

# Air Quality Appraisal for Bray Parish Council - Summer Report - August 2022

Prepared by Dr Ashley Mills and Prof Stephen Peckham, Centre for  
Health Services Studies, The University of Kent. 23/08/22

Contact: [ajsm@kent.ac.uk](mailto:ajsm@kent.ac.uk)

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## 1. Introduction

The Centre for Health Services Studies (CHSS) has been contracted by Bray Parish Council to provide an appraisal of Nitrogen Dioxide (NO<sub>2</sub>) diffusion tube measurements made by Bray Parish Council on advice of CHSS. This document sets out the context for the work in terms of local authority measurements made by Royal Borough of Windsor and Maidenhead (RBWM) and local Air Quality Management Areas (AQMAs).

This is a follow-on from an interim report published at the end of 2021. A full year of data has now been gathered and the bias factor adjustment values are also available for 2021. The bias factor 0.78 has been used as per the Defra LAQM bias factor spreadsheet [1] for 2021.

It is worth observing that the process of bias correction is not very accurate and can (approximately 30% of the time) produce results that are less accurate than not bias correcting [2]. And for example, among the 25 co-location studies that were used by Defra to derive the 2021 bias correction factor, the bias factors range from 0.67 to 1.08. We don't actually know what the bias correction factor would be in our case. Thus the unbiased results are also presented here with the expectation that typically they would bias toward the upper end of likely results but in some instances may be more accurate.

It is important that local authorities look at the overall picture that diffusion tube results paint, given the inherent uncertainty of the technology, and should consider all high results, including those which are unbiased, with appropriate concern.

## 2. Summary of results / recommendations

Bray Parish is situated in an area with poor air quality. At the present time the only focus from RBWM is on the Bray AQMA area and the high values observed therein. However, air quality should be a broader concern in the Parish, as shall be shown below.

Bray Parish Council has monitored NO<sub>2</sub> at 8 locations in the parish via diffusion tube technology, and currently has ratified results for July 2021 through to June 2022. Figure 1 summarises the results obtained so far and shows the results annualised to give a 2021 mean, the bias adjusted results are also shown in brackets (see the caveat below).

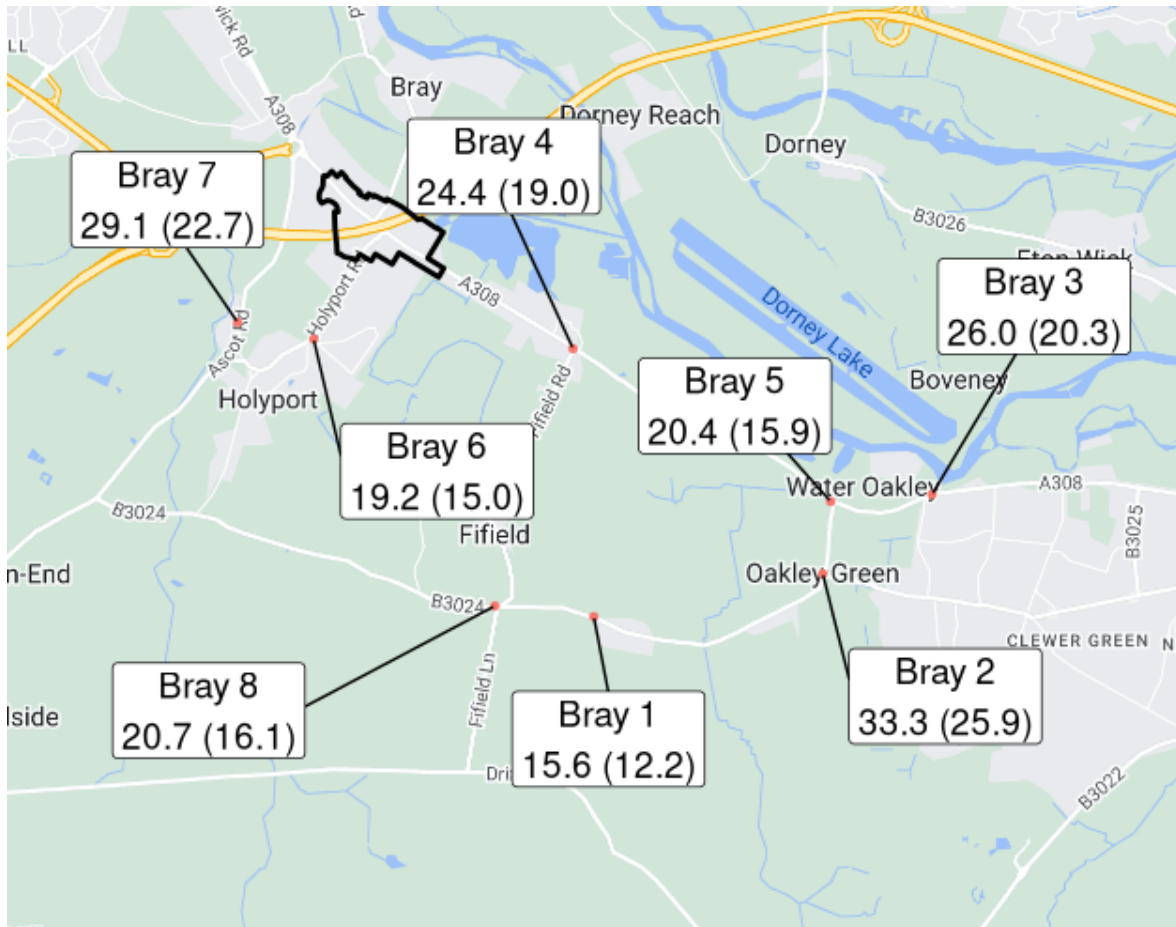


Figure 1 - Results for NO<sub>2</sub> diffusion tubes for 2021. Annualised results shown with bias corrected results shown in brackets. All values are in µg/m<sup>3</sup>.

Given the uncertainty surrounding bias adjustment [2] it is reasonable to think of the values given in the above figure as approximate bounds on expected real values and should be considered indicative of areas that warrant further attention.

At the lower and upper bounds, all of the results exceed the WHO guidelines for health (see Appendix C of this document) for NO<sub>2</sub> of 10 µg/m<sup>3</sup> as an annual mean. The problem varies from 1.5 times the guideline to 3.3 times the guideline. Clearly air quality is a public health issue across the parish and not just in the AQMA. RBWM needs to pay more attention to these areas and instigate its own monitoring regime.

Special care should be taken when considering planning issues that this information is properly accounted for.

Locations Bray 2 and Bray 7 are the highest observed and should be given special consideration by RBWM. Given the results of Bray 3 and Bray 4 it would also be sensible to consider further monitoring along the A308.

The highest monthly value observed so far has been at Bray 7 for October 2021 with a raw value of 38.3 µg/m<sup>3</sup>, 3.8 times the WHO guideline for health.

When a full calendar year of reference data is available for 2022, we will compute and report a calculated annual average for 2022.

### 3. Parish context

Figure 2 shows the parish of Bray in the context of RBWM regional authority along with the AQMAs that belong to this authority.



Figure 2 - Bray Parish in the context of RBWM and its AQMAs

The parish of Bray has an AQMA within it as shown in Figure 3 and Figure 4.

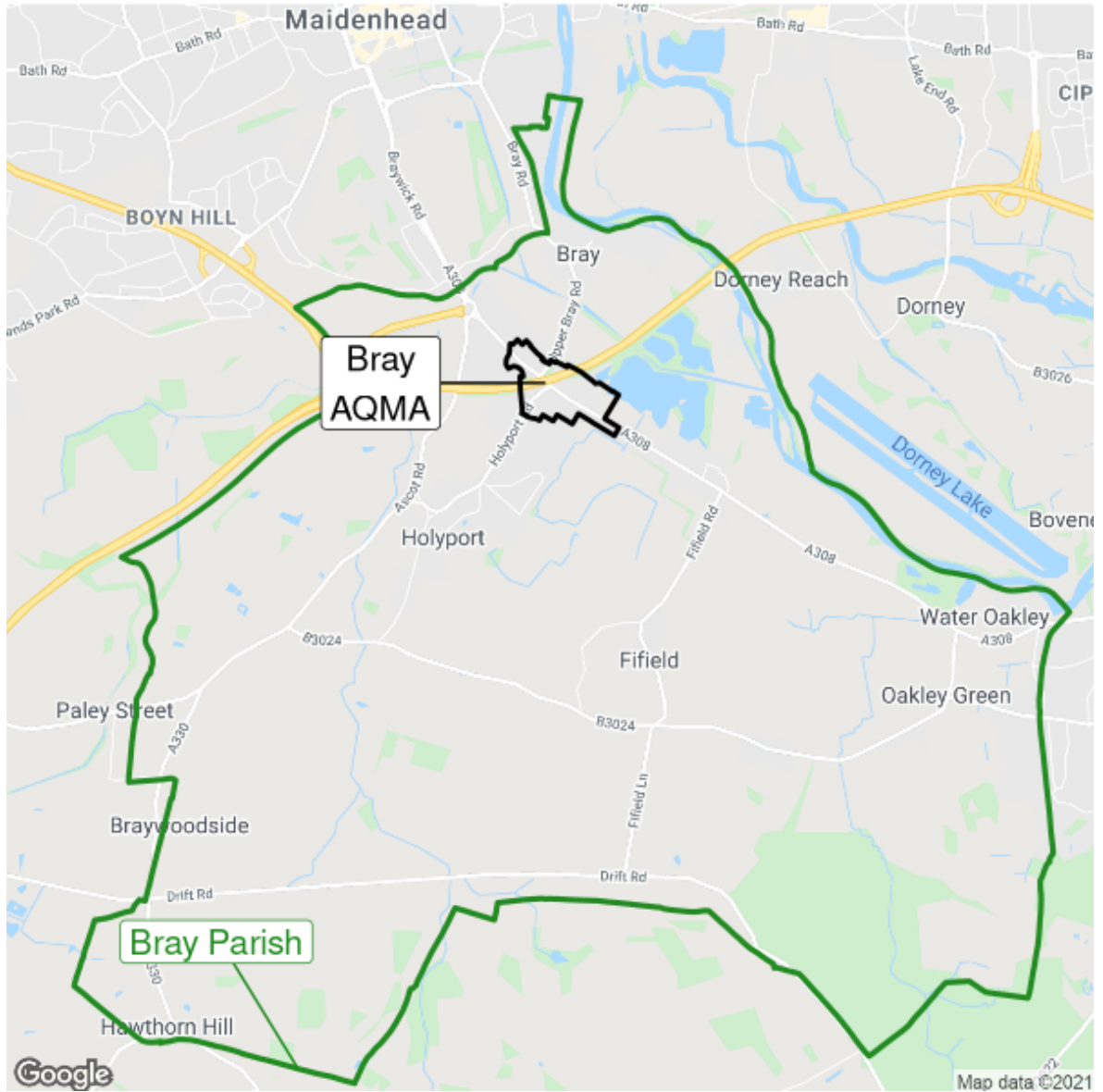


Figure 3 - Bray Parish and the Bray AQMA which falls within its boundary.

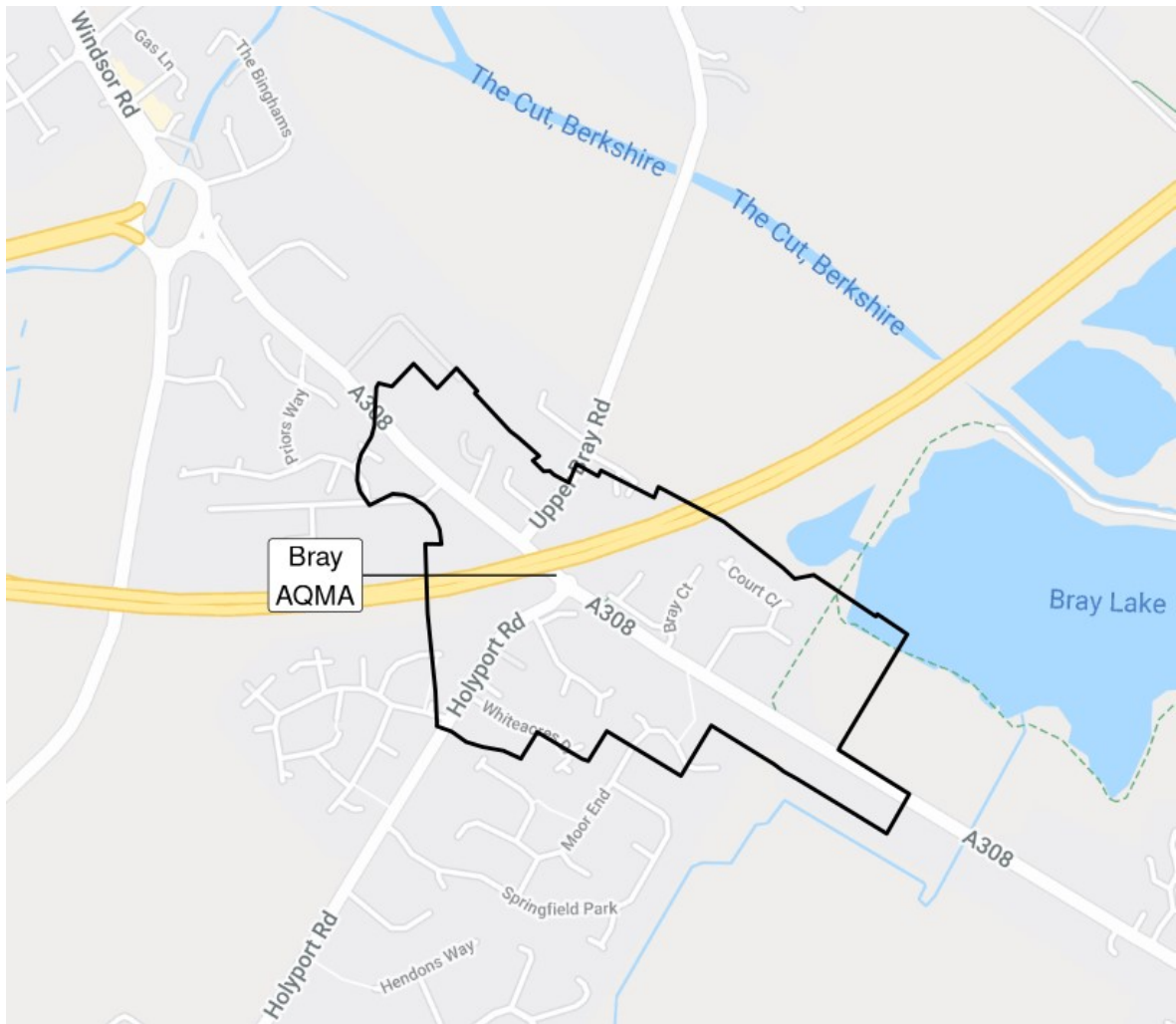


Figure 4 - The Bray AQMA.

## 4. Local authority monitoring

Local authorities with AQMAs are required to produce an Annual Status Report (ASR) regarding air quality in their area. From RBWM's 2020 ASR [3] (Table A.3 – Annual Mean NO<sub>2</sub> Monitoring Results, pages 27-29) we have obtained NO<sub>2</sub> diffusion tube and automatic measurements for 2019. Note that the latest data for a given ASR is always one year in arrears. Figure 5 provides an overview of all NO<sub>2</sub> measurements made for 2019. We have used 2019 as a representative year as it is the last year prior to the disruption caused by COVID.

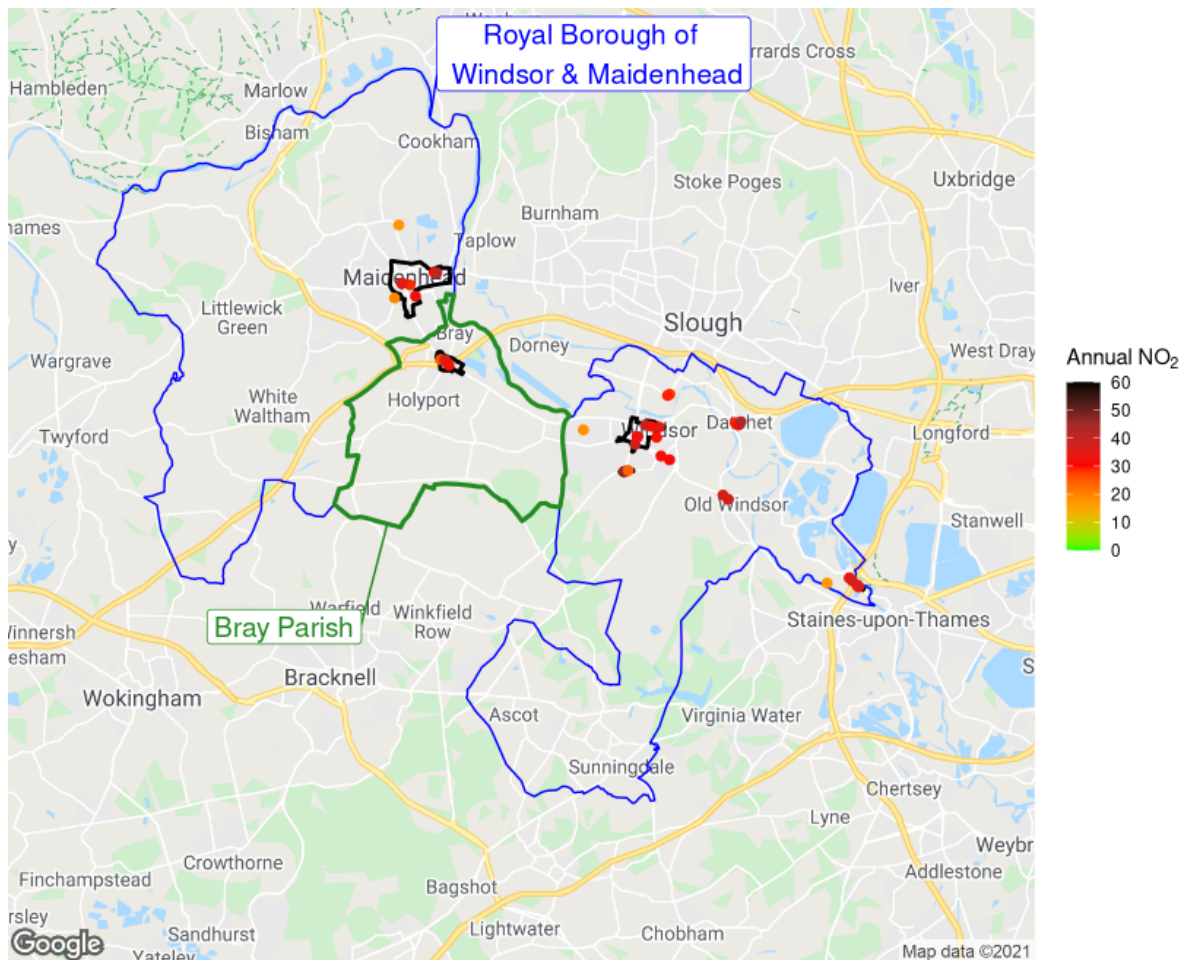


Figure 5 - Overview of NO<sub>2</sub> measurement by RBWM in 2019. Colour represents annual bias corrected and annualised NO<sub>2</sub> (or ratified automatic measurement).

The majority of measurement falls within AQMA areas and covers a very small percentage of the total area. NO<sub>2</sub> measurements are generally poor. The minimum value observed is 16.9 ug/m<sup>3</sup>, the maximum is 47.4 ug/m<sup>3</sup> with median and means of 32.8 ug/m<sup>3</sup> and 32.95 ug/m<sup>3</sup> respectively. Gradko is the laboratory they used, and the bias correction factor was 0.94.

In general poor air quality in urban areas is observed with 14% of measured sites exceeding the national objective of 40 ug/m<sup>3</sup>, and 32% are within 10% of the objective.

Figure 6 shows the RBWM diffusion tube measurements within Bray.

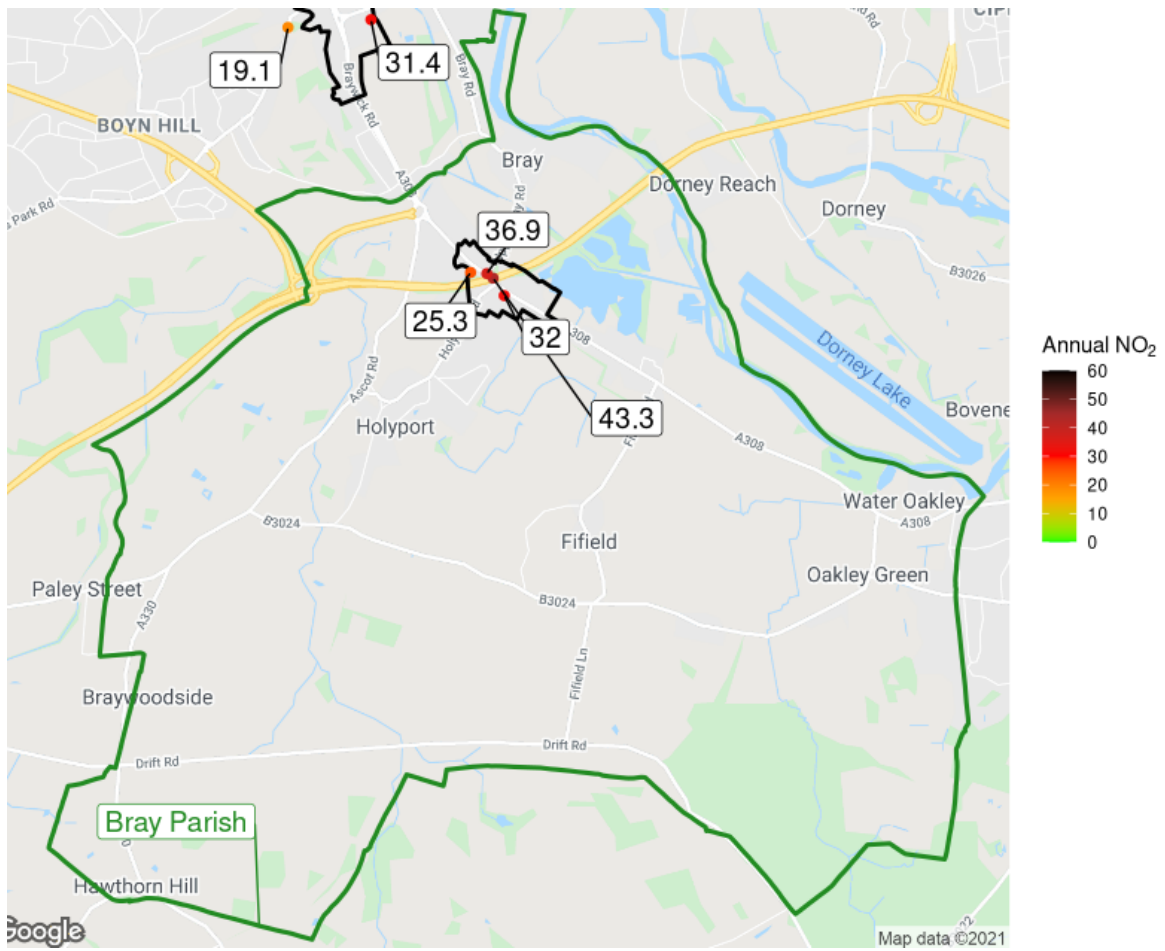


Figure 6 - RBWM NO<sub>2</sub> measurements within Bray

Figure 7 shows the RBWM diffusion tube measurements within the Bray AQMA

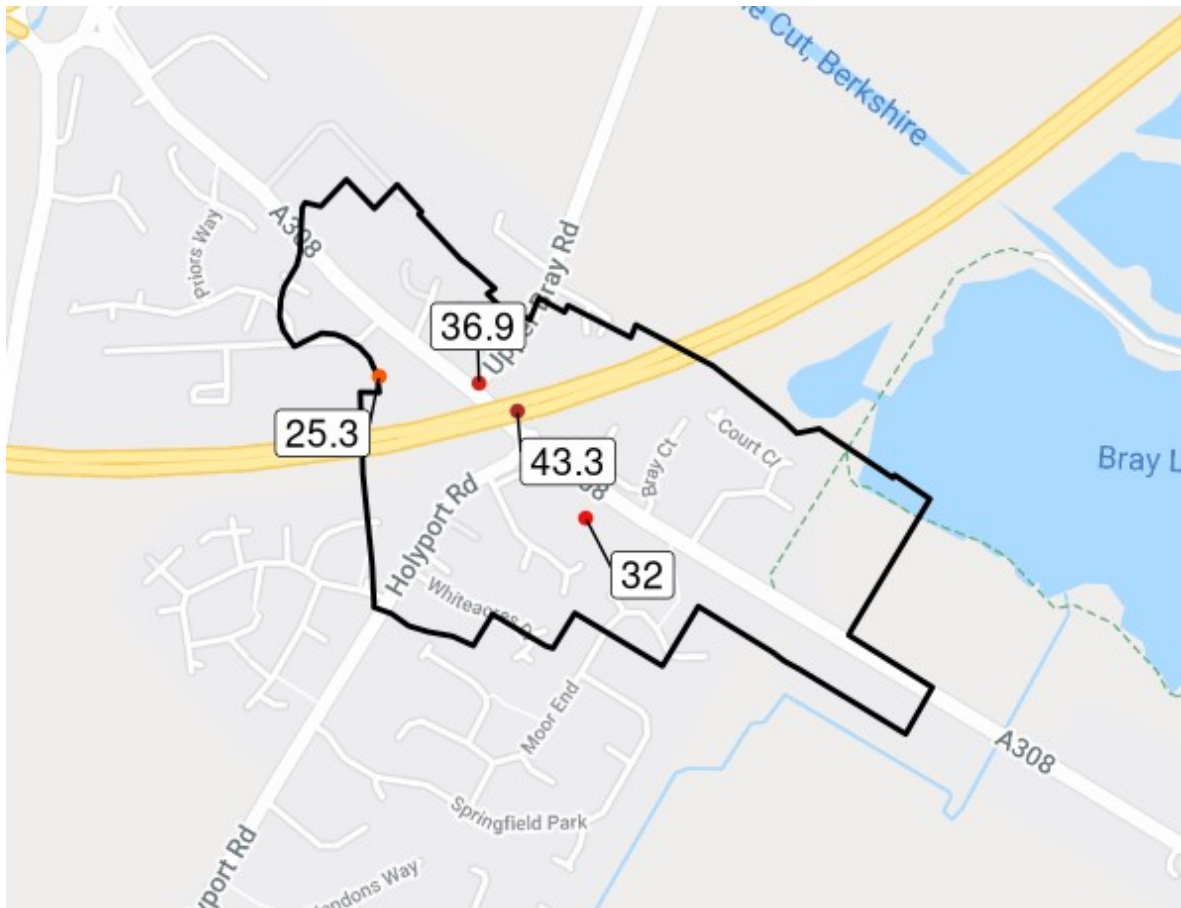


Figure 7 - RBWM diffusion tube NO<sub>2</sub> measurements within the Bray AQMA

## 5. Bray Parish Council monitoring results

### 5.1. Locations

Under the guidance of CHSS at The University of Kent, Bray Parish Council has undertaken diffusion tube measurement at eight locations within the parish, these locations are shown in Figure 8

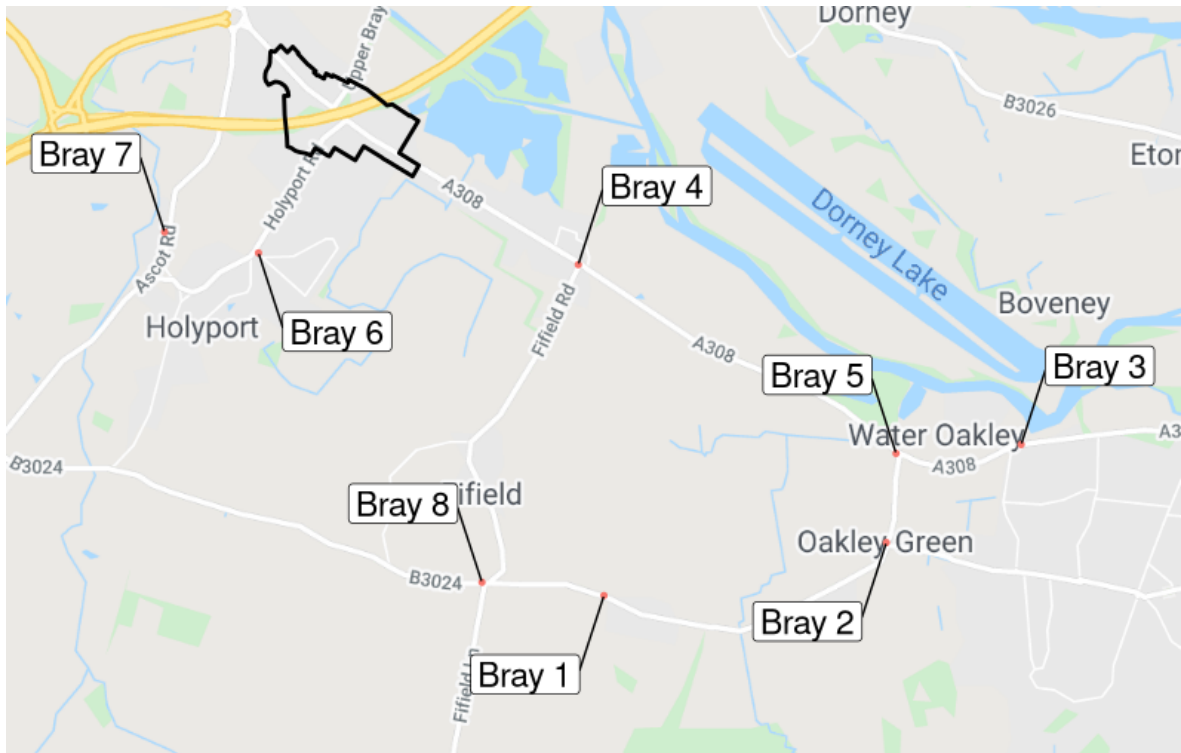


Figure 8 - Locations of NO<sub>2</sub> diffusion tubes in Bray. Bray AQMA also shown.

The latitude and longitudes of each of these sites is shown in **Table 1** below.

Mnemonic	Address	Lat	Lon
Bray 1	Braywood School	51.47745	-0.68423
Bray 2	Dedworth Rd	51.47989	-0.66333
Bray 3	Squires	51.48441	-0.65335
Bray 4	Fifield R	51.4927	-0.68613
Bray 5	Oakley Green	51.484	-0.66261
Bray 6	Holyport School	51.49324	-0.7098
Bray 7	Hearne Drive	51.4942	-0.71675
Bray 8	Fifield Crossroads	51.47806	-0.69326

**Table 1** - Locations of NO<sub>2</sub> diffusion tube sites used by Bray Parish Council.

## 5.2. Results

Bray monitored NO<sub>2</sub> between July 2021 and July 2022. Thus it is possible, via annualisation to derive an estimate of the annual value for 2021 as well as computing an average over the actual measurement period.

## 5.2.1. Measurement period results

Since Bray Parish Council has data available for the period July 2021 to June 2022 a full year of data is available so a calculation across this period can be made. This is not aligned with the calendar year but is a true annual average. The full raw diffusion tube monthly readings for the eight sites across Bray Parish Council are shown in **Table 2**

Site / Month	Bray 1	Bray 2	Bray 3	Bray 4	Bray 5	Bray 6	Bray 7	Bray 8
07/21	12.8	28.3	16.8	21.1	20.9	12.7	25.7	19
08/21	12	23.8	20.3	17.8	14.8	9.8	23.5	19.1
09/21	15.2	34.2	21.6	28.4	19.9	22.2	28.2	20.6
10/21	12.3	35.8	29.2	22.6	17.7	19.3	29.7	20.6
11/21	18.4	33.4	28.3	24.6	20.4	23.5	29.4	20.9
12/21	17.2	32.2	30.4	23	21.4	21	27.7	16.4
01/22	20.2	38.3	28.1	24.9	19.9	25.9	26.9	20.7
02/22	14.8	34	25.9	17.2	18.3	20.3	25.7	17.6
03/22	22.9	37.9	31.8	27.1	28.2	25.2	36.5	29.9
04/22	14.7	31.1	25.2	20.3	19	18.9	27.7	19.8
05/22	11.6	33.5	21.7	18.3	14.1	17.2	23.7	15.9
06/22	12	32.8	20.2	17.9	12.9	16.9	26.4	17.3

**Table 2** - Full monthly raw diffusion tube results for each Bray location.

Since 100% data capture was obtained it is possible to compute direct averages. These are shown in **Table 3**. We have also included “bias corrected” results using a value of 0.77 which is the arithmetic mean of the biases 0.76 and 0.78 for 2020 and 2021 respectively. This gives some indication what these results might look like under bias correction.

Mnemonic	Mean	Bias corrected
Bray 1	15.3	11.8
Bray 2	32.9	25.4
Bray 3	25.0	19.2
Bray 4	21.9	16.9
Bray 5	19.0	14.6
Bray 6	19.4	14.9
Bray 7	27.6	21.2
Bray 8	19.8	15.3

**Table 3** - Mean results across entire measurement period.  
All values shown are in  $\mu\text{g}/\text{m}^3$ .

### 5.2.2. Annual results (2021)

Since Bray Parish Council has data available for the period July 2021 to June 2022 it is possible to estimate the annual averages for 2021 through a process known as annualisation and defined by Defra in its guidance [4]. Accordingly, data has been annualised in line with guidance as explained in Appendix A of this document to give an estimate of the annual average for 2021 for each location. Results have also been bias corrected according to Appendix B of this document, using the latest Defra bias correction spreadsheet.

The full table of raw monthly results for 2021 is shown in **Table 4**

Site / Month	07/21	08/21	09/21	10/21	11/21	12/21
Bray 1	12.8	12	15.2	12.3	18.4	17.2
Bray 2	28.3	23.8	34.2	35.8	33.4	32.2
Bray 3	16.8	20.3	21.6	29.2	28.3	30.4
Bray 4	21.1	17.8	28.4	22.6	24.6	23
Bray 5	20.9	14.8	19.9	17.7	20.4	21.4
Bray 6	12.7	9.8	22.2	19.3	23.5	21
Bray 7	25.7	23.5	28.2	29.7	29.4	27.7
Bray 8	19	19.1	20.6	20.6	20.9	16.4

**Table 4** - Raw monthly diffusion tube results for Bray. All values shown are in  $\mu\text{g}/\text{m}^3$ .

**Table 5** shows the annualised and bias corrected results for each tube where these procedures are carried out as outlined in Appendices A and B of this document.

SiteID	Mean	Annualised (2021)	Annualised and bias corrected (2021)
Bray 1	14.65	15.58	12.15
Bray 2	31.28	33.26	25.95
Bray 3	24.43	25.98	20.26
Bray 4	22.92	24.37	19.01
Bray 5	19.18	20.4	15.91
Bray 6	18.08	19.23	15

Bray 7	27.37	29.1	22.7
Bray 8	19.43	20.66	16.12

**Table 5** - Annualised and bias corrected diffusion tube results for 2021.  
All values shown are in  $\mu\text{g}/\text{m}^3$ .

These results are shown plotted on a map in Figure 9 and Figure 10.

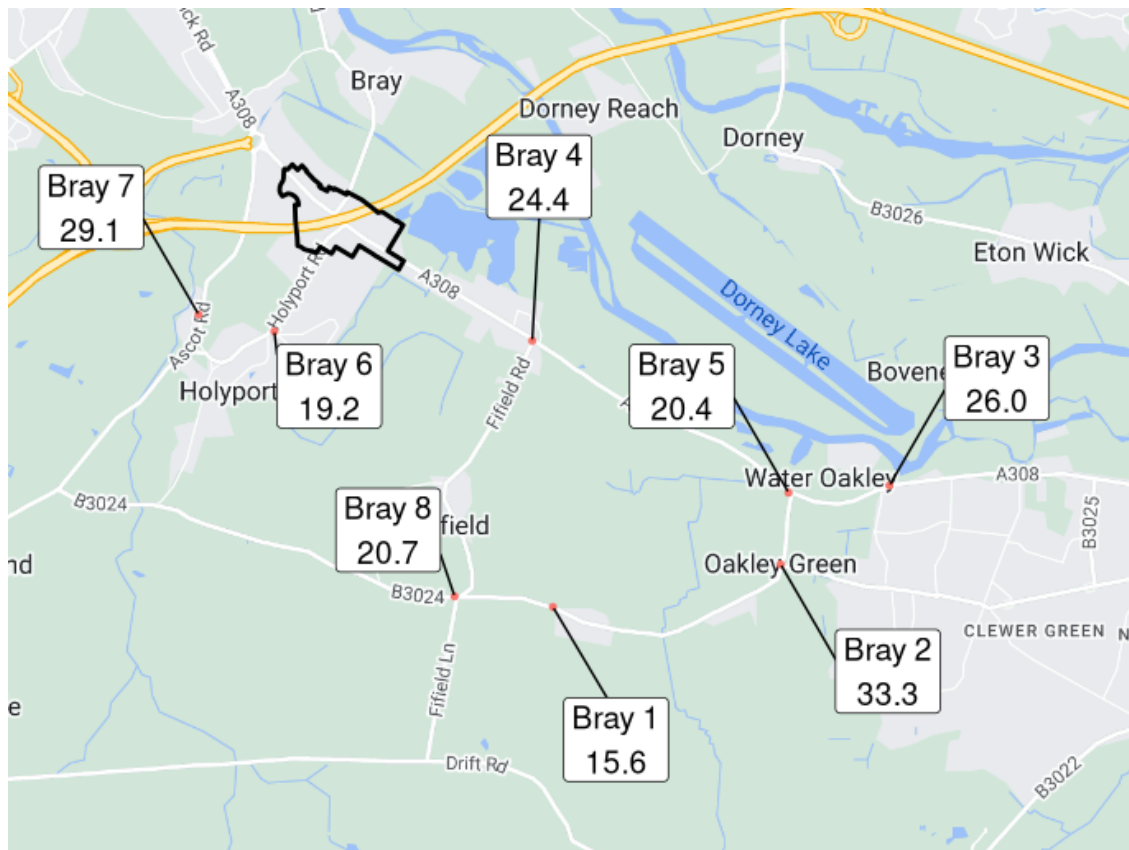


Figure 9 - NO<sub>2</sub> diffusion tube results annualised for 2021 but not bias corrected. All values shown are in  $\mu\text{g}/\text{m}^3$ .

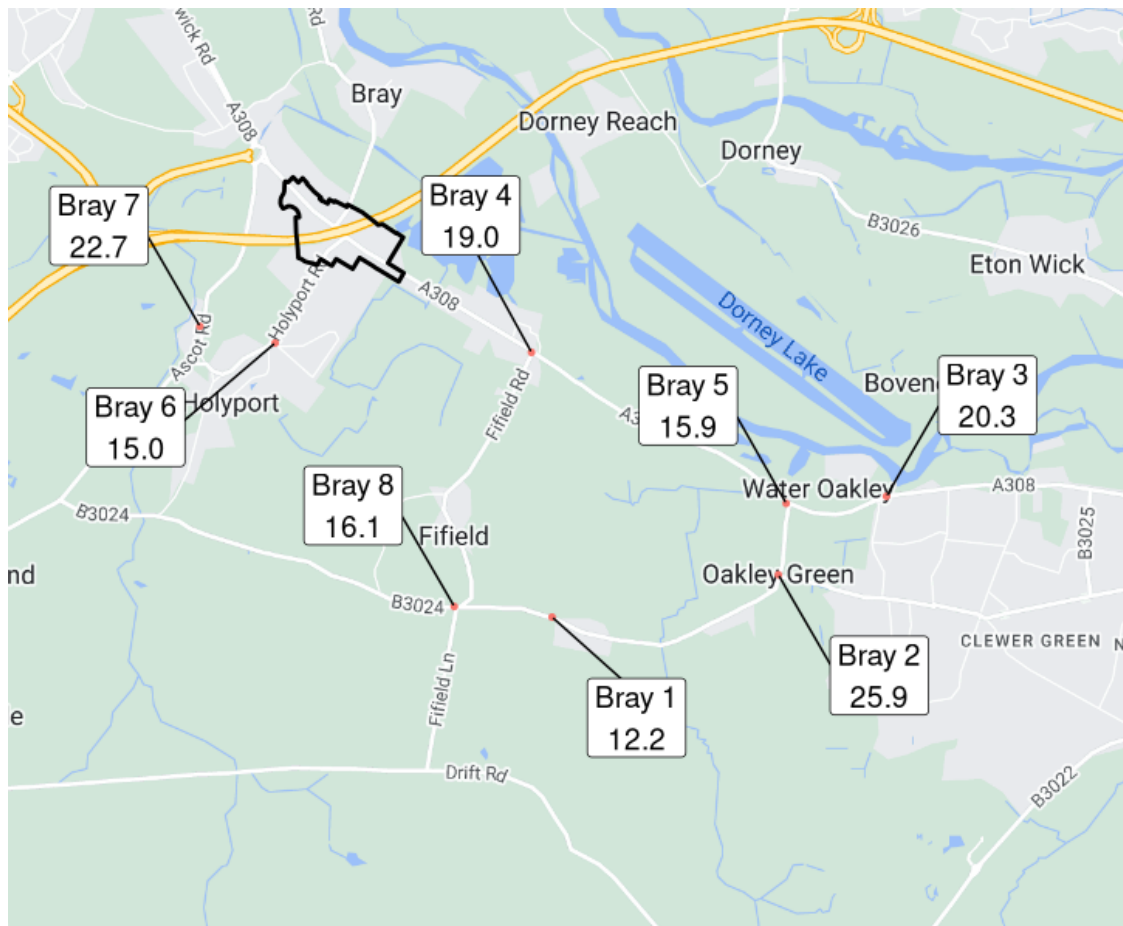


Figure 10 - NO<sub>2</sub> diffusion tube results annualised for 2021 and bias corrected according to the procedure set out in this document. All values shown are in µg/m<sup>3</sup>.

## 6. Appendix A - Annualisation of diffusion tube measurements

Paragraphs 7.197 - 7.199 on page 7-57 of the LAQM technical guidance [4] explain that annualisation may be performed for NO<sub>2</sub> diffusion tube data with less than 9 months of data to obtain an estimate of the annual mean for a given site. They go on to provide an example of how to perform such annualisation in Box 7.10.

Sometimes it is not possible for tubes to be changed according to the suggested timescales [5] when the operation is executed by volunteers or other issues arise. In such cases we have computed period means using time-weighted averaging (as per para 7.199 [4]).

Accordingly, data from London Bexley, Canterbury, Rochester Stoke and Thurrock automatic monitoring stations were used to derive the adjustment factors. All monitors are located in background locations and had a data capture above 85% in 2021. They are managed by the Automatic Urban and Rural Network (AURN), and ratified data was downloaded from the Air Quality England website [6].

### 6.0.1. Annualisation for 2021

Bray's 2021 tubes were exposed from July to December (6 months) which meets the minimum requirements for annualisation (3 months). **Table 6** provides the calculated period and annual means and associated ratios.

	<b>Thurrock</b>	<b>London Bexley</b>	<b>Rochester Stoke</b>	<b>Canterbury</b>
<b>Annual mean</b>	20.42	18.68	9.77	9.78
<b>Period mean</b>	20.26	17.99	8.51	9.23
<b>Means ratio</b>	1.01	1.04	1.15	1.06

**Table 6** - Annual and period (July-Dec) means for background sites and associated means ratios.

Taking the geometric mean of the means ratios in **Table 6** gives the annualisation factor 1.063309.

## 7. Appendix B - Bias correction of diffusion tube measurements

The LAQM guidance recommends that diffusion tube measurements be corrected for “bias”, that is, systematic under or over-estimation of results (see 7.212 onwards of [4]). We have shown that this process is not robust and in 30% of cases is less accurate than using no bias correction [2]. However, we have followed the bias correction procedure so that these results may be examined in line with the guidance.

The current National Diffusion Tube Bias Adjustment Spreadsheet [1] was updated last on 06/22 and has an entry for 2021. We have used the value for 2021 for SOCOTEC 50% Tea / Acetone. The value given is 0.78.

## 8. Appendix C - WHO Guidelines for health

- In 2021 the World Health Organisation updated its air quality guidelines for health [8]. These are replicated in Table 11 below.

Pollutant	Averaging Time	Guideline Value
PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Annual	5
	24-hour <sup>a</sup>	15
PM <sub>10</sub> (µg/m <sup>3</sup> )	Annual	15
	24-hour <sup>a</sup>	45
O <sub>3</sub> (µg/m <sup>3</sup> )	Peak season <sup>b</sup>	60
	8-hour <sup>a</sup>	100
NO <sub>2</sub> (µg/m <sup>3</sup> )	Annual	10
	24-hour <sup>a</sup>	25
SO <sub>2</sub> (µg/m <sup>3</sup> )	24-hour <sup>a</sup>	40
CO (mg/m <sup>3</sup> )	24-hour <sup>a</sup>	4

**Table 11** - WHO guidelines for pollutants, recommended levels.

<sup>a</sup> 99th percentile <sup>b</sup> Average of 8-hour mean O<sub>3</sub> concentration in the six consecutive highest averaging months

## 9. References

- [1] DEFRA, 'National Diffusion Tube Bias Adjustment Factor Spreadsheet (version 06/22)'. [Online]. Available: [https://laqm.defra.gov.uk/wp-content/uploads/2022/06/Database\\_Diffusion\\_Tube\\_Bias\\_Factors\\_v06\\_22-FINAL.xlsx](https://laqm.defra.gov.uk/wp-content/uploads/2022/06/Database_Diffusion_Tube_Bias_Factors_v06_22-FINAL.xlsx)
- [2] A. Mills and S. Peckham, 'Garbage in, gospel out? – Air quality assessment in the UK planning system', *Environ. Sci. Policy*, vol. 101, pp. 211–220, Nov. 2019, doi: 10.1016/j.envsci.2019.06.010.
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- [4] DEFRA, 'Local Air Quality Management Technical Guidance (TG16) - April 2021'. 04/21 [Online]. Available: <https://laqm.defra.gov.uk/documents/LAQM-TG16-April-21-v1.pdf>
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- [6] DEFRA, 'DEFRA UK AIR Data Selector', Dec. 08, 2021. [Online]. Available: [https://uk-air.defra.gov.uk/data/data\\_selector](https://uk-air.defra.gov.uk/data/data_selector). [Accessed: Jan. 18, 2022]
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- [8] World Health Organisation, 'WHO Air Quality Guidelines 2021', 2021. [Online]. Available: <https://www.who.int/news-room/feature-stories/detail/what-are-the-who-air-quality-guidelines>