



# 2016 Air Quality Annual Progress Report for Stirling Council

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

September 2016

|                                |  |
|--------------------------------|--|
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## Executive Summary: Air Quality in Our Area

### Air Quality in the Stirling Area

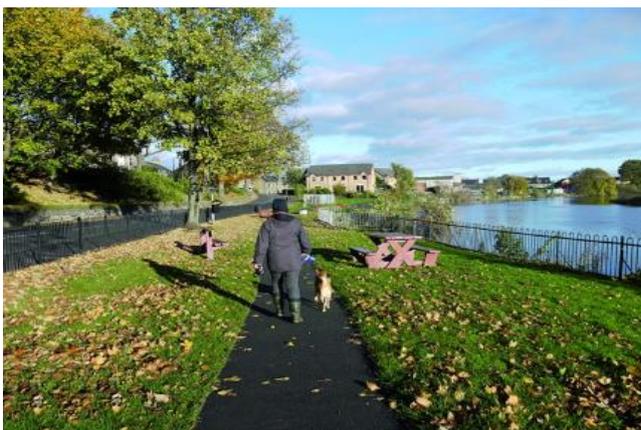
This Annual Progress Report provides an overview of air quality in the Stirling Council area. Air quality monitoring was performed at the automatic monitoring station at Craig's Roundabout in the City of Stirling (nitrogen dioxide (NO<sub>2</sub>) and Particulate Matter (PM<sub>10</sub>) and passive monitoring for NO<sub>2</sub>, using diffusion tubes, at 12 sites in the wider urban area.

Due to ongoing technical issues with the automatic monitor, only limited data was obtained in 2015. As a result, a conservative approach was adopted to data analysis and interpretation – this matter is discussed in Appendix C.

However, based on the available monitoring data for NO<sub>2</sub> and PM<sub>10</sub> there are 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 and where relevant, development applications are assessed on the basis of their potential impact on air quality. Assessments include biomass installations; increased traffic emissions from major housing developments and a major quarry extension application is currently under consideration.



As part of Stirling Council's requirement to produce a Local Transport Strategy, Transport Development, now part of the Sustainable Development Team (established in 2015), developed a City Transport Plan 2013/14 – 2015/16 and Towns Villages and Rural Area Transport Plan 2014.



These plans include an Active Travel Plan to encourage walking and cycling by infrastructure improvements and behaviour change (training and promotion activities). Stirling Council will also be supporting all nurseries and schools in the area to have a School Travel Plan in place by June 2017.

### **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>

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## 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 and follows on from the 2015 Air Quality Updating and Screening Assessment for Stirling Council<sup>(1)</sup>.

**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 <sub>2</sub> )     | 200 µg/m <sup>3</sup> not to be exceeded more than 18 times a year.   | 1-hour mean         | 31.12.2005             |
|   | 40 µg/m <sup>3</sup>  | Annual mean         | 31.12.2005             |
| Particulate Matter (PM <sub>10</sub> )  | 50 µg/m <sup>3</sup> , not to be exceeded more than 7 times a year.   | 24-hour mean        | 31.12.2010             |
|   | 18 µg/m <sup>3</sup>  | Annual mean         | 31.12.2010             |
| Particulate Matter (PM <sub>2.5</sub> ) | 10 µg/m <sup>3</sup>  | Annual mean         | 31.12.2020             |
| Sulphur dioxide (SO <sub>2</sub> )      | 350 µg/m <sup>3</sup> , not to be exceeded more than 24 times a year. | 1-hour mean         | 31.12.2004             |
|   | 125 µg/m <sup>3</sup> , not to be exceeded more than 3 times a year.  | 24-hour mean        | 31.12.2004             |
|   | 266 µg/m <sup>3</sup> , not to be exceeded more than 35 times a year. | 15-minute mean      | 31.12.2005             |
| Benzene                                 | 3.25 µg/m <sup>3</sup>  | Running annual mean | 31.12.2010             |
| 1,3 Butadiene                           | 2.25 µg/m <sup>3</sup>  | Running annual mean | 31.12.2003             |
| Carbon Monoxide                         | 10.0 mg/m <sup>3</sup>  | Running 8-Hour mean | 31.12.2003             |
| Lead                                    | 0.25 µg/m <sup>3</sup>  | 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 this will be unlikely in the future.

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

#### **3.1 Summary of Monitoring Undertaken**

The location of the automatic monitoring site is included in Appendix D (Figures 2 and 3) and the diffusion tube sites as Figure 4.

##### **3.1.1 Automatic Monitoring Sites**

Stirling Council undertook automatic monitoring at one site during 2016. Table A.1 shows details of the site. The air quality data is available at:

[http://www.scottishairquality.co.uk/latest/site-info?site\\_id=STRL&view=graphing](http://www.scottishairquality.co.uk/latest/site-info?site_id=STRL&view=graphing) <sup>(2)</sup>

Further details on how the monitors are calibrated and how the data has been adjusted are included in Appendix C.

The automatic monitor had a number of technical issues in 2014 and 2015 that have resulted in poor data capture rates. This issue is discussed in more detail in Appendix C.

##### **3.1.2 Non-Automatic Monitoring Sites**

Stirling Council undertook non-automatic (passive) monitoring of NO<sub>2</sub> at 12 sites during 2016. Table A.2 in Appendix A provides the details of the sites.

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.

##### **3.2.1 Nitrogen Dioxide (NO<sub>2</sub>)**

###### **Automatic Monitor**

Table A.3 compares the ratified and bias adjusted NO<sub>2</sub> annual mean concentrations for the past 5 years with the air quality objective of 40µg/m<sup>3</sup>.

Table A.4 compares the ratified continuously monitored NO<sub>2</sub> hourly mean concentrations for the past 5 years with the air quality objective of 200µg/m<sup>3</sup>, 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**

The full dataset of diffusion tube monthly mean values is provided in B.1 and a trend graph of this data is presented as Figure B1.

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:

- There does not appear to be any consistent overall trend.
- The conservative approach used to assign bias adjustment factors (outlined in Appendix C) indicates that the mean NO<sub>2</sub> concentration has consistently remained below the limit concentration of 40µg/m<sup>3</sup> during the last 5 years.
- On this basis an AQMA was not considered necessary.

### **3.2.2 Particulate Matter (PM<sub>10</sub>)**

Table A5 compares the ratified and adjusted monitored PM<sub>10</sub> annual mean concentrations for the past 5 years with the air quality objective of 18µg/m<sup>3</sup>.

Table A6 compares the ratified continuous monitored PM<sub>10</sub> daily mean concentrations for the past 5 years with the air quality objective of 50µg/m<sup>3</sup>, 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<sub>2.5</sub>)**

Stirling Council does not monitor for PM<sub>2.5</sub>.

**3.2.4 Sulphur Dioxide (SO<sub>2</sub>)**

Stirling Council does not monitor for SO<sub>2</sub>.

**3.2.5 Carbon Monoxide, Lead and 1, 3-Butadiene**

Stirling Council does not monitor for Carbon Monoxide, Lead and 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.

The Department for Transport traffic count data at the link below was used to look at changes in traffic flow at Henderson Street, Bridge of Allan and Airthrey Road.

[http://www.dft.gov.uk/traffic-counts/area.php?region=Scotland&la=Stirling\(5\)](http://www.dft.gov.uk/traffic-counts/area.php?region=Scotland&la=Stirling(5))

Both traffic count locations showed minor increases over the last year. This increase combined with possible future development reinforces the decision to include two additional diffusion tubes in this area in 2016.

The potential impact of increased traffic is discussed further in Section 4.5.

## 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 13,500 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.

### 4.3 Commercial and Domestic Sources

The locations of the previously assessed, new and proposed biomass installations are summarised in Table 6.1. There are no clusters of installations in 500 x 500 metre squares that could result in cumulative impacts of emissions of PM<sub>10</sub>.

With the exception of the Acharn Development, which has been approved, all are small scale plants with minimal potential for significant release of PM<sub>10</sub> or NO<sub>x</sub>. The applications were screened using the defra review-and-assessment tools <sup>(7)</sup> and further assessment was not considered necessary.

**Table 6.1 Locations of Installed, Permitted and Proposed Biomass Combustion Plant in Stirling Council**

| Name Location                      | Planning Reference | Status  | OS Easting | OS Northing |
|------------------------------------|--------------------|---|------------|-------------|
| Acharn Biomass Energy Plant 5.4MW  | 2011/0011/DET      | Permitted<br>Not Yet Operational                | 255500     | 731000      |
| 14 Back o' Hill Industrial Estate  | 14/00768/FUL       | Operational                                     | 278999     | 694526      |
| Coldoch, Thornhill                 | 14/00761/FUL       | Operational 2015                                | 269836     | 698062      |
| Buchanan Arms Hotel Drymen         | 14/0051/DET        | Not Installed                                   | 247500     | 688393      |
| Muirmill Farm, Fintry              | 15/00436/FUL       | Permitted 02/12/2015<br>Status: Unknown         | 272876     | 683932      |
| Blairdrummond House, Stirling      | 15/00239/FUL       | Permitted 15/06/2015<br>Operational 9/16        | 273189     | 699059      |
| Finnich Malise, Blanefield         | 15/00044/FUL       | Permitted Notice: 07/04/2015<br>Status: Unknown | 247928     | 685329      |
| An T Seann Sgoil, Balquidder       | 14/0150/FUL        | Operational early 2015                          | 253660     | 720902      |
| Lochend Chalets, Port of Menteith  | 14/0265/DET        | Operational January 2015                        | 259156     | 699702      |
| 1 Riverside Cottages, Deanston     | 15/00139/FUL       | Permitted 09/07/2015<br>Status: Unknown         | 271475     | 701710      |
| Wallace View, Stirling             | 15/00251/FUL       | Permitted 18/06/15<br>Status unknown            | 281462     | 696157      |
| 48 Glasgow Road, Blanefield        | 15/00644/FUL       | Permitted 30/11/2015<br>Status: Unknown         | 255744     | 679621      |
| Stewarts House, 14 Main St, Fintry | 15/00151/FUL       | Permitted 09/06/2015<br>Status: Unknown         | 261623     | 686730      |

#### 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

Planning permission, in principle, applications were submitted in 2014/2015 for two major developments.

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<sup>(6)</sup> 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.

Both of the above applications are pending a planning appeal to the Scottish Government.

## **6. Conclusions and Proposed Actions**

### **6.1 Conclusions from New Monitoring Data**

Based on the available monitoring data for NO<sub>2</sub> and PM<sub>10</sub> 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**

The key issue relating to new local development is the potential increase in road traffic and, as a result, two major developments were subject to air quality assessments.

- The assessments concluded that air quality objectives would not be exceeded.
- Biomass applications were screened using the defra review-and-assessment tools and are 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<sub>2</sub> and PM<sub>10</sub> at the locations detailed in this report. Data recovery from the automatic monitor appears to be stable for 2016, to date. Results of the monitoring and other air quality assessment work will be presented in the next Annual Progress Report in 2017.
- Require air quality assessments where a development may result in significant increases in traffic as outlined in TG16.
- 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 Council's requirement to produce a Local Transport Strategy, the Sustainable Development Team has developed a City Transport Plan 2013/14 – 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 supporting all nurseries and schools in the area to have an active travel plan in place by June 2017.

Review and assessment includes: 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 Results

**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) <sup>(1)</sup> | Distance to kerb of nearest road (m) <sup>(2)</sup> | 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              |

**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) <sup>(1)</sup> | Distance to kerb of nearest road (m) <sup>(2)</sup> | Tube co-located with a Continuous Analyser? |
|---------|---|------------------|---------------|---------------|----------------------|----------|--|---|---|
| 1       | Dumbarton Road, Stirling                    | Kerbside         | 279655        | 693240        | NO <sub>2</sub>      | N        | 2  | 0.5   | N   |
| 2       | Port Street, Stirling                       | Kerbside         | 279634        | 693160        | NO <sub>2</sub>      | N        | 2  | 0.5   | N   |
| 3       | Craig's Roundabout (1)                      | Roadside         | 279987        | 693043        | NO <sub>2</sub>      | N        | 10   | 2   | N   |
| 4A,B,C  | Craig's Roundabout (2) (automatic analyser) | Roadside         | 279944        | 693005        | NO <sub>2</sub>      | N        | 10   | 3   | Y   |
| 5       | Lennox Avenue, Stirling                     | Urban background | 279354        | 691933        | NO <sub>2</sub>      | N        | 4  | 1.5   | N   |
| 6       | Barnsdale Road, Stirling                    | Roadside         | 279520        | 691252        | NO <sub>2</sub>      | N        | 18   | 1.5   | N   |
| 7       | Main Street, Plean                          | Roadside         | 283222        | 687582        | NO <sub>2</sub>      | N        | 6  | 1.5   | N   |
| 8       | Alloa Road Roundabout                       | Roadside         | 282075        | 695057        | NO <sub>2</sub>      | N        | 9  | 2   | N   |
| 9       | Henderson Street, Bridge of Allan           | Roadside         | 279177        | 697497        | NO <sub>2</sub>      | N        | 7  | 1.5   | N   |
| 10      | Stirling Road, Dunblane                     | Roadside         | 278081        | 700580        | NO <sub>2</sub>      | N        | 8  | 1.5   | N   |
| 11      | Stirling University                         | Roadside         | 280346        | 696339        | NO <sub>2</sub>      | N        | >50  | 2   | N   |
| 12      | Airthrey Road                               | Roadside         | 280505        | 695719        | NO <sub>2</sub>      | 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). N/A if not applicable.

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

Table A.3 – Annual Mean NO<sub>2</sub> Monitoring Results

| Site ID         | Site Type | Monitoring Type | Valid Data Capture for Monitoring Period (%) (1) | Valid Data Capture 2015 (%) (2) | NO <sub>2</sub> Annual Mean Concentration (µg/m <sup>3</sup> ) <sup>(3)</sup><br>National Air Quality Objective 40 µg/m <sup>3</sup> |      |      |          |          |
|-----------------|-----------|-----------------|--|---------------------------------|--|------|------|----------|----------|
|                 |           |                 |  |                                 | 2011   | 2012 | 2013 | 2014     | 2015     |
| Craig's R'about | Roadside  | Automatic       | 34.4   | 34.4                            | 29   | 29   | 31   | See C1.1 | See C1.1 |
| 1               | Kerbside  | Diffusion Tube  | 75.0   | 75.0                            | 31.8   | 32.1 | 35.0 | 34.6     | 30.5     |
| 2               | Kerbside  | Diffusion Tube  | 100.0  | 100.0                           | 30.1   | 29.5 | 30.8 | 34.1     | 28.8     |
| 3               | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 33.7   | 34.1 | 36.8 | 34.6     | 31.5     |
| 4A              | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 28.2   | 27.4 | 31.1 | 29.8     | 27.6     |
| 4B              | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 27.3   | 29.7 | 29.8 | 29.4     | 27.4     |
| 4C              | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 28.1   | 28.9 | 30.1 | 28.8     | 27.9     |
| 5               | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 15.8   | 15.4 | 17.8 | 16.3     | 14.7     |
| 6               | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 22.2   | 18.9 | 22.2 | 21.1     | 19.1     |
| 7               | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 21.9   | 22.2 | 26.3 | 24.6     | 20.9     |
| 8               | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 35.5   | 31.3 | 36.5 | 34.2     | 31.5     |
| 9               | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 25.9   | 29.5 | 31.7 | 30.4     | 29.5     |
| 10              | Roadside  | Diffusion Tube  | 100.0  | 100.0                           | 20.6   | 21.5 | 20.7 | 20.2     | 19.6     |
| 11              | Roadside  | Diffusion Tube  | 83.3   | 83.3                            |  |      |      |          | 26.7     |
| 12              | Roadside  | Diffusion Tube  | 83.3   | 83.3                            |  |      |      |          | 28.4     |

Notes: Exceedances of the NO<sub>2</sub> annual mean objective of 40µg/m<sup>3</sup> are shown in **bold**.

NO<sub>2</sub> annual means exceeding 60µg/m<sup>3</sup>, indicating a potential exceedence of the NO<sub>2</sub> 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 A.4 – 1-Hour Mean NO<sub>2</sub> Monitoring Results**

| Site ID | Site Type | Monitoring Type | Valid Data Capture for Monitoring Period (%) <sup>(1)</sup> | Valid Data Capture 2015 (%) <sup>(2)</sup> | NO <sub>2</sub> 1-Hour Means > 200µg/m <sup>3</sup> <sup>(3)</sup> |      |      |          |        |
|---------|-----------|-----------------|---|--|--|------|------|----------|--------|
|         |           |                 |   |  | 2011   | 2012 | 2013 | 2014     | 2015   |
| CM1     | Roadside  | Automatic       | 34.4  | 34.4                                       | 1  | 0    | 1    | 3(198.5) | 0(111) |

Notes: Exceedances of the NO<sub>2</sub> 1-hour mean objective (200µg/m<sup>3</sup> 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 85%, the 99.8<sup>th</sup> percentile of 1-hour means is provided in brackets.

**Table A.5 – Annual Mean PM<sub>10</sub> Monitoring Results**

| Site ID         | Site Type | Valid Data Capture for Monitoring Period (%) <sup>(1)</sup> | Valid Data Capture 2015 (%) <sup>(2)</sup> | PM <sub>10</sub> Annual Mean Concentration (µg/m <sup>3</sup> ) <sup>(3)</sup> |      |      |                   |      |
|-----------------|-----------|---|--|--|------|------|-------------------|------|
|                 |           |   |  | 2011   | 2012 | 2013 | 2014              | 2015 |
| Craig's R'about | Roadside  | 86  | 72   | 16   | 16   | 17   | 15.8 <sup>A</sup> | 15   |

A – From SAQ data (65% data capture)

Notes: Exceedances of the PM<sub>10</sub> annual mean objective of 18µg/m<sup>3</sup> 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 A.6 – 24-Hour Mean PM<sub>10</sub> Monitoring Results**

| Site ID         | Site Type | Valid Data Capture for Monitoring Period (%) <sup>(1)</sup> | Valid Data Capture for 2015 (%) <sup>(2)</sup> | PM <sub>10</sub> 24-Hour Means > 50µg/m <sup>3</sup> <sup>(3)</sup> |       |      |       |       |
|-----------------|-----------|---|--|---|-------|------|-------|-------|
|                 |           |   |  | 2011  | 2012  | 2013 | 2014  | 2015  |
| Craig's R'about | Roadside  | 86  | 72   | 1   | 1(39) | 1    | 0(28) | 0(29) |

A – From SAQ data (65% data capture)

Notes: Exceedances of the PM<sub>10</sub> 24-hour mean objective (50µg/m<sup>3</sup> 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.

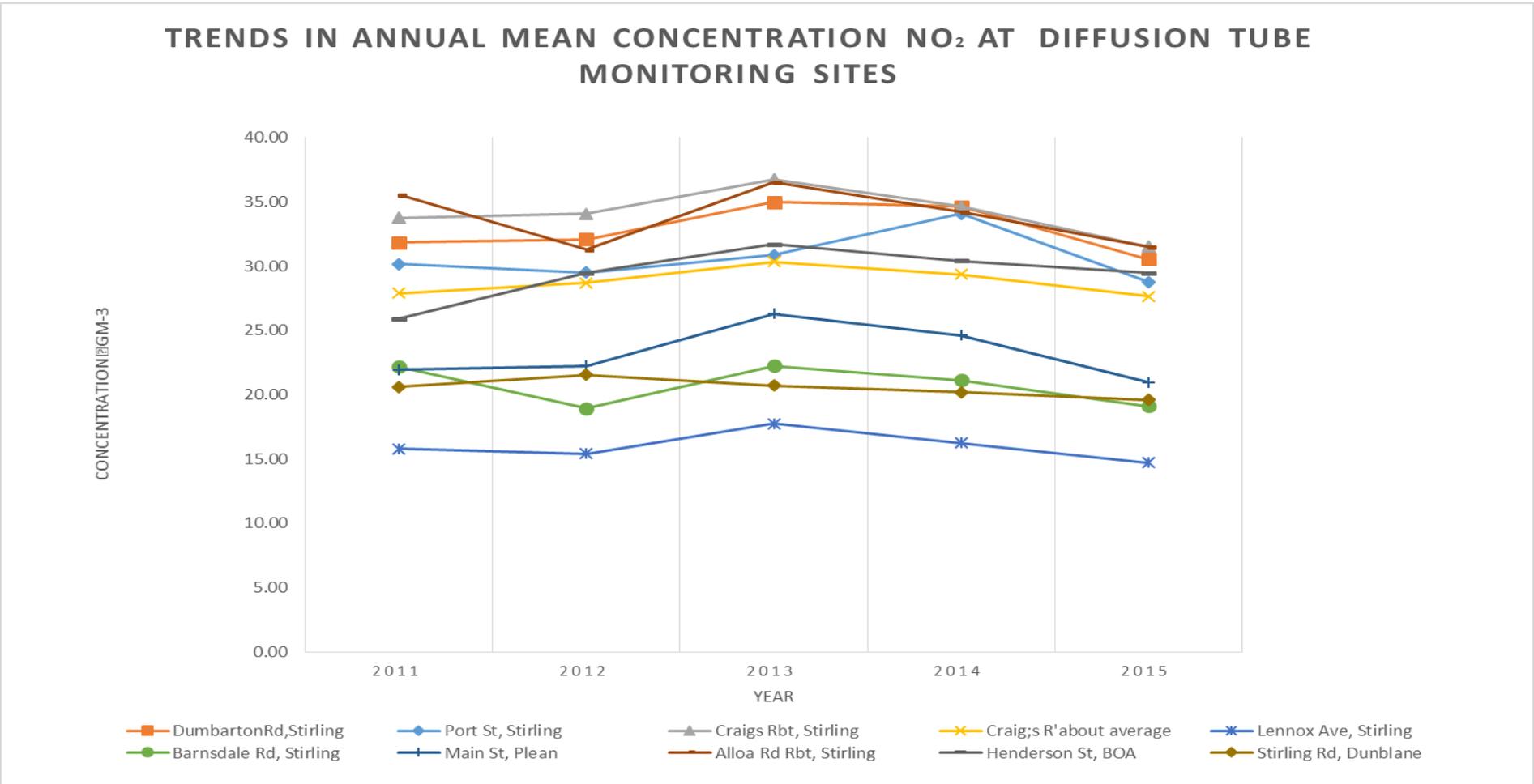
## Appendix B: Full Monthly Diffusion Tube Results for 2016

### Table B.1 – NO<sub>2</sub> Monthly Diffusion Tube Results for 2015

| Site ID | NO <sub>2</sub> Mean Concentrations (µg/m <sup>3</sup> ) |       |         |       |       |       |         |       |         |       |       |         | Annual Mean |                   |
|---------|--|-------|---------|-------|-------|-------|---------|-------|---------|-------|-------|---------|-------------|-------------------|
|         | Jan  | Feb   | Mar     | Apr   | May   | Jun   | Jul     | Aug   | Sep     | Oct   | Nov   | Dec     | Raw Data    | Bias Adjusted (1) |
|         | 1  | 37.70 | missing | 25.00 | 29.40 | 25.40 | missing | 4.90  | missing | 34.50 | 40.00 | 31.60   |             |                   |
| 2       | 31.50  | 26.60 | 29.60   | 27.30 | 21.30 | 20.40 | 23.70   | 23.50 | 28.70   | 35.80 | 35.90 | 27.60   | 27.7        | 28.8              |
| 3       | 30.60  | 34.60 | 33.10   | 29.60 | 25.90 | 23.30 | 24.90   | 25.90 | 33.90   | 38.20 | 33.70 | 30.00   | 30.3        | 31.5              |
| 4A      | 31.60  | 30.60 | 29.50   | 24.50 | 22.50 | 17.60 | 20.30   | 22.40 | 22.90   | 29.50 | 35.70 | 31.10   | 26.5        | 27.6              |
| 4B      | 31.10  | 29.10 | 28.10   | 24.30 | 23.00 | 17.60 | 19.30   | 23.20 | 21.80   | 30.20 | 35.20 | 33.70   | 26.4        | 27.4              |
| 4C      | 32.40  | 31.30 | 29.00   | 24.90 | 21.90 | 16.80 | 22.10   | 19.60 | 27.20   | 32.30 | 37.40 | 27.50   | 26.9        | 27.9              |
| 5       | 17.20  | 15.50 | 16.40   | 13.00 | 8.70  | 7.30  | 9.00    | 11.20 | 14.50   | 21.80 | 18.60 | 16.50   | 14.1        | 14.7              |
| 6       | 19.80  | 27.00 | 19.90   | 18.40 | 14.40 | 10.90 | 15.30   | 15.40 | 19.20   | 18.10 | 21.30 | 20.70   | 18.4        | 19.1              |
| 7       | 23.70  | 21.00 | 21.00   | 19.20 | 16.50 | 13.80 | 9.00    | 17.40 | 19.70   | 31.30 | 25.00 | 24.10   | 20.1        | 20.9              |
| 8       | 32.10  | 28.00 | 28.60   | 31.50 | 27.40 | 27.00 | 28.80   | 30.20 | 25.20   | 39.70 | 34.60 | 30.10   | 30.3        | 31.5              |
| 9       | 34.30  | 35.20 | 32.70   | 25.80 | 26.10 | 20.60 | 22.20   | 22.90 | 30.00   | 31.20 | 30.90 | 28.00   | 28.3        | 29.5              |
| 10      | 26.60  | 24.40 | 16.00   | 18.30 | 13.00 | 12.30 | 13.40   | 14.20 | 17.90   | 21.70 | 29.10 | 19.30   | 18.9        | 19.6              |
| 11      | missing  | 28.20 | 22.90   | 23.70 | 25.20 | 21.90 | 23.30   | 25.90 | 28.80   | 25.90 | 30.60 | missing | 25.6        | 26.7              |
| 12      | missing  | 35.50 | 32.50   | 26.90 | 23.10 | 22.50 | 22.20   | 22.20 | 23.50   | 29.30 | 35.80 | missing | 27.4        | 28.4              |

(1) See Appendix C for details on bias adjustment

Figure B1: Diffusion tube - Trends in Annual Mean Concentration of NO2 at Diffusion Tube Sites



## Appendix C: Supporting Technical Information / Air Quality Monitoring Data QA/QC

### C1 Automatic Site

Stirling Council previously operated two automatic analysers. One located at Craig's Roundabout, Stirling and one at Main Street, Cowie. The OSIRIS light scattering monitor located at Cowie was decommissioned during 2011 due to the history of decreasing results recorded at the site from  $13.0\mu\text{g}/\text{m}^3$  -  $6.3\mu\text{g}/\text{m}^3$  between 2006 and 2010. The OSIRIS monitor, which is capable of measuring  $\text{PM}_{10}$ ,  $\text{PM}_{2.5}$  and  $\text{PM}_1$ , as well as the sum total, is still in working order and available for use at another location should the need arise for further particulate monitoring.

At Craig's Roundabout, there is a chemiluminescence  $\text{NO}_x$  automatic analyser and a Tapered Element Oscillating Microbalance (TEOM) analyser for  $\text{PM}_{10}$ .

#### C1.1 Data Capture Issues

Following an instrument breakdown at the end of September 2014, the  $\text{PM}_{10}$  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  $\text{NO}_2$ , whilst results obtained from their web logger by Stirling Council revealed anomalous monitoring results. This resulted in the  $\text{NO}_2$  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  $\text{NO}_2$  data indicated a possible problem with 'internal sampling' at the automatic monitor and the data was rejected up to 8 August 2015.

## **C1.2 QA/QC 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 EnviroTechnology Services Ltd. Local Site Operator (LSO) calibrations were also performed.

## **C2 Non-Automatic Monitoring Sites**

Non-automatic monitoring is carried out for NO<sub>2</sub> only. There were 22 sites until April 2010 when the number was reduced to 10 based on the history of consistently low concentrations recorded across the network in previous years. Seven of the remaining sites are located within Stirling including a set of three tubes co-located with the automatic analyser at Craig's Roundabout to enable a local bias-adjustment factor to be calculated. From 2015, two new sites were added to the list of monitoring sites due to observed increases in traffic flow to the south of Stirling University.

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 3.

### **C2.2 Bias Correction Factor**

The following discussion includes the Bias Correction Factor for 2014 and 2015.

#### **2014**

A local co-location study was carried out at the automatic monitoring site at Craig's Roundabout, Stirling using triplicate NO<sub>2</sub> diffusion tubes. The calculation was carried out using the local bias adjustment spreadsheet tool: <http://laqm.defra.gov.uk/bias-adjustment-factors/bias-adjustment.html><sup>(3)</sup>. The monthly results from the diffusion tube analysis were compared with the monthly averages calculated from the ratified hourly NO<sub>2</sub> 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.



Figure C.2 General Location of Automatic Monitoring Site

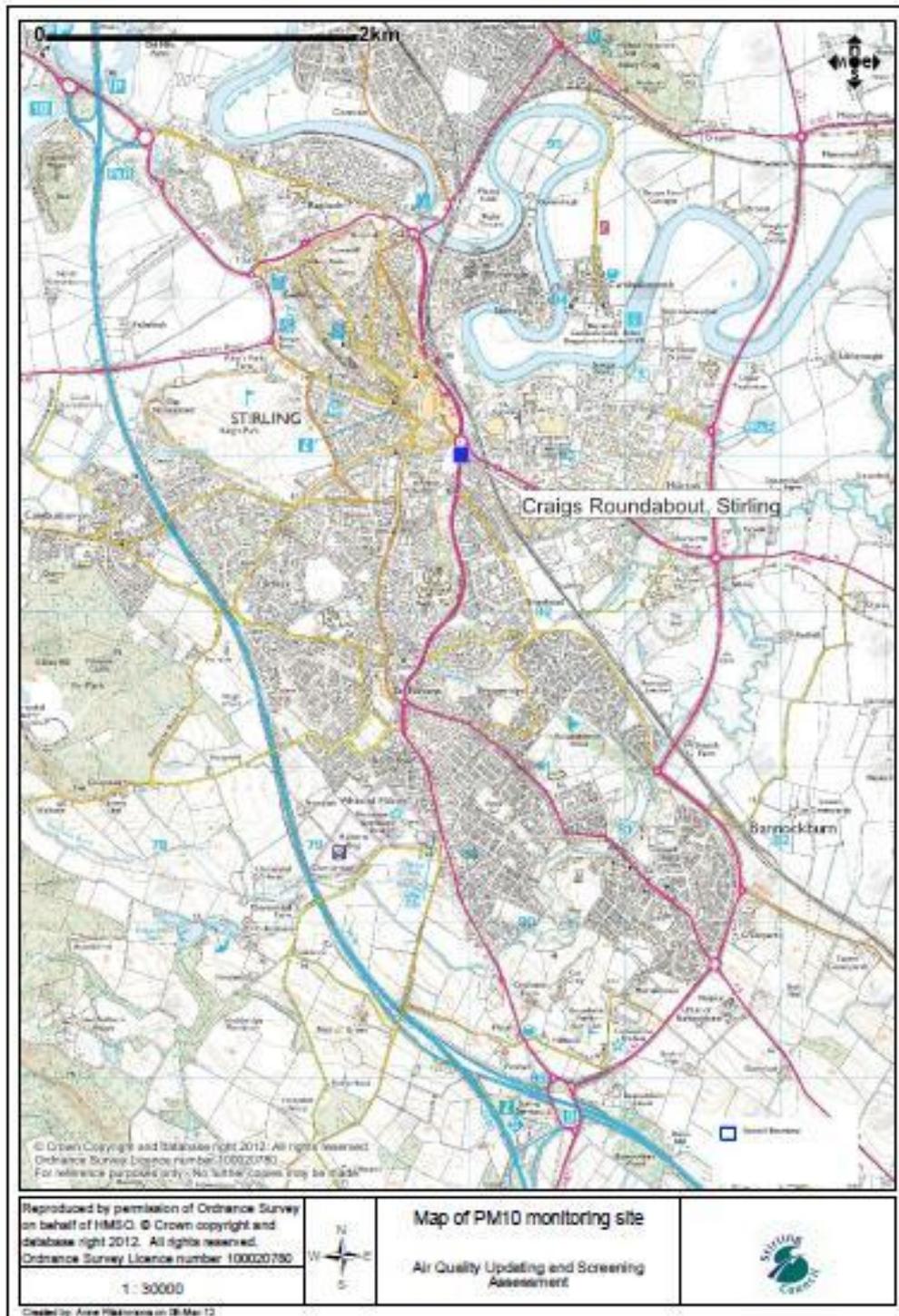


Figure C.3 Detailed location of Automatic Monitor

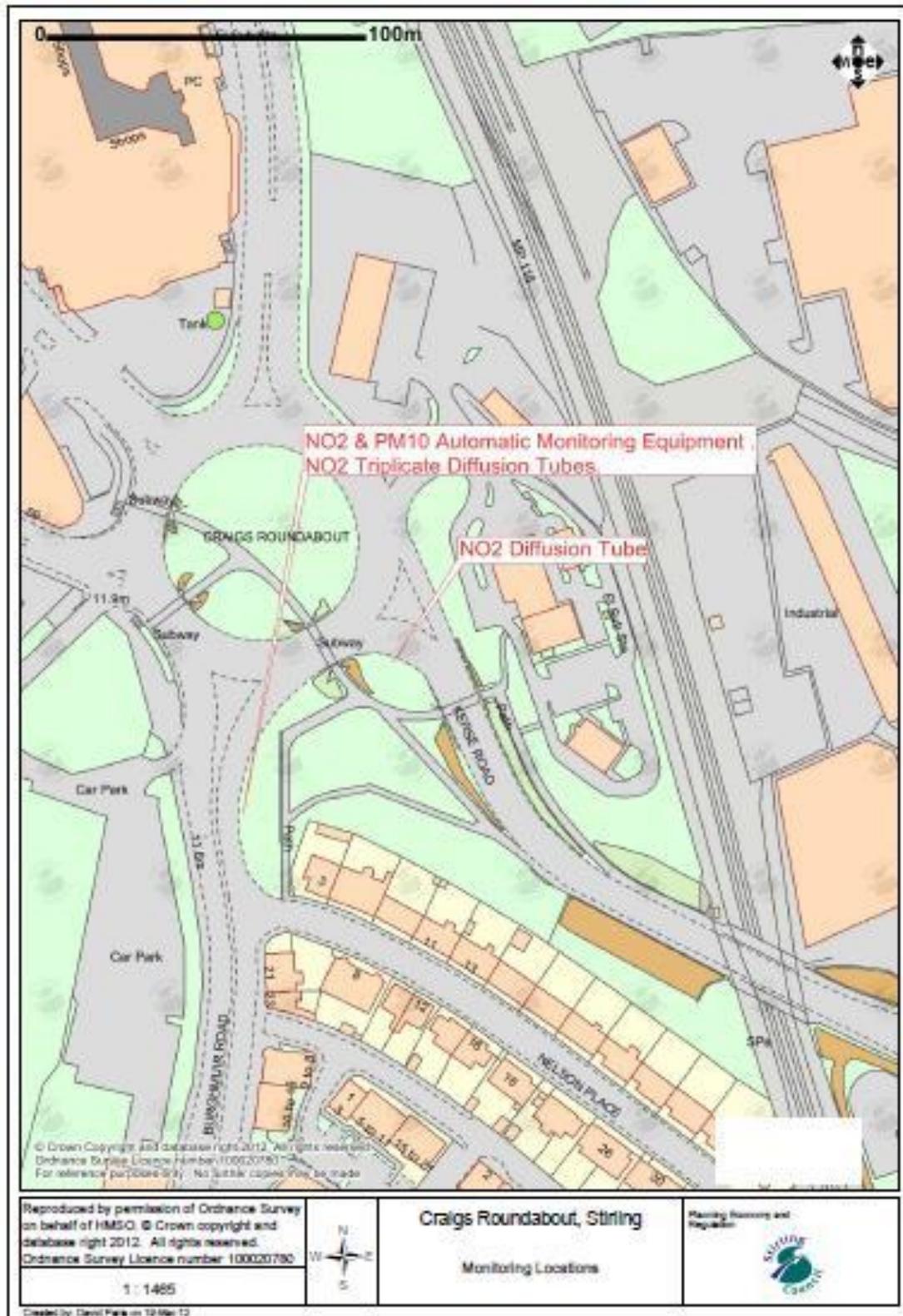
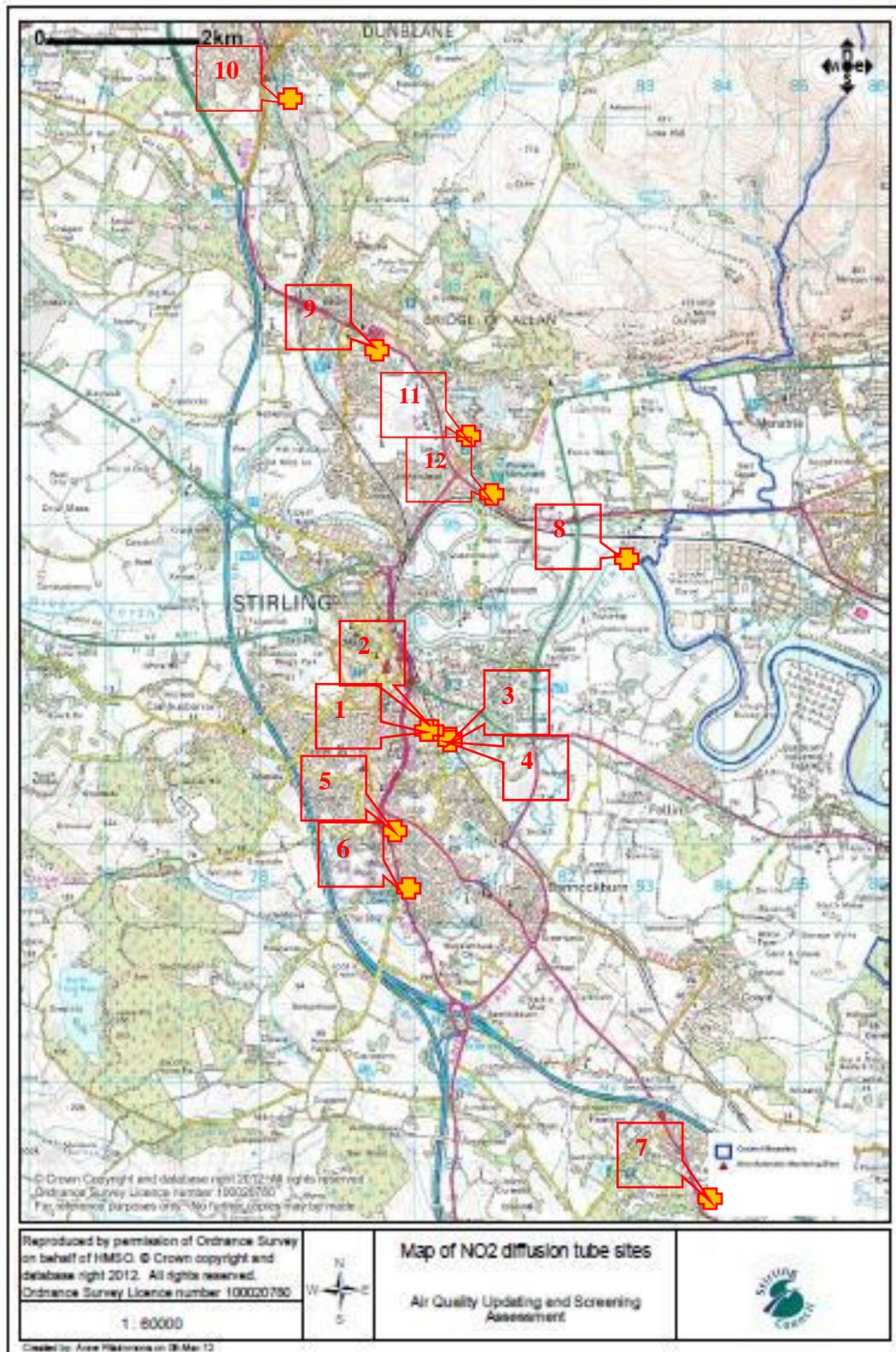


Figure C.4 - Location of Diffusion Tube Sites



## 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              | Local Air Quality Management  |
| NO <sub>2</sub>   | Nitrogen Dioxide  |
| NO <sub>x</sub>   | Nitrogen Oxides   |
| PM <sub>10</sub>  | Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less   |
| PM <sub>2.5</sub> | Airborne particulate matter with an aerodynamic diameter of 2.5µm or less   |
| QA/QC             | Quality Assurance and Quality Control   |
| SO <sub>2</sub>   | Sulphur Dioxide   |

## **References**

- (1) Stirling Council, 2015 Air Quality Updating and Screening Assessment for Stirling Council, February 2016
- (2) <http://www.scottishairquality.co.uk/data/mapping?view=data>
- (3) <http://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html>
- (4) Defra, Local Air Quality Guidance Management, Technical Guidance (TG16), April 2016
- (5) <http://www.dft.gov.uk/traffic-counts/area.php?region=Scotland&la=Stirling>
- (6) <http://laqm.defra.gov.uk/review-and-assessment/tools/modelling.html>
- (7) <http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#biomass>