2017 Air Quality Annual Progress Report (APR) for Stirling Council

In fulfillment of Part IV of the Environment Act 1995 Local Air Quality Management

June 2017

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Executive Summary: Air Quality in Our Area

Air Quality in Stirling Council

This Annual Progress Report provides an overview of air quality in the Stirling Council area. Air quality monitoring was performed at the automatic monitoring station at Craig's Roundabout in the City of Stirling (nitrogen dioxide (NO2) and Particulate Matter (PM10) and passive monitoring for NO2, using diffusion tubes, at 12 sites in the wider urban area.

Based on the available monitoring data for NO2 and PM10 there were no exceedances of the relevant Air Quality Objectives and it is considered unlikely that they will be exceeded in the near future. Therefore, it is not considered necessary to declare an AQMA in the Stirling area.

Actions to Improve Air Quality

New development in the Stirling Area is a key issue affecting air quality. Where relevant, development applications are requested to submit an Air Quality Impact assessment to allow for the potential impact to be assessed and any necessary mitigation measures to be applied. Applications that primarily require this are those that include biomass installations and increased traffic emissions e.g. major housing developments,

Stirling Councils Local Transport Strategy (LTS) establishes a long-term strategic vision for transport management, provision and services, and sets out how Stirling Council will work to promote and deliver sustainable travel and transportation. Routine reviews of the LTS, and the

associated consultations, have identified that progress towards achieving many of the objectives is largely positive.

The Local Transport Strategy is delivered via a number of supporting plans including the City Transport Plan 2013; the Towns, Villages and Rural Transport Plan 2014; and the Active Travel Policy. The Active Travel Plan focuses on encouraging walking and cycling through improving infrastructure and changing behaviours via training and promotion activities.

Stirling Council actively participates in and promotes the Cycle to Work Scheme and the NextBikes cycle hire scheme, encouraging staff to use sustainable methods of transport for both commuting and work purposes.

A number of Schools within the Stirling Council area deliver the Level 1 Bikeability Scotland Cycle Training, providing children with the skills, confidence and encouragement to cycle safely on the roads. Further information can be found at:

http://www.bikeabilityscotland.org/

Local Priorities and Challenges

The anticipated growth in traffic volume is seen as a priority air quality issue and the above plans were developed to manage this issue in to the future. The reports and other related documents can be viewed at:

http://my.stirling.gov.uk/services/transport-and-streets/transport-policy

How to Get Involved

A number of local and national organisations exist to promote more active and sustainable travel and members of the public can access further information or become directly involved by following the links below:

https://www.livingstreets.org.uk/who-we-are/scotland

http://www.sustrans.org.uk/scotland

http://www.stirlingcyclehub.org

http://nextbike.co.uk

Members of the public who wish to access information and advice on air quality across Scotland can do so at:

http://www.scottishairquality.co.uk/

Air quality data specific to the Stirling Council area can be found at:

http://www.scottishairquality.co.uk/latest/site-info?site_id=STRL

Table of Contents

List of Tables

List of Figures

1. Local Air Quality Management

This report provides an overview of air quality in Stirling Council during 2016. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where an exceedance is considered likely the local authority must declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives. This Annual Progress Report (APR) summarises the work being undertaken by Stirling Council to improve air quality and any progress that has been made.

Table 1.1 – Summary of Air Quality Objectives in Scotland

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Nitrogen dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year.	1-hour mean	31.12.2005
	40 µg/m^3	Annual mean	31.12.2005
Particulate Matter (PM_{10})	50 µg/m^3, not to be exceeded more than 7 times a year.	24-hour mean	31.12.2010
	18 µg/m^3	Annual mean	31.12.2010
Particulate Matter ($PM_{2.5}$)	10 µg/m^3	Annual mean	31.12.2020
Sulphur dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year.	1-hour mean	31.12.2004
	125 µg/m^3, not to be exceeded more than 3 times a year.	24-hour mean	31.12.2004
	266 µg/m^3, not to be exceeded more than 35 times a year.	15-minute mean	31.12.2005
Benzene	3.25 µg/m^3	Running annual mean	31.12.2010
1,3 Butadiene	2.25 µg/m^3	Running annual mean	31.12.2003
Carbon Monoxide	10.0 mg/m^3	Running 8-Hour mean	31.12.2003
Lead	0.25 µg/m^3	Annual Mean	31.12.2008

2. Actions to Improve Air Quality

2.1 Air Quality Management Areas

Air Quality Management Areas (AQMAs) are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority must prepare an Air Quality Action Plan (AQAP) within 12 months, setting out measures it intends to put in place in pursuit of the objectives.

Stirling Council does not currently have any AQMAs and the results of past and present monitoring indicate that it will not be necessary to declare any AQMAs in the future.

3. Air Quality Monitoring Data and Comparison with Air Quality Objectives

3.1 Summary of Monitoring Undertaken

This section sets out what monitoring has taken place and how local concentrations of the main air pollutants compare with the objectives.

3.1.1 Automatic Monitoring Sites

Stirling Council undertook automatic (continuous) monitoring at one site during 2016. **Error! Reference source not found.**1 in Appendix A shows details of the site. National monitoring results are available at:

http://www.scottishairquality.co.uk/latest/site-info?site_id=STRL&view=graphing (2)

Maps showing the location of the automatic monitoring site are provided in Appendix A, Figures A.1 and A.2. Further details on how the monitors are calibrated and how the data has been adjusted are included in Appendix C.

3.1.2 Non-Automatic Monitoring Sites

Stirling Council undertook non-automatic (passive) monitoring of NO_2 at 12 sites during 2016. Table A.2 – Details of Non- Automatic Monitoring Sites

in Appendix A provides the details of the sites.

Maps showing the location of the monitoring sites are provided in Appendix A, Figure A.3. Further details on Quality Assurance/Quality Control (QA/QC) and bias adjustment for the diffusion tubes are included in Appendix C.

3.2 Individual pollutants

This section discusses the results and trends for individual pollutants. The air quality monitoring results presented in this section are, where relevant, adjusted for annualisation and bias. Further details on adjustments are provided in Appendix C

3.2.1 Nitrogen Dioxide (NO_2)

Automatic Monitor

Table B.1 in Appendix B compares the ratified and bias adjusted NO_2 annual mean concentrations for the past 6 years with the air quality objective of 40µg/m^3.

Table B.2 – 1-Hour Mean NO2 Monitoring Results

compares the ratified continuously monitored NO_2 hourly mean concentrations for the past 6 years with the air quality objective of 200µg/m^3, not to be exceeded more than 18 times per year.

- The limited data recovery for the automatic monitor in 2014 and 2015 makes interpretation and prediction less reliable, however, the available results indicate that the above objectives have not been exceeded and are unlikely to be exceeded in the future.
- On this basis an AQMA was not considered necessary.

Diffusion Tubes

For diffusion tubes, the full 2016 dataset of mean values is provided in Table B.5 of Appendix B.

Table B.1 in Appendix B compares the ratified continuous monitored NO2 annual mean concentrations for the past 6 years with the air quality objective of 40µg/m^3. A trend graph of this data is presented as Figure B.1 in Appendix B.

The data capture issues at the automatic monitor in 2014 and 2015 have a direct influence on the bias adjustment of the diffusion tube results and the trend graph. However, the following comments are made:

- Since 2013, there appears to be an overall trend indicating that levels of NO2 are decreasing across each site.
- The conservative approach used to assign bias adjustment factors (outlined in Appendix C) indicates that the mean NO_2 concentration has consistently remained below the limit concentration of 40µg/m^3 during the last 6 years.
- On this basis an AQMA was not considered necessary.

3.2.2 Particulate Matter (PM_{10})

Table B.3 in Appendix B compares the ratified and adjusted monitored PM_{10} annual mean concentrations for the past 6 years with the air quality objective of 18µg/m^3. A trend graph of this data is presented as Figure B.2 in Appendix B.

Table B.4 in Appendix B compares the ratified continuous monitored PM_{10} daily mean concentrations for the past 6 years with the air quality objective of 50µg/m^3, not to be exceeded more than 7 times per year.

The limited data recovery for the automatic monitor in 2014 and 2015 makes interpretation and prediction less reliable, however, the following comments are made:

- The available results indicate that the above objectives have not been exceeded and are unlikely to be exceeded in the future.
- On this basis an AQMA was not considered necessary.

3.2.3 Particulate Matter ($PM_{2.5}$)

Stirling Council does not monitor for PM2.5.

3.2.4 Sulphur Dioxide (SO_2)

Stirling Council does not monitor for SO_2.

3.2.5 Carbon Monoxide, Lead and 1, 3-Butadiene

Stirling Council does not monitor for Carbon Monoxide, Lead or 1,3-Butadiene.

4. New Local Developments

This section discusses the new developments that could potentially have a significant impact on air quality in the Stirling area.

4.1 Road Traffic Sources

There are no new road traffic sources, as listed below, that would have a significant impact on air quality.

- Narrow congested streets with residential properties close to the kerb.
- Busy streets where people may spend one hour or more close to traffic.
- Roads with a high flow of buses and/or HGVs.
- Junctions.
- New roads constructed or proposed.
- Bus or coach stations.

4.2 Other Transport Sources

There are no new road traffic sources, as listed below, that would have a significant impact on air quality.

- Airports.
- Locations where diesel or steam trains are regularly stationary for periods of 15 minutes or more, with potential for relevant exposure within 15m.
- Locations with a large number of movements of diesel locomotives, and potential long-term relevant exposure within 30m.
- Ports for shipping.

The Stirling Council Public Transport Co-ordinator confirmed that the total number of movements at Stirling Bus Station in the Thistle Centre was approximately 12,226 every 4 weeks, or less than 475/day. The criterion for assessment where there is

relevant exposure within 10m is 2,500 movements a day. It is therefore concluded that a DMRB assessment is not required.

4.3 Industrial Sources

It is confirmed that there are none of the following that would warrant further assessment:

- Industrial installations: new or proposed installations for which an air quality assessment has been carried out.
- Industrial installations: existing installations where emissions have increased substantially or new relevant exposure has been introduced.
- Industrial installations: new or significantly changed installations with no previous air quality assessment.
- Major fuel storage depots storing petrol.
- Petrol stations.
- Poultry farms.

4.4 Commercial and Domestic Sources

The locations of previously assessed, new and proposed biomass installations are summarised in Table 4.1. There are no clusters of installations in 500 x 500 metre squares that could result in cumulative impacts of emissions of PM10. With the exception of the Acharn Development, which has been approved and is operational, all are small scale plants with minimal potential for significant release of PM10 or NOx. The applications were screened using the Defra review-and-assessment tools [(3)] and further assessment was not considered necessary.

Table 4.1 – Locations of Installed, Permitted and Proposed Biomass Combustion Plant in Stirling Council

Name Location	Planning Reference	Status	OS Easting	OS Northing
Land adjacent to North and West of 27 Whitehouse Rd, Forthside Way	16/00775/FUL	Permitted 27/02/2017 Status: Unknown	280695	693347
Carsten Mews, Drumbeg Rd, Killearn	16/00749/FUL	Permitted 15/02/2017 Status: Unknown	250499	684139
48 Glasgow Road, Blanefield	15/00644/FUL	Permitted 30/11/2015 Status: Unknown	255744	679621
Muirmill Farm, Fintry	15/00436/FUL	Permitted 02/12/2015 Status: Unknown	272876	683932
Lochend Chalets, Port of Menteith	2014/00265/DET	Operational January 2015	259156	699702
Wallace View, Stirling	15/00251/FUL	Permitted 18/06/15 Status unknown	281462	696157
Blairdrummond House, Stirling	15/00239/FUL	Permitted 15/06/2015 Operational 9/16	273189	699059
Stewarts House, 14 Main St, Fintry	15/00151/FUL	Permitted 09/06/2015 Status: Unknown	261623	686730
1 Riverside Cottages, Deanston	15/00139/FUL	Permitted 09/07/2015 Status: Unknown	271475	701710
Finnich Malise, Blanefield	15/00044/FUL	Permitted Notice: 07/04/2015 Status: Unknown	247928	685329
14 Back 'o Hill Industrial Estate	14/00768/FUL	Operational	278999	694526
Coldoch, Thornhill	14/00761/FUL	Operational 2015	269836	698062
The Stables, Burnside Farm, Bannockburn	14/00331/FUL	Permitted 22/07/2014 Status: unkown	280619	689961
Buchannan Arms Hotel Drymen	2014/0051/DET	Not Installed	247500	688393
An T Seann Sgoil, Balquidder	2014/0150/DET	Operational early 2015	253660	720902
Upper Drumbane Farm	13/00785/FUL	Permitted 30/05/2014 Status: Unknown		
Cambusmore House, Doune	13/00774/FUL	Permitted 07/02/2014 Status: unknown	265088	706218

Land 50m North Ballagan House, Strathblane	13/00690/FUL	Permitted 16/12/2013 Status; unknown		
Aucheneck Lodge, Stockiemuir Rd, by Killearn	13/00562/FUL	Permitted 08/11/2013 Status: unknown		
Gem House West Plean Industrial Estate	13/00348/FUL	Permitted 36/08/2013 Status: unknown		
Sauchie Estate, Sauchieburn,	12/00472/FUL	Permitted 21/09/2012 Status: unknown	277933	688963
Acharn Biomass Energy Plant 5.4MW	2011/0011/DET	Permitted Status: Operational	255500	731000
Fintry Sports Club, Fintry	11/00175/FUL	Permitted 16/02/2011 Status: unknown		

4.5 New Developments with Fugitive or Uncontrolled Sources

There are no new road traffic sources, as listed below, that would have a significant impact on air quality

- Landfill sites.
- Quarries (a major quarry extension application is under consideration).
- Unmade haulage roads on industrial sites.
- Waste transfer stations, etc.
- Other potential sources of fugitive particulate matter emissions.

5. Planning Applications

Stirling Councils Local Development Plan (LDP) identifies a number of sites for large scale development between 2014 and 2034. Each development site shall be assessed for its impact on air quality as it goes through the planning consultation process. Where appropriate detailed air quality impact assessments shall be required to be submitted.

A Pre-Planning Consultation for a development site called Durieshill, for approximately 2500 houses, has begun as part of the LDP. As yet an air quality assessment has yet not been submitted to Stirling Council for comment. It is expected that this will be received some time in 2017.

The following Planning Permission in Principle applications submitted in 2014/2015 are pending a planning appeal to the Scottish Government

- Land at Park of Keir Dunblane (14/00455/PPP) - Proposed development of new tennis and golf centre, and enabling housing development
    - An Air Quality Impact Assessment was performed for this development, however, modelling predicted that the proposed development would not result in an exceedance of National Air Quality Objectives.
- Airthrey Kerse, Bridge of Allan (14/00595/PPP) - Development of a public park, residential development of 600 units, commercial space (neighbourhood centre).
    - An Air Quality Impact Assessment, including a Design Manual for Roads and Bridges Air Quality Screening Model[(6)] assessment (DMRB), was performed for this development, however, modelling predicted that the proposed development would not result in an exceedance of National Air Quality Objectives.

6. Conclusions and Proposed Actions

6.1 Conclusions from New Monitoring Data

Based on the data in Tables B.1 to B.5 and the graph in Figure B.1 of Appendix B, it can be seen that there is an overall falling trend in those areas monitored for No_2 and PM_{10}. All sites are below the annual mean objectives for each parameter monitored. Based on the available monitoring data the following conclusions are made:

- Taking into account the poor data recovery from the automatic monitor in 2014 and 2015, there are no exceedances of the relevant Air Quality Objectives and it is considered unlikely that they will be exceeded in the near future.
- On this basis it is not considered necessary to declare an AQMA in the Stirling area.

6.2 Conclusions Relating to New Local Developments

In relation to new local developments, it is determined that the key issue regarding air quality is the potential for increased road traffic. Whilst there have been no major developments in the reporting period of 2016 requiring an air quality assessment, it is recognised that future applications may.

Biomass installations are also still considered a potential source of increased emissions affecting air quality. As such, biomass applications were screened using the Defra review-and-assessment tools and were not expected to have a significant impact on local air quality.

6.3 Proposed Actions

Stirling Council will continue with the following actions:

- Monitor for NO_2 and PM_{10} at the locations detailed in this report. Data recovery from the automatic monitor appears to be stable for 2017, to date. Results of the monitoring and other air quality assessment work will be presented in the next Annual Progress Report in 2018.
- Require air quality assessments where a development may result in significant increases in traffic as outlined in Defra Local Air Quality Guidance Management, Technical Guidance(TG16) [(4)].
- Screening of biomass applications to assess the potential impact on local air quality.
- Provide information and support to Stirling Council Sustainable Development Team on future developments in the Stirling area.

As part of the Councils requirement to produce a Local Transport Strategy, the Sustainable Development Team developed a City Transport Plan 2013/17 – 2015/16 and a Towns Villages and Rural Area Transport Plan 2014. This includes an Active Travel Policy to encourage walking and cycling by infrastructure improvements and behaviour change (training and promotion activities). Stirling Council will also be actively participating in and promoting the Cycle to Work Scheme and the NextBikes cycle hire scheme, encouraging staff to use sustainable methods of transport for both commuting and work purposes.

Reviews and assessment will include monitoring of: the rate of development (which will be informed by the LDP Monitoring Reports); the rate of traffic growth; the rate of modal shift from car to walking, cycling and public transport, and a measure of congestion.

Appendix A: Monitoring Sites

Table A.1 – Details of Automatic Monitoring Sites

Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
Craig's Roundabout	Roadside	279944	693005	NO2	N	Chemiluminescence	10m	3m	2.2
Craig's Roundabout	Roadside	279944	693005	PM10	N	TEOM	10m	3m	2.2

Figure A.1 - General Location of Automatic Monitoring Site

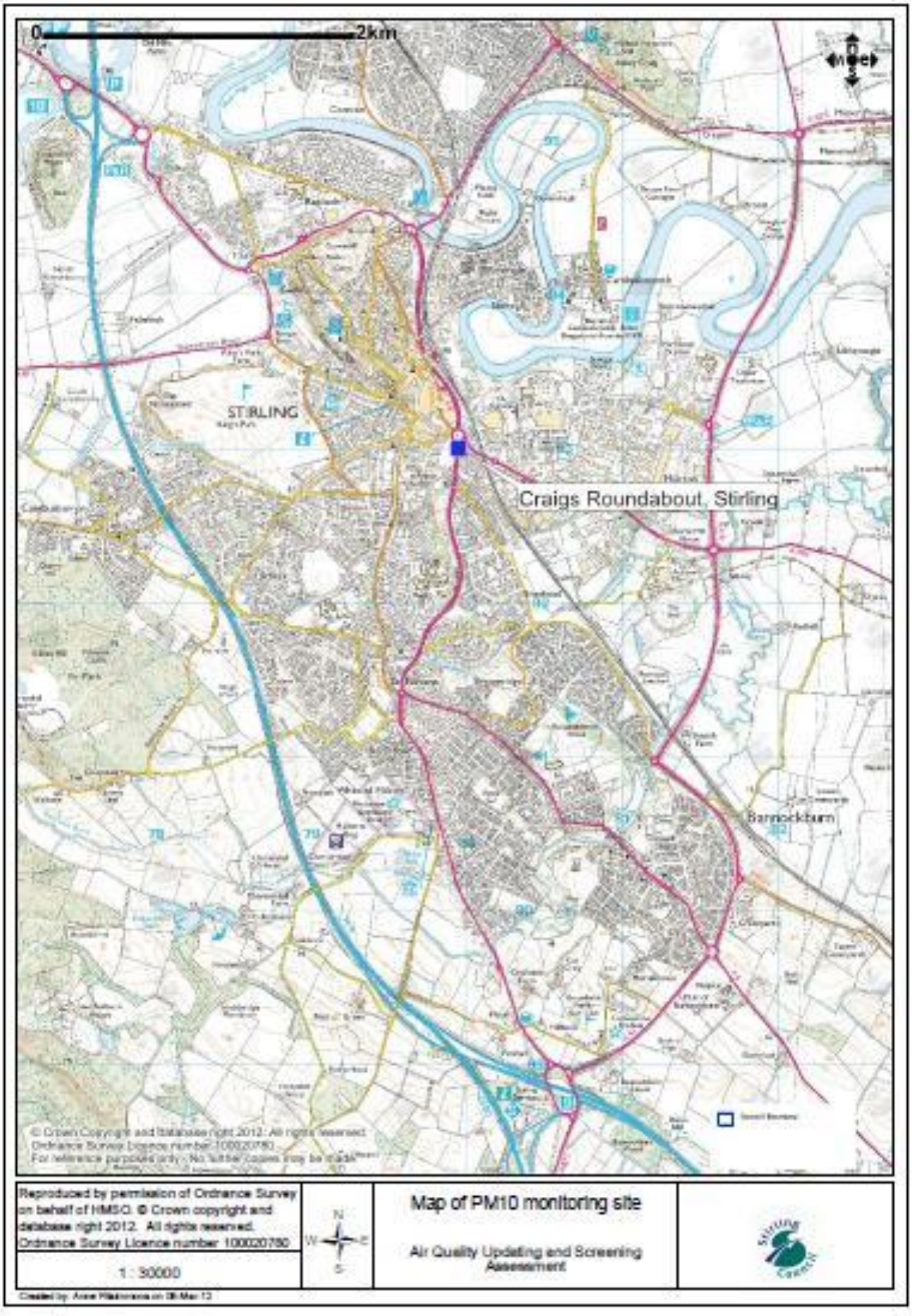


Figure A.2 - Detailed location of Automatic Monitor

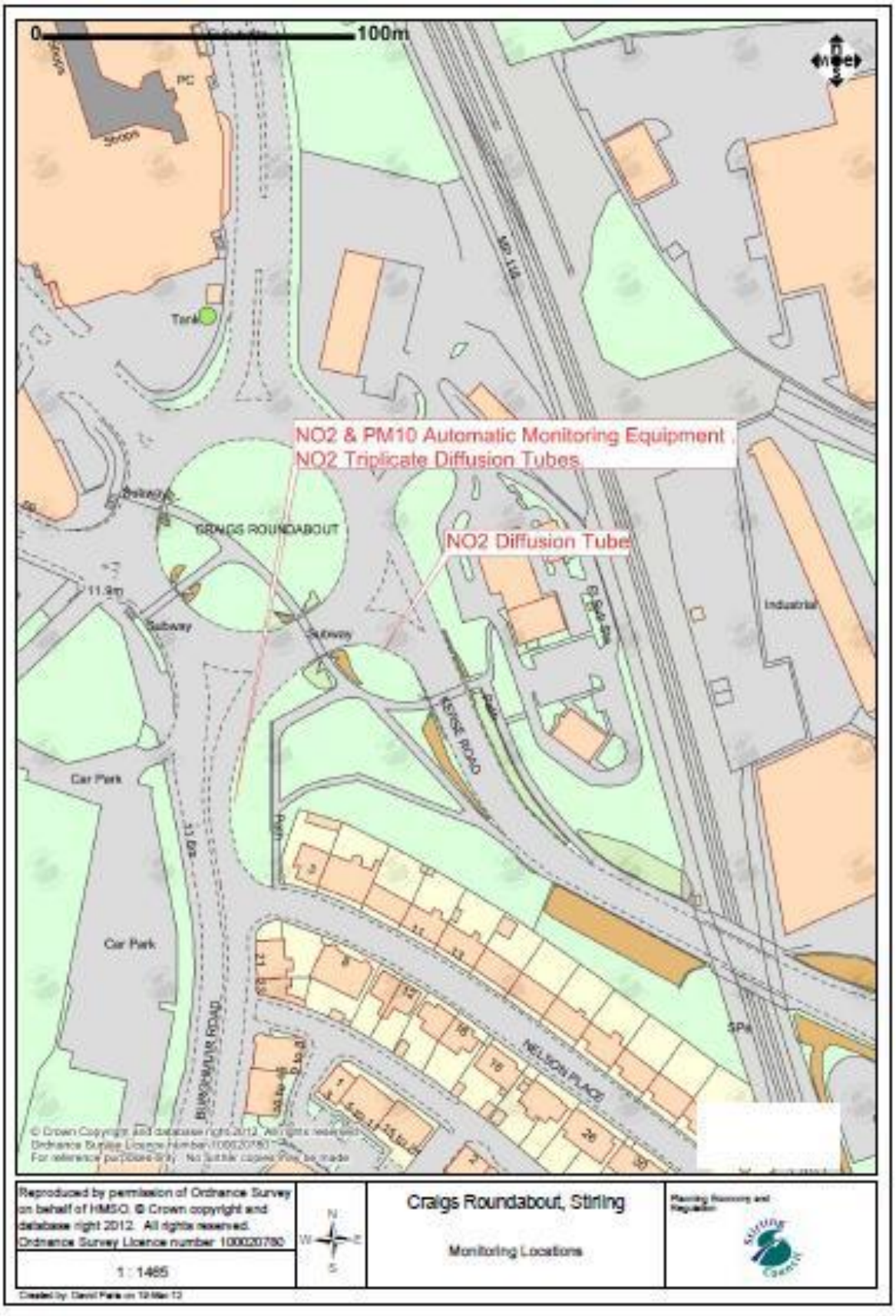


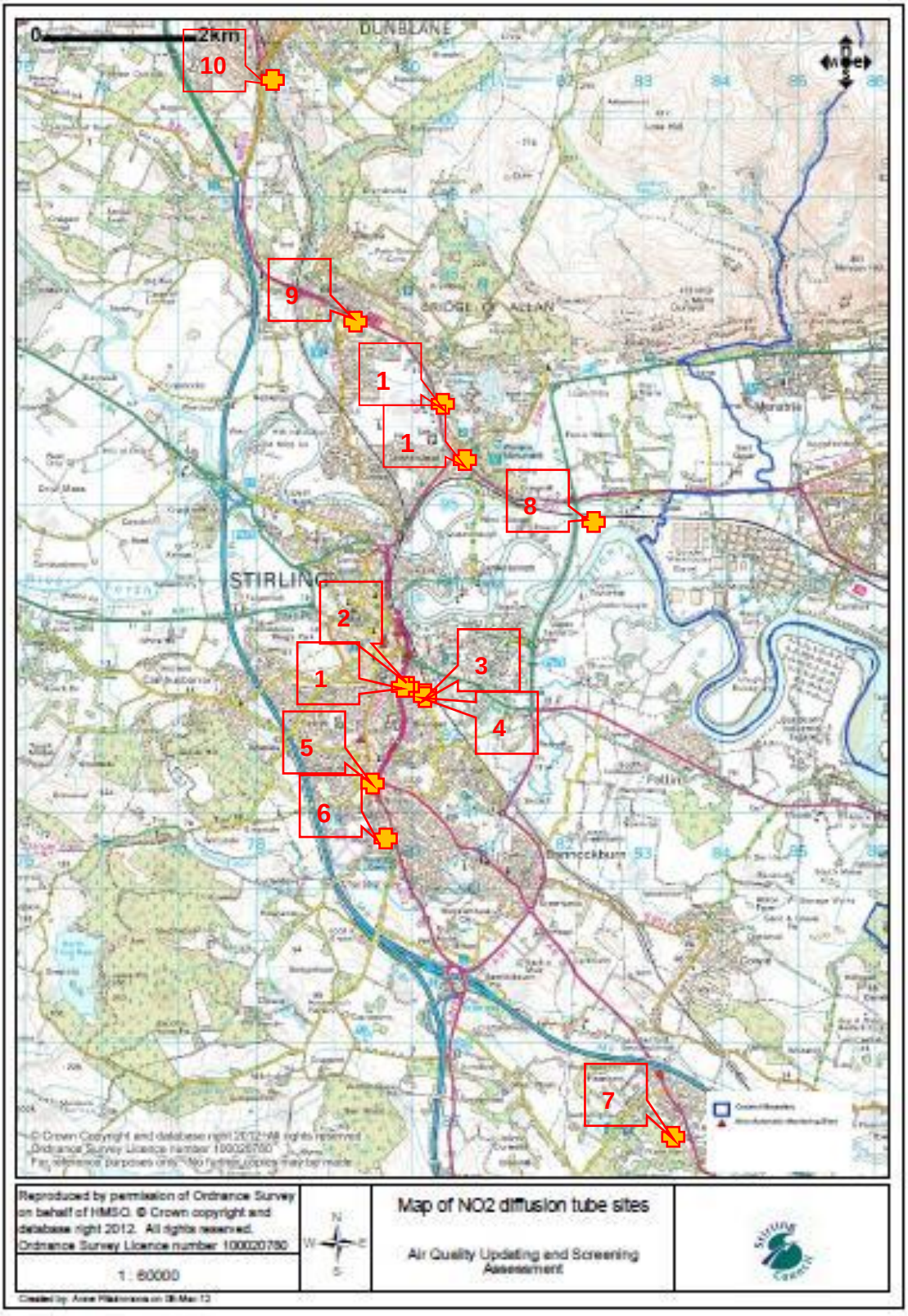
Table A.2 – Details of Non- Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube co-located with a Continuous Analyser?
1	Dumbarton Road, Stirling	Kerbside	279655	693240	NO_2	N	2	0.5	N
2	Port Street, Stirling	Kerbside	279634	693160	NO_2	N	2	0.5	N
3	Craig's Roundabout no. 1	Roadside	279987	693043	NO_2	N	10	2	N
4A,B,C	Craig's Roundabout no. 2 (automatic analyser)	Roadside	279944	693005	NO_2	N	10	3	Y
5	Lennox Avenue, Stirling	Urban background	279354	691933	NO_2	N	4	1.5	N
6	Barnsdale Road, Stirling	Roadside	279520	691252	NO_2	N	18	1.5	N
7	Main Street, Plean	Roadside	283222	687582	NO_2	N	6	1.5	N
8	Alloa Road Roundabout	Roadside	282075	695057	NO_2	N	9	2	N
9	Henderson Street, Bridge of Allan	Roadside	279177	697497	NO_2	N	7	1.5	N
10	Stirling Road, Dunblane	Roadside	278081	700580	NO_2	N	8	1.5	N
11	Stirling University	Roadside	280346	696339	NO_2	N	>50	2	N
12	Airthrey Road	Roadside	280505	695719	NO_2	N	3	2	N

(1) 0 if the monitoring site is at a location of exposure (e.g. installed on/adjacent to the façade of a residential property).

(2) N/A if not applicable.

Figure A.3 - Location of Diffusion Tube Sites



Appendix B: Monitoring Results

Table B.1 – Annual Mean NO_2 Monitoring Results

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	NO_2 Annual Mean Concentration (µg/m^3) (3) National Air Quality Objective 40 µg/m3					
					2011	2012	2013	2014	2015	2016
Craig's R'about	Roadside	Automatic	89	89	29	29	31	See C1.1	See C1.1	23
1	Kerbside	Diffusion Tube	75	75	31.8	32.1	35	34.6	30.5	28.7
2	Kerbside	Diffusion Tube	83.3	83.3	30.1	29.5	30.8	34.1	28.8	23.2
3	Roadside	Diffusion Tube	83.3	83.3	33.7	34.1	36.8	34.6	31.5	27.2
4A	Roadside	Diffusion Tube	83.3	83.3	28.2	27.4	31.1	29.8	27.6	21.0
4B	Roadside	Diffusion Tube	83.3	83.3	27.3	29.7	29.8	29.4	27.4	21.2
4C	Roadside	Diffusion Tube	83.3	83.3	28.1	28.9	30.1	28.8	27.9	21.7
5	Roadside	Diffusion Tube	75	75	15.8	15.4	17.8	16.3	14.7	11.3
6	Roadside	Diffusion Tube	66.7	66.7	22.2	18.9	22.2	21.1	19.1	15.5 (3)
7	Roadside	Diffusion Tube	83.3	83.3	21.9	22.2	26.3	24.6	20.9	17.5
8	Roadside	Diffusion Tube	75	75	35.5	31.3	36.5	34.2	31.5	25.4
9	Roadside	Diffusion Tube	83.3	83.3	25.9	29.5	31.7	30.4	29.5	20.8
10	Roadside	Diffusion Tube	83.3	83.3	20.6	21.5	20.7	20.2	19.6	16.0
11	Roadside	Diffusion Tube	83.3	83.3					26.7	21.9
12	Roadside	Diffusion Tube	83.3	83.3					28.4	22.9

Notes: Exceedances of the NO_2 annual mean objective of 40µg/m3 are shown in **bold**.

NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedence of the NO_2 1-hour mean objective are shown in **bold and underlined.**

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) Means for diffusion tubes have been corrected for bias. All means have been "annualised" as per LAQM.TG(16) if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Table B.2 – 1-Hour Mean NO_2 Monitoring Results

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	NO_2 1-Hour Means > 200µg/m^3 (3)					
					2011	2012	2013	2014	2015	2016
CM1	Roadside	Automatic	89.0	89.0	1	0	1	3(198.5)	0(111)	0 (104)

Notes: Exceedances of the NO_2 1-hour mean objective (200µg/m^3 not to be exceeded more than 18 times/year) are shown in **bold.**

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 90%, the 99.8th percentile of 1-hour means is provided in brackets.

Table B.3 – Annual Mean PM_{10} Monitoring Results

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	PM_{10} Annual Mean Concentration (µg/m^3) (3)					
				2011	2012	2013	2014	2015	2016
Craig's R'about	Roadside	88.73	88.73	16	16	17	15.8[A]	15	13

[A] – From SAQ data (65% data capture)

Notes: Exceedances of the PM_{10} annual mean objective of 18µg/m^3 are shown in **bold.**

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) All means have been "annualised" as per LAQM.TG(16), valid data capture for the full calendar year is less than 75%. See Appendix C for details

Table B.4 – 24-Hour Mean PM_{10} Monitoring Results

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	PM_{10} Annual Mean Concentration ($\mu g/m^3$) (3)					
				2011	2012	2013	2014	2015	2016
Craig's R'about	Roadside	88.73	88.73	1	1(39)	1	0 (28)	0 (29)	36

A – From SAQ data (65% data capture)

Notes: Exceedances of the PM_{10} 24-hour mean objective (50µg/m^3 not to be exceeded more than 7 times/year) are shown in **bold.**

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 85% the 90.4 percentile of 24-hour means is provided in brackets.

Table B.5 – NO_2 Monthly Diffusion Tube Results for 2016

Site ID	NO_2 Mean Concentrations (µg/m3)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean	
													Raw Data	Bias Adjusted (1)
1	missing	missing	missing	33.1	37.3	33.5	21.0	25.3	33.2	38.5	42.5	21.1	32.9	28.7
2	missing	missing	24.2	29.6	26.9	23.4	18.0	23.6	26.3	23.5	37.9	31.5	26.7	23.2
3	missing	missing	25.9	36.0	33.6	35.5	19.2	25.8	31.1	36.8	38.5	30.4	31.3	27.2
4A	missing	missing	21	29.0	27.8	20.8	15.9	128.2	20.1	29.0	33	26.8	24.2	21.0
4B	missing	missing	23.9	27.3	23.0	22.8	16.1	16.8	23.5	30.0	31.4	29.1	24.4	21.2
4C	missing	missing	27.7	29.3	22.5	23.8	17.3	16.9	22.7	29.3	32.7	27.5	25.0	21.7
5	missing	missing	10.7	18.0	missing	6.8	6.7	9.9	10.0	17.8	19.8	17.1	13.0	11.3
6	missing	missing	17.1	18.1	17.8	17.2	11.7	14.2	18.8	25.0	missing	missing	17.5	15.2
7	missing	missing	20.1	26.9	21.1	19.6	12.3	12.3	15.9	24.0	27.6	21.9	20.2	17.5
8	missing	missing	26.5	missing	26.9	33.9	54.4	22.8	29.1	32.8	37.5	29.2	29.2	25.4
9	missing	missing	30.2	27.2	18.9	22.9	14.7	17.6	20.9	24.9	32.4	29.9	24.0	20.8
10	missing	missing	18.6	18.9	19.3	13.3	12.5	12.1	15.3	18.2	30.5	25.3	18.4	16.0
11	missing	missing	22.8	27.1	26.2	26.4	19.1	21.8	25.0	29.2	30.7	23.3	25.2	21.9
12	missing	missing	31.2	34	26.4	22.9	20.5	21.9	18.8	25.0	36.7	25.3	26.3	22.9

(1) See Appendix C for details on bias adjustment

Figure B1 - Diffusion tube - Trends in Annual Mean Concentration of NO_2 at Diffusion Tube Sites

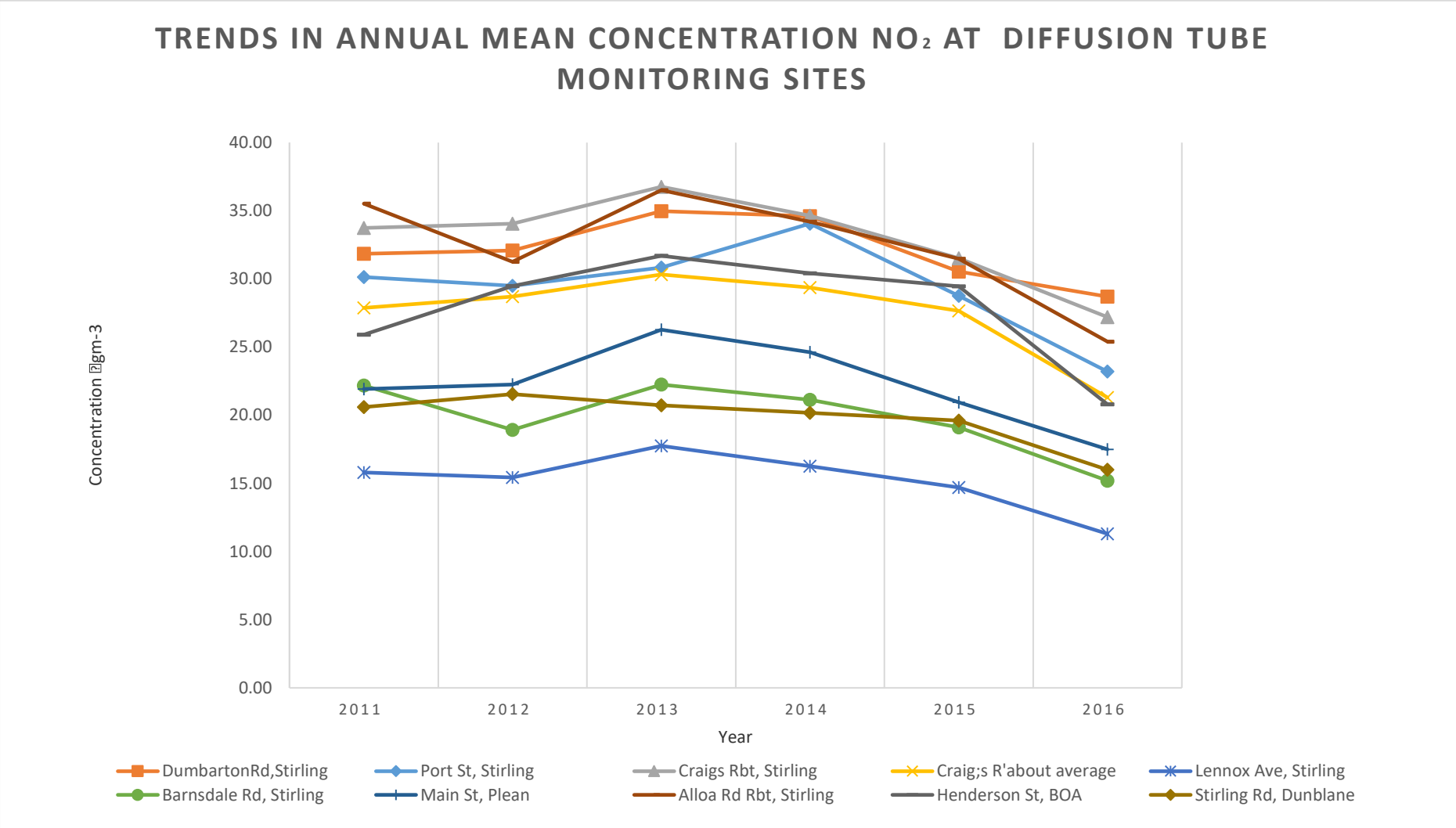
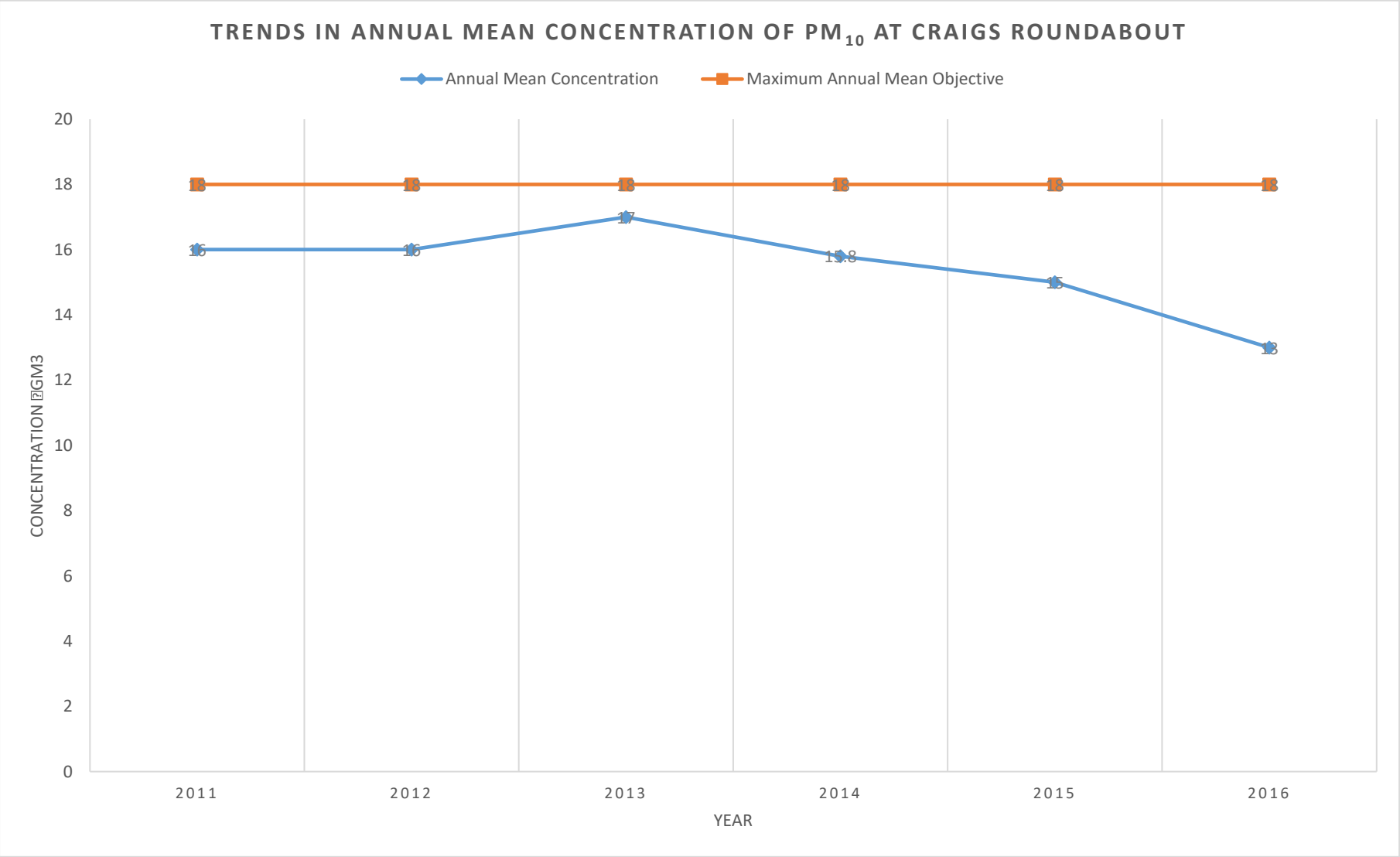


Figure B2 – Trends in Annual Mean Concentration of PM_{10} at Craigs Roundabout



Appendix C: Supporting Technical Information

C1 Automatic Site

Stirling Council operates an automatic monitoring station at Craig's Roundabout. The station houses a chemiluminescence NO_x automatic analyser and a Tapered Element Oscillating Microbalance (TEOM) analyser for PM_{10}. Data recorded by the station is analysed by Ricardo Energy and Environment.

C1.1 Quality Assurance /Quality Control of automatic monitoring site

The automatic monitoring equipment was audited every 6 months by AEA Technology and a routine service and breakdown call out service was contracted to EnviroTechnolgy Services Ltd. Local Site Operator (LSO) calibrations were also performed

C1.2 Data Capture Issues

Following an instrument breakdown at the end of September 2014, the PM10 monitoring equipment was removed by the equipment maintenance contractor for evaluation and repair. It also became evident that the data had not been received by the Scottish Air Quality website since February 2014 for NO_2, whilst results obtained from their web logger by Stirling Council revealed anomalous monitoring results. This resulted in the NO_2 monitoring equipment and the web logger also being removed from the site for detailed assessment by the equipment maintenance contractor. It was February/March 2015 before all the equipment (instruments and power supply consumer units) was repaired and re-installed on site, however, it was April 2015 before results from all equipment were being recorded and downloaded to the Scottish Air Quality website.

In August 2015, we were informed, retrospectively, that the NO_2 data indicated a possible problem with 'internal sampling' at the automatic monitor and the data was rejected up to 8 August 2015.

C2 Non-Automatic Monitoring Sites

Non-automatic monitoring is carried out for NO_2 only. There are twelve monitoring sites, seven of which are located within Stirling. Of these, a set of three tubes are co-located with the automatic analyser at Craig's Roundabout to enable a local bias-adjustment factor to be calculated.

The tubes are provided and analysed by Edinburgh Scientific Services using 50% TEA in Acetone and are changed on a monthly basis by Stirling Council personnel. A map of the diffusion tube locations is shown in Figure A.3 of Appendix A.

C2.1 Data Capture Issues

No NO_2 data was captured across all 12 of the non-automatic monitoring sites in January and February of 2016. After submission of the NO_2 tubes, it was found that no monitoring data had been captured. Following correspondence with Edinburgh Scientific Services, it was identified that the wrong monitoring tubes had been provided to Stirling Council. This matter was rectified as soon as possible, allowing data to be captured from March onwards.

C2.2 Bias Correction Factor

C2.2.1 - 2014

A local co-location study was carried out at the automatic monitoring site at Craig's Roundabout, Stirling using triplicate NO_2 diffusion tubes. The calculation was carried out using the local bias adjustment spreadsheet tool: https://laqm.defra.gov.uk/bias-adjustment-factors/local-bias.htmll[5]. The monthly results from the diffusion tube analysis were compared with the monthly averages calculated from the ratified hourly NO_2 data from the chemiluminescent analyser for matching exposure periods. The locally derived bias adjustment factor for 2014 was found to be 1.22, higher than normal due the limited data capture from the automatic monitor. The National Diffusion

Tube Bias Adjustment Factor for the testing laboratory was considerably different at 0.76.

However, due to the limited data capture of the automatic monitor in 2014 the Scottish Environment Protection Agency (SEPA) recommended that the matter was discussed with the LAQM Helpdesk and a surrogate factor generated.

Based on a comparison to the factors used from 2008 to 2013 (respectively, 1.06, 0.92, 1.08, 1.02, 0.9, 1.03) and consideration of the advice presented in LAQM TG16[4], a factor of 1.1 was considered to be both realistic and conservative. This adjustment was applied to the 2014 diffusion tube data.

C2.2.2 - 2015

Based on the results for 2015 the locally derived bias adjustment factor was calculated using the above tool as 1.04 and the national figure was reported as 0.76.

The data capture for the automatic monitor during 2015 was also limited (34.4%), however, the figure of 1.04 was used as it is more consistent with previous figures and also conservative.

The output from the Local Bias Adjustment Spreadsheet is shown in Table C1 below.

Figure C.1 – Extract from Local Bias Adjustment Factor Tool

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm^{-3}	Tube 2 µgm^{-3}	Tube 3 µgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1			31.6	31.1	32.4	32	0.7	2	1.6			Good	
2			30.6	29.1	31.3	30	1.1	4	2.8			Good	
3			29.5	28.1	29.0	29	0.7	2	1.8			Good	
4			24.5	24.3	24.9	25	0.3	1	0.8			Good	
5			22.5	23.0	21.9	22	0.6	2	1.4			Good	
6			17.6	17.6	16.8	17	0.5	3	1.1			Good	
7			20.3	19.3	22.1	21	1.4	7	3.5			Good	
8			22.4	23.2	19.6	22	1.9	9	4.7			Good	
9			22.9	21.8	27.2	24	2.9	12	7.1	24.3	100	Good	Good
10			29.5	30.2	32.3	31	1.5	5	3.6	34.4	100	Good	Good
11			35.7	35.2	37.4	36	1.2	3	2.9	35.5	100	Good	Good
12			31.1	33.7	27.5	31	3.1	10	7.7	33.9	50	Good	or Data Capture
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Poor Overall DC

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Stirling Craigs Roundabout

Precision: 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%

Bias calculated using 3 periods of data

Bias factor A: 1.04 (0.92 - 1.2)

Bias B: -4% (-16% - 9%)

Diffusion Tubes Mean: 30 µgm^{-3}

Mean CV (**Precision**): 7

Automatic Mean: 31 µgm^{-3}

Data Capture for periods used: 100%

Adjusted Tubes Mean: 31 (28 - 36) µgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA

Bias calculated using 3 periods of data

Bias factor A: 1.04 (0.92 - 1.2)

Bias B: -4% (-16% - 9%)

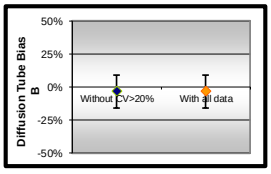
Diffusion Tubes Mean: 30 µgm^{-3}

Mean CV (**Precision**): 7

Automatic Mean: 31 µgm^{-3}

Data Capture for periods used: 100%

Adjusted Tubes Mean: 31 (28 - 36) µgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

C2.2.3 - 2016

A bias adjustment factor was applied to the annual mean NO2 concentrations for 2016. The factor of 0.87 was obtained from taken from the National Diffusion Tube Bias Adjustment Factor Spreadsheet version 06/17 which can be downloaded at :

https://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html

C3 –Annualising of Means Monitoring Data

Where the valid data capture for the full calendar year is less than 75%, the means have been “annualised” as per Box 7.9 and 7.10 of the LAQM TG (16).

Figure C3.1 – Annualising Continuous Monitoring Data

Box 7.9 – Example: Annualising Continuous Monitoring Data

It has only been possible to carry out a monitoring survey at site for six months between July and December 2015. The measured mean concentration **M** for this period is 30.2µg/m3. How can this be used to estimate the annual mean for this location?

 Identify two to four nearby, long-term, continuous monitoring sites, ideally those forming part of the national network. The data capture for each of these sites should ideally be at least 85%. These sites should be background (Urban Background, Suburban or Rural) sites to avoid any very local effects that may occur at Urban Centre, Roadside or Kerbside sites, and should, wherever possible lie within a radius of about 50 miles. If no background sites are available, and the site to be annualised is itself a Urban Centre, Roadside or Kerbside site, then it is permissible to annualise using roadside or kerbside sites rather than background sites, though this should be clearly stated in the annual report.

- Obtain the annual means, **Am**, for the calendar year for these sites.
- Work out the period means, **Pm**, for the period of interest, in this case July to December 2015.
- Calculate the ratio, **R**, of the annual mean to the period mean (**Am/Pm**) for each of the sites.
- Calculate the average of these ratios, **Ra**. This is then the annualisation factor.
- Multiply the measured period mean concentration **M** by this annualisation factor **Ra** to give the estimate of the annual mean for 2015.

For this example the best estimate of the annual mean for site S in 2015 will be **M × Ra = 30.2 × 0.944 = 28.5µg/m3.**

Background Site	Annual mean 2015 (Am)	Period Mean 2015 (Pm)	Ratio (Am/Pm)
A	28.6	29.7	0.963
B	22.0	22.8	0.965
C	26.9	28.9	0.931
D	23.7	25.9	0.915
Average (Ra)			**0.944**

If the short-term period covers, for instance, February to June 2016, and the work is being carried out in August 2016, then an annual mean for 2016 will not be available. The calculation can then be carried out using the ratio to the 2015 annual mean, but the result is then an estimate of the 2015 annual mean at the short-term site. The 2016 bias correction factor would also not be available, and so it would be necessary to use the 2015 factor instead.

Figure C3.2 – Annualising No_2 Diffusion Tube Monitoring Data

Box 7.10 – Example: Annualising NO2 Diffusion Tube Monitoring Data

A diffusion tube site (D1) has 8 months' worth of data and so it is necessary to annualise. A continuous background site (B1) has greater than 85% data capture for the year. The tubes were set out in accordance with the recommended calendar for 2015. If there are many locations to be annualised then it can be quicker to average the background site data to the same calendar as the diffusion tubes. The results are given in the below table. In addition, the results are given for the background site for those months that D1 data are available (Column B1 when D1 is Available).

Start Date	End Date	B1	D1	B1 when D1 is Available
7 January 2015	4 February 2015	15.6	38.4	15.6
4 February 2015	4 March 2015	38.3		
4 March 2015	1 April 2015	22.7	43.1	22.7
1 April 2015	29 April 2015	22.2		
29 April 2015	27 May 2015	24.9	51.3	24.9
27 May 2015	1 July 2015	20.8		
1 July 2015	29 July 2015	18.1	31.3	18.1
29 July 2015	26 August 2015	16.1	26.8	16.1
26 August 2015	30 September 2015	25.5	41.0	25.5
30 September 2015	28 October 2015	21.1		
28 October 2015	2 December 2015	28.1	29.8	28.1
2 December 2015	6 January 2016	32.0	39.8	32.0
Average		**23.8**	**37.7**	**22.9**

The annual mean (**Am**) of B1 is 23.8µg/m3. The period mean (**Pm)**, of B1 is 22.9µg/m3. The ratio **R** of the annual mean to the period mean (**Am/Pm**) is 1.04. This process should be repeated for all continuous background sites. If no continuous monitoring sites are available, then diffusion tube sites from background locations with 12 months' data may be used. In either case, the more background sites that can be identified the better. Calculate the average of these ratios **Ra**. This is then the annualisation factor.

The measured period mean concentration **M** is 37.7µg/m3. Multiply by this annualisation factor Ra to give the estimate of the annual mean for 2015. Assuming that all other background sites yielded an annualisation factor of 1.04, then Ra in this example is 1.04; and the annualised average of **D1 = M × Ra = 37.7 ×1.04 = 39.2µg/m3.**

If the periods that the tubes were out varied beyond the 4 to 5 week recommendation, then it may be necessary to do a time weighted average rather than simple average in order to calculate M, Am and Pm.

Glossary of Terms

Abbreviation	Description
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the LA intends to achieve air quality limit values'
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed / are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
APR	Air quality Annual Progress Report
AURN	Automatic Urban and Rural Network (UK air quality monitoring network)
Defra	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges – Air quality screening tool produced by Highways England
LAQM TG16	Local Air Quality Management Technical Guidance 2016
LDP	Local Development Plan
LSO	Local Site Operator
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5µm or less
QA/QC	Quality Assurance and Quality Control
SO_2	Sulphur Dioxide

References

(1) 2016 Air Quality Annual Progress Report for Stirling Council

(2) http://www.scottishairquality.co.uk/latest/site-info?site_id=STRL&view=graphing

(3) https://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#biomass

(4) Defra, Local Air Quality Guidance Management, Technical Guidance (TG16), April 2016

(5) https://laqm.defra.gov.uk/bias-adjustment-factors/bias-adjustment.html

(6) http://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html

(7) http://laqm.defra.gov.uk/review-and-assessment/tools/modelling.html