LONDON BOROUGH OF
RICHMOND UPON THAMES

Air Quality Annual Status Report 2016

Environment

23 September 2016

London Borough of Richmond upon Thames Air Quality Annual Status Report for 2015

Date of publication: 23rd September 2016

This report provides a detailed overview of air quality in the London Borough of Richmond upon Thames during 2015. It has been produced to meet the requirements of the London Local Air Quality Management statutory process[1].

[1] LLAQM Policy and Technical Guidance 2016 (LLAQM.TG(16)). https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/working-boroughs

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Executive Summary

The London Borough of Richmond upon Thames is committed to improving air quality in the Borough. As such the Council is demonstrating its political leadership; taking action; leading by example; monitoring air quality; using the planning system; integrating air quality into the public health system; and informing the public. This 2016 Annual Status Report reviews recent air quality monitoring in the Borough in accordance with Defra LAQM guidance. In so doing it fulfils one further aspect of this ongoing commitment

The report identifies that:

For carbon monoxide, benzene, 1,3-butadiene, lead and sulphur dioxide there is not a significant risk of the objectives being exceeded in the Council's area.

In December 2000 the Council designated an AQMA across the whole Borough for nitrogen dioxide and particles (specifically PM_{10}). The findings from this report indicate that the AQMA should be maintained.

In view of the findings from the report the Council will undertake the following actions:

1. Undertake consultation with the statutory and other consultees as required.
2. Maintain the existing monitoring programme.
3. Update and implement its Air Quality Action Plan in pursuit of the AQS objectives.
4. Prepare for the submission of its next Air Quality report.

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Abbreviations

AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQO	Air Quality Objective
BEB	Buildings Emission Benchmark
CAB	Cleaner Air Borough
CAZ	Central Activity Zone
EV	Electric Vehicle
GLA	Greater London Authority
LAEI	London Atmospheric Emissions Inventory
LAQM	Local Air Quality Management
LLAQM	London Local Air Quality Management
NRMM	Non-Road Mobile Machinery
PM_{10}	Particulate matter less than 10 micron in diameter
$PM_{2.5}$	Particulate matter less than 2.5 micron in diameter
TEB	Transport Emissions Benchmark
TfL	Transport for London

Air Quality Objectives

The air quality objectives applicable to LAQM **in England** are set out in the Air Quality (England) Regulations 2000 (SI 928), The Air Quality (England) (Amendment) Regulations 2002 (SI 3043), and are shown in Table A. This table shows the objectives in units of microgrammes per cubic metre µg m^{-3} (milligrammes per cubic metre, mg m^{-3} for carbon monoxide) with the number of exceedences in each year that are permitted (where applicable).

Table A. Summary of National Air Quality Standards and Objectives

Pollutant	Objective (UK)	Averaging Period	Date[1]
Nitrogen dioxide - NO_2	200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	31 Dec 2005
	40 µg m^{-3}	Annual mean	31 Dec 2005
Particles - PM_{10}	50 µg m^{-3} not to be exceeded more than 35 times a year	24-hour mean	31 Dec 2004
	40 µg m^{-3}	Annual mean	31 Dec 2004
Particles - $PM_{2.5}$	25 µg m^{-3}	Annual mean	2020
	Target of 15% reduction in concentration at urban background locations	3 year mean	Between 2010 and 2020
Sulphur Dioxide (SO_2)	266 µg m^{-3} not to be exceeded more than 35 times a year	15 minute mean	31 Dec 2005
	350 µg m^{-3} not to be exceeded more than 24 times a year	1 hour mean	31 Dec 2004
	125 µg m^{-3} mot to be exceeded more than 3 times a year	24 hour mean	31 Dec 2004

Note: [1]by which to be achieved by and maintained thereafter

1. Air Quality Monitoring

The latest monitoring results for 2015 confirm that air pollution in the LBRuT still exceeds the Government Air Quality objectives, and therefore there is still a need for LBRuT to be designated as an AQMA and to pursue improvements in air quality.

The Council (and NPL for $PM_{2.5}$) routinely monitor the pollutants below:

- NO_2
- PM_{10}
- Ozone (O_3)
- $PM_{2.5}$

The Council previously monitored SO_2 (ceased in April 2011), CO (ceased in April 2012), and Benzene (ceased in January 2012) which are not included in this report. Please see previous Council reports for further information.

1.1 Locations

Automatic Monitoring Sites

The continuous monitors collect real time data, which are stored as 15-minute means and can be converted into the various averages. This type of equipment provides accurate readings of pollution levels but is expensive, so using them for a large coverage of LBRuT is cost prohibitive.

The sites (see Table B) are also representative of relevant exposure either at the site or very close by. The two Richmond operated sites are part of the King's London Air Quality Network, as is the site at the National Physical Laboratory (NPL) which is also part of the government's UK Automatic Urban and Rural Network (AURN). Richmond also has a mobile Air Quality monitoring unit, which was stationed at 3 different sites during 2015. Annual averages are not possible and it has therefore been decided to omit data from this site for 2015.

All data undergo quality assurance and quality control (QA/QC) procedures to ensure that the data obtained is of a high quality. The standards of QA/QC at the LAQN sites are similar to those of the government's AURN sites. For QA/QC purposes, all the continuous analysers are manually checked and calibrated every two weeks, serviced every six months and audited by an independent auditor (the National Physical Laboratory) every six months. Subsequent data ratification is undertaken by King's College London. Further details of the sites can be found at www.londonair.org.uk.

Table B. Details of Automatic Monitoring Sites for 2015

Site ID	Site Name	X (m)	Y (m)	Site Type	In AQMA?	Distance from monitoring site to relevant exposure	Distance to kerb of nearest road (N/A if not applicable)	Inlet height	Pollutants monitored	Monitoring technique
RI1	**Castelnau Library**, Barnes	522500	177165	Roadside	Y	8m	3m	2.35m	NO2, PM10	Chemiluminescent; TEOM
RI2	**Wetlands Centre**, Barnes	522991	176495	Suburban	Y	N/A	N/A	3.2m	NO2, PM10,O3	Chemiluminescent; TEOM
TD0	**NPL -** Teddington AURN	515542	170420	Suburban	Y	N/A	N/A	N/A	NO2,PM2.5, O3	Chemiluminescent; FDMS

Non-Automatic Monitoring Sites

Table C lists the details of the NO2 diffusion tube monitoring locations in the LBRuT. The tubes are a relatively cheap way of monitoring, which therefore allows samples to be taken across the whole LBRuT and gives a Borough-wide view. The results provide monthly averages and so provide an indication of NO2 pollution levels. The accuracy of the diffusion tube readings can be increased when their results are compared, and the bias adjusted, with data from the more accurate continuous monitors. The Council had a network of 62 diffusion tube sites across the Borough in 2015. Three of the diffusion tubes sites are triplicate and collocated with automatic monitoring sites. One automatic monitoring site, the Air Quality mobile unit, was stationed at 3 different sites during 2015, so no annual averages are possible. It has therefore been omitted from this report.

Table C. Details of Non-Automatic Monitoring Sites for 2015

Site ID	Site Name	X (m)	Y (m)	Site Type	In AQMA?	Distance of tube to kerbside (m)	Distance of receptor to kerbside (m)	Inlet height (approx.) (m)	Pollutants monitored	Tube co-located with an automatic monitor? (Y/N)
1	Hampton Court Rd, Hampton	515824	168815	roadside	Y	1.7m	1.9m	2.2m	NO2	N
2	Percy Rd, Hampton (nr. Oldfield Rd)	513229	169712	roadside	Y	1.3m	3.0m	2.2m	NO2	N
3	Uxbridge Rd, Hampton (nr. Arundel Close)	513850	171040	roadside	Y	1.5m	10.7m	2.2m	NO2	N
4	Hampton Rd, Teddington (nr. Bushy Pk Gardens)	514882	171155	kerbside	Y	0.6m	9.8m	2.2m	NO2	N
6	Kingston Rd, Teddington (nr. Woffington Close)	517266	170031	kerbside	Y	0.7m	6.5m	2.2m	NO2	N
7	Broad St, Teddington (Boots)	515624	170975	kerbside	Y	0.8m	2.5m	2.2m	NO2	N
9	Hampton Rd, Twickenham	514842	172346	kerbside	Y	0.6m	2.0m	2.2m	NO2	N

10	Twickenham Rd, Twickenham (opp. Fulwell golf course)	513278	172199	kerbside	Y	0.6m	7.2m	2.2m	NO2	N
11	Percy Rd, Whitton (nr. Percy Way)	514050	173189	kerbside	Y	0.6m	9.1m	2.2m	NO2	N
12	Hanworth Rd, Whitton	512600	173404	kerbside	Y	0.6m	7.4m	2.2m	NO2	N
13	Whitton Rd, Whitton, (opp. rugby ground)	515235	174083	kerbside	Y	0.8m	6.3m	2.2m	NO2	N
14	Cross Deep, Twickenham (nr Poulett Gardens)	516133	173051	kerbside	Y	0.3m	2.7m	2.2m	NO2	N
15	Richmond Rd, Twickenham (opp. Marble Hill Pk)	517197	173939	kerbside	Y	0.6m	1.8m	2.2m	NO2	N
16	St Margarets Rd, St Margarets (nr. Bridge Rd)	516742	174373	roadside	Y	1.2m	3.1m	2.2m	NO2	N
17	Red Lion Street, Richmond	517916	175257	kerbside	Y	0.5m	2.0m	2.2m	NO2	N
18	Lower Mortlake Rd, Richmond (nr. Trinity Rd)	518822	175590	kerbside	Y	0.9m	9.3m	2.2m	NO2	N
19	Kew Rd, Kew (nr. Walpole Av)	518637	176161	kerbside	Y	0.7m	16m	2.2m	NO2	N
20	Mortlake Rd, Kew (nr. Kent Rd)	519205	177221	kerbside	Y	0.6m	2.8	2.2m	NO2	N
21	Lower Richmond Rd, Mortlake (nr. Kingsway)	520053	175826	roadside	Y	2.0m	7.0m	2.2m	NO2	N

22	Castelnau, Barnes (nr. Hammersmith Bridge)	522845	177904	kerbside	Y	0.5m	4.2m	2.2m	NO2	N
23	Castelnau Library, Barnes (static site)	522502	177166	roadside	Y	3.3m	9m	2.2m	NO2	Y
24	Lonsdale Road, Barnes (nr. Suffolk Rd)	521750	177056	kerbside	Y	0.3m	6.3m	2.2m	NO2	N
25	URRW, (nr. Sheen School)	521130	175450	roadside	Y	2.3m	2.5m	2.2m	NO2	N
26	URRW, Sheen (nr. Courtland Estate)	519031	175021	roadside	Y	0.6m	11.8	2.2m	NO2	N
27	Queens Rd, Richmond (nr. Russell Walk)	518745	174346	roadside	Y	2.3m	5.2m	2.2m	NO2	N
28	Holly Lodge, Richmond Pk	519467	173993	urban background	Y	2175m	N/A	2.2m	NO2	N
29	Petersham Rd, Ham (nr. Sandy Lane)	517967	172543	kerbside	Y	0.6m	3.6m	2.2m	NO2	N
30	German School, Petersham Rd	518003	173233	roadside	Y	1.9m	1.3m	2.2m	NO2	N
31	A316	515438	174048	roadside	Y	1.0m	6.4m	2.2m	NO2	N
32	Kings St, Twickenham	516226	173195	roadside	Y	1.7m	3.8m (2.8m pavement café)	2.2m	NO2	N
33	Heath Rd, Twickenham	515927	173129	roadside	Y	3.3m	4.6m	2.2m	NO2	N
34	Thames St, Hampton	513552	169498	roadside	Y	1.4m	1.3m	2.2m	NO2	N
35	High St, Hampton Wick	517524	169583	roadside	Y	1.3m	1.4m	2.2m	NO2	N
36	Upper Richmond Road West(URRW), Sheen Lane	520510	175393	kerbside	Y	0.9m	2.2m	2.2m	NO2	N

37	Wetlands, Barnes (static site)	522989	176727	urban background	Y	1160m	230m	2.2m	NO2	Y
39	Richmond Rd, Richmond Bridge, East Twickenham	517592	174404	roadside	Y	1.2m	2.7m	2.2m	NO2	N
40	Staines Rd, Twickenham	514278	172521	kerbside	Y	0.4m	11.9m	2.2m	NO2	N
41	Paradise Rd, Richmond	518102	174854	kerbside	Y	0.9m	5.6m	2.2m	NO2	N
42	The Quadrant, Richmond	517991	175075	roadside	Y	2.5m	1.8m	2.2m	NO2	N
43	Hill St, Richmond	517771	174701	kerbside	Y	0.7m	1.6m	2.2m	NO2	N
44	Sheen Rd, Richmond (near shops)	518458	175042	kerbside	Y	0.5m	0.5m	2.2m	NO2	N
45	154 High St, Teddington,	516260	171140	kerbside	Y	0.5m	3.3m	2.2m	NO2	N
47	Causeway, Teddington	515829	170967	roadside	Y	1.8m	2.7m	2.2m	NO2	N
48	Stanley Rd, Teddington (junc. Strathmore Rd)	515059	171805	roadside	Y	2.4m	7.1m	2.2m	NO2	N
49	URRW War Memorial, Sheen Lane, Sheen	520505	175390	kerbside	Y	0.9m	2.9m	2.2m	NO2	N
50	URRW, nr. Clifford Av, Sheen	519962	175321	kerbside	Y	0.7	2.7	2.2m	NO2	N
51	Sheen Lane, Sheen (railway crossing)	520497	175790	kerbside	Y	0.4m	1.3m	2.2m	NO2	N
52	Clifford Av, Chalkers Corner	519776	175746	kerbside	Y	0.5	2.2	2.2m	NO2	N
53	co-located on mobile Air Quality unit	3 sites	3 sites	roadside	Y	varies	varies	2.2m	NO2	Y

54	Mortlake Road, adjacent to West Hall Road, Kew	519585	176492	kerbside	Y	0.6	1.4	2.2m	NO2	N
55	Mortlake Road, adjacent to Cemetery Gates, Kew	519793	176142	kerbside	Y	0.6	4.1	2.2m	NO2	N
56	A316 (St Magarets)	516791	174521	kerbside	Y	7.3m	9.6m	2.2m	NO2	N
57	A316 (Lincoln Avenue)	513953	172915	kerbside	Y	12.7m	16.3m	2.2m	NO2	N
58	London Road, Twickenham	516039	173766	kerbside	Y	0.7m	6.4m	2.2m	NO2	N
59	Whitton Rd, Twickenham (near Twickenham bridge)	515980	173758	kerbside	Y	0.6m	1.4m	2.2m	NO2	N
60	Waldegrave Rd, Teddington	515894	171148	kerbside	Y	0.5m	2.2m	2.2m	NO2	N
61	London Road, Twickenham (near Waitrose)	516224	173444	roadside	Y	1.8m	4.3m	2.2m	NO2	N
62	High Street, Barnes	521651	176430	kerbside	Y	0.4m	2.3m	2.2m	NO2	N
63	High Street, Whitton	514181	173875	kerbside	Y	0.8m	3.2m	2.2m	NO2	N
64	High Street, Hampton Hill	514484	171251	kerbside	Y	0.5m	1.6m	2.2m	NO2	N
Rut 01	Civic Centre, York St, Twickenham	516356	173365	roadside	Y	2.9m	3.0m	3.5m	NO2	N
Rut 02	George Street, Richmond	517917	174928	kerbside	Y	0.7m	2.2m	2.2m	NO2	N

1.2 Comparison of Monitoring Results with AQOs

Table D. Annual Mean NO2 Ratified and Bias-adjusted Monitoring Results (g m-3) For results that indicate the exposure estimate, calculated for the nearest residential façade see Table M.

Site ID	Site type	Valid data capture for monitoring period %	Valid data capture 2015 %	Annual Mean Concentration (μgm^{-3})						
				2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Castelnau Library, Barnes (RI1)	Roadside	100%	99%	**42**	**43**	39	37	39	37	34
Wetlands Centre, Barnes (RI2)	Suburban	100%	94%	28	30	26	25	24	25	21
NPL - Teddington AURN (TD0)	Suburban	100%	96%	22	24	21	36	21	27	19
1	Roadside	100	92	**53**	**51**	**44**	**45**	**47**	**49**	**41**
2	Roadside	100	100	39	39	31	34	32	33	28

3	Roadside	100	100	**44**	**44**	35	**44**	**44**	**44**	**41**
4	Kerbside	100	100	**47**	39	38	**44**	**44**	**44**	36
5	Kerbside	closed	closed	37	38	32	33	closed	closed	closed
6	Kerbside	100	92	**47**	**48**	34	**43**	**43**	**41**	36
7	Kerbside	100	83	**69**	**69**	**49**	**59**	**61**	**54**	**47**
8	Kerbside	closed	closed	38	39	30	34	closed	closed	closed
9	Kerbside	100	92	**57**	**55**	**47**	**50**	**49**	**48**	**42**
10	Kerbside	100	100	**45**	**47**	**36**	**44**	**46**	**47**	**43**
11	Kerbside	100	100	**50**	**52**	**46**	**54**	**49**	**48**	**44**
12	Kerbside	100	100	**49**	**52**	**41**	**45**	**49**	**46**	**41**
13	Kerbside	100	92	**50**	**53**	**42**	**48**	**48**	**47**	**42**
14	Kerbside	100	92	**54**	**52**	**38**	**48**	**46**	**45**	39
15	Kerbside	100	100	**55**	**53**	**41**	**44**	**40**	40	37
16	Roadside	100	92	**49**	**48**	38	**45**	**44**	**43**	41
17	Kerbside	100	92	31	**79**	**65**	**70**	**68**	**<u>68</u>**	**<u>63</u>**
18	Kerbside	100	100	**64**	**70**	**66**	**68**	**71**	**<u>66</u>**	**<u>67</u>**
19	Kerbside	100	100	**60**	**46**	**50**	**56**	**53**	**55**	**48**
20	Kerbside	100	100	**58**	**54**	**40**	**53**	**51**	**55**	**48**
21	Roadside	100	100	**47**	**47**	39	**43**	**44**	**41**	37
22	Kerbside	100	92	**60**	**55**	**46**	**51**	**57**	**59**	53
23	Roadside	100	100	**43**	**43**	35	38	39	38	35
24	Kerbside	100	100	**46**	**42**	36	**40**	**40**	**40**	35
25	Roadside	100	100	**45**	**42**	32	**47**	**51**	**51**	**45**
26	Roadside	100	100	**54**	**46**	**40**	**42**	**43**	**42**	**40**
27	Roadside	100	100	**46**	**44**	38	**41**	**40**	38	37
28	Urban background	100	100	23	24	20	22	21	18	17

29	Kerbside	100	92	**45**	39	37	**43**	39	36	30
30	Roadside	100	92	**41**	**41**	33	36	38	34	29
31	Roadside	100	92	**60**	**53**	**50**	**59**	**61**	**<u>62</u>**	**54**
32	Roadside	100	100	**110**	**102**	**75**	**77**	**74**	**<u>73</u>**	**<u>62</u>**
33	Kerbside	100	100	**63**	**66**	**47**	**58**	**62**	**<u>69</u>**	**<u>61</u>**
34	Roadside	100	100	**44**	**42**	36	39	38	40	33
35	Roadside	100	100	**54**	**54**	**46**	**50**	**52**	**48**	**43**
36	Kerbside	100	100	**61**	**60**	**46**	**54**	**56**	**56**	**49**
37	Urban background	100	100	28	28	26	25	25	22	21
38	Kerbside	closed	closed	**40**	**40**	35	closed	closed	closed	closed
39	Kerbside	100	92	**73**	**70**	**58**	**62**	**56**	**56**	**52**
40	Kerbside	100	100	**41**	31	37	**43**	**41**	**40**	36
41	Kerbside	100	100	**48**	**49**	38	**45**	**42**	**41**	38
42	Roadside	100	100	**60**	**69**	**53**	**56**	**58**	**54**	**47**
43	Kerbside	100	100	**81**	**82**	**74**	**78**	**87**	**<u>80</u>**	**<u>80</u>**
44	Kerbside	100	100	**53**	**49**	**42**	**46**	**45**	**45**	39
45	Kerbside	100	100	**49**	**48**	**44**	**43**	**48**	**45**	35
46	Kerbside	closed	closed	**47**	**48**	36	**41**	closed	closed	closed
47	Roadside	100	92	**47**	**49**	33	**40**	40	37	32
48	Roadside	100	100	**52**	**54**	**43**	**42**	45	**45**	39
49	Kerbside	100	100	**49**	**50**	39	**47**	45	**45**	39
50	Kerbside	100	100	**69**	**64**	**49**	**63**	**61**	**<u>60</u>**	**57**
51	Kerbside	100	92	**41**	39	32	36	34	34	28
52	Kerbside	100	100	**70**	**71**	**52**	**59**	**59**	**<u>62</u>**	**55**
53	varies	100	N/A	**41**	**55**	**51**	**46**	**48**	**48**	N/A

54	Roadside	100	100	Not open	**62**	**44**	**55**	**54**	**56**	**51**
55	Roadside	100	100	Not open	**59**	**41**	**48**	**52**	**55**	**50**
56	Kerbside	100	100	Not open	**41**	35	**41**	**46**	38	37
57	Kerbside	100	100	Not open	35	24	38	39	36	33
58	Kerbside	100	100	Not open	Not open	**43**	**52**	**58**	**50**	**46**
59	Kerbside	100	92	Not open	Not open	Not open	**44**	**46**	**<u>62</u>**	**40**
60	Kerbside	100	83	Not open	Not open	Not open	**40**	32	**<u>96</u>**	27
61	Roadside	100	92	Not open	Not open	Not open	**55**	**58**	closed	**48**
62	Kerbside	100	92	Not open	Not open	Not open	Not open	**54**	closed	**46**
63	Kerbside	100	100	Not open	Not open	Not open	Not open	**43**	**42**	38
64	Kerbside	100	100	Not open	Not open	Not open	Not open	**54**	32	**55**
Rut 01	Kerbside	100	100	Not open	**70**	**48**	**53**	**60**	**54**	**45**
Rut 02	Kerbside	100	100	Not open	**106**	**93**	**95**	**94**	**52**	**<u>88</u>**
RUT 03	Background	closed	closed	32	32	26	closed	closed	**42**	closed
RUT 04	Background	closed	closed	30	29	29	closed	closed	**<u>60</u>**	closed

Notes: Exceedance of the NO_2 annual mean AQO of 40 µgm^{-3} are shown in **bold**.
NO_2 annual means in excess of 60 µg m^{-3}, indicating a potential exceedance of the NO^2 hourly mean AQS objective are shown in bold and underlined.
The bias adjustment factor used for all roadside/kerbside sites is 0.92 calculated using the Castelnau site. The bias adjustment factor for background sites 28 and 37 is 1.00 calculated using the Wetlands site.

Diffusion Tube Monitoring Data

Table D shows the NO2 diffusion tube monitoring results, with bias corrected values for each year from 2009 to 2015. (Note – see Table N for the unbiased monthly data for 2015 and Table M for the distance corrected). The results in bold indicate an exceedance of the annual mean objective of 40 μg m-3 and the results underlined indicate NO2 annual means in excess of 60 μg m-3 indicating a potential exceedance of the NO2 hourly mean AQS objective.

The data capture for the sites was very good, with an overall data capture of 97%. No sites had a data capture less than 75%, therefore annualising of data was not required.

The total number of sites where monitoring was undertaken was 62. The results from the 2015 monitoring show that the objective of 40 μg m-3 was exceeded at 33 sites. Six of these sites also exceeded an annual mean of 60 μg m-3 which indicates that the 1 hour-mean objective may also have been exceeded at these locations. This represents a slight improvement on the last 3 years, but was achieved in 2011, when 33 sites also exceeded. It is clearly too early to say whether or not this is a true downward trend, so these results should be treated with caution; 2016 may well show a return to slightly higher levels. In any event this still indicates that slightly more than half the sites exceed the objective of 40 μg m-3 with 2 sites recording at least double the objective. After the distance correction, the annual mean objective is exceeded at 24 sites, with 2 of them exceeding the annual mean concentration of 60 μg m-3. There was only a small variation between the locations for the different years; this was due to some of the sites being closed or moved. For all years 2009 – 2015, other than 2015 and 2011 the number of sites exceeding the objective was more than 46.

The overall monitoring results for the Borough therefore show that NO2 concentrations exceeded the UK annual mean objective (as it has done for each year since 2005). This is also in line with the modelling prediction of the Borough (reported in the 2014 Progress Report). Improvements are still required.

Table E. NO_2 Automatic Monitor Results: Comparison with 1-hour Mean Objective

Site ID	Valid data capture for monitoring period %	Valid data capture 2015 %	Number of Hourly Means > 200 μgm^{-3}						
			2009	2010	2011	2012	2013	2014	2015
Castelnau Library, Barnes (R1)	N/A	99	1	0	0	0	2	0	0
Wetlands Centre, Barnes (R2)	N/A	94	0	0	0	0	0	0	0
NPL - Teddington AURN (TD0)	N/A	96	0	0	0	0	0	0	0

Notes: Exceedance of the NO_2 short term AQO of 200 μgm^{-3} over the permitted 18 days per year are shown in **bold**.

Automatic Monitoring Site data

The NO_2 monitoring results for the three LBRuT automatic sites are compared directly to the annual mean and hourly mean objectives. The data for 2015 is fully ratified. The Mobile Air Quality Unit was located at 3 sites during 2015, the longest of which was out of the borough. It has therefore been decided not to include results in this report.

The 2015 NO_2 data capture for each site was good, representing more than 94%. Data capture for the R1 (Castelnau) was 99% for R2 (Wetlands) 94% and for the TD0 (National Physic Laboratory) it was 96%.

Table E provides the results of automatic monitoring for NO_2 for the 1-hour mean objective of 200 $\mu g\ m^{-3}$. This objective is less stringent than the annual mean and it was met at all sites and for every year reported with the exception of Castelnau where this standard was exceeded twice in 2013 and once in 2009.

Table D provides the 2015 results of the NO_2 automatic monitoring and a comparison with the annual mean objective.
The 2015 results show that all three sites met the objective of 40 $\mu g\ m^{-3}$. The 2015 annual mean for the R2 (Wetlands) and TD0 (Teddington) sites were 21 and 19 $\mu g\ m^{-3}$ respectively. These sites are both backgrounds sites and therefore representative of low pollution in the Borough. The annual mean at the R1 (Castelnau) roadside site was 34 $\mu g\ m^{-3}$, a slightly lower concentration than in previous years reported. The annual mean for all 3 sites was slightly lower than in each of the previous 7 years but as with the NO2 diffusion tube results it is too early to say whether or not this is part of a downward trend.

Table F. Annual Mean PM_{10} Automatic Monitoring Results (µg m^{-3})

Site ID	Valid data capture for monitoring period % [a]	Valid data capture 2015 %	Annual Mean Concentration (µgm^{-3})						
			2009	2010	2011	2012	2013	2014	2015
Castelnau Library, Barnes (RI1)	100	99	21	21	23	21	22	20	22
Wetlands Centre, Barnes (RI2)	100	98	21	19	22	18	20	18	17

Notes: Exceedance of the PM_{10} annual mean AQO of 40 µgm^{-3} are shown in **bold**.

PM_{10}

The LBRuT uses a Tapered Element Oscillating Microbalance (TEOM) to continuously monitor PM_{10}. All TEOM results are converted to reference equivalence using the Volatile Correction Method (VCM), which is administered by King's College London, when they process our monitoring data. As mentioned in section 1, PM_{10} is a specified pollutant for the whole Borough AQMA.

The PM10 monitoring results for the LBRuT automatic sites are compared directly to the annual mean and 24 hour mean objectives. Tables F and G provide results for the period from 2009 to 2015 inclusive. All year data are fully ratified.

PM10 measurement was undertaken at two and the data capture was very good, representing more than 98% at each site. The R1 Castelnau site achieved 99% and the R2 Wetlands site 98%.

Table F provides results of automatic monitoring of PM10 and a comparison with annual mean objective. The objective of 40 μg m-3 was met at each site for every year reported.

The 2015 annual mean for the background site at the Wetlands Centre in Barnes was fractionally lower than in 2014 and 2012 and the lowest recoded in the last 7 years, whilst the roadside site at Castlenau recorded a slight increase from 2014. The annual means from 2009 to 2015 at both sites were similar for each year, and no upward or downward trend can be detected.

Table G provides the comparison with 24-hour mean objective. The objective of no more than 35 days exceeding 50 μg m-3 was met at each site for all years reported. All sites however exceeded this daily standard at least once for all years reported. The number of days exceeding the daily standard at each site was low in 2009, 2010, 2014 and 2015.

For 2011 the sites had an increased number of days that exceeded compared to previous years. This was mainly as a result of the episodes that arose in the early part of the year and also during November. These peaks in PM10 concentrations occur during periods of stable conditions, specifically during winter when London sources can dominate concentrations, at other times high pressure systems can lead to imported transboundary PM10 from elsewhere in the UK and Europe.

The concentrations measured in Richmond are considered typical of those measured elsewhere across London (KCL, 2012).

Table G. **PM_{10} Automatic Monitor Results: Comparison with 24-Hour Mean Objective**

Site ID	Valid data capture for monitoring period %	Valid data capture 2015 %	Number of Daily Means > 50 µgm^{-3}						
			2009	2010	2011	2012	2013	2014	2015
Castelnau Library, Barnes (R1)	100	99	4	2	15	14	10	4	5
Wetlands Centre, Barnes (R2)	100	98	5	1	17	13	6	3	1

Notes: Exceedance of the PM_{10} short term AQO of 50 µg m^{-3} over the permitted 35 days per year or where the 90.4th percentile exceeds 50 µg m^{-3} are shown in **bold**. Where the period of valid data is less than 90% of a full year, the 90.4th percentile is shown in brackets after the number of exceedances.

Table H. **Annual Mean $PM_{2.5}$ Automatic Monitoring Results (µg m^{-3})**

Site ID	Valid data capture for monitoring period %	Valid data capture 2015 %	Annual Mean Concentration (µgm^{-3})						
			2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NPL Teddington	N/A	N/A	N/A	14	17.5	11.5	16.7	N/A	N/A
Valid Data capture %	N/A	N/A	N/A	77%	80%	98%	52%	N/A	N/A

$PM_{2.5}$ monitoring was undertaken at the National Physical Laboratory (NPL) background site using the Filter Dynamics Measurement System (FDMS). The monitoring started in 2009 and ended in mid-2013.

Table 1 $PM_{2.5}$ levels at NPL

NPL – Teddington AURN	2010	2011	2012	2013
Annual mean [a]	14	17.5	11.5	16.7
Data capture (%)	77%	80%	98%	52%

The objective, which is not part of LAQM, is (i) an annual average target value of 25 µg m-3 by 2010; (ii) limit value of 25 µg m-3 by 2015; (iii) exposure reduction target of up to 20% reduction of urban background particulate matter levels from a reference year of 2010, to be achieved by 2020.

The results show that the PM2.5 levels for 2010, 2011 and 2012 were below the target value. The results for the PM2.5 levels for 2013 were also below, although they do not represent the full year.

2. Action to Improve Air Quality

Table J. Commitment to Cleaner Air Borough Criteria

Theme	Criteria		Achieved (Y/N)	Evidence
1. Political leadership	***1.a***	Pledged to become a Cleaner Air for London Borough (at cabinet level) by taking significant action to improve local air quality and signing up to specific delivery targets.	Y	Member sign up for LBRUT April 2013
	1.b	Provided an up-to-date Air Quality Action Plan (AQAP), fully incorporated into LIP funding and core strategies.	N	In progress
2. Taking action	**2.a**	Taken decisive action to address air pollution, especially where human exposure and vulnerability (e.g. schools, older people, hospitals etc) is highest.	Y	On-going Cleanerair4schools project, funded through MAQF.
	2.b	Developed plans for business engagement (including optimising deliveries and supply chain), retrofitting public buildings using the RE:FIT framework, integrating no engine idling awareness raising into the work of civil enforcement officers, (etc etc)	Y	The Council has participated in a trial that involves liaising with businesses to explore the possibility of retiming deliveries to off peak periods in two of the Council's district and local centres (Hampton Hill and St Margarets).
	2.c	Integrated transport and air quality, including by improving traffic flows on borough roads to reduce stop/start conditions		The borough works with TfL to identify junctions where traffic signal timings can be improved to help smooth traffic flows. As part of any wider transport schemes, opportunities are also taken to review signal timings and junction layouts where congestion is an issue, for instance at Hospital Bridge Road / Powdermill Lane,

				along Kingston Road and through the application of the 'SCOOT' system in Twickenham Town Centre. The borough has also implemented a range of schemes to help encourage sustainable transport, which in term reduce reliance on the private car helping to ease congestion.
	2.d	Made additional resources available to improve local air quality, including by pooling its collective resources (s106 funding, LIPs, parking revenue, etc).	Y	The Council makes use of a range of funding sources to help deliver its transport schemes which in turn deliver air quality benefits. Sources include TfL LIP funding, other TfL funding streams (such as Borough Cycle Programme and Incubator funding), s106 funding, Council uplift funding, Council revenue funding and Mayor's Air Quality funding. For instance the Council recently ran a project in schools to raise awareness of air quality issues, which was funded through a combination of LIP and MAQF funding.
3. Leading by	**3.a**	Invested sufficient resources to complement and drive action from others	Y	One AQ officer and budget of £30,000

example	**3.b**	Maintained an appropriate monitoring network so that air quality impacts within the borough can be properly understood	Y	All existing AQ monitors maintained
	3.c	Reduced emissions from council operations, including from buildings, vehicles and all activities.	Y	LBRUT has installed solar panels on the roof of the Civic Centre to help reduce emissions.
	3.d	Adopted a procurement code which reduces emissions from its own and its suppliers activities, including from buildings and vehicles operated by and on their behalf (e.g. rubbish trucks).	Y	50% of the fleet are Euro 4 50 % of fleet are Euro 5/6
4. Using the planning system	**4.a**	Fully implemented the Mayor's policies relating to air quality neutral, combined heat and power and biomass.	Y	All approved planning applications meet the Mayor's requirements relating to AQ neutral and CHPs
	4.b	Collected s106 from new developments to ensure air quality neutral development, ***where possible***	N	None has been collected.
	4.c	Provided additional enforcement of construction and demolition guidance, with regular checks on medium and high risk building sites.	Y	Strict planning conditions for construction and demolition applied to all major sites. Complaints responded to.
5. Integrating air quality into the public health system	**5**	Included air quality in the borough's Health and Wellbeing Strategy and/or the Joint Strategic Needs Assessment	Y	Health and Wellbeing Strategy includes air quality as a key theme.
6. Informing the public	**6.a**	Raised awareness about air quality locally	Y	airTEXT is promoted on the website and at local events. aitTEXT has been included as a recommendation for practices and the HRCH respiratory care team to promote COPD Pathway review. Lessons are given to local

				schools to raise awareness for air quality.

2.1 Air Quality Action Plan Progress

The London Borough of Richmond upon Thames has updated its original Air Quality Action Plan every year since 2002. Considering recent developments in the area of Air Quality and a significant change of impetus, we now feel the need to completely refresh the Air Quality Action Plan; this is currently in progress with consultants.

3. Planning Update and Other New Sources of Emissions

Richmond is currently undergoing consultation on its Local Plan Policy; Air Quality will be addressed fully in this document, this represents a commitment to tackling poor air quality through the planning process.

Planning applications are assessed for any air quality impacts on neighbouring sensitive receptors, during both the development phase and the end use phase. Each site is subject to the provisions of the National Considerate Constructors Scheme. From 1/9/15 an NRMM condition has been added to standard planning conditions to ensure all major sites register on the NRMM website. In 2016 we also employed a member of staff to check onsite compliance.

Major Development Sites for which air quality was a consideration in 2015 include:-

Teddington Studios, Broom Road, Teddington, TW11 9NT

REEC – Richmond College, Egerton Rd, Twickenham, TW2 7SJ

Twickenham Railway Station, London Rd, Twickenham TW1 1BD

Twickenham Sorting Office, London Rd, Twickenham, TW1 1EE

Sandycombe Centre, 1-9 Sandycombe Rd, Richmond TW9 2EP

Biomass boilers

The LBRUT, in line with the Mayor's approach, has discouraged all applications for biomass boilers if they did not meet the standards required for air quality protection in the urban environment.

3.1 New or significantly changed industrial or other sources

The Annual Status Report has not identified any new or significantly altered road traffic, industrial, commercial or domestic sources that require further action.

Conclusions

In 2015 NO_2 concentrations were found to exceed the objective of 40ug/m^3 at many of the locations monitored. This conclusion remains true even when façade level corrections are made, indicating that there are still exceedances with relevant public exposure. This indicates the continuing need for the Borough to remain designated as a Borough-wide AQMA, for NO_2. The results further indicate that the hourly objective is potentially exceeded however at some sites.

The PM_{10} monitoring results show that the annual mean PM_{10} and daily mean PM_{10} limits were not exceeded at any site in the Borough during the last seven years. However, modelling undertaken for 2015 (from the 2014 Progress Report) indicates that we should expect the objectives to be exceeded at a few vulnerable receptor sites. On that basis the AQMA designation for PM_{10} is retained.

The Authority as a matter of course will continue to review and evaluate its NO_2 diffusion tube locations annually and move or add tubes where gaps are identified.

The PM_{10} monitoring results show that the annual mean PM_{10} and daily mean PM_{10} limits were not exceeded at any site in the Borough during the last seven years. However, the 2015 modelling indicates that we should expect the objectives to be exceeded at a few vulnerable receptor sites. On that basis it is thought best to retain the AQMA designation for PM10.

Richmond Council is in the process of updating its Air Quality Action Plan (AQAP). These actions are designed to achieve air quality improvements across the borough.

The Council is further reducing the emissions by encouraging developers to participate in the 'Considerate Constructor Scheme' , register all construction vehicles and site generators on the NRMM website and comply with requirements and assess all major developments for air quality.

At the regional level, the Borough continues to work with the Mayor of London's plan to reduce emissions in his London Air Quality Strategy.

Appendix A Details of Monitoring Site QA/QC

A.1 Automatic Monitoring Sites

All data undergoes quality assurance and quality control (QA/QC) procedures to ensure that the data obtained are of a high quality.

Each NO2 continuous analyser is automatically calibrated every night and also manually checked and calibrated every two weeks by the local authority Air Quality Officer. There is a need for frequent calibration adjustments as the gradual build-up of dirt within the analyser reduces the response rate. This fall off in response needs appropriate correction, to ensure the recording of the true concentrations. The calibration process involves checking the monitoring accuracy against a known concentration of span gas. The span gas used is nitric oxide and is certified to an accuracy of 5%. Both the automatic and manual calibrations use this same certified span gas (i.e. the automatic overnight one does not use the less accurate permeation tube method).

The NO2 and ozone continuous analysers are serviced every six months by Enviro Technology Services plc and also audited by NPL every six months as part of the King's LAQN QA/QC procedure, to ensure optimum data quality.

Teddington (AURN) monitoring station at NPL is part of the AURN and the QA/QC for this station is managed by AEA Technology. For more information go to www.airquality.co.uk/archive/index.php (Defra, 2009d).

PM_{10} Monitoring Adjustment

PM10 particulates are measured using Tapered Element Oscillating Microbalance (TEOM) analysers, with the data presented as the gravimetric equivalent.

No automatic or fortnightly calibrations are carried out on TEOMs. Calibrations are only carried as part of the routine servicing and regular independent audits. The on-going performance of the monitor is checked on-line, by the King's College London Duty Officer. The role of the LSO at the fortnightly visits is to make more detailed performance checks. The LSO is also on standby at other times, to change the TEOM's monitoring filter as required, depending on the filter loading.

Since 2009, TEOM data have been improved by routine adjustments, using the volatile correction method (VCM). This corrects for the loss of any volatile mass, which has been driven off by the heat applied in the TEOM's inlet column. The VCM adjustments are carried out by King's College London, prior to dissemination of the data.

The TEOM equipment is serviced every six months by Enviro Technology Services plc and also audited by NPL every six months as part of the King's LAQN QA/QC procedure, to ensure optimum data quality. Both sites are part of the LAQN and King's are responsible for the daily data collection, storage, validation and dissemination via the LAQN website (www.londonair.org.uk). King's ratifies the data periodically, viewing data over longer time periods and using the results from fortnightly checks, equipment services and equipment audits.

A.2 Diffusion Tube Quality Assurance / Quality Control

Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe (EC, 2008) sets data quality objectives for NO_2 along with other pollutants. Under the Directive, annual mean NO_2 concentration data derived from diffusion tube measurements must demonstrate an accuracy of ±25 % to enable comparison with the NO_2 air quality objectives of the Directive.

In order to ensure that NO_2 concentrations reported are of a high quality, strict performance criteria need to be met through the execution of QA and QC procedures. A number of factors have been identified as influencing the performance of NO_2 diffusion tubes including the laboratory preparing and analysing the tubes, and the tube preparation method (AEA, 2008). QA and QC procedures are therefore an integral feature of any monitoring programme, ensuring that uncertainties in the data are minimised and allowing the best estimate of true concentrations to be determined.

Our NO_2 diffusion tubes are analysed for us by Gradko using 50% TEA in acetone method of preparation. Gradko take an active role in developing rigorous QA and QC procedures in order to maintain the highest degree of confidence in their laboratory measurements. Gradko were involved in the production of the Harmonisation Practical Guidance for NO_2 diffusion tubes (AEA, 2008) and have been following the procedures set out in the guidance since January 2009. Since April 2014 Gradko has taken part in a new scheme AIR PT , which combines two long running PT schemes: LGC Standards STACKS PT scheme and HSL WASP PT scheme.

This section contains details of Gradko International Ltd's Results of laboratory precision

- performance in AIR NO2 PT Scheme (April 2014 – February 2016

- Summary of Precision Scores for 2013 - 2015

- UKAS schedule of accreditation

Summary of Laboratory Performance in AIR NO2 Proficiency Testing Scheme (April 2014 – February 2016).

Gradko participate in the AIR PT NO_2 diffusion tube scheme which uses artificially spiked diffusion tubes to test each participating laboratory's analytical performance on a quarterly basis. The scheme is designed to help laboratories meet the European Standard. Gradko demonstrated "good" laboratory performance for every month in 2015 for 50% TEA in Acetone.

Reports are prepared by LGC for BV/NPL on behalf of Defra and the Devolved Administrations. Background AIR is an independent analytical proficiency-testing (PT) scheme, operated by LGC Standards and supported by the Health and Safety Laboratory (HSL). AIR PT is a new scheme, started in April 2014, which combines two long running PT schemes: LGC Standards STACKS PT scheme and HSL WASP PT scheme.

Table 1: Laboratory summary performance for AIR NO_2 PT rounds AR001, 3, 4, 6, 7, 9, 10 and 12

The following table lists those UK laboratories undertaking LAQM activities that have participated in recent AIR NO_2 PT rounds and the percentage (%) of results submitted which were subsequently determined to be **satisfactory** based upon a z-score of ≤ ± 2 as defined above.

AIR PT Round	AR001	AR003	AR004	AR006	AR007	AR009	AR010	AR012
Round conducted in the period	April – May 2014	July – August 2014	October – November 2014	January – February 2015	April – May 2015	July – August 2015	October – November 2015	January – February 2016
Aberdeen Scientific Services	100 %	100 %	100 %	100 %	100 %	75 %	100 %	100 %
Cardiff Scientific Services	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]
Edinburgh Scientific Services	100 %	100 %	100 %	75 %	100 %	100 %	100 %	100 %
Environmental Services Group, Didcot [1]	100 %	100 %	100 %	87.5 %	100 %	100 %	100 %	100 %
Exova (formerly Clyde Analytical)	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]
Glasgow Scientific Services	100 %	100 %	100 %	100 %	100 %	100 %	100 %	75 %
Gradko International [1]	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Kent Scientific Services	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]	NR [3]
Kirklees MBC	100 %	100 %	100 %	75 %	100 %	100 %	100 %	100 %
Lambeth Scientific Services	50 %	100 %	100 %	25 %	100 %	100 %	100 %	100 %
Milton Keynes Council	100 %	100 %	75 %	100 %	100 %	100 %	100 %	50 %
Northampton Borough Council	100 %	0 %	0 %	100 %	100 %	100 %	100 %	50 %
Somerset Scientific Services	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
South Yorkshire Air Quality Samplers	100 %	100 %	100 %	100 %	100 %	100 %	75 %	100 %
Staffordshire County Council	100 %	25 %	100%	100 %	100 %	75 %	75 %	75 %
Tayside Scientific Services (formerly Dundee CC)	NR [2]	100 %	100 %	100 %	NR [2]	NR [2]	NR [2]	100 %
West Yorkshire Analytical Services	75 %	100 %	75 %	100 %	75 %	75 %	75 %	75 %

[1] Participant subscribed to two sets of test samples (2 x 4 test samples) in each AIR PT round.
[2] NR No results reported
[3] Kent Scientific Services, Cardiff Scientific Services and Exova (formerly Clyde Analytical) no longer carry out NO_2 diffusion tube monitoring and therefore did not submit results.

2013 - 2015 Summary of Precision Results for Nitrogen Dioxide Diffusion Tube Collocation Studies for Gradko Laboratory 50% TEA in Acetone

Gradko, 50% TEA in Acetone	
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	G
2013	P
2014	G
2014	G
2014	G
2014	G
2014	G
2014	G
2014	G
2014	G
2014	G
2014	P
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G
2015	G

2013 Results of study carried out in 2013

2014 Results of study carried out in 2014

2015 Results of study carried out in 2015

Numerical results for this data are contained in the National Bias Adjustment Spreadsheet version 06/16.

P Poor Precision

G Good Precision

Gradko demonstrated “good” laboratory performance for every month in 2015 for 50% TEA in Acetone.

Gradko is accredited by UKAS for the analysis of NO_2 diffusion tubes. It undertakes the analysis of the exposed diffusion tubes by ultra violet spectrophotometry.

Schedule of Accreditation
issued by
United Kingdom Accreditation Service
2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK

UKAS TESTING 2187 Accredited to ISO/IEC 17025:2005	Gradko International Ltd (Trading as Gradko Environmental) **Issue No:** 019 **Issue date:** 04 September 2015	
	St Martins House **77 Wales Street** **Winchester** **Hampshire** **SO23 0RH**	**Contact: Mr A Poole** **Tel: +44 (0)1962 860331** **Fax: +44 (0)1962 841339** **E-Mail: diffusion@gradko.co.uk** **Website: www.gradko.co.uk**
Testing performed at the above address only		

DETAIL OF ACCREDITATION

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used
ATMOSPHERIC POLLUTANTS Collected on diffusion (sorbent) tubes and monitors	Chemical Tests	Documented In-House Methods
	Ammonia	GLM 8 by Ion Chromatography
	Benzene Toluene Ethyl benzene Xylene	GLM 4 by Thermal Desorption/ FID Gas Chromatography
	Hydrogen chloride Nitrogen dioxide Sulphur dioxide Hydrogen fluoride	GLM 3 by Ion Chromatography
	Hydrogen sulphide	GLM 5 by Colorimetric determination (UV Spectrophotometry)
	Ozone	GLM 2 by Ion Chromatography
	Nitrogen Dioxide	GLM 7 by Colorimetric determination (UV Spectrophotometry)
	Nitrogen Dioxide (as Nitrite)	GLM 9 by continuous flow colorimetric analyser
	Sulphur dioxide	GLM 1 by Ion Chromatography
	Formaldehyde	GLM 18 by HPLC

2187 Accredited to ISO/IEC 17025:2005	**Schedule of Accreditation** issued by **United Kingdom Accreditation Service** 2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK **Gradko International Ltd** **(Trading as Gradko Environmental)** **Issue No:** 019 **Issue date:** 04 September 2015

Testing performed at main address only

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used
ATMOSPHERIC POLLUTANTS Collected on diffusion (sorbent) tubes and monitors (cont'd)	Chemical Tests (cont'd)	
Flexible Scope encompassing Volatile Organic Compounds to in-house validation criteria	Volatile Organic Compounds Including: Benzene 1,3-Butadiene 1,2-Dichloro(Z)ethene, Ethylbenzene Indane Naphthalene Styrene Tetrachloroethylene Toluene Trichloroethylene 1,2,3-Trimethylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene p-Xylene o-Xylene **The laboratory holds a flexible scope of accreditation for these tests.** **Please contact the laboratory for details of the individual compounds they can analyse using this method.**	GLM 13 by Thermal Desorption GC-Mass Spectrometry
END		

NO_2 diffusion tube analysis method

NO_2 diffusion tubes are passive monitoring devices. They are made up of a Perspex cylinder, with 2 stainless steel mesh discs, coated with TEA absorbent held inside a polythene cap, which is sealed onto one end of the tube. Diffusion tubes operate on the principle of molecular diffusion, with molecules of a gas diffusing from a region of high concentration (open end of the tube) to a region of low concentration (absorbent end of the tube) (AEA, 2008). NO_2 diffuses up the tube because of a concentration gradient and is absorbed by the TEA, which is present on the coated discs in the sealed end of the tube. All Richmond NO_2 diffusion tubes are prepared by Gradko using 50% v/v TEA with Acetone as the absorbent.

Prior to and after sampling, an opaque polythene cap is placed over the end of the diffusion tube opposite the TEA coated discs to prevent further adsorption. The NO_2 diffusion tubes are labelled and kept refrigerated in plastic bags prior to and after exposure.

<u>Discussion of Choice of Factor to Use</u>

Diffusion Tube Bias Adjustment Factors from Local Co-location Studies

In 2015 the Borough undertook co-location studies at two continuous NO_2 monitoring sites, together with 3 x NO_2 diffusion tubes at each of the following the locations:

- **Richmond 1 Castelnau (site 23):** a roadside site, used to bias adjust all other kerbside and roadside sites in the borough. In 2015 the annual average for the Castelnau diffusion tubes (№ 23) was 36 μg m^{-3}; for the continuous site (R1) it was 34 μg m^{3}. Thus the bias adjustment factor is **0.92**

- **Richmond 2 Barnes Wetlands (site 37):** a suburban site used to bias adjust the two background sites, 28 and 37. In 2015 the annual average for the Wetlands diffusion tubes (№ 37) was 21 μg m^{-3}; for the continuous site (R2) it was 21 μg m^{3}. Thus the bias adjustment factor is **1.00**
- **The National bias adjustment factor** for Gradko using 50% TEA in acetone was **0.96.**

The overall precision and data capture for this co-location study was very good, as it has been over recent years. So, it was decided to use local adjustment figures, 1) as they are more representative of local conditions and 2) in the interests of consistency, since local adjustment figures have been used since 2002 for all annual Air Quality Reports for Defra.

Factor from Local Co-location Studies

The local bias adjustment factors for the Borough are provided in Table A.1 for 2010 to 2015. From 2010 to 2015 all kerbside and roadside sites in the Borough are bias adjusted using the factor from the local roadside co-location site at Richmond 1 Castelnau. All background sites in the Borough are bias adjusted using the factor from the local suburban co-location site at the Richmond 2 Barnes Wetlands. This is with the exception of 2014 data when the bias adjustment factor was the average of the three static sites in the borough – the third was the Air Quality mobile, which was at the same roadside site for the duration of 2014.

The methodology for calculating the bias adjustment was followed using the guidance on the AEA spreadsheet. The co-location questionnaire was also completed and submitted to Nick Martin at NPL to be included in the National Diffusion Tube Bias Adjustment Factor Spreadsheet.

Table A.1 2010 to 2015 NO_2 diffusion tube bias adjustment factors for the Borough

Source of bias adjustment factor	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Local roadside co-location study at Richmond 1 Castelnau	1.06	0.92	1.06	0.96	0.95	0.92
Local background co-location study at Richmond 2 Wetlands Barnes	1.02	1.03	1.04	0.95	1.09	1.00
National factor (not used)	1.03	0.95	1.01	1.01	0.97	0.96

A.3 Adjustments to the Ratified Monitoring Data

Distance Adjustment

Table M. Annual Mean NO2 Ratified and Bias-adjusted Monitoring Results (g m-3) The results in brackets indicate the exposure estimate, calculated for the nearest residential façade following the procedure as specified in LLAQM.TG(16).

Site ID	**Site type**	**Annual Mean Concentration (µgm^{-3})**						
		2009[c]	**2010**	**2011**	**2012** [c]	**2013**[c]	**2014** [c]	**2015** [c]
		(Bias Adjustment Factor = 1.00)	**(Bias Adjustment Factor = 1.06)**	**(Bias Adjustment Factor = 0.92)**	**(Bias Adjustment Factor = 1.06)**	**(Bias Adjustment Factor = 0.96)**	**(Bias Adjustment Factor = 0.97)**	**(Bias Adjustment Factor = 0.92)**
1	roadside	53 (53)	**51 (50)**	**44 (43)**	**45 (46)**	**47 (46)**	**49 (48)**	**41 (41)**
2	roadside	39 (37)	39 (36)	31 (29)	34 (34)	32 (31)	33	28 (28)
3	roadside	44 (42)	**44** (33)	35 (28)	**44 (40**)	**44** (33)	**44** (37)	**41** (35)
4	kerbside	47 (44)	39 (31)	38 (30)	**44 (40)**	**44** (34)	**44** (35)	36 (31)
5	kerbside	37 (34)	38 (31)	32 (27)	33 (33)	Closed	Closed	closed
6	kerbside	47 (40)	**48** (38)	34 (29)	43 (40)	**43** (35)	**41** (35)	36 (32)
7	kerbside	69 (57)	**69 (59)**	**49 (43)**	**59 (54)**	**61 (53)**	**54 (48)**	**47 (42)**
8	kerbside	38 (37)	39 (31)	30 (26)	34 (34)	Closed	Closed	closed
9	kerbside	57 (50)	**55 (48)**	**47 (42)**	**50 (47)**	**49 (44)**	**48 (43)**	**42** (39)
10	kerbside	45 (41)	**47** (37)	36 (33)	**44 (42)**	**46 (42)**	**38**	**43** (35)
11	kerbside	50 (43)	**52** (38)	**46** (35)	**54 (46)**	**49** (38)	**48** (38)	**44** (35)
12	kerbside	49 (44)	**52** (39)	**41** (32)	**45 (41)**	**49** (37)	**46** (37)	**41** (34)
13	kerbside	50 (44)	**53 (42)**	**42** (34)	**48 (43)**	**48** (38)	**47** (39)	**42** (36)
14	kerbside	54 (50)	**52 (42)**	38 (32)	**48 (44)**	**46** (38)	**45** (39)	39 (35)
15	kerbside	55 (49)	**53 (47)**	**41 (40)**	**44 (42)**	**40** (37)	**40** (37)	37 (35)

16	roadside	49 (49)	**48 (43)**	38 (35)	**45 (42)**	**44** (38)	**43 (40)**	**41** (38)
17	kerbside	31	**79 (67)**	**65 (55)**	**70 (59)**	**68 (57)**	**68 (58)**	**63 (54)**
18	kerbside	64 (50)	**70 (52)**	**66 (47)**	**68 (48)**	**71 (49)**	**66 (48)**	**67 (48)**
19	kerbside	60 (48)	**46** (37)	**50** (35)	**56** (38)	**53** (36)	**55** (39)	**48** (35)
20	kerbside	58 (54)	**54 (42)**	**40** (36)	**53 (45)**	**51 (43)**	**55 (47)**	**48 (42)**
21	roadside	47 (46)	**47 (42)**	39 (35)	**43** (38)	44 (38)	**41** (37)	37 (34)
22	kerbside	60 (57)	**55 (46)**	**46** (38)	**51 (41)**	**57 (45)**	**59 (47)**	**53 (43)**
23	roadside	43 (43)	**43 (40)**	35 (32)	38 (35)	39 (35)	38	35 (33)
24	kerbside	46 (43)	**42** (36)	36 (30)	**40** (33)	**40** (32)	**40** (34)	35 (31)
25	roadside	45 (45)	**42 (42)**	32 (32)	**47 (47)**	**51 (51)**	**51 (51)**	**45 (45)**
26	roadside	54 (52)	**46** (37)	**40** (31)	**42** (33)	**43** (33)	**42** (34)	**40** (32)
27	roadside	46 (46)	**44 (41)**	38 (35)	**41** (38)	**40** (37)	37	37 (35)
28	urban backgro und	23	24 (24)	20 (20)	22 (22)	21 (21)	18	17 (N/A)
29	kerbside	45 (41)	39 (39)	37 (37)	**43 (43)**	39 (39)	36	30 (30)
30	roadside	41 (44)	**41 (42)**	33 (34)	36 (36)	38 (39)	34	29 (29)
31	roadside	60 (57)	**53 (42)**	**50 (40)**	**59 (50)**	**61 (47)**	**62 (49)**	**54 (44)**
32	roadside	110 (89)	102 (88)	**75 (66)**	**77 (70)**	**74 (65)**	**73 (68)**	**62 (56)**
33	kerbside	63 (56)	66 (53)	**47** (39)	**58 (51)**	**62 (50)**	**69 (56)**	**61 (50)**
34	roadside	44 (43)	42 (42)	36 (36)	39(39)	38 (38)	**40 (40)**	33 (33)
35	roadside	54 (53)	**54 (54)**	**46 (46)**	**50 (50)**	**52 (52)**	**48 (48)**	**43 (43)**
36	kerbside	61 (62)	**60 (55)**	**46 (42)**	**54 (49)**	**56 (50)**	**56 (51)**	**49 (45)**
37	urban backgro und	28	28	26	25	25	22	21 (N/A)
38	kerbside	40 (36)	40 (34)	35 (30)	closed	closed	closed	closed
39	kerbside	73 967)	**70 (62)**	**58 (52)**	**62 (58)**	**56 (51)**	**56 (51)**	**52 (48)**

40	kerbside	41 (39)	31 (27)	37 (28)	**43** (39)	**41** (31)	**40** (33)	36 (30)
41	kerbside	48 (44)	**49 (42)**	38 (33)	**45** (38)	**42** (36)	**41** (36)	38 (38)
42	roadside	60 (59)	**69 (73)**	**53 (55)**	**56 (59)**	**58 (61)**	**54 (56)**	**47 (49)**
43	kerbside	81 (64)	**82 (73)**	**74 (66)**	**78 (70)**	**87 (77)**	**80 (72)**	**80 (72)**
44	kerbside	53 (48)	**49 (49)**	**42 (42)**	**46 (46)**	**45 (45)**	**45 (45)**	39 (39)
45	kerbside	49 (45)	**48 (40)**	**44 (37)**	**43 (41)**	**48 (40)**	**45** (39)	35 (32)
46	kerbside	47 (42)	**48** (39)	36 (31)	**41** (39)	closed	closed	closed
47	roadside	47 (42)	**49 (44)**	33 (32)	**40 (40)**	**40** (39)	37	32 (31)
48	roadside	52 (49)	**54 (46)**	**43 (37)**	**42 (40)**	**45 (39)**	**45 (40)**	39 (36)
49	kerbside	49 (49)	**50 (45)**	39 (36)	**47 (42)**	**45 (40)**	**45 (41)**	39 (36)
50	kerbside	69 (55)	**64 (55)**	**49 (42)**	**63 (53)**	**61 (52)**	**60 (52)**	**57 (49)**
51	kerbside	41 (40)	39 (37	32 (30)	36 (34)	34 (32)	34	28 (28)
52	kerbside	70 (66)	**71 (60)**	**52 (45)**	**59 (50)**	**59 (50)**	**62 (53)**	**55 (47)**
53	varies	41 (41)	**55 (45)**	**51 (43)**	**46(43)**	**48 (40)**	**48** (38)	N/A
54	roadside	Not open	**62 (57)**	**44 (41)**	**55 (50)**	**54 (49)**	**56 (52)**	**51 (47)**
55	roadside	Not open	**59 (49)**	**41** (35)	**48 (40)**	**52 (42)**	**55 (45)**	**50 (42)**
56	kerbside	Not open	**41** (39)	35 (30)	**41 (41)**	**46 (44)**	38	37 (36)
57	kerbside	Not open	24 (23)	38 (38)	39 (38)		36	33 (32)
58	kerbside	Not open	**43** (39)	**52 (49)**	**58 (51)**		**50 (40)**	**46** (38)
59	kerbside	Not open	Not open	Not open	**44 (41)**	**46 (43)**	**42 (40)**	**40** (38)
60	kerbside	Not open	Not open	Not open	**40** (39)	32 (30)	32	27 (27)
61	roadside	Not open	Not open	Not open	**55 (47)**	**58 (51)**	**54 (49)**	**48 (44)**

62	kerbside	Not open	Not open	Not open	Not open	**54 (45)**	**52 (45)**	**46 (40)**
63	kerbside	Not open	Not open	Not open	Not open	**43** (38)	**42** (38)	38 (35)
64	kerbside	Not open	Not open	Not open	Not open	**54 (48)**	**60 (53)**	**55 (49)**
Rut 01	kerbside	Not open	**70 (70)**	**48 (48)**	**53 (53)**	**60 (60)**	**62 (62)**	**45 (45)**
Rut 02	kerbside	Not open	**106 (90)**	**93 (78)**	**95 (80)**	**94 (79)**	**96 (81)**	**88 (75)**
RUT 03	Background	32	32	26	closed	closed	closed	closed
RUT 04	Background	30	29	29 (36)	closed	closed	closed	closed

Appendix B Full Monthly Diffusion Tube Results for 2015

Table N. NO_2 Diffusion Tube Results

Site ID	Valid data capture for monitoring period % [a]	Valid data capture 2015 % [b]	Annual Mean NO_2													
			Jan	Feb	March	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Annual mean – raw data [c]	Annual mean – bias adjusted [d]
1	100	92	54.3	49.0	40.4	44.4	39.9	47.9		39.3	45.2	47.1	41.2	40.2	**44**	**41**
2	100	100	33.8	38.1	31.1	28.2	21.0	25.3	23.6	28.1	33.3	38.1	31.1	24.1	**30**	28
3	100	100	53.2	51.7	42.8	44.1	36.1	41.6	38.8	39.0	40.8	48.8	38.6	33.0	**42**	**41**
4	100	100	44.9	50.6	39.7	42.5	29.7	36.2	34.7	37.2	17.6	52.2	35.5	31.0	**38**	36
6	100	92	46.9	43.6	40.2		31.6	34.3	31.1	37.7	43.3	48.8	32.9	26.3	**38**	36
7	100	83	50.7	59.7		57.2		52.7	40.0	45.9	55.5	70.2	34.5	28.1	**49**	**47**
9	100	92	43.0	48.0	36.8	48.4		39.5	33.7	43.3	44.8	57.6	47.5	38.9	**44**	**42**
10	100	100	52.6	58.2	43.9	43.6	35.8	39.6	38.9	42.3	40.7	47.6	49.2	43.9	**45**	**43**
11	100	100	52.9	55.6	45.3	39.9	36.9	44.3	32.3	45.3	48.5	51.3	47.9	44.9	**45**	**44**
12	100	100	49.2	47.3	42.1	47.3	35.7	38.7	38.2	41.5	48.7	54.7	43.0	32.2	**43**	**41**
13	100	92	44.0	48.7	41.9	49.6	33.1		40.3	45.4	44.1	55.2	41.1	38.6	**44**	**42**
14	100	92	46.8	51.4	43.0	41.1	31.0	34.7		41.1	41.6	50.7	40.5	23.3	**40**	39
15	100	100	46.9	40.8	36.1	40.0	35.0	37.8	38.1	38.9	40.8	47.2	37.6	29.2	**39**	37
16	100	92	49.0	61.4	49.6		33.6	36.6	34.5	37.8	43.6	49.5	41.5	34.1	**43**	**41**
17	100	92	59.2	65.6	60.0		67.4	73.7	65.5	68.9	68.7	77.9	67.9	49.7	**66**	**63**
18	100	100	113.7	63.9	64.7	66.6	64.2	65.5	67.9	67.9	70.6	73.6	59.0	58.8	**70**	**67**

19	100	100	57.6	60.3	55.0	55.8	43.5	47.7	44.4	52.7	46.6	51.2	56.4	23.4	**50**	**48**
20	100	100	60.1	50.3	42.0	49.5	45.1	52.2	47.3	52.4	53.3	52.6	53.4	45.4	**50**	**48**
21	100	100	47.9	44.0	31.2	44.2	35.7	34.4	32.7	33.0	44.5	48.3	38.3	28.9	39	37
22	100	92	59.6	55.9	48.2	51.3	56.1	52.9	52.2	55.4	55.6		47.1	68.4	**55**	**53**
23	100	100	37.1	46.9	35.1	36.3	30.0	31.6	28.6	33.5	40.6	32.2	35.1	31.3	36	35
24	100	100	40.0	44.4	37.1	37.5	34.1	28.6	30.9	29.1	39.9	47.2	36.8	30.4	36	35
25	100	100	43.2	50.6	48.5	57.3	40.9	50.8	49.8	42.1	48.1	56.3	43.5	36.3	**47**	**45**
26	100	100	55.5	47.1	43.8	44.0	37.0	38.1	36.1	34.4	40.6	43.8	40.9	37.3	**42**	**40**
27	100	100	42.7	53.8	39.2	38.7	30.0	37.7	34.9	39.2	39.9	41.1	32.2	29.3	38	37
28	100	100	21.3	21.3	18.3	17.0	12.7	14.5	10.9	14.5	21.6	26.4	17.4	12.8	17	17
29	100	92	39.0	38.7	33.3	33.3	22.8	27.6	20.6	30.3	35.4		31.6	29.0	31	30
30	100	92	37.1	25.9	34.1	34.1	19.6	29.2	28.9	28.4	33.5	41.0		21.4	30	29
31	100	92	56.5	67.0	53.1	60.7	45.0	49.8		53.0	57.4	63.2	60.7	54.5	**56**	**54**
32	100	100	68.8	67.1	59.7	69.9	52.3	66.8	61.5	69.8	63.9	76.5	60.3	57.4	**64**	**62**
33	100	100	58.6	72.7	83.5	71.7	53.3	73.3	50.0	60.8	78.2	79.7	48.4	35.7	**64**	**61**
34	100	100	45.3	40.3	39.7	36.8	25.7	31.5	30.0	23.6	38.0	42.4	32.3	24.7	34	33
35	100	100	50.5	47.7	41.9	39.2	40.0	43.1	44.7	48.1	44.0	48.7	47.9	41.8	**45**	**43**
36	100	100	50.5	59.1	54.7	59.2	47.6	53.8	41.1	50.8	54.4	67.8	40.9	35.1	**51**	**49**
37	100	100	24.8	27.5	20.3	19.9	17.5	17.4	15.7	17.8	23.8	31.9	20.7	16.7	21	21
39	100	92	53.3	58.4	61.0	54.3	59.2		51.4	52.4	56.4	61.3	46.8	41.2	**54**	**52**
40	100	100	41.6	47.0	39.4	40.8	26.0	32.5	30.7	35.7	37.0	48.4	36.0	32.8	37	36
41	100	100	47.4	45.8	41.9	38.2	35.8	37.8	36.9	36.1	41.4	47.4	40.3	30.7	**40**	**38**
42	100	100	40.7	51.9	53.3	59.9	38.1	48.8	43.1	51.6	58.1	71.5	36.2	38.3	**49**	**47**
43	100	100	84.6	89.6	70.5	82.3	80.8	88.5	95.2	88.6	77.2	84.6	87.4	69.0	**83**	**80**
44	100	100	41.5	45.0	42.6	46.7	34.2	40.5	36.1	37.9	41.6	58.0	36.4	29.7	**41**	39
45	100	100	43.7	44.8	37.4	33.9	27.6	34.1	31.8	36.5	37.1	41.6	38.5	35.4	37	35

47	100	92	39.4	44.9	35.5	37.3		29.0	19.4	27.6	39.5	40.6	28.2	19.9	33	32
48	100	100	55.3	24.2	39.3	41.6	34.8	38.6	37.9	38.9	38.1	46.1	52.2	35.0	**40**	39
49	100	100	38.3	48.8	41.5	45.3	32.8	42.2	32.0	36.0	47.7	60.1	33.4	27.0	**40**	39
50	100	100	66.2	61.1	53.2	67.2	54.8	62.4	49.0	54.9	66.9	72.3	55.1	44.0	**59**	**57**
51	100	92	33.6	39.2	37.6	30.4	25.4	28.0	24.3	16.8	34.4		32.4	22.3	29	28
52	100	100	50.8	67.9	58.7	59.3	51.5	54.9	56.9	55.5	56.3	82.2	46.9	44.2	**57**	**55**
54	100	100	70.0	69.7	46.0	45.7	48.0	52.1	57.7	48.4	56.4	57.2	48.8	43.1	**54**	**51**
55	100	100	52.5	57.6	49.5	54.4	43.0	46.0	50.2	52.9	57.5	72.1	48.0	44.6	**52**	**50**
56	100	100	51.2	45.9	42.1	37.6	29.9	36.1	36.8	36.3	44.3	49.2	35.4	23.0	39	37
57	100	100	35.9	46.0	35.7	33.1	29.9	32.4	30.6	30.4	37.4	43.2	35.6	24.8	35	33
58	100	100	51.9	52.3	47.6	46.6	43.7	50.8	39.0	50.7	47.3	56.0	54.6	38.4	**48**	**46**
59	100	92	48.2	46.6	34.1	45.3	34.8		33.8	44.6	48.5	63.0	38.5	26.0	**42**	**40**
60	100	83	34.8	38.3	30.1	31.9	21.6		21.0	26.7		34.6	24.7	22.2	29	27
61	100	92	46.3	50.6	48.1	62.5		47.9	47.1	51.4	52.1	61.3	48.1	35.5	50	48
62	100	92		53.3	47.5	44.3	50.4	54.8	48.4	40.9	51.2	54.7	49.8	35.1	**48**	**46**
63	100	100	42.7	47.4	41.0	40.9	29.7	31.2	33.3	40.1	35.6	45.9	43.0	41.0	39	38
64	100	100	74.9	67.4	57.2	55.6	54.8	60.5	51.8	49.2	64.1	65.3	50.5	39.0	58	55
Rut 01	100	100	49.9	48.4	42.4	47.8	40.6	53.8	37.7	54.2	47.2	50.5	48.6	41.6	**47**	**45**
Rut 02	100	100	90.8	87.1	86.3	88.8	91.9	106.2	80.5	89.1	93.8	128.7	86.5	74.9	**92**	**88**

Exceedance of the NO_2 annual mean AQO of 40 μgm^{-3} are shown in **bold**.
[a] data capture for the monitoring period, in cases where monitoring was only carried out for part of the year
[b] data capture for the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%)
[c] Means should be "annualised" in accordance with LLAQM Technical Guidance, if valid data capture is less than 75%
[d] The bias adjustment factor used for all roadside/kerbside sites is 0.92 which is calculated using the Castlenau site. The bias adjustment factor for both background sites is 1.00 calculated using Wetlands.