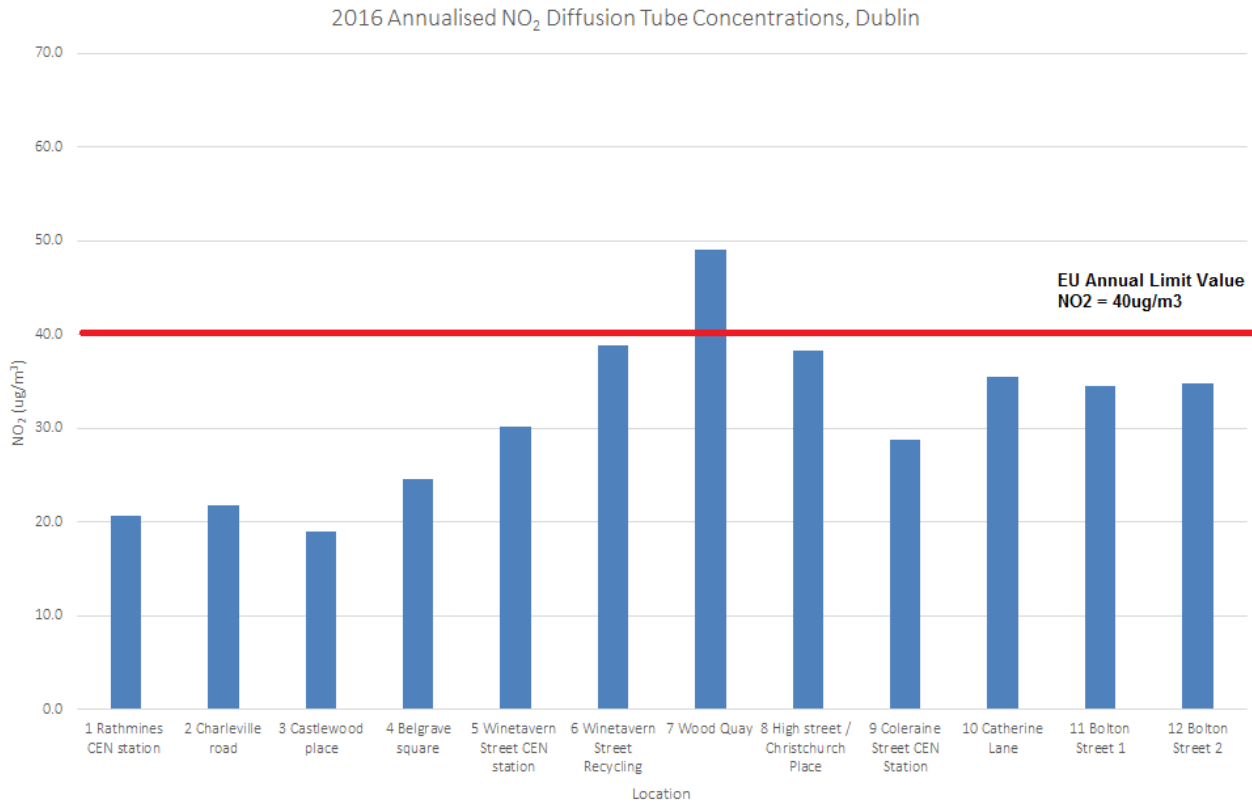


FIGURE 4 ANNUALISED NO₂ DIFFUSION TUBE CONCENTRATION IN 2016

Table 3 details the annualized mean bias adjusted NO₂ concentrations for the locations assessed in 2017. The concentrations ranged from 16.9 µg/m³ (Wynnefield Road, Dublin 6) to 64.4 µg/m³ (Pearse Street, Dublin 2). The lowest concentrations were observed at the suburban background location while the urban centre locations and traffic classified sites showed higher levels. When compared to the legislative limit value, eleven locations showed an indicative value higher than the annual nitrogen dioxide limit value of 40 µg/m³ requiring further investigation. For illustrative purposes, Figure 5 presents a bar chart of the mean annualized concentrations at each location. The performance of the collocated diffusion tubes at Rathmines was within 10% of the CEN monitored average.

TABLE 3 2017 NITROGEN DIOXIDE DIFFUSION TUBE RESULTS

Number	Location	Classification Type	Data Capture (%)	Result (µg/m3)
1	St Johns Road, D8	Urban Traffic	100	53.6
2	Victoria Quay, D8	Urban Traffic	100	52.3
3	Wolfe Tone Quay, D8	Urban Traffic	100	48.4
4	Benburb Street, D8	Urban Background	100	30.2
5	Old Abbey Street, D1	Urban Traffic	90	37.8
6	Gardiner Street Lower, D1	Urban Traffic	90	49.8
7	Amien Street North, D1	Urban Traffic	90	46.1
8	Amien Street South, D1	Urban Traffic	100	45.0
9	North Wall Quay 1, D1	Urban Traffic	100	47.8
10	North Wall Quay 2, D1	Urban Traffic	100	35.6
11	North Wall Quay 3, D1	Urban Traffic	100	39.9
12	North Wall Quay 4, D1	Urban Traffic	70	37.2

Number	Location	Classification Type	Capture Rate (%)	Result ($\mu\text{g}/\text{m}^3$)
13	Pigeon House Road, D4	Suburban Background	100	24.3
14	Sean Moore Road, D4	Suburban Traffic	100	20.2
15	Ringsend Fitzwilliam Street, D4	Suburban Traffic	80	29.2
16	York Street, D4	Suburban Background	90	18.4
17	Pearse Street 1, D2	Urban Traffic	100	45.3
18	Pearse Street 2, D2	Urban Traffic	100	46.0
19	Pearse Street 3, D2	Urban Traffic	100	50.8
20	Pearse Street 4, D2	Urban Traffic	100	64.4
21	Charlemont Mall, D2	Suburban Background	100	23.8
22	Charlemont Place, D2	Suburban Background	70	21.2
23	Ranelagh Road, D6	Suburban Traffic	100	18.6
24	Kingsland Parade , D2	Suburban Background	100	28.9
25	Wynnefield Road , D6	Suburban Background	100	16.9 *

*Diffusion tubes were collocated with the CEN NO₂ monitor at Wynnefield Road. Average from the CEN monitor for the corresponding period was 15.4 $\mu\text{g}/\text{m}^3$

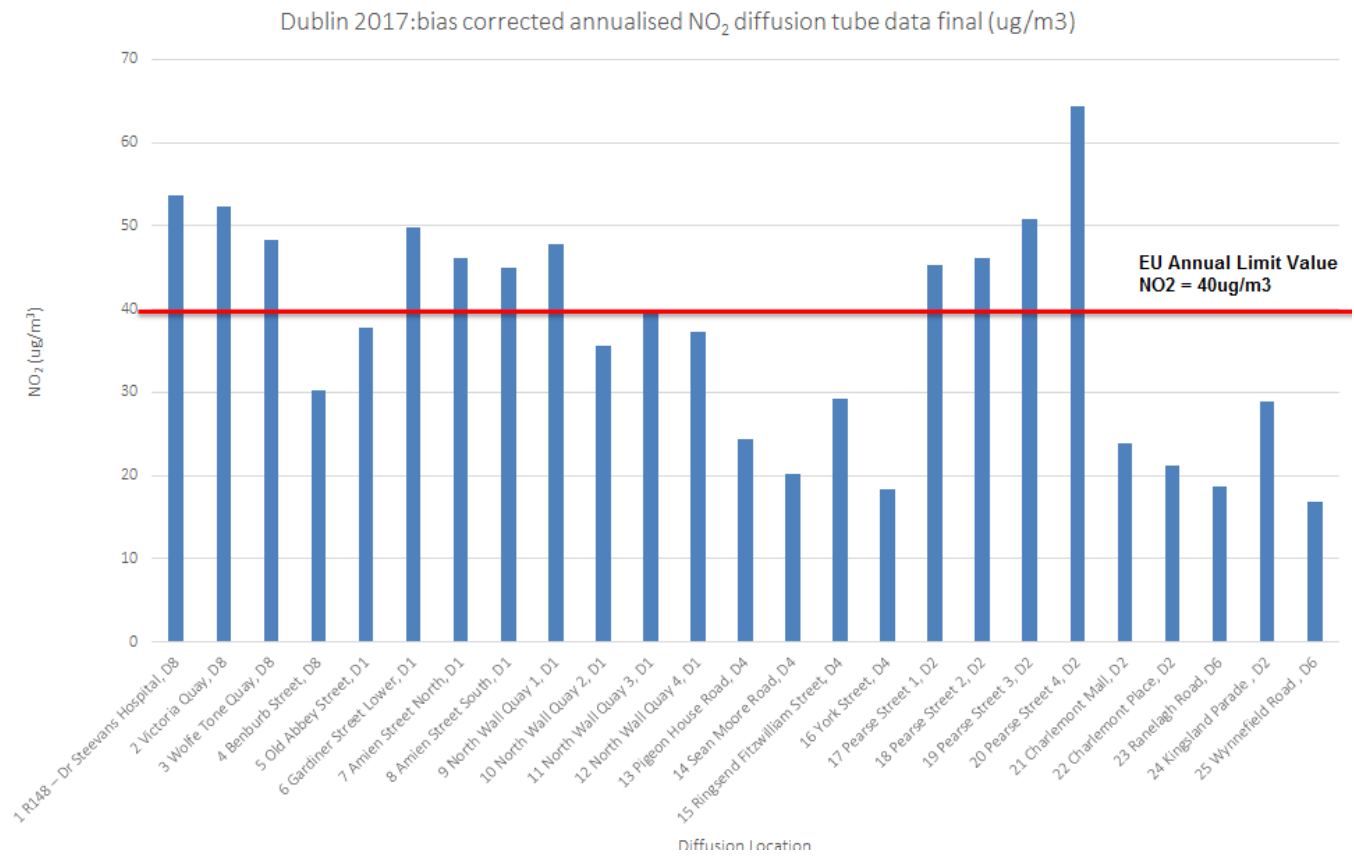


FIGURE 5 ANNUALISE NO₂ DIFFUSION TUBES CONCENTRATIONS IN 2017

CONCLUSIONS

The main conclusions of the 2016 - 2017 Dublin NO₂ diffusion tubes assessment are:

- Concentrations of NO₂ were highest at urban traffic locations and lowest at the suburban background location. The highest mean annualised NO₂ concentration measured during the 2-year survey was 64.4µg/m³ at Pearse Street Dublin 2 followed by St Johns Road West, Dublin 8.
- An indicative value for NO₂, higher than the EU NO₂ annual limit value of 40µg/m³ was recorded at 1 of the 12 locations assessed in 2016, while 11 of the 25 locations assessed in 2017 indicatively exceeded this level. This highlights the significant impact that current traffic volumes within the city are having on the locations assessed. This investigation links to the expansion of the national monitoring network and modelling activities as part of the National Ambient Air Quality Monitoring Programme 2017 – 2022 (AAMP).
- The diffusion tube method when compared to the CEN method was within 10% of the study average at the Rathmines site highlighting the suitability of the technique for future use in Dublin and other urban areas in Ireland.



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