Annual Progress Report (APR)

2021 Air Quality Annual Progress Report (APR) for Falkirk Council

In fulfilment of Part IV of the Environment Act 1995

Local Air Quality Management

June 2021

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Executive Summary: Air Quality in Our Area

Air Quality in Falkirk Council

In 2020, the air quality within the Falkirk Council area continued to be good from 2019.

The Falkirk Council air quality monitoring results for all pollutants measured have shown a decrease in National Air Quality Strategy (NAQS) objective exceedances from 2019 for all pollutants measured. There were two NAQS objective exceedances in 2019 and none were recorded throughout Falkirk Council's extensive air quality monitoring network in 2020. Please note that travel has been subjected to various national and local restrictions during 2020 and 2021 as a result of the Coronavirus (COVID-19) pandemic[Ref 1].

An air quality summary report for Falkirk Council in relation to the Coronavirus (COVID-19) specific restrictions has been completed by Ricardo via the Scottish Air Quality website and can be viewed here: http://www.scottishairquality.scot/assets/documents//Falkirk_covid_analysis_updated.html

The Falkirk Town Centre Air Quality Management Action Plan (AQAP) was approved in June 2015 and focuses on long-term key point actions to reduce air pollution in the area rather than short-term fixes. Key measures outlined in the plan include:

- Reducing emissions from individual vehicles.
- Promoting the ECOStars Fleet Recognition Scheme.
- Promoting alternative and sustainable modes of transport.
- To educate and inform the public on air quality issues.

In 2020, Falkirk Council made significant progress in implementing these measures. To illustrate, there are now thirty-nine operational electric vehicle (EV) charging bays throughout the Falkirk Council area with an additional sixty-three (providing various charging capacities: 7, 22, 50, 150kW) being planned to be installed in various locations in the Falkirk Council area in the upcoming year. This action helps to promote alternative, sustainable modes of travel and to achieve measures included in Falkirk Council's Climate Change and Sustainability Policies.

On the 10th August 2020, the Falkirk Stadium Vehicle Charging Hub was opened and became operational accepting electric vehicles to park and charge-up. The £1.4m facility has charging capacity for twenty-six electric vehicles - 30% more than the second largest EV facility in Scotland which supports the Scottish Government's ambition to phase-out the need for new petrol and diesel vehicles by 2032 as outlined in the [Renewable and Low Carbon Energy Policy](). The Falkirk Stadium Vehicle Charging hub is an integral part of Transport Scotland's [Electric A9]() project with the overall aim of improving the electric vehicle charging infrastructure throughout Scotland.

Falkirk Council's vehicle fleet was enhanced in 2020 which now includes two new electric minibuses and forty electric cars and vans. Further information on the Council's new electric fleet can be found here:
https://www.falkirk.gov.uk/employees/news/article.aspx?aid=6735

The Council also promoted a variety of active and sustainable travel measures in 2020/21 to help reduce overall local traffic emissions. Full details of the progress Falkirk Council is making towards these measures are outlined in Section 2 'Actions to Improve Air Quality'.

The 2020 air quality monitoring results (as displayed in Appendix A 'Tables A.3' and 'A.4') show that all seven automatic nitrogen dioxide (NO_2) analysers in Falkirk Council's air monitoring network achieved both NO_2 NAQS (1hr and annual mean) objectives.

Falkirk Council measured particulate matter (PM_{10}) concentrations at seven site locations during 2020. The relevant Scottish NAQS objectives for PM_{10} were achieved at all seven site locations.

The monitoring sites with the highest recorded annual mean PM_{10} concentrations in 2020 (but within the Scottish NAQS PM_{10} objective) were: Main Street, Bainsford (Roadside, 11µg/m^3) and A4 Falkirk Haggs (Roadside, 10µg/m^3). Over a five-year period (from 2016 to 2020), five sites have recorded PM_{10} (annual mean) concentration reductions, these were: A4 Falkirk Haggs, A5 Falkirk Hope Street (Roadside), A7 Falkirk West Bridge Street (Roadside), A8 Grangemouth AURN (Urban Background/Industrial) and A10 Grangemouth Municipal Chambers (Urban Background/Industrial). Two sites have recorded concentration increases, these were: A14 Banknock 3 (Urban Background) and A15 Main Street, Bainsford. In 2020, the A14 Banknock 3 monitoring site recorded the greatest number of daily exceedances (one) which remains the same exceedance count from Falkirk Council's 2020 APR results. This result achieved the NAQS PM_{10} 24-hr objective (50µg/m^3 not to be exceeded more than seven times per year). The full results are shown in Appendix A, 'Table A.6'. Over a five-year period (from 2016 to 2020), one site, A14 Banknock 3, has recorded a PM_{10} (24-hr mean) concentration reduction. Six monitoring sites have remained at the same number of 24-hour mean exceedances (zero): A4 Falkirk Haggs, A5 Falkirk Hope Street, A7 Falkirk West Bridge Street, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A15 Main Street, Bainsford.

Particulate Matter ($PM_{2.5}$) is measured at five site locations within the Falkirk Council area, these are: A4 Haggs, A7 Falkirk West Bridge Street, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A14 Banknock 3. Two sites: A5 Falkirk Hope Street and A15 Main Street, Bainsford have PM_{10}-only monitoring data available for 2020 so a locally-derived correction ratio was used to calculate the $PM_{2.5}$ results for these sites – further information on estimating $PM_{2.5}$ results from PM_{10} measurements using monitoring data can be shown in Appendix C, 'Supporting Technical Information / Air Quality Monitoring Data', 'QA/QC of Automatic Monitoring',

During 2020 there were no exceedances of the $PM_{2.5}$ Scottish NAQS objective limit (10µg/m^3) at any of the monitoring sites.

The sites with the highest recorded annual mean $PM_{2.5}$ concentrations in 2020 (within the Scottish NAQS PM_{10} objective) were: A15 Main Street, Bainsford (6.2µg/m^3), A8 Grangemouth AURN (6µg/m^3) and A4 Haggs (6µg/m^3). Annual data capture was reasonable for A15 Main Street, Bainsford (80%), good for A8 Grangemouth AURN (94%) but very poor for A4 Haggs (29%).

The two sites with the lowest $PM_{2.5}$ (annual mean) concentrations were: A14 Banknock 3 (3.6µg/m^3) and A7 Falkirk West Bridge Street (4.4µg/m^3) / A10 Grangemouth Municipal Chambers (4.4µg/m^3). Data capture rates were poor for all sites at 63% and 38% / 63% respectively.

Over a five-year period (from 2016 to 2020) one site (A7 Falkirk West Bridge Street) has recorded a $PM_{2.5}$ (annual mean) concentration reduction. One monitoring site (Banknock 3) has recorded a slight concentration increase. Five sites: A4 Haggs, A5 Falkirk Hope Street, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A15 Main Steet, Bainsford have remained at the same $PM_{2.5}$ (annual mean) concentrations over this period.

Over a five-year period (from 2016 – 2020) the $PM_{2.5}$ concentrations recorded at the Grangemouth AURN site remained at the same level of 6 µg/m^3. 2019 saw a marginal concentration increase to 8µg/m^3 however, this concentration remains reasonably low and within the Scottish NAQS ($PM_{2.5}$ annual mean) objective. This reduction may be may be attributed to the commissioning of the Tail Gas Treatment (TGT) unit at the INEOS

Grangemouth complex in 2013. Since the commissioning of the TGT unit, SO_2 concentrations have reduced within the Grangemouth AQMA. As sulphate species are known to contribute towards the formation of secondary $PM_{2.5}$, a reduction in SO_2 could also impact local $PM_{2.5}$ concentrations.

In 2020, Falkirk Council monitored SO_2 at six site locations. Four of the monitoring sites are located within the Grangemouth AQMA (declared for 15-minute SO_2 NAQS objective) and two of the sites are located outwith this AQMA.

There were no exceedances of the SO_2 NAQS objectives (15-minute, hourly or daily) recorded at any of the Falkirk Council monitoring site locations during 2020.

The site recording the only exceedance of the 15-minute SO_2 NAQS objective during 2020 was Grangemouth AURN (six). No other SO_2 exceedances were recorded at any of the other monitoring sites during 2020.

This is the seventh consecutive year that no exceedances of the SO_2 NAQS objectives (15-minute, hourly or daily) have been recorded at any site in the Grangemouth AQMA. It is important to stress that although there were exceedances of the 15-minute and 1-hour NAQS objectives, the number of exceedances were below the maximum permitted.

The benzene and 1, 3-butadiene diffusion tube monitoring completed by Falkirk Council in 2020 met the NAQS (annual running mean) objectives for each pollutant respectively.

The Grangemouth Emission Study has now been completed by Sweco consultants and can be shown in Appendix C, ‘Additional Air Quality Works Undertaken by Falkirk Council During 2020’, ‘Grangemouth 2020 Emissions Study’.

Actions to Improve Air Quality

Falkirk Council made significant improvements to its air quality monitoring network during 2020. These improvements included upgrading three Rupprecht and Patashnick (R&P) Tapered Element Oscillating Microbalance (TEOM) particulate (PM_{10}) analysers to combined ($PM_{10+2.5}$) Palas Fidas 200 analysers at the Falkirk Hope Street, Main Street, Bainsford and Grangemouth Zetland Park sites. These upgrades enabled Falkirk Council to increase its $PM_{2.5}$ monitoring capability to seven sites in total.

Two new air conditioning systems were installed in the Grangemouth AURN site to replace the older, smaller capacity units that were unsuitable for providing heating / cooling of the site throughout the year.

Scottish Government Local Air Quality Management (LAQM) contribution funding was provided for the commencement of a three-year study of $PM_{2.5}$ airborne emissions and associated Poly Aromatic Hydrocarbons (PAH) from domestic solid fuel appliances (such as wood burning stoves) within the Falkirk Council area. This study would aim to offer a contribution to improving air quality in the local area and consequently aim to improve overall public health. We would envisage that if successful, the study could be replicated across all local authority areas and to help inform a national discussion within Scotland and further afield.

A new automatic zero scrubber unit was installed in the Bo'ness site to remove the requirement of supplying zero air gases to this site into the future.

The Falkirk Council Environmental Health department now own a fully electric van (Renault Kangoo ZE33), this van is used for all routine air quality site work. See photos below for equipment / vehicle upgrades.

Photo 1 Palas Fidas 200 Combined $PM_{10+2.5}$ Analyser at the Falkirk Hope Street Site

Photo 2 Palas Fidas 200 Combined $PM_{10+2.5}$ Analyser at the Main Street, Bainsford Site

Photo 3 Palas Fidas 200 Combined $PM_{10+2.5}$ Analyser at the Grangemouth Zetland Park Site

Photo 4 New Air Conditioning Units Installed at the Grangemouth AURN Site

Photo 5 New Air Conditioning Units Installed at the Grangemouth AURN Site

Photo 6 New Zero Air Scrubber Installed at the Bo'ness Site

Photo 7 Falkirk Council Environmental Health – Fully Electric Van (Renault Kangoo ZE33)

ECOStars Fleet Recognition Scheme

Throughout 2020/21 Falkirk Council's ECOStars fleet recognition scheme has grown significantly from 227 to 252 members. Falkirk Council's ECOStars taxi scheme has a small but engaged membership of 7 members. ECOStars membership consists of vehicle fleet operators located within the Falkirk Council local authority area as well as those whose depots are located out with the Council boundary but operate vehicles within that area; all of these operators have an impact on local air quality. In addition, Falkirk Council has been working closely with fellow members of the East Central Scotland Vehicle Emissions Partnership (ECSVEP Switch Off and Breathe) to work to the objectives set out in the Scottish Government's Cleaner Air for Scotland (CAFS, 2015) strategy. Air Quality Action Plan (AQAP) funding has been provided to continue the operation of the Falkirk ECOStars scheme (for fleet operators and taxis) during 2020/21.

Falkirk Council also continues to work closely with its partner organisations to manage local air quality issues. The Council works regularly with organisations such as SEPA, INEOS and Petroineos to help reduce exceedances of the SO_2 NAQS objectives within the Grangemouth AQMA.

Local Priorities and Challenges

Education and Awareness of Air Quality Issues

In 2021 Falkirk Council will be developing our engagement with local schools through promotion of air quality education resources such as the 'Learn About Air' teaching package, promoting the Clean Air Day in Scotland and working closer with the Falkirk Council Transport Planning department on promoting alternative and sustainable local transport solutions.

Low Emission Zones

Low Emission Zones (LEZ) are currently being planned and operated in the four major Scottish cities: Glasgow, Edinburgh, Aberdeen and Dundee over the next few years. There are no current plans for any form of LEZ in the Falkirk Council area. Falkirk Council has undertaken the 'Stage 1 Screening Exercise (clause 2.2.25)' assessment in the 2020 APR in accordance with the Scottish Government's National Low Emissions Framework to inform this process.

How to Get Involved

To obtain further information on air quality within the Falkirk Council area, please visit our air quality policy webpage:

http://www.falkirk.gov.uk/services/environment/environmental-policy/air-quality/

There are ten automatic air quality monitoring sites across the Falkirk Council area. The air quality data from all the monitoring sites (excluding Banknock 2 station) can be viewed on the Scottish Air Quality website at:

http://www.scottishairquality.co.uk/latest/summary?view=la

To learn more about the ECOStars Fleet Recognition Scheme and for details of how to join if you are a commercial fleet operator please visit:

https://www.ecostars-uk.com/eco-stars-schemes/

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1 Local Air Quality Management

This report provides an overview of air quality in Falkirk Council during 2020. 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 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 Falkirk 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 Concentration	Air Quality Objective Measured as	Date to be Achieved by
Nitrogen dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
Nitrogen dioxide (NO_2)	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
Particulate Matter (PM_{10})	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
Sulphur dioxide (SO_2)	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
Sulphur dioxide (SO_2)	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

2 Actions to Improve Air Quality

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.

Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online at https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=371 – see full list at https://uk-air.defra.gov.uk/aqma/list.

Falkirk Town Centre AQMA

The Falkirk town centre AQMA for NO2 (annual mean) remains justified as although there were no exceedances of the NO2 (annual mean) NAQS objective recorded in 2020 there have been consecutive diffusion tube exceedances (such as NA27 Falkirk West Bridge Street location) in previous years which haven't been affected by Coronavirus (COVID-19) Scottish Government travel restrictionsRef1. One diffusion tube (NA27 Falkirk West Bridge Street) was close to the NAQS annual limit (40µg/m3) with the highest concentration of 35µg/m3 recorded in 2020.

There have been over five years where PM10 (24-hr and annual mean) results at both Falkirk Town Centre AQMA automatic monitoring locations (Falkirk Hope Street and Falkirk West Bridge Street) have complied with the PM10 NAQS objective. It is anticipated that the PM10 element (24-hr and annual mean) of the Falkirk Town Centre AQMA will be assessed for revocation eligibility during 2021.

Haggs AQMA

The Haggs AQMA was declared on the 18th March 2010 following NAQS exceedances for NO2 (annual mean). Since the AQMA was declared, measured concentrations (using automatic and non-automatic monitoring methods) of NO2 have complied with the NAQS objectives consistently over the past six years (since 2015). It is anticipated that the Haggs AQMA will be revoked in 2021. The 'Falkirk Council Proposal for Revocation of Haggs

AQMA' can be shown in Appendix C: 'Supporting Technical Information / Air Quality Monitoring Data QA/QC'.

Grangemouth AQMA

Although the SO2 NAQS objectives have been achieved within the Grangemouth AQMA for seven consecutive years, Falkirk Council considers the AQMA remains justified based upon continual exceedances of the 15min SO2 NAQS objective concentration recorded at the A8 Grangemouth AURN, A9 Grangemouth Moray and A10 Grangemouth Municipal Chambers sites for the past five consecutive years. The Grangemouth Emission Study (which includes a review of the Grangemouth AQMA) has been completed by Sweco consultants and can be shown in Appendix C 'Additional Air Quality Works Undertaken by Falkirk Council During 2020'.

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Pollutants and Air Quality Objectives	City / Town	Description	Action Plan
Falkirk Town Centre	NO_2 annual mean PM_{10} 24-hour mean and annual mean	Falkirk	An area encompassing an area of Falkirk Town Centre	Air Quality Action Management Plan (Falkirk Town Centre and Haggs) 2015 Air Quality Management Action Plan (Falkirk Town Centre and Haggs) June 2015
Haggs	NO_2 annual mean	Haggs	An area that connects Banknock and Haggs around the road junction of the A803 and M80	Air Quality Management Plan (Falkirk Town Centre and Haggs) 2015 Air Quality Management Action Plan (Falkirk Town Centre and Haggs) June 2015
Grangemouth	SO_2 15-min mean	Grangemouth	An area encompassing the Grangemouth industry areas, shipping port and adjacent residential areas	Air Quality Action Plan Update (Grangemouth) 2009 Available on request

Cleaner Air for Scotland

'Cleaner Air for Scotland – The Road to a Healthier Future (CAFS)' is a national cross-government strategy that sets out how the Scottish Government and its partner organisations propose to reduce air pollution further to protect human health and fulfil Scotland's legal responsibilities as soon as possible. A series of actions across a range of policy areas are outlined, a summary of which is available on the Scottish Government's website. Progress by Falkirk Council against relevant actions within this strategy is demonstrated below.

2.1.1 Transport – Avoiding Travel – T1

All local authorities should ensure that they have a corporate travel plan (within a carbon management plan or similar) which is consistent with any local air quality action plan. Falkirk Council has a local transport strategy published in 2014 entitled Falkirk Council Local Transport Strategy. This strategy sets out the Council's overall transport vision. This includes objectives directly related to providing sustainable transport options such as encouraging more travel by foot, bicycle, rail, and ensuring new transport infrastructure is delivered to support future sustainable travel choices. The Council also has a Road Safety Plan which is associated with the above strategy, it can be accessed here: Road Safety Plan.

Falkirk Council has an active travel scheme which promotes alternative transport methods to car. Projects completed with local communities in 2020 include:

- Take the Right Route: utilising online marketing campaigns, extensive local bus / newspaper / business advertising and social media presence incorporating market research feedback.
- Green Travel Map: The map covers the main built up areas and highlights many routes which are suitable for both walkers and cyclists. They include cycle paths, shared use paths and canal towpaths, amongst others.
- Town Centre First: Bus Promotion Initiative: Partnership between Falkirk Council, Falkirk Delivers (Town Centre Management team) and First Bus. The aim of the project is to encourage bus travel and for the community to think 'shop local first'. Both bus use and local shopping has rapidly declined nationwide over the last

decade. The Coronavirus (COVID-19) pandemic[Ref 1] has accelerated this decline. The 'Town Centre First' project aims to assist in overcoming this decline and encourage support for both bus use and localised shopping habits.

- School engagement: Promote the National bi-annual Walk to School campaign (May and October) to all primary schools in the Falkirk Council area. Falkirk Council have been promoting the 'Walk to School Campaign' since 2004. In 2020, Falkirk Council achieved 100% school engagement. We will continue to sustain this high level of engagement with working towards the primary outcome of more people choosing to walk or cycle for short, local journeys.
- Walk to School campaigns delivered to fifty primary schools in the Falkirk Council area in 2020.
- Falkirk Active Travel Hub (Forth Environment Link) is in Falkirk town centre (203 High Street, Falkirk, FK1 1DU) and is open to the public to increase awareness of active travel throughout the region.

2.1.2 Climate Change – Effective co-ordination of climate change and air quality policies to deliver co-benefits – CC2

Scottish Government expects any Scottish local authority which has or is currently developing a Sustainable Energy Action Plan to ensure that air quality considerations are covered. Falkirk Council has a dedicated Climate Change and Sustainability team and associated webpage which outlines what the Council has completed and what they are committed to achieving. The webpage also provides links to:

- Sustainable Procurement including a Procurement Strategy 2020 - 2023.
- Sustainable Transport including the Falkirk Area Green Travel Map.
- Sustainable Falkirk including the Sustainable Falkirk Map.

The webpage also provides a link to the Council's Carbon Management Plan 2015 - 2021.

Progress and Impacts of Measures to address Air Quality in Falkirk Council

Falkirk Council has taken forward several measures during the current reporting year of 2020 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.2. More details on these measures can be found in the AQAP relating to each AQMA. Key completed measures are:

- Measure 4: Monitoring network requirements reviewed and upgraded where necessary such as upgrading three R&P TEOM PM_{10} particulate analysers to combined ($PM_{10+2.5}$) Palas Fidas 200 analysers at the following sites: Falkirk Hope Street, Main Street, Bainsford and Grangemouth Zetland Park.
- Measure 5: New Environmental Health fully electric van (Renault Kangoo ZE33) now in use for all air quality site work within the Falkirk Council area.
- Measure 16: Continuation and increased members of the ECOStars Fleet Recognition scheme.

Falkirk Council expects the following measures to be completed over the course of the next reporting year:

- Review of Falkirk Town Centre (PM_{10}) AQMA with potential revocation (reduction of Falkirk Council AQMAs from three to two).
- Dedicated and tailored air quality data collection system with secure webpage log-in for data security and back-up which can be used on multiple devices.
- Replacement of older (NO_X and SO_2) analysers with new models (providing increased accuracy, availability of spares, less breakdowns and expensive maintenance visits etc.).
- Continuation of ECOStars Fleet Recognition Scheme with new members added (Increased fleet efficiency measures / knowledge) – Scottish Government AQAP funding dependant.

Table 2.2 – Progress on Measures to Improve Air Quality

Meas. No.	Measure	Category	Focus	Lead Authority	Planning Phase	Impleme-ntation Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date	Estimated Completion Date	Comments
1	Improving SO_2 data access	Public Information	Supplying SO_2 monitoring data to SEPA, Petroineos, INEOS and other interested organisations.	Falkirk Council	2013	2013	AQ Objectives met during 2016-2020.	Anticipated reduction in SO_2 concentration/ breaches of NAQS objectives.	Data sent after Grangemouth SO_2 exceedances- monthly summary reports sent with ongoing totals.	Completed, and monthly reports ongoing.	
2	Grangemouth Working Group	Policy Guidance and Development Control	Bringing together: Petroineos, INEOS, S. Gov, SEPA and Falkirk Council.	Falkirk Council	2013	2013	AQ Objectives met in during 2016-2020.	Reduction in SO_2 due to cooperative working and agreement of priorities.	Completed. TGU fully commissioned in August 2013, meeting held in November 2013. Further meeting only if breach of objective occurs.	Completed.	

3	Text Alert System	Public Information	Real-time notification of exceedances by SMS and Email.	Falkirk Council	2013	2013	Text alerts received by Falkirk Council, SEPA, Petroineos and INEOS when an NAQS objective exceedance occurs within the Grangemouth AQMA.	Anticipated reduction in SO_2 NAQS objective exceedances due to real time alerts of exceedances supplied to SEPA, Petroineos and INEOS so action to rectify any plant emission / process issues can be addressed.	Completed and on-going.	Completed in 2013 / Upgraded in 2018	Rather than a text alert system linked to individual analysers this system has been upgraded in 2018 to incorporate the Council's data collection system and can be used for any measured pollutant.
4	Review Monitoring Network	Public Information	Grangemouth Moray SO_2 in Scottish Air Quality Network (SAQN).	Falkirk Council	Falkirk Park St ceased operation in April 2014.	2014 and 2015	All Grangemouth automatic monitoring sites are affiliated with the SAQN.	Affiliation with the SAQN increases data capture allowing better comparison to the NAQS objectives.	Completed. In addition, the Bo'ness, Falkirk Graham's Rd, and Main St, Bainsford stations were	Completed.	

			Monitoring conducted in Grangemouth Zetland Park.		Zetland Park commen ced operation April 2015.				affiliated to the SAQN in 2016.		
5	Electric Vehicles and Plug-ins	Promoting Low Emission Transport	Cars / Fleet	Falkirk Council	2012	2012 and on-going	Charging points at Falkirk Council depots	Anticipated reduction in NO_X and PM emissions due to increased use of electric vehicles.	In 2020, the EV charging point bays increased to 39. These are located at depots and public places across the Falkirk Council area. There are 63 being planned in coming year. Falkirk Council increased its electric vehicle fleet to 42 available for use by Council staff.	Completed and on-going	The air quality team within the Env. Health Department at Falkirk Council have received a new fully electric (Renault Kangoo ZE33) van in June 2019 – further details provided in Section 'Actions to Improve Air

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6	Eco-advanced Driver Training	Promoting Low Emission Transport	All types of vehicle, fuel use and emissions	Falkirk Council	2014	2015	Offered to Council services by fleet	Anticipated reduction in NO_X and PM emissions due to promotion of efficient driving practices.	Offered to Council services by fleet.	Completed and on-going training offered.	
7	Review of School Bus Contracts with View to Raising EURO Engine Standards	Vehicle Fleet Efficiency	Buses	Falkirk Council	2017	2021	n/a	Anticipated reduction in NO_X and PM emissions from buses operating within the Falkirk Council area.	Meetings to be arranged in 2021/22 with Public Transport Co-ordinator and Procurement Services to discuss the feasibility of raising the EURO standards for local and school bus contracts from 2021 onwards.	2021	

8	Improvements of Traffic Lights at Bankside	Transport Planning and Infrastructure	Congestion	Falkirk Council	2013	2014	n/a	Anticipated reduction in NO_X and PM emissions due to traffic queue reduction at Bankside traffic lights.	Completed.	Completed.	
9	Feasibility Study of Haggs Infrastructure Changes	Transport Planning and Infrastructure	Congestion	Falkirk Council	Dependent on developer contributions and planning applications.	Dependent on developer contributions and planning applications.	n/a.	Anticipated reduction in NO_X and PM emissions.	Dependent on developer contributions and planning applications.	Dependent on developer contributions and planning applications. Future action.	
10	Feasibility study of West Bridge St and Town Centre Traffic Management Changes (speed limits, TROs etc.)	Transport Planning and Infrastructure	Congestion	Falkirk Council	n/a	n/a	n/a	Anticipated reduction in NO_X and PM emissions.	This measure was linked to a planning application to build new council offices at Falkirk Town Centre Municipal Buildings.	Completed	

									However, this project is still being decided upon. However, traffic signals along West Bridge St have been altered to improve traffic flows.		
11	Take the Right Route / Walk to School & School Travel Plan Pack	Promote Travel Alternatives	Car travel	Falkirk Council	2009	2013 and ongoing	Scheme in place and publicly advertised on Falkirk Council website.	Anticipated reduction in NO_X and PM emissions due to an increase in green travel such as walking and cycling.	In 2020 Take the Right Route continually promoted across the Falkirk Council area with on street interviews, online campaigns, bus and newspaper advertising and leaflets distributed.	Completed and on-going.	
12	Bike Hire Scheme	Promote Travel Alternatives	Mode transfer	Falkirk Council	2016	2018	Unknown	Anticipated reduction in NO_X and PM emissions due	Forth Bike (in conjunction with Forth Environment	Completed. Forth Bike scheme established	

								to an increase in green travel alternatives.	Link) operates an electric bike hire scheme within the Falkirk and Stirling area The Forth Bike system currently includes over one hundred electric pedal assist (Pedelec) bikes spread between their four local stations: the Falkirk Wheel, the Helix, Forth Valley Royal Hospital, and University of Stirling.	and running in 2020. Expansion of the scheme expected in future years.	
13	Soft Measures e.g. travel planning (larger employers, schools), journey sharing,	Promote Travel Alternatives	Variety	Falkirk Council	2006	2014	Development of Travel Plans	Anticipated reduction in NO_X and PM emissions due to promotion of travel alternatives.	Increased fuel efficient and electric pool car vehicles for staff use as part of Council's travel plan	On-going	

	changes to mileage, home and mobile working.								Operational car sharing database for Falkirk Council area.		
14	Consideration of Air Quality in Local Development Plan	Policy Guidance and Development Control	Development	Falkirk Council	2015	2015	Air quality policy statement in local development plan	Air Quality Assessment required for developments within AQMAs.	Air quality policy statement in plan.	Completed	
15	Appropriate Air Quality Monitoring in AQMAs.	Public Information	Improving data capture.	Falkirk Council	2005	2005	Good data capture (90%) in AQMAs	Good data capture will allow strict comparison of PM_{10}, $PM_{2.5}$, SO_2, NO_X concentrations against the NAQS objectives.	Monitoring maintained in AQMAs. Equipment upgrades completed during 2020.	Completed and on-going	
16	Promotion of ECO Stars	Vehicle Fleet Efficiency	Commercial vehicles, taxis and private hire cars.	Falkirk Council	2013	2013 and on-going	The latest Falkirk Eco Stars report shows that recruitment in	Anticipated reduction in NO_X and PM emissions due to promotion of	During 2020, reference to EcoStars is now included in the tender	On-going	

							Falkirk has 227 members.	efficient driving practices.	specification for Falkirk Council Adult and Children's Service passenger transport. Member meetings were held regularly during 2020.		
17	Review of Park and Ride Facilities	Transport Planning and Infrastructure	Cars	Falkirk Council	2017	2018	Ongoing.	Anticipated reduction in NO_x and PM emissions.	There is currently no progress in taking forward any new bus park and ride facilities. However, additional parking has been created at Falkirk High and Larbert train stations to help improve park and ride facilities.	Completed and on-going	

18	Taxi Licensing	Vehicle Fleet Efficiency	Taxis	Falkirk Council	2013	2015	Increase in taxi services signed up to Eco Stars Scheme.	Anticipated reduction in NO_X and PM emissions due to promotion of efficient driving and vehicles.	Changes to licensing in May 2013 and Eco Stars extended to taxis and private hire cars.	On-going	
19	Vehicle Emissions Partnership (testing and idling) - enforcement and fines rather than raising awareness.	Promoting Low Emission Transport	Cars	Falkirk and other neighbouring authorities.	2012	2012 and on-going	Maintain membership of the partnership.	Anticipated reduction in NO_X and PM emissions through anti-idling enforcement.	The ESVEP continues to assist in promoting anti idling in the Falkirk Council area. Improvements of the associated ‘Switch Off and Breathe’ website have taken place.	On-going subject to annual funding allocation.	
20	Introduce Quality Bus Corridors	Transport Planning and Infrastructure	Buses	Falkirk Council	2017	On-going depending on funding to complete the scheme.	Unknown	Anticipated reduction in NO_X and PM emissions through improved public transport.	The Council has secured areas of land along the A803 Glasgow Road corridor in Camelon. In addition to this	2030	

									the Council has updated the traffic signals on the B902 Grahams Road corridor to “intelligent” traffic signals which better manage the flows of traffic increasing green time along the main corridor, the knock on effect of this improves bus journey times into the town centre.		

3 Air Quality Monitoring Data and Comparison with Air Quality Objectives

Summary of Monitoring Undertaken

3.1.1 Automatic Monitoring Sites

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

Falkirk Council undertook automatic (continuous) monitoring at ten sites during 2020. Table A.1 in Appendix A shows the details of the sites. National monitoring results are available at http://www.scottishairquality.scot/.

Maps showing the location of the monitoring sites are provided in Appendix A, Figure 25 A) to F). Further details on how the monitors are calibrated and how the data has been adjusted are included in Appendix C 'Supporting Technical Information / Air Quality Monitoring Data QA/QC'.

3.1.2 Non-Automatic Monitoring Sites

Falkirk Council undertook non-automatic (passive) monitoring of NO_2 at sixty-one sites during 2020. Table A.2 in Appendix A shows the details of the sites.

Falkirk Council also undertook non-automatic (passive) monitoring of 1, 3 butadiene at three sites during 2020. Table A.9 in Appendix A shows the details of the 1, 3 butadiene sites.

In addition, Falkirk Council also undertook non-automatic (passive) monitoring of benzene at sixteen sites during 2020. Table A.10 in Appendix A shows the details of the benzene sites.

Maps showing the location of the monitoring sites are provided in Appendix A, Figure 26 A) to C). Further details on Quality Assurance/Quality Control (QA/QC) and bias adjustment for the diffusion tubes are included in Appendix C 'Supporting Technical Information / Air Quality Monitoring Data QA/QC'.

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 'Supporting Technical Information / Air Quality Monitoring Data QA/QC'.

3.1.3 Nitrogen Dioxide (NO_2)

Table A.3 in Appendix A compares the ratified and adjusted monitored NO_2 (annual mean) concentrations for the past five years with the NAQS objective limit of 40 µg/m^3.

For diffusion tubes, the full 2020 dataset of monthly mean values is provided in Appendix B 'Full Monthly Diffusion Tube Results for 2020'.

Table A.4 in Appendix A compares the ratified continuous monitored NO_2 hourly mean concentrations for the past five years with the air quality objective of 200µg/m^3, not to be exceeded more than 18 times per year.

<u>NO_2 Automatic Analyser Results</u>

The 2020 monitoring results (as displayed in Appendix A Tables A.3 and A.4) show that all seven automatic NO_2 analysers in the Falkirk Council's air monitoring network met both NO_2 NAQS objectives (1hr and annual mean). The highest NO_2 annual mean result in 2020 was recorded at the Falkirk West Bridge Street site (27µg/m^3) - this result has decreased (11 µg/m^3) from 2019's result (38µg/m^3). The lowest result was recorded at the Grangemouth AURN (11µg/m^3) site. The Grangemouth AURN NO_2 annual mean result has decreased from 15µg/m^3 in 2019. Overall, all fixed automatic site's NO_2 concentrations have decreased significantly from 2019's results however, this is most likley to be attributed to the Coronavirus (COVID-19) travel restrictions[Ref1] which commenced in late March 2020 and continued into 2021. This resulted in less daily vehicle trips due to the 'Stay at Home' Scottish Government advice. The last exceedance in relation to NO_2 annual mean concentrations was recorded in 2014 at the Falkirk West Bridge Street site (41µg/m^3).

Over a five year period (from 2016 to 2020), all seven monitoring sites have recorded annual mean NO_2 concentration reductions. There have been minor fluctuations in results during this period but all remain within the NO_2 NAQS (1hr and annual mean) objecvtives.

Long term NO_2 trend graphs are shown in Appendix A, Figures 1 to 7. There is an overall downward trend in NO_2 (annual mean) concentrations at the following monitoring sites: A4

Haggs (Figure 1), A5 Falkirk Hope Street (Figure 2), A10 Grangemouth Municipal Chambers (Figure 6) and A15 Main Street Bainsford (Figure 7). A8 Grangemouth AURN (Figure 4) trend has largely remained at the same concentration. The A7 Falkirk West Bridge Street (Figure 3) site shows flucuations upwards and downwards over this time period.

Likely contributing factors to the reduction in NO_2 concentrations at the above sites include the Coronavirus (COVID-19) pandemic[Ref 1] in March 2020 to 2021 (resulting in less road traffic), traffic-light timing amendments (on Falkirk West Bridge Street) to minimise congestion and prevent excessive idling (within the Falkirk town centre area), road upgrades (M80 at Haggs) and speed limit enforcement measures (30mph on the A803). Increased ownership of hybrid and electric vehicles may also have contributed to the overall NO_2 reduction.

<u>Annual NO_2 Diffusion Tube Results</u>

The 2020 annual NO_2 diffusion tube monitoring results (as displayed in Appendix A Table A.3) shows that no (non-automatic) NO_2 tubes exceeded the NAQS (annual mean) objective limit of 40µg/m^3. All sixty-one tubes in Falkirk Council's network met the NO_2 NAQS (annual mean) objective.

One diffusion tube was close to the 40µg/m^3 annual limit with the highest concentration recorded at the NA27 Falkirk West Bridge Street (35µg/m^3) site. This tube is located within the Falkirk Town Centre AQMA at a roadside location.

Diffusion tube NA27 is co-located with the Falkirk West Bridge Street fixed automatic monitoring station. This site contains a NO_2 reference method (Chemiluminescence) analyser (API Teledyne T200) which has recorded an annual NO_2 concentration of 27µg/m^3 during 2020. The reference analyser result is significantly lower than the diffusion tube for 2020.

Historically, diffusion tube NA27 Falkirk West Bridge Street records a higher concentration than the automatic analyser despite the close proximity to one another. The most likely reason for a higher concentration at this location is that the automatic site is located at a further distance from the road than the NA27 tube location and is therefore less exposed to traffic emissions. The NA27 Falkirk West Bridge Street diffusion tube concentrations regularly exceeds the NAQS objective for NO_2 - this is the second occasion over a five year period that the result has complied with the NAQS objective for NO_2.

The lowest NO_2 annual mean diffusion tube concentrations in 2020 were recorded at the following locations: NA105 West of Shieldhill (Rural, 6µg/m^3) and NA64 New Hallglen Road, Falkirk (Urban Background 11µg/m^3).

In addition, the diffusion tubes are affected by several sources of interference which can cause substantial under or overestimation (often referred to as "bias") compared to the automatic NO_2 (chemiluminescence) reference analyser (as defined within the EU as the reference method)[Ref 2]. Due to this, NO_2 concentrations recorded using diffusion tubes are typically of lower accuracy than that recorded by the reference method using automatic (chemiluminescence) NO_2 analysers.

3.1.4 Particulate Matter (PM_{10})

Table A.5 in Appendix A compares the ratified and adjusted monitored PM_{10} annual mean concentrations for the past five years with the PM_{10} NAQS (annual mean) objective of 18µg/m^3.

Table A.6 in Appendix A compares the ratified continuous monitored PM_{10} daily mean concentrations for the past five years with the PM_{10} NAQS (24-hr mean) objective of 50µg/m^3, not to be exceeded more than seven times per year.

Falkirk Council measured PM_{10} concentrations at seven locations during 2020. The relevant Scottish NAQS objectives for PM_{10} were met at all seven locations.

The sites with the highest recorded annual mean PM_{10} concentrations in 2020 (but within the Scottish NAQS PM_{10} objective) were: A4 Falkirk Haggs (10µg/m^3) and A15 Main Street, Bainsford (11µg/m^3). Overall annual data capture was good for two of these sites (A5 Falkirk Hope Street: 87% and A8 Grangemouth AURN: 97%) . The Falkirk West Bridge Street site recorded low PM_{10} annual data capture of 38%, this was due to a significant communications fault between the Palas Fidas 200 analyser and the onsite datalogger with the Fidas being removed from site for a prolonged period for workshop investigation in May 2020. Lower than average annual data capture was recorded for Falkirk Haggs (56%), Grangemouth Municipal Chambers (63%) and Main Street, Bainsford (80%), this was due to the transition from removing R&P TEOM PM_{10} analysers to installing the upgraded Palas Fidas 200 analysers in late 2020. Low annual data capture was also recorded at Banknock 3 (63%) - this was due to an overdue service/data clearing issue with the Turnkey Osiris analyser as Falkirk Council were unable to enter residential premises due to Coronavirus (COVID-19) restrictions[Ref 1].

The two sites with the lowest PM_{10} (annual mean) concentrations were: A14 Banknock 3 (7.8µg/m^3) and A7 Falkirk West Bridge Street (8.4µg/m^3). Data capture rates were poor for both sites at 63% and 38% respectively.

Over a five year period (from 2016 to 2020), five sites have recorded PM_{10} (annual mean) concentration reductions, these were: A4 Falkirk Haggs, A5 Falkirk Hope Street, A7 Falkirk West Bridge Street, A8 Grangemouth AURN and A10 Grangemouth Municipal Chambers. Two sites have recorded concentration increases, these were: A14 Banknock 3 and A15 Main Street, Bainsford.

In 2020, the A14 Banknock 3 monitoring site recorded the greatest number of daily exceedances (one) which remains the same exceedance count from 2019's result. This result is within the NAQS PM_{10} 24-hr objective (50µg/m^3 not to be exceeded more than seven times per year). The full results are shown in Appendix A, Table A.6.

Over a five year period (from 2016 to 2020), one site (A14 Banknock 3) has recorded a PM_{10} (24-hr mean) concentration reduction. The remaining six sites have remained at the same number of PM_{10} 24-hour mean exceedances (zero): A4 Falkirk Haggs, A5 Falkirk Hope Street, A7 Falkirk West Bridge Street, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A15 Main Street, Bainsford.

3.1.5 Particulate Matter ($PM_{2.5}$)

Table A.7 in Appendix A compares the ratified and adjusted monitored $PM_{2.5}$ (annual mean) concentrations for the past five years with the $PM_{2.5}$ NAQS (annual mean) objective limit of 10µg/m^3.

$PM_{2.5}$ is measured at five locations within the Falkirk Council area, these are: A4 Haggs, A7 Falkirk West Bridge Street, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A14 Banknock 3. Two sites: A5 Falkirk Hope Street and A15 Main Street, Bainsford have PM_{10}-only monitoring data available for 2020 so a locally derived correction ratio was used to calculate $PM_{2.5}$ results for these sites – further information on estimating $PM_{2.5}$ from PM_{10} measurements can be shown in Appendix C, 'Supporting Technical Information / Air Quality Monitoring Data QA/QC', 'QA/QC of Automatic Monitoring',

During 2020 there were no exceedances of the $PM_{2.5}$ Scottish NAQS (annual mean) objective limit (10µg/m^3) at any of the monitoring sites.

The sites with the highest recorded $PM_{2.5}$ (annual mean) concentrations in 2020 (within the Scottish NAQS PM_{10} annual mean objective) were: A15 Main Street, Bainsford (6.2µg/m^3), A8 Grangemouth AURN (6µg/m^3) and A4 Haggs (6µg/m^3). Annual data capture was reasonable for A15 Main Street, Bainsford (80%), good for A8 Grangemouth AURN (94%) but very poor for A4 Haggs (29%).

The two sites with the lowest $PM_{2.5}$ (annual mean) concentrations were: A14 Banknock 3 (3.6µg/m^3) and A7 Falkirk West Bridge Street (4.4µg/m^3) / A10 Grangemouth Municipal Chambers (4.4µg/m^3). Data capture rates were poor for all sites at 63% and 38% / 63% respectively.

Over a five year period (from 2016 to 2020) one site (A7 Falkirk West Bridge Street) has recorded a $PM_{2.5}$ (annual mean) concentration reduction. One monitoring site (Banknock 3) has recorded a slight concentration increase. Five sites: A4 Haggs, A5 Falkirk Hope Street, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A15 Main Steet, Bainsford have remained at the same concentrations over this period.

The $PM_{2.5}$ concentrations at the Grangemouth AURN site have, in general, remained at the same level of 6µg/m^3. 2019 saw a marginal concentration increase to 8µg/m^3 however, this concentration remains reasonably low and within the Scottish $PM_{2.5}$ NAQS (annual mean) objective. This reduction may be may be attributed to the commissioning of the Tail Gas Treatment (TGT) unit at the INEOS Grangemouth complex in 2013. Since the commissioning of the TGT unit, SO_2 concentrations have reduced within the Grangemouth AQMA. As sulphate species are known to contribute towards the formation of secondary $PM_{2.5}$, a reduction in SO_2 could also impact local $PM_{2.5}$ concentrations.

Long-term trend analysis has been completed on two sites for $PM_{2.5}$ (data availability dependant) and can be shown in Appendix A, Figures 15 and 16. In general terms, there has been a long-term reduction in $PM_{2.5}$ concentrations at the A7 Falkirk West Bridge Street and A8 Grangemouth AURN site and since 2016.

To appraise compliance with the $PM_{2.5}$ NAQS (annual mean) objective at locations that currently do not monitor $PM_{2.5}$ concentrations, Falkirk Council has previously applied locally derived correction factors of 0.5 (non-urban roadside), 0.57 (urban roadside) and 0.67 (urban background / industrial) following LAQM TG(16)[Ref 2] guidance. This methodology provides an estimation of $PM_{2.5}$ results derived from PM_{10} data where only one of the two metrics were available. For urban roadside sites the correction factor was derived using PM data from the A7 Falkirk West Bridge Street site, for the background / industrial sites the factor was derived using PM data from the A8 Grangemouth AURN site and for non-urban roadside sites the correction factor was derived using PM data from the A13 Banknock 2 site. For further details of these factors see Appendix C, ‘Table C.1’.

During 2020, the $PM_{2.5}$ concentration estimations indicate that the two sites (A5 Falkirk Hope Street and A15 Main Street, Bainsford) where the correction factor was applied complied with the $PM_{2.5}$ NAQS (annual mean) objective. See Appendix A ‘Table A.12’ for a full comparison of estimated $PM_{2.5}$ annual mean concentrations against the $PM_{2.5}$ NAQS (annual mean) objective.

3.1.6 Sulphur Dioxide (SO_2)

Table A.8 in Appendix A compares the ratified continuous monitored SO_2 concentrations for year 2020 with the NAQS (15-min, 1-hr and 24-hr) objectives for SO_2.

In 2020, Falkirk Council monitored SO_2 at six locations. Four of the sites are located within the Grangemouth (15-minute NAQS objective) AQMA and two of the sites are located outwith this AQMA.

There were no exceedances of the SO_2 objectives (15-minute, hourly or daily) recorded at any of the Falkirk Council monitoring locations during 2020.

The site recording the only exceedance of the 15-minute NAQS objective during 2020 was Grangemouth AURN (six). No other SO_2 exceedances were recorded at any of the other sites during 2020.

This is the seventh consecutive year that no breaches of the SO_2 NAQS objectives (15-minute, hourly or daily) have been recorded at any site in the Grangemouth AQMA. It is important to stress that although there were exceedances of the 15-minute and 1-hour NAQS objectives, the number of exceedances were below the maximum permitted.

Polar roses displaying average SO_2 concentrations for the Grangemouth sites are shown in Appendix A ‘Figure 24, A) to F)’.

The Grangemouth Emission Study has now been completed by Sweco consultants and can be shown in Appendix C, ‘Supporting Technical Information / Air Quality Monitoring Data QA/QC’, ‘Additional Air Quality Works Undertaken by Falkirk Council During 2020’.

3.1.7 Carbon Monoxide, Lead, and 1,3-Butadiene

Carbon Monoxide

No monitoring undertaken.

Lead

No monitoring undertaken.

1, 3-Butadiene

In 2020, Falkirk Council monitored 1, 3-butadiene at three locations using passive diffusion tubes. All the results were within the NAQS objective and are shown in Appendix A, 'Table A.9'. No changes have occurred since the submission of the previous APR.

Benzene

In 2020, Falkirk Council monitored benzene at sixteen locations using passive diffusion tubes. In addition, at the A8 Grangemouth AURN site, a pumped diffusion tube operates as part of the AURN network. The results from the passive diffusion tubes are shown in Appendix A Table A.10 with the pumped diffusion tube results shown in Appendix A Table A.11.

All the benzene concentrations recorded by the passive diffusion tubes were within the NAQS objectives. None of the sixteen benzene diffusion tubes achieved 100% data capture due to the 'Stay at Home' Scottish Government Coronavirus (COVID-19) advice[Ref 1] which affected the April 2020 diffusion tube collection only. Twelve tubes achieved 91% annual data capture (NA3, NA21, NA27, NA37, NA42, NA55, NA77, NA80, NA81, NA94, NA116 and NA117) and four tubes achieving 83% (NA38, NA41, NA44 and NA105).

In 2020, the pumped diffusion tube at the A8 Grangemouth AURN site recorded an annual average concentration of 0.53µg/m^3. The concentration recorded continues to be within the relevant annual mean NAQS objective (of 3.25µg/m^3) and is a slight decrease (of 0.25µg/m^3) compared to 2019's result (0.78µg/m^3).

4 New Local Developments

Road Traffic Sources

4.1.1 Narrow Congested Streets

There have been no significant changes from last year's APR. There are no new locations that are likely to be considered as congested residential streets that have not been assessed in previous APRs or are not already in AQMAs.

4.1.2 Busy Streets

Falkirk Council has not identified any streets where pedestrians may spend one hour or more in close proximity to road traffic.

For information: the Falkirk Council automatic air monitoring network recorded no exceedances of the NO_2 NAQS (1hr mean) and the NO_2 non-automatic diffusion tube NAQS objectives in 2020.

4.1.3 Roads with a High Flow or Buses and / or HGVs

Since the closure of the Falkirk town centre bus station in August 2018, additional buses are using Upper Newmarket Street. As this road has witnessed an increase in bus traffic, Falkirk Council have kept the additional NO_2 (diffusion tube) monitoring location on Glebe Street active.

The number of buses would be less than 2019 and there was a reduced timetable and service provision due the Coronavirus (COVID-19)[Ref1] Scottish Government travel restrictions and drop in overall passenger numbers.

HGVs may have been reduced as the restrictions impacted on non-essential retail and non-essential activities that would be dependent on delivery vehicles.

4.1.4 Junctions

There were no new road junctions constructed during 2020 within the Falkirk Council area. There were however, two junction improvements completed in 2020, these were:

- Barnego Road / Stirling Street, Dunipace
- Quarry Brae North / Main Street, Brightons

4.1.5 New Roads Constructed or Proposed

Falkirk Council received an air quality impact assessment (AQIA) report in November 2020 for a proposed upgrade to a section of main roads and associated junctions. These upgrades are proposed to take place between Earlsgate and the Forth Valley College on the A904 and alongside the Helix and Falkirk Football Club along the A9 road. Further details of this proposed development and the AQIA can be found in Section 5 'Planning Applications'.

4.1.6 Roads with Significantly Changed Traffic Flows

All roads in Falkirk will have experienced significant changes in traffic flows as a result of Coronavirus (COVID-19) [Ref 1] and the travel restrictions introduced by the Scottish Government with less traffic movements than previous years.

In addition, Falkirk Council carried out less traffic-related data collection during 2020 as a result of the Coronavirus (COVID-19) restrictions[Ref 1] and the Scottish Government advice on the need to travel.

4.1.7 Bus or Coach Stations

The Falkirk town centre bus station was located adjacent to Meadow Street as indicated using this weblink, the station closed in August 2018 after many years of operation. Bus routes have subsequently been diverted via the Upper Newmarket Street hub since the closure of the main town centre bus station. There are no new bus or coach stations constructed or planned for the foreseeable future within the Falkirk Council area.

Other Transport Sources

4.2.1 Airports

The nearest major airport to the Falkirk Council area is Edinburgh. Airport passenger movements were 1,301,197 in 2020[Ref 3] - this is a decrease of 1721 from 2019 (1,302,918) This airport does not need considering further as it is greater than 1km from the Falkirk Council boundary.

Falkirk Council is not aware of any significant changes to Cumbernauld airport. This is a small airport situated near to the Falkirk Council boundary.

No other new airports are constructed or planned for the foreseeable future.

4.2.2 Stationary trains

Falkirk Council has not identified any new locations where locomotives or trains are stationary for more than 15-minutes that would not have been assessed in previous APRs.

4.2.3 Railways (diesel and steam trains)

Falkirk Council confirms that there are no new locations with a large number of movements of diesel trains, and potential long-term relevant exposure within 30m.

4.2.4 Ports for Shipping

Falkirk Council confirms that there are no ports or shipping that requires further consideration. The Grangemouth Port is the nearest major port within Falkirk Council area and this has been operating for many years.

Industrial Sources

Industrial Installations – New / Proposed Installations

Proposed Pharmaceuticals Manufacturing Facility Expansion – Piramal, Grangemouth

During September 2020, Falkirk Council received a pre-scoping opinion for a proposed development to expand the Piramal pharmaceutical site to include a multi-suite facility (approximately 4.7 acres) of brownfield site on their existing site in Roseland Hall, Grangemouth.

The proposed development contained details to expand manufacturing capability to include a new dedicated facility.

The development proposals comprise the following:

- Construction of a new facility containing four bulk manufacturing suites, with associated buffer preparation, storage, and support utilities.
- In addition, the new facility will include laboratory support, warehousing, offices and associated support infrastructure.
- Vehicular access to be gained from the existing road at Roseland Hall with two access points - one for staff and one for service vehicles.
- Limited landscaping around access and carparking routes with appropriate surface water drainage and discharge.
- The site will be secured with a 2m (min) perimeter fence

An Environmental Impact Assessment (EIA) for the development was produced by Ironside Farrar (report ref: 50447/September 2020) which considered the air quality impacts of the proposed development. Specifically, within section 2.6, considered:

- The impacts of the construction of the proposed development on dust soiling and concentrations of PM_{10} during the construction period.
- The impacts of emissions from road traffic generated by the development on concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ at sensitive locations along the local road network.
- The impacts of nitrogen oxides emissions from the gas-fired energy plant within the development on local air quality conditions; and
- Whether any additional mitigation measures will be required to address any significant air quality effects.

The production process is a closed system, with no direct emissions to air. Therefore, there no further assessment of odours or other emissions from the process itself is required.

Construction Dust Assessment

Given the size of the development, it is anticipated that a construction dust assessment will be required as part of the air quality chapter of the environmental statement. The assessment methodology will follow that set out in the Institute of Air Quality Management's (IAQM) guidance on the 'Assessment of Dust from Demolition and Construction'[Ref 4]. It will identify the potential for dust to be generated and the sensitivity of the surrounding area and will combine these to determine the risk of dust impacts without appropriate mitigation. This information will then be used to determine the appropriate level of mitigation required to ensure that there are no significant effects.

Road Traffic Emissions Assessment

The development and its traffic generation will initially be screened against the criteria set out in the Environmental Protection UK (EPUK) and IAQM guidance document on 'Planning for Air Quality'[Ref 5]. Due to the scale of the development, it is likely that the changes in traffic on roads near to sensitive receptors will fall below the relevant criteria. However, if necessary, roadside pollutant concentrations, and the impacts of the development-generated traffic, will be predicted using the ADMS-Roads dispersion model. The model will be verified against local monitoring data.

The Ironside Farrar EIA (report ref: 50447/September 2020) was reviewed by Falkirk Council Environmental Health and was deemed satisfactory and in accordance with current and correct dust management guidance such as the stated IAQM and EPUK. The AQIA is still to be produced and will be assessed when received by Falkirk Council.

Commercial and Domestic Sources

4.4.1 Biomass Combustion Plants

Falkirk Council did not receive any applications in 2020 for any proposed biomass combustion plants.

4.4.2 Biomass Combustion Plants – Combined Sources

Falkirk Council has received no significant number of complaints about particular areas in relation to or changes to the following:

- Complaints about nuisance dust or odour relating to burning from domestic biomass appliances.
- Visual signs of chimney smoke being emitted from several properties in close proximity to each other.
- Significant odours of burning biomass fuel.
- Known high levels of sales of biomass or other fuels via home delivery or local outlets.
- Areas known to have limited or no access to mains gas.

4.4.3 Domestic Solid Fuel Burning

In 2020, Falkirk Council has received a large volume of complaints in relation to smoke and odour from domestic biomass sources such as wood burning stoves and open garden bonfires. These complaints were investigated thoroughly and advice was provided on smoke control area rules, Department for Environment Food and Rural Affairs (DEFRA) approval of stoves including using authorised fuels, guidance on efficient stove use and recommended regular maintenance measures. Relevant and current guidance is now provided by Falkirk Council Environmental Health within the initial planning phase of new residential and commercial developments in relation to installing new combustion appliances such as wood burning stoves. This guidance includes adhering to local smoke control area rules, DEFRA approval of stoves, using authorised fuels and providing information on flue height and termination to allow effective smoke dispersal to minimise local smoke / odour nuisance.

A map of the smoke control areas in the Falkirk Council area is available to view via Falkirk Council website at: http://www.falkirk.gov.uk/services/environment/environmental-policy/air-quality/smoke-control-areas.aspx

4.4.4 Combined Heat and Power (CHP) Plant

Falkirk Council did not receive any applications in 2020 for any CHP plant.

4.5 New Developments with Fugitive or Uncontrolled Sources

Falkirk Council did not receive any applications in 2020 for any new developments with fugitive or uncontrolled sources.

Landfill sites are regulated by SEPA licences and no changes with respect to the pollutants covered in this report have been indicated by SEPA.

5 Planning Applications

Proposed Flood Prevention Scheme – Grangemouth – Environmental Impact Assessment – January 2020

Falkirk Council received an Environmental Impact Assessment (EIA) for a proposed large-scale flood prevention scheme in Grangemouth in January 2020. The Grangemouth Flood Protection Scheme is the largest flood defence project in Scotland and one of the biggest in the United Kingdom, protecting communities in areas such as Grangemouth, Wholeflats, Glensburgh, Langlees, Carron, Carronshore and Stirling Road, Camelon. The scheme was identified as the highest priority given the potentially huge costs if an extreme flood event were to occur. Whilst other parts of Scotland have been significantly affected by flooding over the last five years, Grangemouth has fortunately avoided significant flooding.

An EIA for the development was produced by Jacobs which considered the air quality and climate change impacts of the proposed development. Specifically, within section 12 considered:

The potential emission sources of air pollutants and dust associated with the Scheme considered within this chapter include:

- Dust emissions generated by the earthworks and construction related activities during the construction phase.
- Construction emissions of pollutants to air from on-road vehicles travelling on the local road network and off-road machinery.
- Greenhouse gas (GHG) emissions (expressed as carbon dioxide equivalent: CO_2e) from the construction phase (e.g. carbon embodied in the materials used to construct the Scheme and emissions from construction activities and the transport of materials and waste to and from the construction areas); and
- GHG emissions resulting from the operation of the Scheme. Although the Scheme is a passive scheme and there would be no direct carbon emissions from operation, there would be emissions from activities associated with maintenance, repair, refurbishment, or replacement of the various elements of the Scheme during its operational lifetime.

The EIA has considered the potential impacts to local air quality during the construction phase including construction dust, emissions from construction related road traffic and machinery and effects on climate (Greenhouse Gas Emissions). The pollutants assessed within this EIA were particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2) and carbon dioxide (CO_2).

Falkirk Council reviewed the EIA for air quality on 22/01/2020 and made the following comments:

- It is noted that there is no assessment of the demolition phase of the scheme as it is anticipated that the proposed engineered measures are to be maintained for over 100 years with future extensions or improvement being developed as required.

- The scope of pollutants assessed is satisfactory, the report focusses on nitrogen dioxide (NO_2) and particulate matter ($PM_{10+2.5}$) from vehicle use and larger dust particles released from the construction phase. Although the Grangemouth AQMA is declared for SO_2, the report states this pollutant is not anticipated to be emitted as a result of the construction or operation of the proposed scheme so is not included in this assessment.

- All stated International and national legislation with associated NAQS objectives are current and correct. The stated local policy statement which references Falkirk Council policy ‘RW07 Air Quality’ is current and correct.

- The construction dust for the various proposed work sections have been assessed using the IAQM methodology and the emissions from ‘Construction Related Road Traffic’ have been assessed using Design Manual for Roads and Bridges (DMRB) which is recommended / acceptable;

- All stated info related to LAQM / AQMAs with regards to baseline conditions are correct.

- It is noted that the dust risk assessed at each section is classed as negligible to medium risk with proposed mitigation measures in accordance with IAQM guidance set out in Section 12.6.1. As stated, the Grangemouth Flood Prevention (GFP) scheme represents a relatively large construction site with mitigation methods already available that have been successfully applied on other, similar sized schemes.

- Monitoring measures are stated in the EIA ‘Table 12-12’ with each category covered, it is stated that the site will have to develop a Dust Management Plan (DMP) and adhere to and implement mitigation measures as described.

Overall, a reasonably detailed assessment of air quality for the proposed scheme, it has to be noted that If any air emission / dust complaints are received during the duration of planned works, Falkirk Council have an obligation to investigate and ensure the stated mitigation measures (as included in the DMP) are being adhered to.

Proposed Residential Development – Wilson Avenue, Polmont - Air Quality Impact Assessment – January 2020

Falkirk Council received an AQIA for a proposed residential development at Wilson Avenue, Polmont in January 2020. The proposed development is for the erection of twenty-eight residential dwellings (seven houses and twenty-one flats). The AQIA report was completed by ITP Energised for Falkirk Council (report ref: 2830).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 3.5.7 'Operational Phase: Road Traffic Emissions' with impacts at nearest human receptors being stated as "significantly below relevant Air Quality Standards".

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in the AQIA's Appendix C 'Construction Dust Risk Assessment' are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The ITP Energised (report ref: 2830) AQIA report for the proposed residential development at Wilson Avenue, Polmont proposed development was deemed satisfactory by Falkirk Council.

Proposed Residential Development – Loch View, Stirling Road, Larbert - Air Quality Impact Assessment – February 2020

Falkirk Council received an AQIA for a proposed residential development at Loch View, Stirling Road, Larbert in February 2020. The proposed development is for the erection of sixty residential dwellings. The AQIA report was completed by The Airshed for Avant Homes (report ref: Project AS 0712).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development.

Although traffic generated NO_2 levels are considered within this report, PM_{10} levels (from road traffic) have not been reported upon.

Increased road traffic flows from the planned residential development have been displayed in Table 1 ‘Predicted Baseline and Scheme Flows 2021’. The report states that ‘The latest air quality review and assessment report issued by Falkirk Council indicates that “air pollution is not an issue in Larbert. The results from air quality monitoring in Larbert summarised in Table 2 below indicate that levels are well below the relevant Air Quality Objectives for NO_2”.

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 2 ‘Dust Control Measures During Construction’ are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The Airshed (report ref: Project AS 0712) AQIA report for the proposed residential development at Loch View, Stirling Road, Larbert proposed development was deemed satisfactory by Falkirk Council.

Proposed Residential Development – 35 Main Street, Bonnybridge - Air Quality Impact Assessment – February 2020

Falkirk Council received an AQIA for a proposed residential development at 35 Main Street, Bonnybridge in February 2020. The proposed development is seeking to build twenty-two residential dwellings. The AQIA report was completed by ITP Energised for Falkirk Council (report ref: 2962).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 3.5.2 ‘Operational Phase: Road Traffic Emissions’ with impacts at nearest human receptors being stated as “significantly below relevant Air Quality Standards”.

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 3 ‘Construction Dust Risk Assessment’ are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The ITP Energised (report ref: 2962) AQIA report for the proposed residential development at 35 Main Street, Bonnybridge proposed development was deemed satisfactory by Falkirk Council.

Proposed Residential Development – Graham Terrace, Airth - Air Quality Assessment – March 2020

Falkirk Council received an AQIA for a proposed residential development at Graham Terrace in March 2020. The proposed development is for the erection of one hundred and eight dwellings, in a variety of house sizes. The air quality assessment report was completed by ITP Energised for Lochay Homes Ltd (report ref: 3130).

The air quality assessment report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 5 ‘Assessment Results’ with impacts at nearest human receptors being fully assessed. The report states in Section 7 ‘Conclusions’ that:

“No exceedances of the AQSs for NO_2, PM_{10} and $PM_{2.5}$ are predicted at any of the sensitive human receptors within the study area as a result of the Proposed Development.

The change in NO_2, PM_{10} and $PM_{2.5}$ annual mean concentrations between the future without Proposed Development and future with Proposed Development scenarios shows that the Proposed Development is predicted to have a negligible impact at all human receptors within the study area. The predicted short-term mean concentrations for NO_2 and PM_{10} which are relevant for the short-term exposure of members of public, comply with the relevant AQSs for NO_2 and PM_{10} at all human receptors.

There are no exceedances of the AQS for NO_x predicted at the nearby sensitive ecological receptor as a result of the Proposed Development.

In summary, the significance of effect on local air quality of the Proposed Development is assessed as not significant.

There are also no exceedances of the AQSs for NO_2, PM_{10} and $PM_{2.5}$ predicted at any of the propose residential receptors within the Proposed Development.”

All legislation, policies and guidance referenced within the report are current, applicable and correct.

Falkirk Council reviewed the ITP Energised air quality impact assessment (report ref: 3130 v2) for Lochay Homes Limited 'Graham Terrace, Airth' proposed development as satisfactory.

Proposed Residential Development – Kilsyth Road, Banknock - Air Quality Assessment – March 2020

Falkirk Council received an AQIA for a proposed residential development at Kilsyth Road, Banknock in March 2020. The proposed development is for the erection of one-hundred and five residential dwellings (eighty-one houses and twenty-four flats). The AQIA report was completed by ITP Energised for Falkirk Council (report ref: 2876).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 3.5.2 'Operational Phase: Road Traffic Emissions' with impacts at nearest human receptors being stated as "significantly below relevant Air Quality Standards for NO_2, PM_{10} and $PM_{2.5}$".

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 6 'Construction Dust Risk Assessment' are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The ITP Energised (report ref: 2876) AQIA report for the proposed residential development at Kilsyth Road, Banknock proposed development was deemed satisfactory by Falkirk Council.

Proposed Residential Development – The Drum, Phase 5, Bo'ness - Air Quality Assessment – March 2020

Falkirk Council received an AQIA for a proposed residential development at The Drum, Phase 5, Bo'ness in March 2020. The proposed development is for the erection of sixty-four dwellings, in a variety of house sizes. The air quality assessment report was completed by Ensafe for Ogilvie Homes (report ref: AQ108930).

The air quality assessment report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$). Additionally, given the proximity of the development site to the A993 and A904, recognised sources of road vehicle exhaust emissions, there is potential to expose future site users to elevated pollutant concentrations.

Increased road traffic from the planned residential development has been fully assessed in Section 5.2 'Operational Phase Assessment' and Appendix 2 'Assessment Inputs' with impacts at nearest human receptors being fully assessed. The report states in Section 7 'Conclusions' that:

"During the construction phase of the development there is the potential for air quality impacts as a result of fugitive dust emissions from the site. These were assessed in accordance with the IAQM methodology. Assuming good practice dust control measures are implemented, the residual potential air quality impacts from dust generated by construction, earthworks and track out activities was predicted to be not significant.

Potential impacts during the operational phase of the development may occur due to road traffic exhaust emissions associated with vehicles travelling to and from the site. An assessment was therefore undertaken using the EPUK and IAQM screening criteria to determine the potential for vehicle trips generated by the development to affect local air quality. This indicated that impacts are likely to be not significant throughout the operational phase."

Falkirk Council reviewed the Ensafe air quality impact assessment (AQ108930) for Ogilvie Homes Ltd 'The Drum, Phase 5, Bo'ness' and made the following comments:

- Please note that Falkirk Council has four AQMAs active rather than five as stated in section 4.1.
- Please note that the DEFRA Technical Guidance (TG16)[Ref 2] has been updated in Feb 2018 rather than 2016 as stated – so please refer to this guidance in future.
- All other air quality legislation, policies, standards and guidance referenced within the report are current, applicable and correct.

A second version of the AQIA was produced which addressed the above comments which was then deemed satisfactory by Falkirk Council.

Proposed Mixed-Use Development – Gilston Park, Bo'ness – Updated Air Quality Assessment – October 2020

Falkirk Council received an updated AQIA for a proposed mixed-use development at Gilston Park, Bo'ness in October 2020. The proposed development is seeking permission to build up to a capacity of five hundred residential units including housing, businesses, neighbourhood centre and greenspace at Gilston Park, East of Polmont. The site will connect to a new roundabout on the A803 to facilitate development of this area. The AQIA report was completed by ITP Energised for Hansteen Land Ltd (report ref: 3257).

The previous ITP Energised AQIA in relation to this development has been updated to reflect:

- Change in future receptor locations.
- Change to proposed development generated traffic based on the updated mix of uses and proposed housing numbers.
- Change to the predicted future year of completion (from 2032 to 2029).
- Update of dispersion models versions including new software capabilities and availability of built-in vehicle emissions factors (DEFRA, 2019).
- Updated concentration maps for baseline year of 2020.
- Proposed changes in odour / dust emissions from the neighbouring Avondale landfill site

ITP Energised have used ADMS Roads 5 – latest version of this emission modelling software which is satisfactory.

The pollutants assessed within the report are nitrogen dioxide (NO_2) and fine particulate matter ($PM_{10+2.5}$).

Increased road traffic from the planned development has been fully assessed in section 3.5.2 'Operational Phase' with relevant traffic displayed in Tables 4A-E with impacts at nearest human receptors being stated in Section 7. 'Conclusion' as "negligible". It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 5 'Construction Dust Risk Assessment' are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable, and correct.

The ITP Energised (report ref: 3257) air quality assessment for the proposed mixed-use development at Gilston Park, Polmont proposed development was deemed satisfactory by Falkirk Council.

Proposed Mixed-Use Development – Gilston Park, Bo'ness – Updated Odour and Dust Risk Assessment – November 2020

Falkirk Council received an updated Odour and Dust Risk Assessment Report for a proposed mixed-use development at Gilston Park, Bo'ness in November 2020. The proposed development is seeking permission to build up to a capacity of five hundred residential units including housing, businesses, neighbourhood centre and greenspace at Gilston Park, East of Polmont. The site will connect to a new roundabout on the A803 road to facilitate development of this area. The updated Odour and Dust Risk Assessment Report was completed by ITP Energised for Hansteen Land Ltd (report ref: 3257 v2).

The previous ITP Odour and Dust Risk Assessment (2017) in relation to this development has been updated to reflect:

- The updated draft masterplan as shown in 'Drawing 1'.
- A review of updated operational procedures at Avondale facilities.
- A review of complaints received by SEPA from members of the public from 2018-2020; and
- A review of SEPA inspection reports of Avondale facilities 2018-2020.

<u>Odour Assessment</u>

ITP Energised have used five years of Met Office derived wind data from Edinburgh Gogarbank and completed a qualitative odour assessment in accordance with the IAQM method including reference to FIDOL factors. A review of SEPA odour complaints has been completed in section 4.2.3 as stated. A review of SEPA inspection reports 2018-2020 has been completed in section 4.2.4 as stated.

The odour assessment results conclude in section 5.1: "The likely effect of odour emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as 'negligible to slight'. The significance of the effect of odour emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as 'not significant'."

Dust Assessment

ITP Energised have used the IAQM Assessment of Mineral Dust Impacts for Planning (12) guidance document which is satisfactory. The dust assessment results conclude in section 5.1: “The likely effect of dust emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as ‘negligible’. ‘The significance of the effect of dust emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as ‘not significant’”.

Please note the stated mitigation measures stated in Section 6 are in relation to building design stage features to help minimise odour and dust risk at all proposed future receptors within the proposed development. This area has had historical odour issues associated with it.

All stated guidance and policy documents appear to be current, applicable and correct.

Falkirk Council reviewed the ITP Energised (report ref: 3257 v2) Odour and Dust Risk Assessment for the mixed-use development at Gilston Park, Polmont proposed development which appears to be satisfactory.

Proposed Road Improvement Development – A9 A904 – Air Quality Assessment – November 2020

Falkirk Council received an AQIA report for a proposed upgrade to a section of road and associated junctions. These upgrades are proposed to take place between Earlsgate and the Forth Valley College on the A904 road and alongside the Helix and Falkirk Football Club along the A9 road. The proposed development is seeking permission to undertake these upgrades as part of the Falkirk Gateway Masterplan. An initial design has been submitted that involves road widening and general improvements, three new roundabouts, improvement of the existing A9/A904 roundabout, and an iconic pedestrian crossing structure over the existing A9/A904 roundabout. The AQIA was completed by WSP on behalf of Falkirk Council (report ref: WSP-9750-0000-R-007).

After assessing the WSP Air Quality Assessment ‘A9-A904 Improvement Scheme’ Ref: WSP-9750-0000-R-007 it is noted within ‘Executive Summary’, p6 and Section 5.2 ‘Operational Phase’, 5.2.10 ‘Annual Mean $PM_{2.5}$ Concentrations’, p27’ that:

“For $PM_{2.5}$ (during the Operational Phase), exceedances of the annual mean objective are predicted at three receptors with and without the Proposed Scheme in place.” It is noted that there are no predicted exceedances for PM_{10} and NO_2 from the Proposed Scheme on local receptors.

An **objection** was submitted on air quality-related grounds for the predicted exceedances (during the operational phase of the Proposed Scheme) of the particulate matter ($PM_{2.5}$) national air quality strategy objective at the three local receptors.

If additional mitigation measures (within the 'Do Something' scenario) were considered to reduce these $PM_{2.5}$ exceedances to within the National Air Quality Strategy Objective at the three receptors, then this can be further assessed and commented upon.

All stated legislation, policy, scope and methodology of the WSP air quality impact report appear to be current and correct.

6 Impact of COVID-19 upon LAQM

Falkirk Council endeavoured to minimise disruption from Coronavirus (COVID-19)[Ref 1] restrictions on LAQM duties during 2020. In line with Scottish Government national advice[Ref 1], staff were instructed to work from home (where possible) and minimise unnecessary travel. Due to the key role LAQM has on human health, LAQM duties were considered 'essential' in understanding how local air quality was affected by irregular daily travel patterns and other Coronavirus (COVID-19) restrictions.

'Did your local authority maintain diffusion tube monitoring networks as normal (exposure and analysis in line with diffusion tube calendar) during 2020, including over the lockdown period?'

Falkirk Council completed the majority of its diffusion tube exposure and analysis in line with the DEFRA 2020 Diffusion Tube Calendar. The only month that was missed during 2020 was April – all diffusion tube results including annual data capture rates can be shown in 'Appendix A: Monitoring Results', 'Table A.3 Annual Mean NO_2 Monitoring Results ($\mu g/m^3$)'. The planned diffusion tube change in April 2020 was missed due to several factors such as organising relevant sample media to be delivered to staff's homes, uncertainty over travel advice and rearranging sample media logistics.

'Did your local authority maintain automatic air quality monitoring sites as normal (LSO visits, etc.) during 2020, including over the lockdown period?'

Falkirk Council maintained all nine automatic monitoring stations during 2020 without any significant periods of non-operation of these sites. Fortnightly routine LSO calibration visits to sites were reduced to one monthly visits from April 2020 until November 2020. Normal fortnightly LSO calibration visit resumed as normal from November 2020 onwards.

'Did your local authority carry out any low-cost monitoring during 2020, including over the lockdown period?'

No additional low-cost monitoring was carried out in 2020 by Falkirk Council.

Falkirk Council are now operating a normal LSO service of all automatic and non-automatic monitoring with no anticipated major disruption to its air quality monitoring services going forward.

7 Conclusions and Proposed Actions

Conclusions from New Monitoring Data

Falkirk Council has assessed its automatic and non-automatic 2020 air quality monitoring data and results.

The 2020 monitoring results (as displayed in Appendix A Tables A.3 and A.4) show that all seven automatic NO_2 analysers in Falkirk Council's air monitoring network met both NO_2 NAQS (1-hr and annual mean) objectives. The highest NO_2 annual mean result in 2020 was recorded at Falkirk West Bridge Street site (27µg/m^3) - this has decreased (11 µg/m^3) from 2019's result (38µg/m^3). The lowest result was recorded at the Grangemouth AURN (11µg/m^3) site. The Grangemouth AURN NO_2 annual mean result has decreased from 15µg/m^3 in 2019. Overall, all fixed automatic site's NO_2 concentrations have decreased significantly from 2019's results however, this is most likley to be attributed to the Coronavirus (COVID-19) restrictions[Ref 1] which commenced in late March 2020 and lasted into 2021. These restrictions resulted in less daily vehicle trips due to the 'Stay at Home' Scottish Government advice. The last exceedance in relation to NO_2 annual mean concentrations was recorded in 2014 at the Falkirk West Bridge Street site (41µg/m^3).

Over a five year period (from 2016 to 2020), all seven monitoring sites have recorded annual mean NO_2 concentration reductions. There have been minor fluctuations in results during this period but all remain within the NAQS (annual mean) objective.

The 2020 annual NO_2 diffusion tube monitoring results (as displayed in Appendix A, 'Table A.3') shows that no (non-automatic) NO_2 tubes exceeded the NAQS (annual mean) objective of 40µg/m^3. All sixty-one tubes in Falkirk Council's network met the NAQS objective.

One diffusion tube was close to the 40µg/m^3 NAQS annual limit with the highest concentration recorded at the NA27 Falkirk West Bridge Street (35µg/m^3) site. This tube is located at a roadside location and is within the Falkirk Town Centre AQMA.

Historically, diffusion tube NA27 Falkirk West Bridge Street records a higher concentration than the automatic analyser despite the close proximity to one another. The most likely reason for a higher concentration at this location is that the automatic site is located further from the road than the NA27 tube location and is therefore less exposed to traffic emissions. The NA27 Falkirk West Bridge Street diffusion tube concentrations regularly exceeds the NAQS objective for NO_2, This is the second occasion over a five year period that the result has complied with the NAQS objective for NO_2.

The lowest NO_2 annual mean diffusion tube concentrations in 2020 were recorded at the following locations: NA105 West of Shieldhill (6µg/m^3) and NA64 New Hallglen Road, Falkirk (11µg/m^3).

Falkirk Council measured PM_{10} concentrations at seven locations during 2020. The Scottish NAQS (annual mean) objective for PM_{10} were met at all seven monitoring locations. The sites with the highest recorded PM_{10} (annual mean) concentrations in 2020 (but within the Scottish NAQS PM_{10} annual mean objective) were: A4 Falkirk Haggs (10µg/m^3) and A15 Main Street, Bainsford (11µg/m^3).

During 2020 there were no exceedances of the $PM_{2.5}$ Scottish NAQS (annual mean) objective (10µg/m^3) at any of the monitoring sites.

The sites with the highest recorded $PM_{2.5}$ (annual mean) concentrations in 2020 (within the Scottish NAQS PM_{10} objective) were: A15 Main Street, Bainsford (6.2µg/m^3), A8 Grangemouth AURN (6µg/m^3) and A4 Haggs (6µg/m^3). Annual data capture was reasonable for A15 Main Street, Bainsford (80%), good for A8 Grangemouth AURN (94%) but very poor for A4 Haggs (29%).

The two sites with the lowest $PM_{2.5}$ (annual mean) concentrations were: A14 Banknock 3 (3.6µg/m^3) and A7 Falkirk West Bridge Street (4.4µg/m^3) / A10 Grangemouth Municipal Chambers (4.4µg/m^3). Data capture rates were poor for all sites at 63% and 38% / 63% respectively.

Over a five year period (from 2016 to 2020) one site, A7 Falkirk West Bridge Street has recorded a $PM_{2.5}$ (annual mean) concentration reduction. One monitoring site (Banknock 3) has recorded a slight concentration increase. Five sites: A4 Haggs, A5 Falkirk Hope Street, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A15 Main Steet, Bainsford have remained at the same concentrations over this period.

There were no exceedances of the SO_2 objectives (15-minute, hourly or daily) recorded at any of the Falkirk Council monitoring locations during 2020.

The site recording the only exceedances of the 15-minute NAQS objective during 2020 was Grangemouth AURN (six). No other SO_2 exceedances were recorded at any of the other sites during 2020.

This is the seventh consecutive year that no breaches of the SO_2 NAQS objectives (15-minute, hourly or daily) have been recorded at any site in the Grangemouth AQMA. It is important to stress that although there were exceedances of the 15-minute and 1-hour NAQS objectives, the number of exceedances were below the maximum permitted.

In 2020, Falkirk Council monitored 1, 3-butadiene at three locations using passive diffusion tubes. All the results were within the NAQS objective. Falkirk Council monitored benzene at sixteen locations using passive diffusion tubes. All the benzene concentrations recorded by the passive diffusion tubes were within the NAQS objectives. None of the sixteen benzene diffusion tubes achieved 100% data capture due to the 'Stay at Home' Scottish Government Coronavirus (COVID-19) restrictions[Ref 1] which affected the April 2020 diffusion tube collection. In 2020, the pumped diffusion tube at the A8 Grangemouth AURN site recorded an annual average concentration of 0.53µg/m^3. The concentration recorded continues to be within the relevant annual mean NAQS objective (of 3.25µg/m^3) and is a slight decrease (of 0.25µg/m^3) compared to 2019's result (0.78µg/m^3).

Local Air Quality Policy PG (S) 16[Ref 2] states that "There are no set criteria on which a revocation decision will be based, and the Scottish Government considers each request on a case by case basis. A minimum requirement however will normally be at least three consecutive years where the objectives of concern are being achieved."

Although SO_2 NAQS objectives have been achieved within the Grangemouth AQMA for seven consecutive years; Falkirk Council considers the AQMA remains justified based upon continual exceedances of the 15min SO_2 NAQS objective concentration recorded at the A8 Grangemouth AURN, A9 Grangemouth Moray and A10 Grangemouth Municipal Chambers sites for the past five consecutive years. The Grangemouth Emission Study (which includes a review of the Grangemouth AQMA) has been completed by Sweco consultants and can be shown in Appendix C 'Additional Air Quality Works Undertaken by Falkirk Council During 2020'.

The Falkirk town centre AQMA for NO_2 (annual mean) remains justified as although there were no exceedances of the NO_2 NAQS (annual mean) objective recorded in 2020 there have been consecutive diffusion tube (such as NA27 Falkirk West Bridge Street) exceedances in previous years which haven't been affected by the Coronavirus (COVID-19) Scottish Government travel restrictions[Ref1] which has affected 2020 and 2021 air quality data. One diffusion tube was close to the 40µg/m^3 NAQS annual limit with the highest concentration recorded at the NA27 Falkirk West Bridge Street (35µg/m^3) site.

There have been over five years where PM_{10} results at both Falkirk Town Centre AQMA automatic monitoring locations (Falkirk Hope Street and Falkirk West Bridge Street) have complied with the PM_{10} NAQS objective. It is anticipated that the PM_{10} element of the Falkirk Town Centre AQMA will be assessed for revocation eligibility during 2021.

The Haggs AQMA was declared on the 18th March 2010 following NAQS exceedances for NO_2 (annual mean). Since the AQMA was declared, measured concentrations (using automatic and non-automatic monitoring methods) of NO_2 have complied with the NAQS objectives consistently over the past six years (since 2015). It is anticipated that the Haggs AQMA will be revoked in 2021. The ‘Falkirk Council Proposal for Revocation of Haggs AQMA’ can be shown in Appendix C ‘Supporting Technical Information / Air Quality Monitoring Data QA/QC’,

Site A15 Main St, Bainsford met all NAQS objectives for NO_2 and PM_{10} in 2020. There was a $PM_{2.5}$ (annualised estimation) NAQS (annual mean) exceedance (12µg/m^3) recorded at this site in 2018. Falkirk Council undertook a Detailed Assessment (DA) of NO_2, PM_{10} and $PM_{2.5}$ in Main St, Bainsford in 2016 (DA report contained within the 2016 APR). There is no further requirement to update the Detailed Assessment until NAQS objective breaches are recorded at the roadside automatic site.

Conclusions relating to New Local Developments

Falkirk Council received an Environmental Impact Assessment (EIA) for a proposed large-scale flood prevention scheme in Grangemouth in January 2020. The Grangemouth Flood Protection Scheme is the largest flood defence project in Scotland and one of the biggest in the United Kingdom, protecting communities in areas such as Grangemouth, Wholeflats, Glensburgh, Langlees, Carron, Carronshore and Stirling Road, Camelon. The scheme was identified as the highest priority given the potentially huge costs if an extreme flood event were to occur. Whilst other parts of Scotland have been significantly affected by flooding over the last five years, Grangemouth has fortunately avoided significant flooding.

An EIA for the development was produced by Jacobs which considered the air quality and climate change impacts of the proposed development. Specifically, within section 12 considered:

The potential emission sources of air pollutants and dust associated with the Scheme considered within this chapter include:

- Dust emissions generated by the earthworks and construction related activities during the construction phase.
- Construction emissions of pollutants to air from on-road vehicles travelling on the local road network and off-road machinery.
- Greenhouse gas (GHG) emissions (expressed as carbon dioxide equivalent: CO2e) from the construction phase (e.g. carbon embodied in the materials used to construct the Scheme and emissions from construction activities and the transport of materials and waste to and from the construction areas); and
- GHG emissions resulting from the operation of the Scheme. Although the Scheme is a passive scheme and there would be no direct carbon emissions from operation, there would be emissions from activities associated with maintenance, repair, refurbishment, or replacement of the various elements of the Scheme during its operational lifetime.

The EIA has considered the potential impacts to local air quality during the construction phase including construction dust, emissions from construction related road traffic and machinery and effects on climate (Greenhouse Gas Emissions). The pollutants assessed within this EIA were particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2) and carbon dioxide (CO_2).

Falkirk Council reviewed the EIA for air quality on 22/01/2020 and made the following comments:

- It is noted that there is no assessment of the demolition phase of the scheme as it is anticipated that the proposed engineered measures are to be maintained for over 100 years with future extensions or improvement being developed as required.

- The scope of pollutants assessed is satisfactory, the report focusses on nitrogen dioxide (NO_2) and particulate matter ($PM_{10+2.5}$) from vehicle use and larger dust particles released from the construction phase. Although the Grangemouth AQMA is declared for SO_2, the report states this pollutant is not anticipated to be emitted as a result of the construction or operation of the proposed scheme so is not included in this assessment.

- All stated International and national legislation with associated NAQS objectives are current and correct. The stated local policy statement which references Falkirk Council policy ‘RW07 Air Quality’ is current and correct.

- The construction dust for the various proposed work sections have been assessed using the IAQM methodology and the emissions from ‘Construction Related Road Traffic’ have been assessed using Design Manual for Roads and Bridges (DMRB) which is recommended / acceptable;

- All stated info related to LAQM / AQMAs with regards to baseline conditions are correct.

- It is noted that the dust risk assessed at each section is classed as negligible to medium risk with proposed mitigation measures in accordance with IAQM guidance set out in Section 12.6.1. As stated, the Grangemouth Flood Prevention (GFP) scheme represents a relatively large construction site with mitigation methods already available that have been successfully applied on other, similar sized schemes.

- Monitoring measures are stated in the EIA ‘Table 12-12’ with each category covered, it is stated that the site will have to develop a Dust Management Plan (DMP) and adhere to and implement mitigation measures as described.

Overall, a reasonably detailed assessment of air quality for the proposed scheme, it has to be noted that If any air emission / dust complaints are received during the duration of planned works, Falkirk Council have an obligation to investigate and ensure the stated mitigation measures (as included in the DMP) are being adhered to.

Falkirk Council received an AQIA for a proposed residential development at Wilson Avenue, Polmont in January 2020. The proposed development is for the erection of twenty-eight residential dwellings (seven houses and twenty-one flats). The AQIA report was completed by ITP Energised for Falkirk Council (report ref: 2830).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 3.5.7 'Operational Phase: Road Traffic Emissions' with impacts at nearest human receptors being stated as "significantly below relevant Air Quality Standards".

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in the AQIA's Appendix C 'Construction Dust Risk Assessment' are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The ITP Energised (report ref: 2830) AQIA report for the proposed residential development at Wilson Avenue, Polmont proposed development was deemed satisfactory by Falkirk Council.

Falkirk Council received an AQIA for a proposed residential development at Loch View, Stirling Road, Larbert in February 2020. The proposed development is for the erection of sixty residential dwellings. The AQIA report was completed by The Airshed for Avant Homes (report ref: Project AS 0712).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. Although traffic generated NO_2 levels are considered within this report, PM_{10} levels (from road traffic) have not been reported upon.

Increased road traffic flows from the planned residential development have been displayed in Table 1 'Predicted Baseline and Scheme Flows 2021'. The report states that 'The latest air quality review and assessment report issued by Falkirk Council indicates that "air pollution is not an issue in Larbert. The results from air quality monitoring in Larbert summarised in Table 2 below indicate that levels are well below the relevant Air Quality Objectives for NO_2".

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 2 'Dust Control Measures During Construction' are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The Airshed (report ref: Project AS 0712) AQIA report for the proposed residential development at Loch View, Stirling Road, Larbert proposed development was deemed satisfactory by Falkirk Council.

Falkirk Council received an AQIA for a proposed residential development at 35 Main Street, Bonnybridge in February 2020. The proposed development is seeking to build twenty-two residential dwellings. The AQIA report was completed by ITP Energised for Falkirk Council (report ref: 2962).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 3.5.2 ‘Operational Phase: Road Traffic Emissions’ with impacts at nearest human receptors being stated as “significantly below relevant Air Quality Standards”.

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 3 ‘Construction Dust Risk Assessment’ are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The ITP Energised (report ref: 2962) AQIA report for the proposed residential development at 35 Main Street, Bonnybridge proposed development was deemed satisfactory by Falkirk Council.

Falkirk Council received an AQIA for a proposed residential development at Graham Terrace in March 2020. The proposed development is for the erection of one hundred and eight dwellings, in a variety of house sizes. The air quality assessment report was completed by ITP Energised for Lochay Homes Ltd (report ref: 3130).

The air quality assessment report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 5 'Assessment Results' with impacts at nearest human receptors being fully assessed. The report states in Section 7 'Conclusions' that:

"No exceedances of the AQSs for NO_2, PM_{10} and $PM_{2.5}$ are predicted at any of the sensitive human receptors within the study area as a result of the Proposed Development.

The change in NO_2, PM_{10} and $PM_{2.5}$ annual mean concentrations between the future without Proposed Development and future with Proposed Development scenarios shows that the Proposed Development is predicted to have a negligible impact at all human receptors within the study area. The predicted short-term mean concentrations for NO_2 and PM_{10} which are relevant for the short-term exposure of members of public, comply with the relevant AQSs for NO_2 and PM_{10} at all human receptors.

There are no exceedances of the AQS for NO_x predicted at the nearby sensitive ecological receptor as a result of the Proposed Development.

In summary, the significance of effect on local air quality of the Proposed Development is assessed as not significant.

There are also no exceedances of the AQSs for NO_2, PM_{10} and $PM_{2.5}$ predicted at any of the propose residential receptors within the Proposed Development."

All legislation, policies and guidance referenced within the report are current, applicable and correct.

Falkirk Council reviewed the ITP Energised air quality impact assessment (report ref: 3130 v2) for Lochay Homes Limited 'Graham Terrace, Airth' proposed development as satisfactory.

Falkirk Council received an AQIA for a proposed residential development at Kilsyth Road, Banknock in March 2020. The proposed development is for the erection of one-hundred and five residential dwellings (eighty-one houses and twenty-four flats). The AQIA report was completed by ITP Energised for Falkirk Council (report ref: 2876).

The AQIA report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

Increased road traffic from the planned residential development has been fully assessed in Section 3.5.2 'Operational Phase: Road Traffic Emissions' with impacts at nearest human receptors being stated as "significantly below relevant Air Quality Standards for NO_2, PM_{10} and $PM_{2.5}$".

It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 6 'Construction Dust Risk Assessment' are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable and correct.

The ITP Energised (report ref: 2876) AQIA report for the proposed residential development at Kilsyth Road, Banknock proposed development was deemed satisfactory by Falkirk Council.

Falkirk Council received an AQIA for a proposed residential development at The Drum, Phase 5, Bo'ness in March 2020. The proposed development is for the erection of sixty-four dwellings, in a variety of house sizes. The air quality assessment report was completed by Ensafe for Ogilvie Homes (Ref: AQ108930).

The air quality assessment report was requested to identify the potential impact to local air quality as a result of increased traffic on the local road network due to the proposed development. The pollutants that were assessed within this air quality assessment were nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$). Additionally, given the proximity of the development site to the A993 and A904, recognised sources of road vehicle exhaust emissions, there is potential to expose future site users to elevated pollutant concentrations.

Increased road traffic from the planned residential development has been fully assessed in Section 5.2 'Operational Phase Assessment' and Appendix 2 'Assessment Inputs' with impacts at nearest human receptors being fully assessed. The report states in Section 7 'Conclusions' that:

"During the construction phase of the development there is the potential for air quality impacts as a result of fugitive dust emissions from the site. These were assessed in accordance with the IAQM methodology. Assuming good practice dust control measures are implemented, the residual potential air quality impacts from dust generated by construction, earthworks and track out activities was predicted to be not significant.

Potential impacts during the operational phase of the development may occur due to road traffic exhaust emissions associated with vehicles travelling to and from the site. An assessment was therefore undertaken using the EPUK and IAQM screening criteria to determine the potential for vehicle trips generated by the development to affect local air quality. This indicated that impacts are likely to be not significant throughout the operational phase."

Falkirk Council reviewed the Ensafe air quality impact assessment (AQ108930) for Ogilvie Homes Ltd 'The Drum, Phase 5, Bo'ness' and made the following comments:

- Please note that Falkirk Council has four AQMAs active rather than five as stated in section 4.1.
- Please note that the DEFRA Technical Guidance (TG16) has been updated in Feb 2018 rather than 2016 as stated – so please refer to this guidance in future.
- All other air quality legislation, policies, standards and guidance referenced within the report are current, applicable and correct.

A second version of the AQIA was produced which addressed the above comments which was then deemed satisfactory by Falkirk Council.

Falkirk Council received an updated AQIA for a proposed mixed-use development at Gilston Park, Bo'ness in October 2020. The proposed development is seeking permission to build up to a capacity of five hundred residential units including housing, businesses, neighbourhood centre and greenspace at Gilston Park, East of Polmont. The site will connect to a new roundabout on the A803 to facilitate development of this area. The AQIA report was completed by ITP Energised for Hansteen Land Ltd (report ref: 3257).

The previous ITP Energised AQIA in relation to this development has been updated to reflect:

- Change in future receptor locations.
- Change to proposed development generated traffic based on the updated mix of uses and proposed housing numbers.
- Change to the predicted future year of completion (from 2032 to 2029).
- Update of dispersion models versions including new software capabilities and availability of built-in vehicle emissions factors (DEFRA, 2019).
- Updated concentration maps for baseline year of 2020.
- Proposed changes in odour / dust emissions from the neighbouring Avondale landfill site

ITP Energised have used ADMS Roads 5 – latest version of this emission modelling software which is satisfactory.

The pollutants assessed within the report are nitrogen dioxide (NO_2) and fine particulate matter ($PM_{10+2.5}$).

Increased road traffic from the planned development has been fully assessed in section 3.5.2 ‘Operational Phase’ with relevant traffic displayed in Tables 4A-E with impacts at nearest human receptors being stated in Section 7. ‘Conclusion’ as “negligible”. It is unlikely that air quality / dust issues should arise if the mitigation measures outlined in Appendix 5 ‘Construction Dust Risk Assessment’ are fully implemented with regards to the construction phase of the development. All legislation, policies and guidance referenced within the report are current, applicable, and correct.

The ITP Energised (report ref: 3257) air quality assessment for the proposed mixed-use development at Gilston Park, Polmont proposed development was deemed satisfactory by Falkirk Council.

Falkirk Council received an updated Odour and Dust Risk Assessment Report for a proposed mixed-use development at Gilston Park, Bo’ness in November 2020. The proposed development is seeking permission to build up to a capacity of five hundred residential units including housing, businesses, neighbourhood centre and greenspace at Gilston Park, East of Polmont. The site will connect to a new roundabout on the A803 road to facilitate development of this area. The updated Odour and Dust Risk Assessment Report was completed by ITP Energised for Hansteen Land Ltd (report ref: 3257 v2).

The previous ITP Odour and Dust Risk Assessment (2017) in relation to this development has been updated to reflect:

- The updated draft masterplan as shown in ‘Drawing 1’.
- A review of updated operational procedures at Avondale facilities.
- A review of complaints received by SEPA from members of the public from 2018-2020; and
- A review of SEPA inspection reports of Avondale facilities 2018-2020.

<u>Odour Assessment</u>

ITP Energised have used five years of Met Office derived wind data from Edinburgh Gogarbank and completed a qualitative odour assessment in accordance with the IAQM method including reference to FIDOL factors. A review of SEPA odour complaints has been completed in section 4.2.3 as stated. A review of SEPA inspection reports 2018-2020 has been completed in section 4.2.4 as stated.

The odour assessment results conclude in section 5.1: “The likely effect of odour emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as ‘negligible to slight’. The significance of the effect of odour emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as ‘not significant’.”

<u>Dust Assessment</u>

ITP Energised have used the IAQM Assessment of Mineral Dust Impacts for Planning (12) guidance document which is satisfactory. The dust assessment results conclude in section 5.1: “The likely effect of dust emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as ‘negligible’. ‘The significance of the effect of dust emitted from the Avondale installations upon future on-site receptors at the Proposed Development has been assessed as ‘not significant’”.

Please note the stated mitigation measures stated in Section 6 are in relation to building design stage features to help minimise odour and dust risk at all proposed future receptors within the proposed development. This area has had historical odour issues associated with it.

All stated guidance and policy documents appear to be current, applicable and correct.

Falkirk Council reviewed the ITP Energised (report ref: 3257 v2) Odour and Dust Risk Assessment for the mixed-use development at Gilston Park, Polmont proposed development which appears to be satisfactory.

Falkirk Council received an AQIA report for a proposed upgrade to a section of road and associated junctions. These upgrades are proposed to take place between Earlsgate and the Forth Valley College on the A904 road and alongside the Helix and Falkirk Football Club along the A9 road. The proposed development is seeking permission to undertake these upgrades as part of the Falkirk Gateway Masterplan. An initial design has been submitted that involves road widening and general improvements, three new roundabouts, improvement of the existing A9/A904 roundabout, and an iconic pedestrian crossing structure over the existing A9/A904 roundabout. The AQIA was completed by WSP on behalf of Falkirk Council (report ref: WSP-9750-0000-R-007).

After assessing the WSP Air Quality Assessment ‘A9-A904 Improvement Scheme’ Ref: WSP-9750-0000-R-007 it is noted within ‘Executive Summary’, p6 and Section 5.2 ‘Operational Phase’, 5.2.10 ‘Annual Mean $PM_{2.5}$ Concentrations’, p27’ that:

"For $PM_{2.5}$ (during the Operational Phase), exceedances of the annual mean objective are predicted at three receptors with and without the Proposed Scheme in place." It is noted that there are no predicted exceedances for PM_{10} and NO_2 from the Proposed Scheme on local receptors.

An **objection** was submitted on air quality-related grounds for the predicted exceedances (during the operational phase of the Proposed Scheme) of the particulate matter ($PM_{2.5}$) national air quality strategy objective at the three local receptors.

If additional mitigation measures (within the 'Do Something' scenario) were considered to reduce these $PM_{2.5}$ exceedances to within the National Air Quality Strategy Objective at the three receptors, then this can be further assessed and commented upon.

All stated legislation, policy, scope and methodology of the WSP air quality impact report appear to be current and correct.

Proposed Actions

Although SO_2 NAQS objectives have been achieved within the Grangemouth AQMA for seven consecutive years, Falkirk Council considers the AQMA remains justified based upon continual exceedances of the SO_2 NAQS (15 min) objective concentration recorded at the A8 Grangemouth AURN, A9 Grangemouth Moray and A10 Grangemouth Municipal Chambers sites for the past five consecutive years. The Grangemouth Emission Study (which includes a review of the Grangemouth AQMA) has been completed by Sweco consultants and can be shown in Appendix C 'Additional Air Quality Works Undertaken by Falkirk Council During 2020'.

The Falkirk town centre AQMA for NO_2 (annual mean) remains justified as although there were no exceedances of the NO_2 (annual mean) NAQS objective recorded in 2020 there have been consecutive diffusion tube (such as NA27 Falkirk West Bridge Street) exceedances in previous years which haven't been affected by the Coronavirus (COVID-19) Scottish Government travel restrictions[Ref1] which has affected 2020/21 air quality data. One diffusion tube was close to the 40µg/m^3 annual limit with the highest concentration recorded at the NA27 Falkirk West Bridge Street (35µg/m^3) site.

There have been over five years where PM_{10} results at both Falkirk Town Centre AQMA automatic monitoring locations (Falkirk Hope Street and Falkirk West Bridge Street) have complied with the PM_{10} NAQS objective. It is anticipated that the PM_{10} element of the Falkirk Town Centre AQMA will be assessed for revocation eligibility during 2021.

The Haggs AQMA was declared on the 18th March 2010 following NAQS exceedances for NO_2 (annual mean). Since the AQMA was declared, measured concentrations (using automatic and non-automatic monitoring methods) of NO_2 have complied with the NAQS objectives consistently over the past six years (since 2015). It is anticipated that the Haggs AQMA will be revoked in 2021. The 'Falkirk Council Proposal for Revocation of Haggs AQMA' can be shown in Appendix C: Supporting Technical Information / Air Quality Monitoring Data QA/QC.

Site A15 Main St, Bainsford met all NAQS objectives for NO_2 and PM_{10} in 2020. There was a $PM_{2.5}$ (annualised estimation) NAQS (annual mean) exceedance (12 µg/m3) recorded at this site in 2018. Falkirk Council undertook a Detailed Assessment (DA) of NO_2, PM_{10} and $PM_{2.5}$ in Main St, Bainsford in 2016 (DA report contained within the 2016 APR). There is no further requirement to update the Detailed Assessment until NAQS objective breaches are recorded at the roadside automatic site.

The Air Quality Progress Report (APR) as required by the Scottish Government shall be submitted in June 2022.

Appendix A: Monitoring Results

Table A.1 – Details of Automatic Monitoring Sites

Site ID	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)
A3	Bo’ness	Urban Background / Industrial	299815	681481	SO_2	N	SO_2: Horiba, APSA 370, UV Fluorescence.	5	22	1.2
A4	Falkirk Haggs	Roadside	278977	679271	NO_2, PM_{10}, $PM_{2.5}$	Y (NO_2)	NO_2: API Teledyne T200, Chemiluminescence. $PM_{10+2.5}$: Palas Fidas 200 (Optical).	5	2	1.2
A5	Falkirk Hope Street	Roadside	288688	680218	SO_2, NO_2, PM_{10}, $PM_{2.5}$	Y (NO_2 and PM_{10})	SO_2: Horiba APSA 360, UV Fluorescence. NO_2: Horiba APNA 360, Chemiluminescence. $PM_{10+2.5}$: Palas Fidas 200 (Optical).	1	5	1.5
A7	Falkirk West Bridge Street	Roadside	288457	680064	NO_2, PM_{10}, $PM_{2.5}$	Y (NO_2 and PM_{10})	NO_2: API Teledyne T200, Chemiluminescence. $PM_{10+2.5}$: Palas Fidas 200 (Optical).	1	2	1.2

Site ID	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)
A8	Grangemouth Automatic Urban and Rural Network (AURN)	Urban Background / Industrial	293830	681022	Benzene, SO_2, NO_2, PM_{10} and $PM_{2.5}$	Y (SO_2)	Benzene: Pumped absorption tube. SO_2: Ecotech Serinus 50, UV Fluorescence. NO_2: API Teledyne T200, Chemiluminescence. PM_{10}: Met One 1020 Beta Attenuation Monitor (BAM). $PM_{2.5}$: Met One 1020 Beta Attenuation Monitor (BAM).	5	20	3.5
A9	Grangemouth Moray	Urban Background / Industrial	293469	681321	SO_2, NO_2	Y (SO_2)	SO_2: Horiba APSA 370, UV Fluorescence. NO_2: API Teledyne T200, Chemiluminescence.	1	25	3.5
A10	Grangemouth Municipal Chambers	Urban Background / Industrial	292816	682009	SO_2, NO_2, PM_{10}, $PM_{2.5}$	Y (SO_2)	SO_2: Horiba APSA 370, UV Fluorescence. NO_2: Horiba APNA 360, Chemiluminescence. $PM_{10+2.5}$: Palas Fidas 200 (Optical).	1	40	3.5
A11	Grangemouth Zetland Park	Urban Background / Industrial	292969	681106	SO_2, PM_{10}, $PM_{2.5}$	Y (SO_2)	SO_2: Horiba APSA 360, UV Fluorescence. $PM_{10+2.5}$: Palas Fidas 200 (Optical).	1	135	3.5
A13	Banknock 2 **(AQMA Revoked in Jan 2021)**	Roadside	277247	679027	PM_{10}	N (PM_{10})	Palas Fidas 200 (Optical). (Analyser transferred to nearby Haggs on 23/07/2020 – site to be decommissioned in 2021)	7	3	1.2
A14	Banknock 3	Urban Background	277168	679254	PM_{10}, $PM_{2.5}$	N (PM_{10})	Turnkey Osiris (Optical)	19	17	1.3

Site ID	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)
A15	Main St, Bainsford	Roadside	288566	681508	NO_2, PM_{10}	N	NO_2: Horiba APNA 360, Chemiluminescence. $PM_{10+2.5}$: Palas Fidas 200 (Optical).	1	2	1.2

Notes:

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

(2) N/A if not applicable.

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? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Tube Height (m)
NA3	Tinto Drive, Grangemouth	Urban Background	293427	680386	Benzene, NO_2	N	<5	2.6	N	3
NA5	Copper Top pub, Camelon	Roadside	287332	680333	NO_2	N	<2	0.6 (Traffic Island)	N	2.3
NA7	Irving Parish Church, Camelon	Urban Background	287324	680442	NO_2	N	<5	1.4	N	2.6
NA9	Bellsdyke Rd, Larbert	Roadside	286048	683542	NO_2	N	<2	0.7	N	2.5
NA19	Kilsyth Rd, Banknock	Roadside	278779	679301	NO_2	Y, Haggs	<2	2.2	N	1.9
NA20	Garngrew Rd, Haggs	Urban Background	278957	679172	NO_2	N	<5	1.5	N	2.5
NA21	Grangemouth Rd, Falkirk College	Roadside	290112	680500	Benzene, NO_2	N	<2	1.8	N	2.5
NA24	Kerse Lane, Falkirk	Roadside	289189	680018	NO_2	Y, FTC AQMA	<2	3	N	2.5
NA26	Weir St, Falkirk	Urban Background	289207	680123	NO_2	Y, FTC AQMA	<5	1.7	N	2.5
NA27	West Bridge St, Falkirk	Roadside	288490	680055	Benzene, NO_2	Y, FTC AQMA	<2	0.5	Y	2.2
NA29	Wellside Place, Falkirk	Urban Background	288467	680220	NO_2	N	<5	1.6	N	2.4
NA36	Kerr Crescent, Haggs	Roadside	278985	679273	NO_2	Y, Haggs AQMA	<5	2.1	N	2.5
NA37	Denny Town House	Urban Centre	281226	682526	Benzene, NO_2	N	<5	8.9	N	2.5
NA38	Larbert Village Primary School	Urban Background	285937	682309	Benzene, NO_2	N	<5	2.3	N	2.4
NA41	Seaview Place, Bo’ness	Roadside	299722	681594	Benzene, 1,3	N	<2	0.1	N	2.5

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Tube Height (m)
					Butadiene, NO_2					
NA42	Municipal Chambers, Grangemouth	Urban Centre / Industrial	292817	682000	Benzene, NO_2	N	<5	37.5	Y	3
NA44	Harvey Avenue, Polmont	Urban Background	293720	678911	Benzene, NO_2	N	<5	1.6	N	2.4
NA48	Hayfield, Falkirk	Urban Background	289197	681564	NO_2	N	<5	3.1	N	2.5
NA50	Upper Newmarket St, Falkirk	Urban Background	288671	680047	NO_2	Y, FTC AQMA	<5	9	N	2.3
NA51	Mary St, Laurieston	Roadside	290965	679490	NO_2	N	1	4.5	N	2.4
NA52	Main St, Larbert	Roadside	285866	682356	NO_2	N	<2	4.4	N	2.6
NA53	Denny Cross	Roadside	281211	682727	NO_2	N	<2	0.8	N	2.9
NA58	Callendar Rd, Falkirk	Roadside	290194	679624	NO_2	N	<2	0.5	N	2.5
NA59	Carron Rd, Bainsford	Roadside	288392	681931	NO_2	N	<2	1.2	N	2.4
NA60	Ronades Rd, Carron	Roadside	288133	681587	NO_2	N	<2	1.6	N	2.3
NA61	Canal Rd, Falkirk	Roadside	287976	680656	NO_2	N	<2	1.5	N	2.3
NA62	Arnot St, Falkirk	Roadside	289125	679705	NO_2	Y, FTC AQMA	<2	1.2	N	2.1
NA63	Camelon Rd, Falkirk	Urban Background	288055	680134	NO_2	On FTC AQMA boundary	<5	1.4	N	2.3
NA64	New Hallglen Rd, Falkirk	Roadside	288807	678422	NO_2	N	<2	1.7	N	2.7
NA65	Redding Rd, Redding	Roadside	291356	678644	NO_2	N	<2	0.6	N	2.4

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Tube Height (m)
NA67	Queen St, Falkirk	Urban Background	289430	680433	NO_2	N	<5	1.8	N	2.9
NA69	Kerse Lane, Falkirk	Roadside	289025	679991	NO_2	Y, FTC AQMA	<2	2.3	N	2.7
NA71	Park St, Falkirk	Roadside	288910	680112	NO_2	Y, FTC AQMA	<2	1.5	N	2.1
NA72	Vicar St, Falkirk	Roadside	288824	680120	NO_2	Y, FTC AQMA	<2	1.5	N	2.5
NA73	West Bridge St RHS, Falkirk	Roadside	288467	680048	NO_2	Y, FTC AQMA	<2	0.3	N	2.5
NA76	Tryst Rd, Stenhousemuir	Roadside	286851	683229	NO_2	N	<2	1.8	N	2.4
NA77	Kinnaird Village	Roadside	286490	683775	Benzene, NO_2	N	<2	3.9	N	2.5
NA78	Glen Brae, Falkirk	Roadside	288525	678991	NO_2	N	<2	2.6	N	2.2
NA80	Cow Wynd, Falkirk	Roadside	288765	679456	Benzene, NO_2	N	<2	1.8	N	2.5
NA81	Grahams Rd, Falkirk	Roadside	288817	680911	Benzene, NO_2	N	<2	0.5	N	2.3
NA82	Castings Av, Falkirk	Roadside	288858	681036	NO_2	N	<2	1	N	2.5
NA83	Main St, Bainsford	Roadside	288614	681415	NO_2	N	<2	0.5	N	2.6
NA85	Auchincloch Dr, Banknock	Roadside	278752	679049	NO_2	Y, Haggs AQMA	<2	0.8	N	2.5
NA86	Wolfe Rd, Falkirk	Urban Background	289667	679871	NO_2	N	<2	2	N	2.5
NA87	M80 Slip South, Haggs	Roadside	279017	679305	NO_2	Y, Haggs AQMA	<2	1.6	N	1.8
NA88	Ure Crescent, Bonnybridge	Roadside	282444	681074	NO_2	N	<2	1.7 (16 to M876)	N	2.5
NA89	Grahams Rd / Meeks Rd, Falkirk	Roadside	288856	680336	NO_2	Y, FTC AQMA	<2	2.2	N	2.3

Site ID	Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Tube Height (m)
NA94	A905 (Glensburgh Road), Grangemouth	Roadside	291213	681074	NO_2	N	7	5.4	N	2.4
NA98	Arnothill, Falkirk	Urban Background	288080	680073	NO_2	N	23	1.6	N	2.2
NA99	St Crispins Pl, Falkirk	Roadside	288924	679675	NO_2	Y, FTC AQMA	7.6	2.7	N	2
NA101	Glensburgh Rd (2), Grangemouth	Roadside	291127	682007	NO_2	N	7	0.9	N	2.2
NA105	West of Shieldhill	Rural	288279	676875	Benzene, NO_2	N	Background Rural Site	1.7	N	1.6
NA107	Main St (East), Bainsford	Roadside	288640	681396	NO_2	N	4	0.5	N	2.3
NA110	Banknock 2 Air Quality Station	Roadside	277247	679027	NO_2	N	5.2	2.6	N	1.8
NA111	Falkirk West Bridge St, Air Quality Station	Urban Centre	288457	680064	NO_2	Y, FTC AQMA	4.3	2.3	Y	1.8
NA114	Glasgow Rd, Camelon	Roadside	286624	680577	NO_2	N	2	0.5	N	2.6
NA115	Brown St, Camelon	Urban Background	286761	680413	NO_2	N	2	1.5	N	2.1
NA116	Kersiebank Avenue, Grangemouth	Urban Background / Industrial	293671	680347	Benzene, NO_2	N	2	2.75	N	2.27
NA117	Oswald Avenue (East), Grangemouth	Urban Background / Industrial	294101	681532	Benzene, NO_2	Y, GM AQMA	2.5	2.2	N	2.27
NA118	Glebe Street, Falkirk	Roadside	288726	680096	NO_2	Y, FTC AQMA	2.5	1.6	N	2.27
NA119	Hendry Street, Falkirk	Urban Background	288728	681383	NO_2	N	3	1.3	N	2.3

Notes:

(1) 0m 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.

Table A.3 – Annual Mean NO_2 Monitoring Results (µg/m³)

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	NO_2 Annual Mean Concentration (µg/m³) (3)				
					2016	2017	2018	2019	2020
A4	Falkirk Haggs	Automatic	89	89	33	28	28	27	18
A5	Falkirk Hope St	Automatic	83	83	23	19	21	20	14
A7	Falkirk West Bridge St	Automatic	88	88	37	36	39	38	27
A8	Grangemouth AURN	Automatic	98	98	16	14	14	15	11
A9	Grangemouth Moray	Automatic	75	75	18	17	17	15	12
A10	Grangemouth Municipal Chambers	Automatic	95	95	21	17	18	17	12
A15	Main St, Bainsford	Automatic	65	65	24	23	22	25	20.3
NA3	Tinto Drive, Grangemouth	Diffusion Tube	91	91	19	18	18	19	15
NA5	Copper Top pub, Camelon	Diffusion Tube	91	91	25	24	24	27	19
NA7	Irving Parish Church, Camelon	Diffusion Tube	83	83	16	15	17	15	12
NA9	Bellsdyke Rd, Larbert	Diffusion Tube	91	91	25	24	22	23	18
NA19	Kilsyth Rd, Banknock	Diffusion Tube	91	91	33	26	28	27	21
NA20	Garngrew Rd, Haggs	Diffusion Tube	91	91	24	22	22	22	18
NA21	Grangemouth Rd, Falkirk College	Diffusion Tube	83	83	28	28	28	26	21
NA24	Kerse Lane, Falkirk	Diffusion Tube	91	91	35	39	34	33	25
NA26	Weir St, Falkirk	Diffusion Tube	91	91	18	17	20	18	13
NA27	West Bridge St, Falkirk	Diffusion Tube	91	91	**48**	38	**44**	**47**	35
NA29	Wellside Pl, Falkirk	Diffusion Tube	91	91	17	17	18	17	13
NA36	Kerr Crescent, Haggs	Diffusion Tube	91	91	38	35	37	35	27
NA37	Denny Town House	Diffusion Tube	91	91	17	15	17	17	14
NA38	Larbert Village Primary School	Diffusion Tube	83	83	17	15	17	16	13
NA41	Seaview Pl, Bo'ness	Diffusion Tube	83	83	21	20	22	23	19

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	NO_2 Annual Mean Concentration (µg/m³) (3)				
					2016	2017	2018	2019	2020
NA42	Municipal Chambers, Grangemouth	Diffusion Tube	91	91	20	17	19	19	15
NA44	Harvey Av, Polmont	Diffusion Tube	91	91	12	16	19	18	14
NA48	Hayfield, Falkirk	Diffusion Tube	91	91	19	16	18	19	15
NA50	Upper Newmarket St, Falkirk	Diffusion Tube	91	91	24	20	24	24	18
NA51	Mary St, Laurieston	Diffusion Tube	91	91	25	22	24	24	18
NA52	Main St, Larbert	Diffusion Tube	91	91	24	21	23	22	20
NA53	Denny Cross	Diffusion Tube	83	83	29	23	26	27	21
NA58	Callendar Rd, Falkirk	Diffusion Tube	83	83	23	19	23	21	16
NA59	Carron Rd, Bainsford	Diffusion Tube	91	91	26	28	28	29	23
NA60	Ronades Rd, Carron	Diffusion Tube	91	91	26	23	24	25	21
NA61	Canal Rd, Falkirk	Diffusion Tube	91	91	24	20	24	23	19
NA62	Arnot St, Falkirk	Diffusion Tube	91	91	39	34	34	34	27
NA63	Camelon Rd, Falkirk	Diffusion Tube	83	83	36	33	35	34	27
NA64	New Hallglen Rd, Falkirk	Diffusion Tube	91	91	18	14	16	17	11
NA65	Redding Rd, Redding	Diffusion Tube	91	91	26	23	24	24	19
NA67	Queen St, Falkirk	Diffusion Tube	83	83	29	27	27	26	22
NA69	Kerse Lane, Falkirk	Diffusion Tube	91	91	34	30	32	30	23
NA71	Park St, Falkirk	Diffusion Tube	91	91	29	30	31	30	25
NA72	Vicar St, Falkirk	Diffusion Tube	91	91	32	25	26	27	22
NA73	West Bridge St RHS, Falkirk	Diffusion Tube	91	91	22	28	31	31	24
NA76	Tryst Rd, Stenhousemuir	Diffusion Tube	91	91	22	19	20	20	16
NA77	Kinnaird Village	Diffusion Tube	91	91	33	21	22	23	18
NA78	Glen Brae, Falkirk	Diffusion Tube	83	83	31	28	30	28	21
NA80	Cow Wynd, Falkirk	Diffusion Tube	83	83	27	29	28	30	25
NA81	Grahams Rd, Falkirk	Diffusion Tube	91	91	19	28	30	32	24
NA82	Castings Av, Falkirk	Diffusion Tube	91	91	38	17	19	18	15
NA83	Main St, Bainsford	Diffusion Tube	91	91	21	31	34	34	25
NA85	Auchincloch Dr, Banknock	Diffusion Tube	91	91	16	17	19	20	14
NA86	Wolfe Rd, Falkirk	Diffusion Tube	91	91	32	15	16	16	12

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) [1]	Valid Data Capture 2020 (%) [2]	NO_2 Annual Mean Concentration (µg/m^3) [3]				
					2016	2017	2018	2019	2020
NA87	M80 Slip South, Haggs	Diffusion Tube	91	91	30	27	28	31	21
NA88	Ure Crescent, Bonnybridge	Diffusion Tube	91	91	30	28	27	27	20
NA89	Grahams Rd / Meeks Rd, Falkirk	Diffusion Tube	91	91	32	28	30	30	23
NA94	A905 (Glensburgh Rd), Grangemouth	Diffusion Tube	91	91	21	30	31	30	24
NA98	Arnothill, Falkirk	Diffusion Tube	91	91	26	19	18	13	16
NA99	St Crispins Pl, Falkirk	Diffusion Tube	91	91	21	24	25	25	20
NA101	Glensburgh Rd (2), Grangemouth	Diffusion Tube	91	91	21	24	23	23	17
NA105	West of Shieldhill	Diffusion Tube	91	91	8	7	8	8	6
NA107	Main St (East), Bainsford	Diffusion Tube	83	83	30	26	27	30	23
NA110	Banknock 2 Air Quality Station	Diffusion Tube	91	91	19	16	16	16	13
NA111	Falkirk West Bridge St, Air Quality Station	Diffusion Tube	91	91	**43**	36	37	38	31
NA114	Glasgow Rd, Camelon	Diffusion Tube	66	66	New Location for 2018		39	**41**	31
NA115	Brown St, Camelon	Urban Background	91	91	New Location for 2018		18	19	13
NA116	Kersiebank Avenue, Grangemouth	Urban Background / Industrial	91	91	New Location for 2019			20	15
NA117	Oswald Avenue (East), Grangemouth	Urban Background / Industrial	91	91	New Location for 2019			20	15
NA118	Glebe Street, Falkirk	Roadside	91	91	New Location for 2019			23	18
NA119	Hendry Street, Falkirk	Urban Background	83	83	New Location for 2019			22	18

Notes:

Exceedances of the NO_2 annual mean objective of 40µg/m^3 are shown in bold.

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

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.

(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%).

Table A.4 – 1-Hour Mean NO_2 Monitoring Results, Number of 1-Hour Means > 200µg/m^3

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
A4 Falkirk Haggs	Roadside	Automatic	89	89	0 (119)	0 (107)	0	0	0
A5 Falkirk Hope St	Urban Background	Automatic	83	83	0	0 (82)	0	0	0 (81)
A7 Falkirk West Bridge St	Roadside	Automatic	88	88	0 (107)	0	0	0	0
A8 Grangemouth AURN	Urban Background / Industrial	Automatic	98	98	0	0	0	0	0
A9 Grangemouth Moray	Urban Background / Industrial	Automatic	75	75	0	0	0	0	0 (70)
A10 Grangemouth Municipal Chambers	Urban Background / Industrial	Automatic	95	95	0 (72)	0	0	0	0
A15 Main St, Bainsford	Roadside	Automatic	65	65	0 (94)	0	0	0	0 (88)

Notes:

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

If the period of valid data is less than 85%, the 99.8th percentile of 1-hour means is provided in brackets.

(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%).

Figure 1 – A4 Falkirk Haggs Long Term NO_2 Concentrations

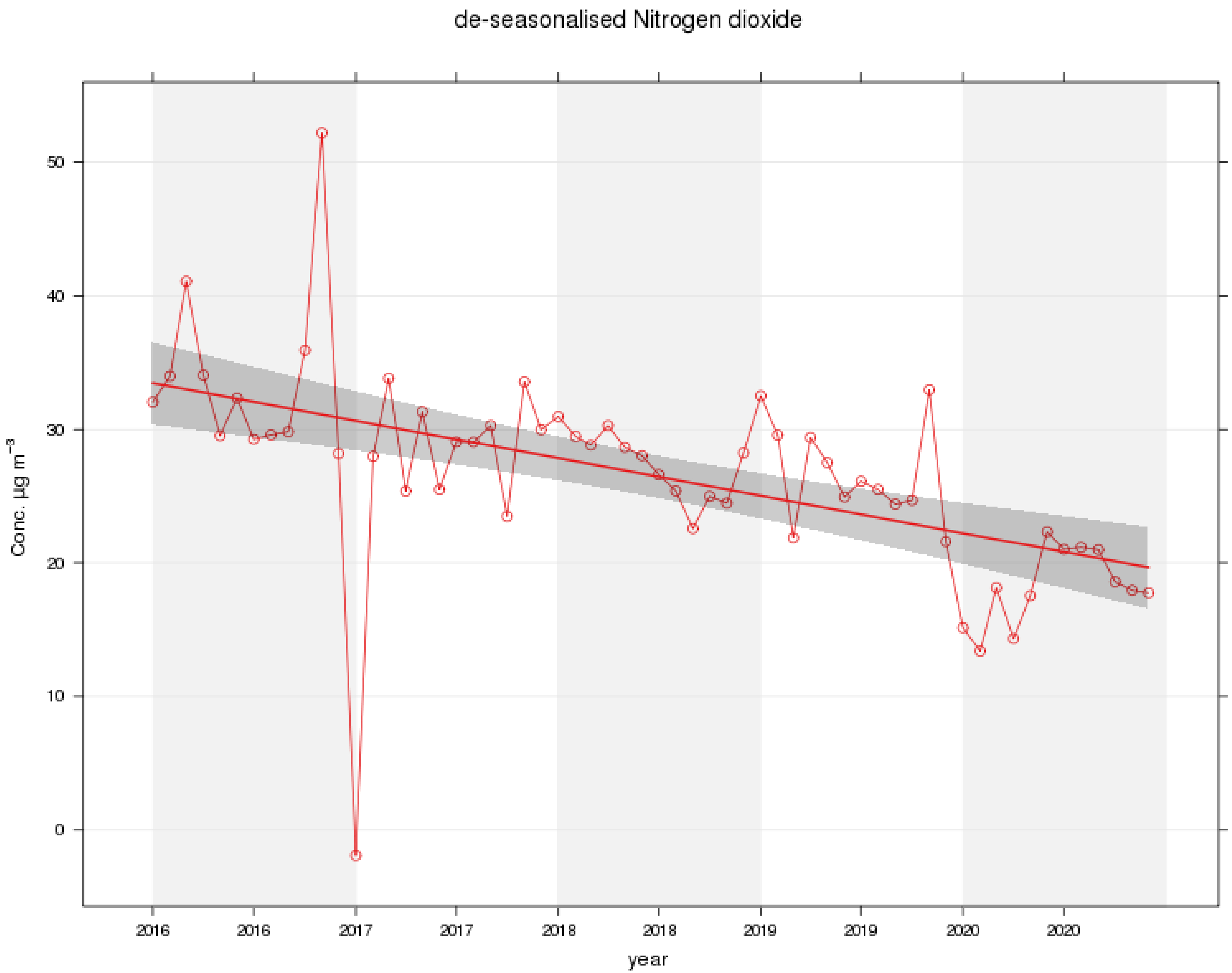


Figure 2 – A5 Falkirk Hope St Long Term NO_2 Concentrations

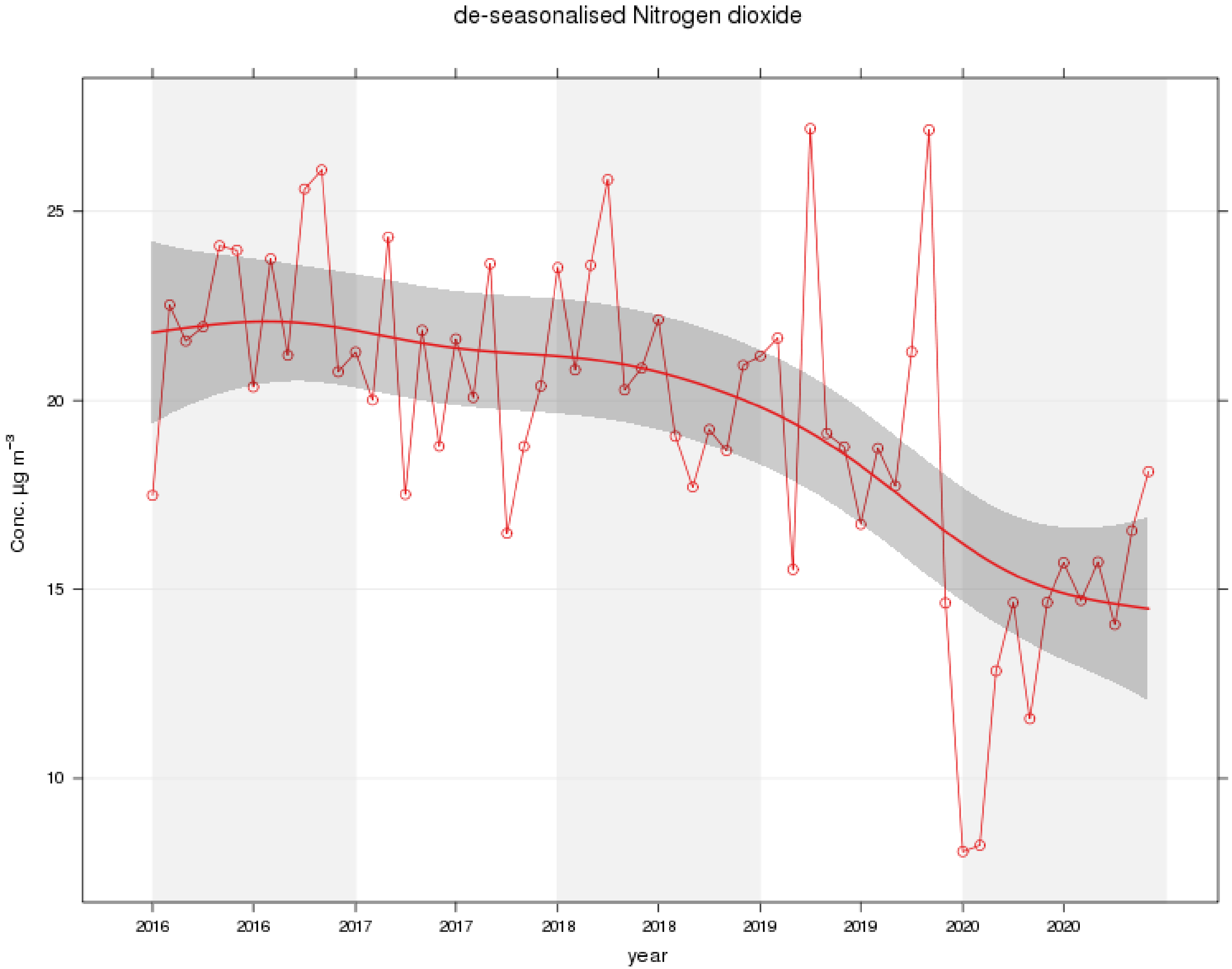


Figure 3 – A7 Falkirk West Bridge St Long Term NO_2 Concentrations

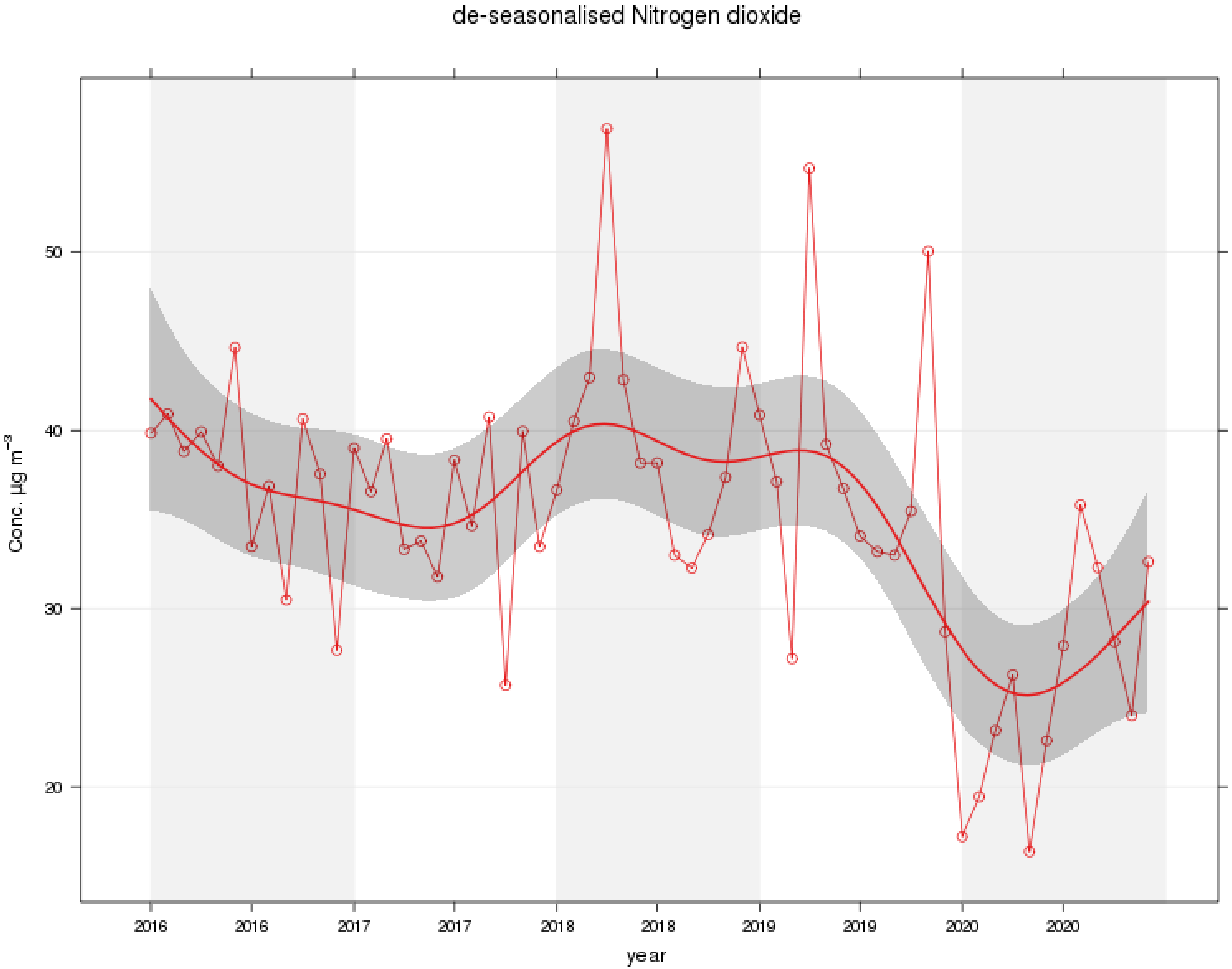


Figure 4 – A8 Grangemouth AURN Long Term NO_2 Concentrations

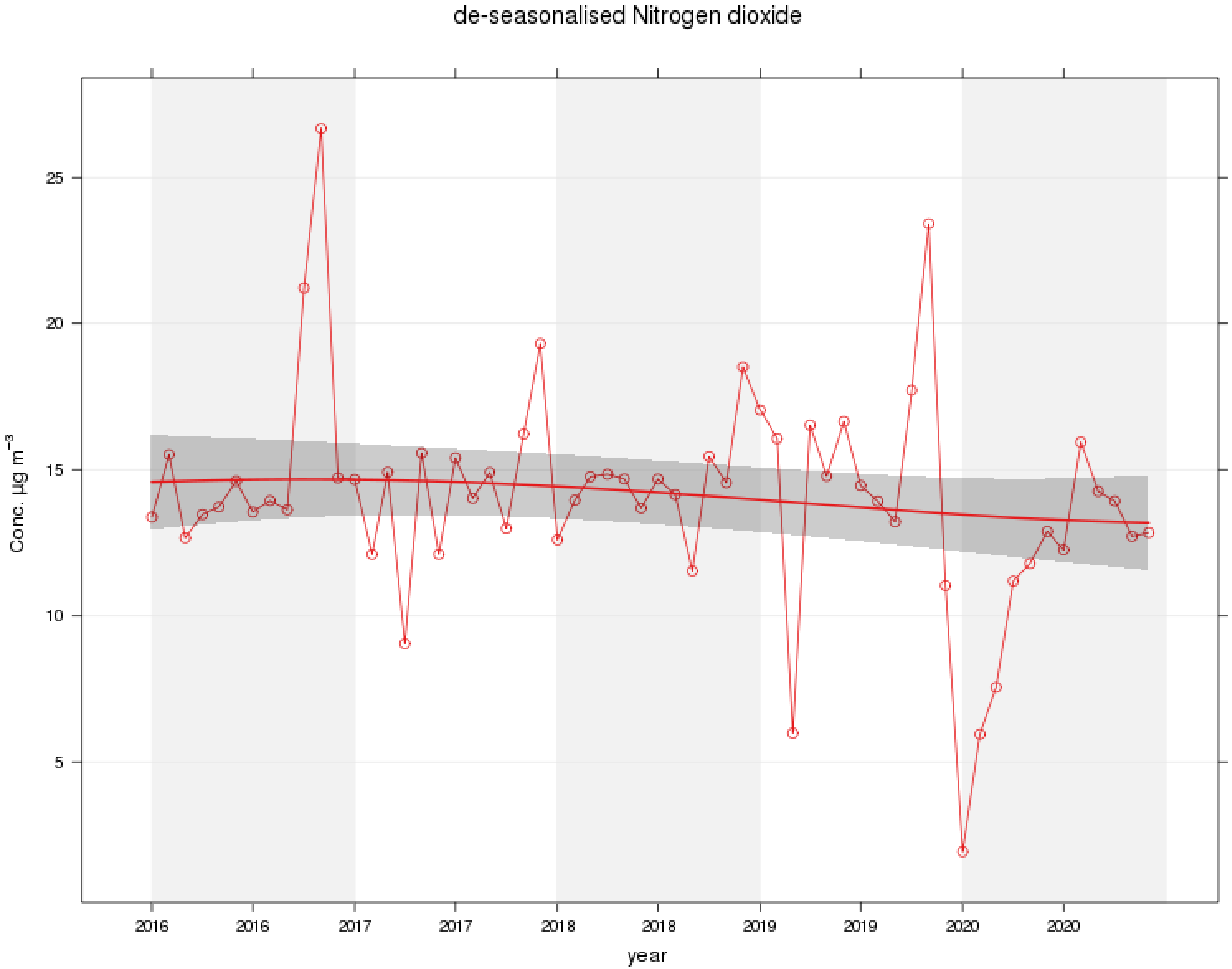


Figure 5 – A9 Grangemouth Moray Long Term NO_2 Concentrations

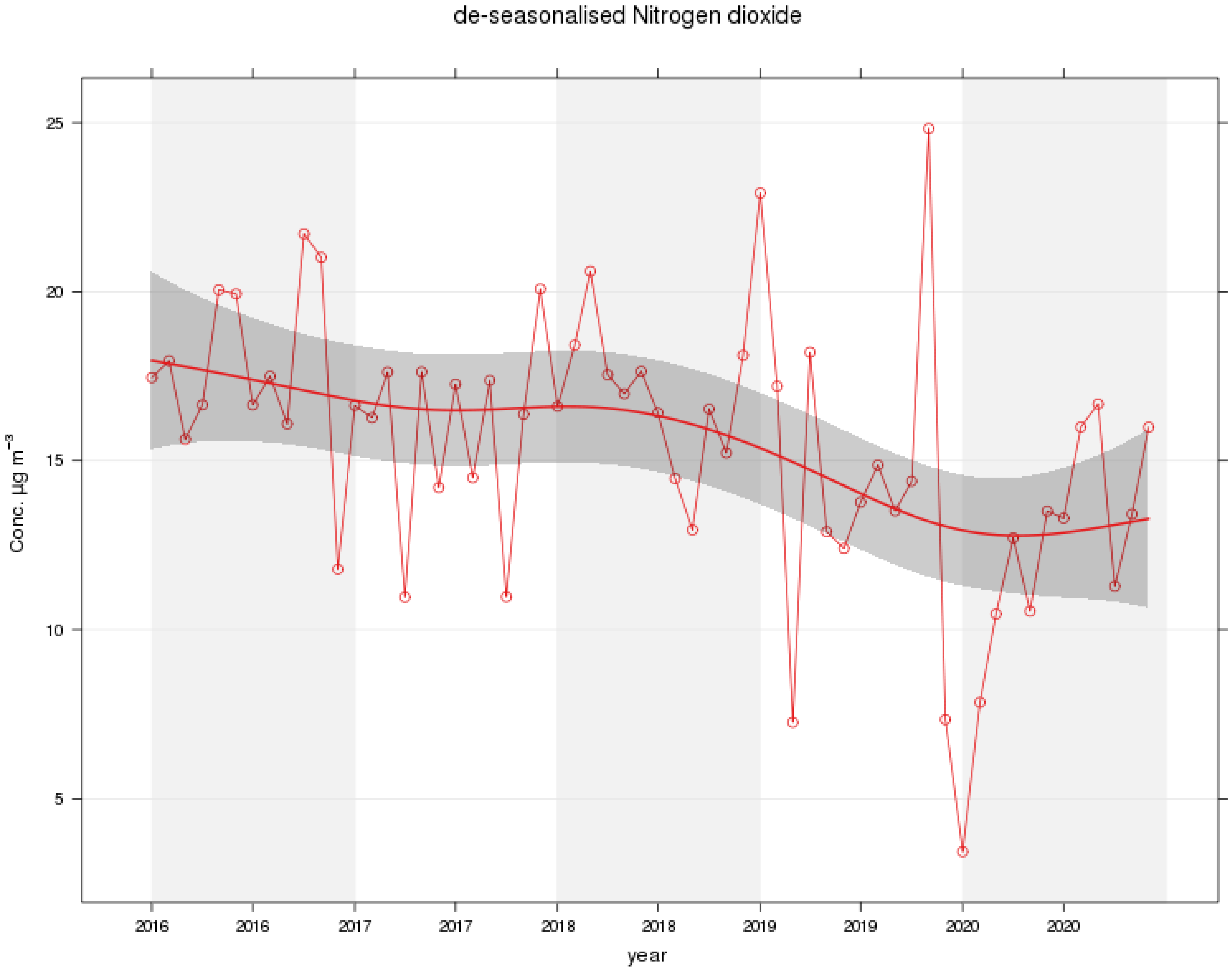


Figure 6 – A10 Grangemouth Municipal Chambers Long Term NO_2 Concentrations

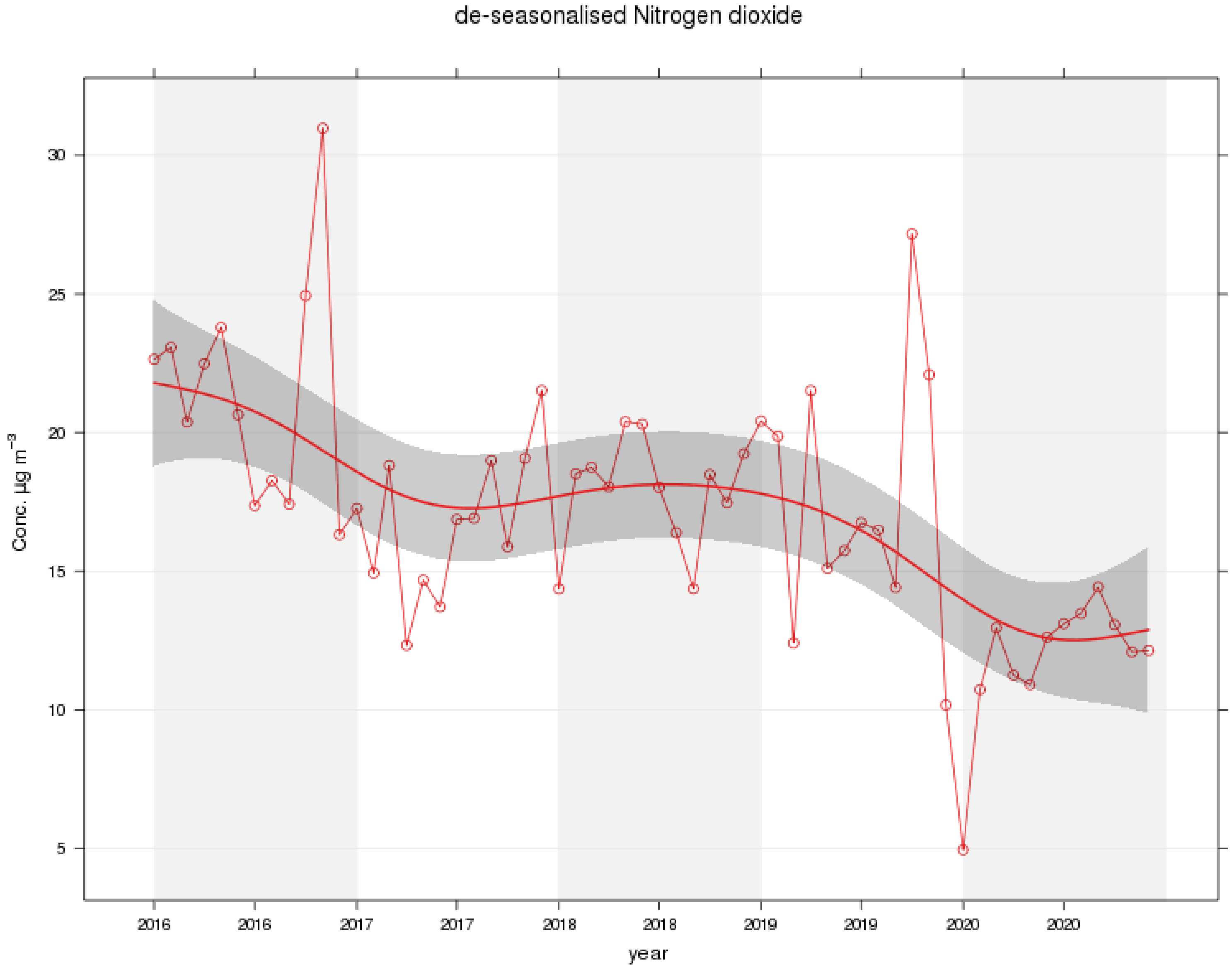


Figure 7 – A15 Main St, Bainsford Long Term NO_2 Concentrations

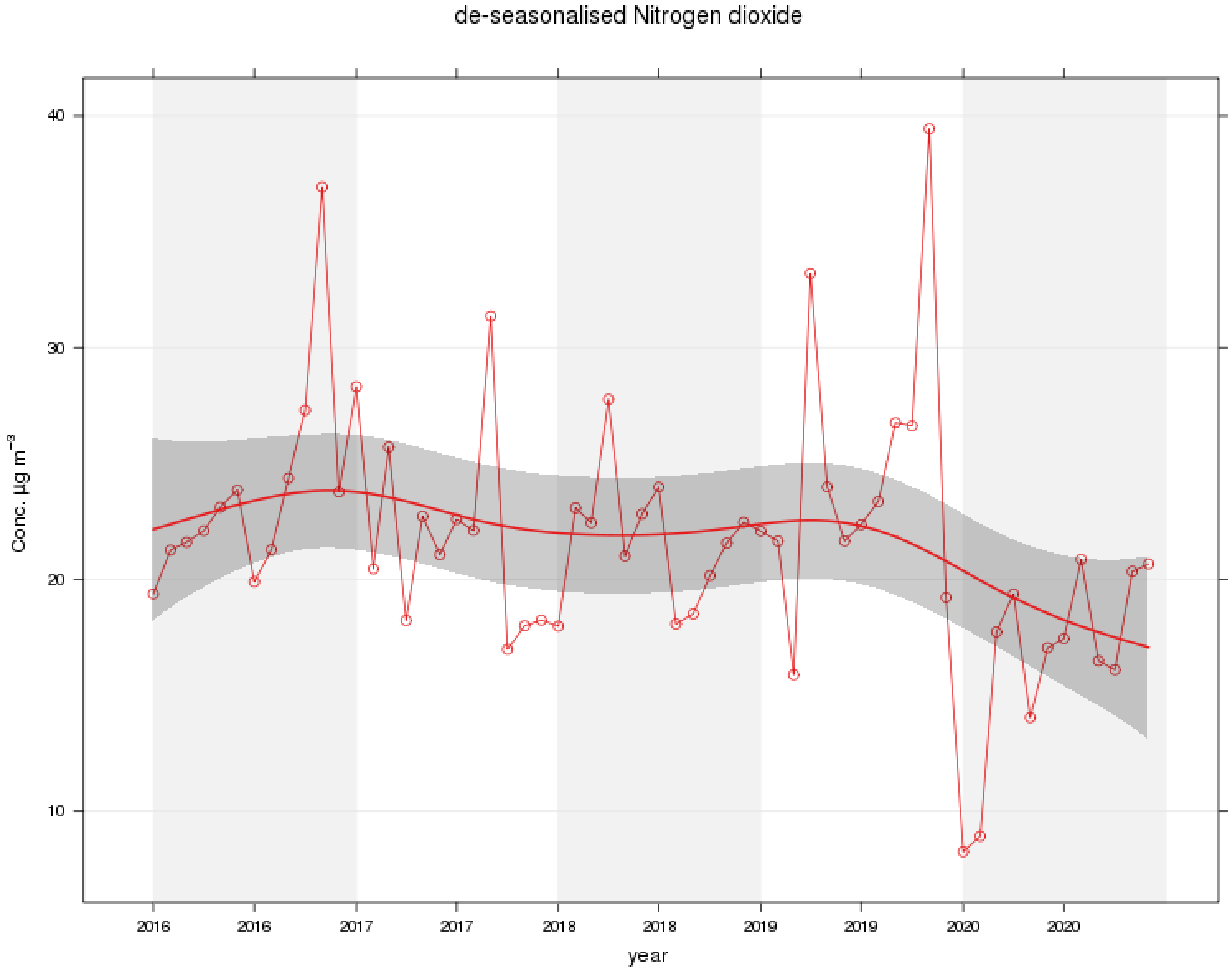


Table A.5 – Annual Mean PM_{10} Monitoring Results ($\mu g/m^3$)

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
A4	Falkirk Haggs	56	56	14	12	14	14	10
A5	Falkirk Hope St	87	87	PM_{10} analyser transferred from Falkirk Grahams Rd to Hope St site on 10/10/2018		11	13	9
A7	Falkirk West Bridge St	38	38	15	10	6	11	8.4
A8	Grangemouth AURN	97	97	11	9	12	13	9
A10	Grangemouth Municipal Chambers	63	63	13	12	12	14	9.6
A14	Banknock 3	63	63	n/n	7	6.9	7.9	7.8
A15	Main St, Bainsford	80	80	10	13	12	14	11

Notes:

Exceedances of the PM_{10} annual mean objective of 18 $\mu g/m^3$ are shown in bold.

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.

(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%).

Table A.6 – 24-Hour Mean PM_{10} Monitoring Results, Number of PM_{10} 24-Hour Means > 50µg/m^3

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
A4	Falkirk Haggs	56	56	0	0	0	4	0 (21)
A5	Falkirk Hope St	87	87	PM10 analyser transferred from Grahams Rd to Hope St on 10/10/2018		0 (30)	1	0
A7	Falkirk West Bridge St	38	38	0	0	0 (47)	1	0 (18)
A8	Grangemouth AURN	97	97	0	1	0	2	0
A10	Grangemouth Municipal Chambers	63	63	0	0	0	2	0 (17)
A14	Banknock 3	63	63	3	0	2 (10)	1	1 (15.6)
A15	Main St, Bainsford	80	80	0 (16)	0	0 (33)	5	0

Notes:

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

If the period of valid data is less than 85%, the 98.1st percentile of 24-hour means is provided in brackets.

(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%).

Figure 8 – A4 Haggs Long Term PM_{10} (24-hour mean) Concentrations

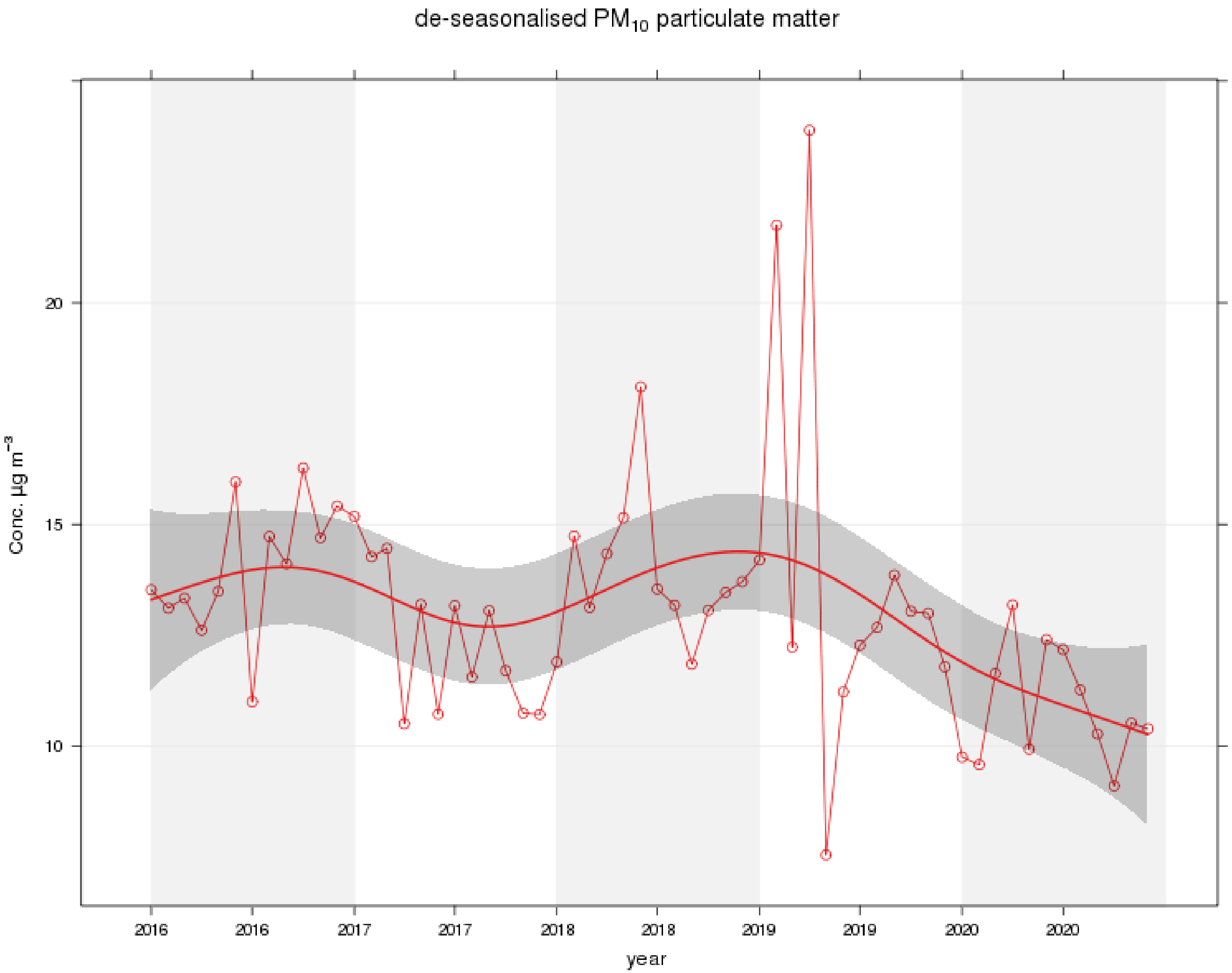


Figure 9 – A5 Falkirk Hope St Long Term PM_{10} (24-hour mean) Concentrations

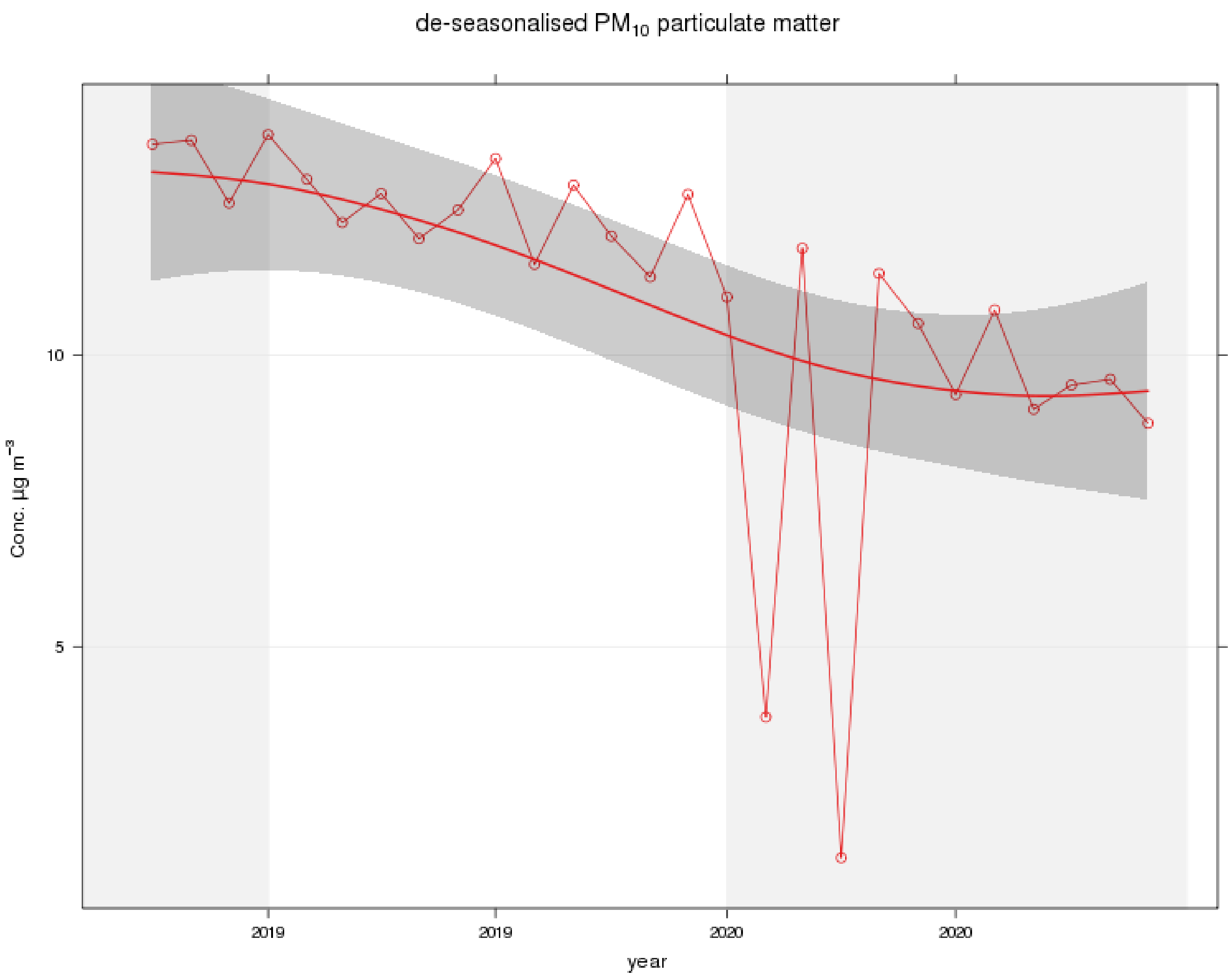


Figure 10 – A7 Falkirk West Bridge St Long Term PM_{10} (24-hour mean) Concentrations

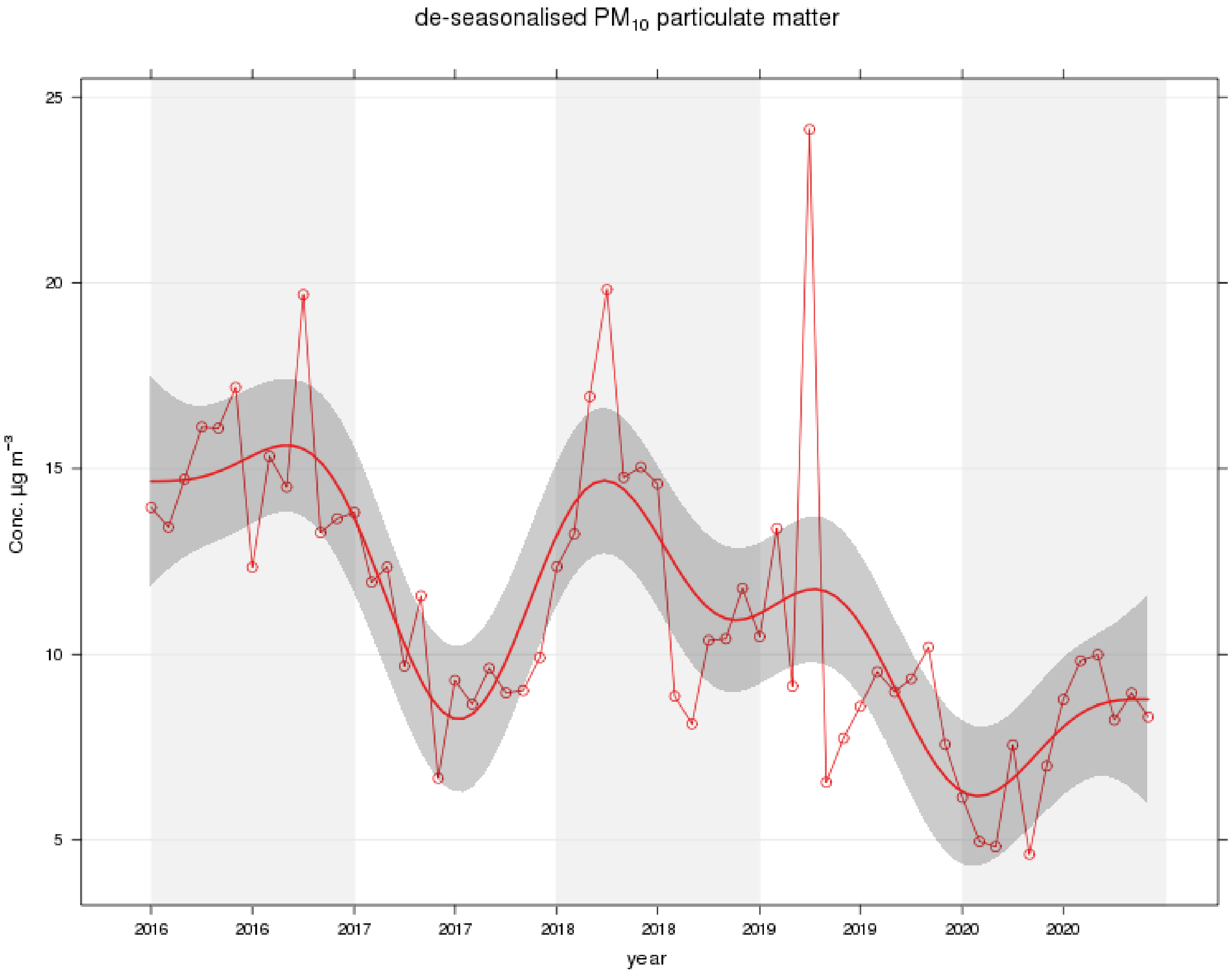


Figure 11 – A8 Grangemouth AURN Long Term PM_{10} (24-hour mean) Concentrations

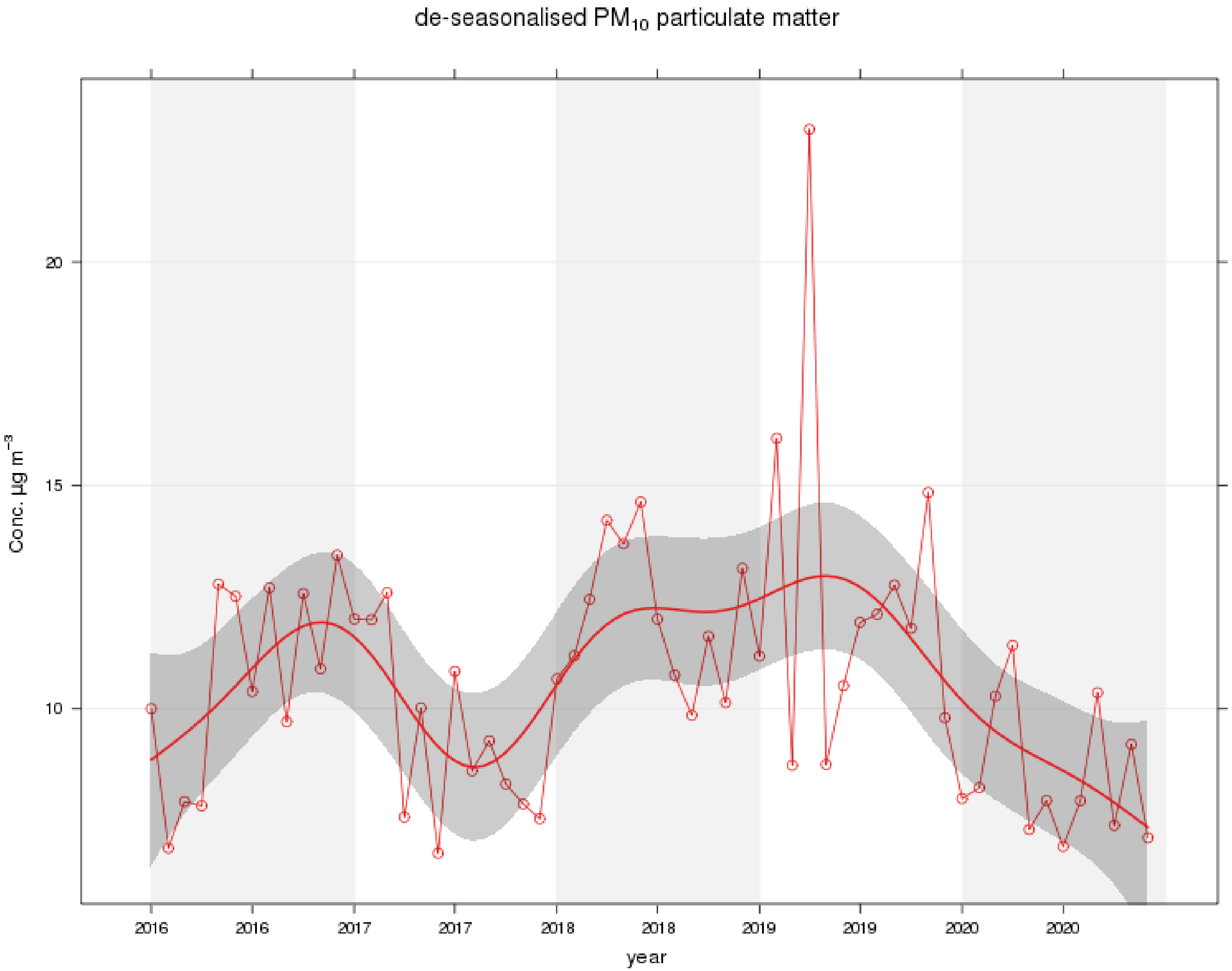


Figure 12 – A10 Grangemouth Municipal Chambers Long Term PM_{10} (24-hour mean) Concentrations

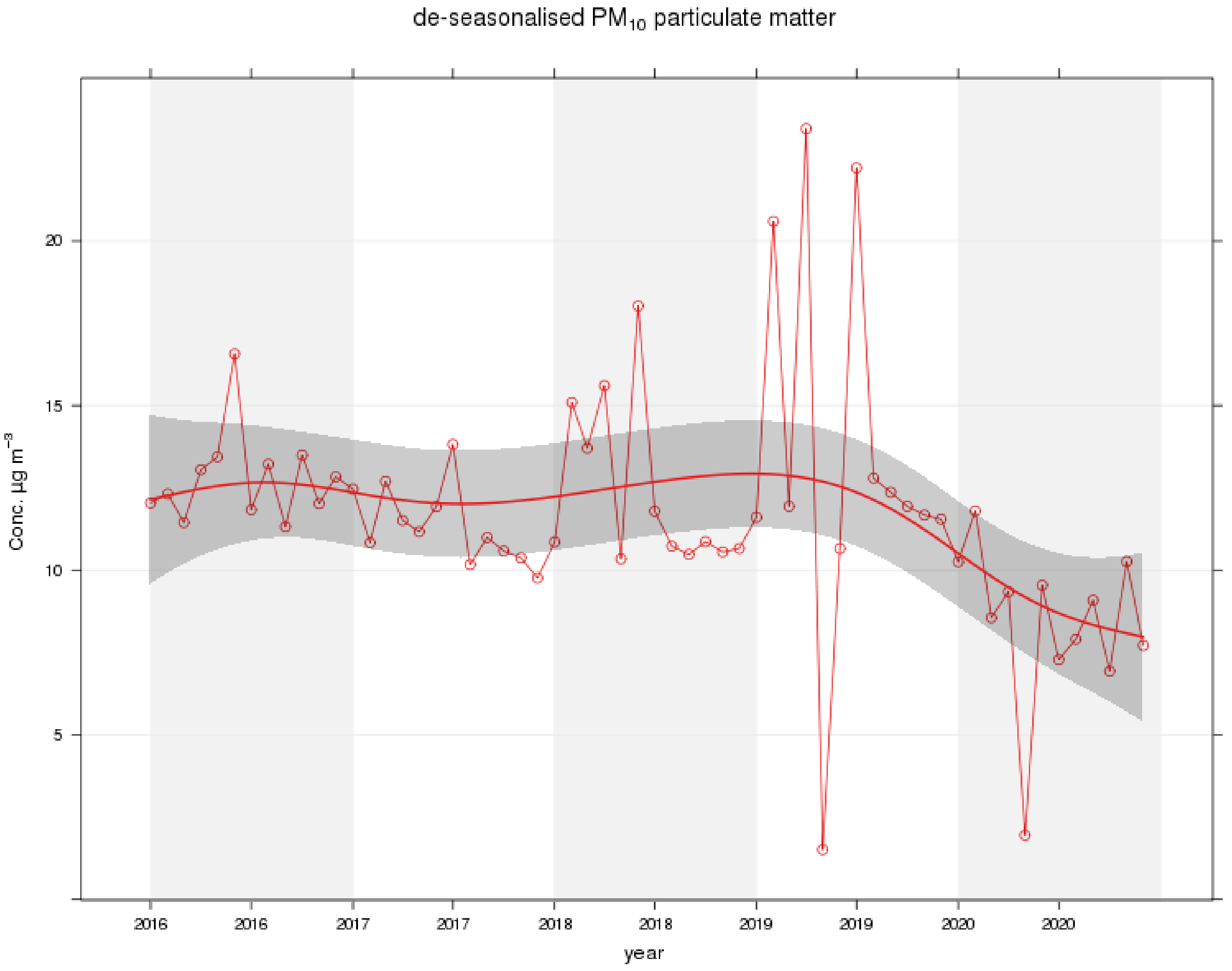


Figure 13 – A15 Main St, Bainsford Long Term PM_{10} (24-hour mean) Concentrations

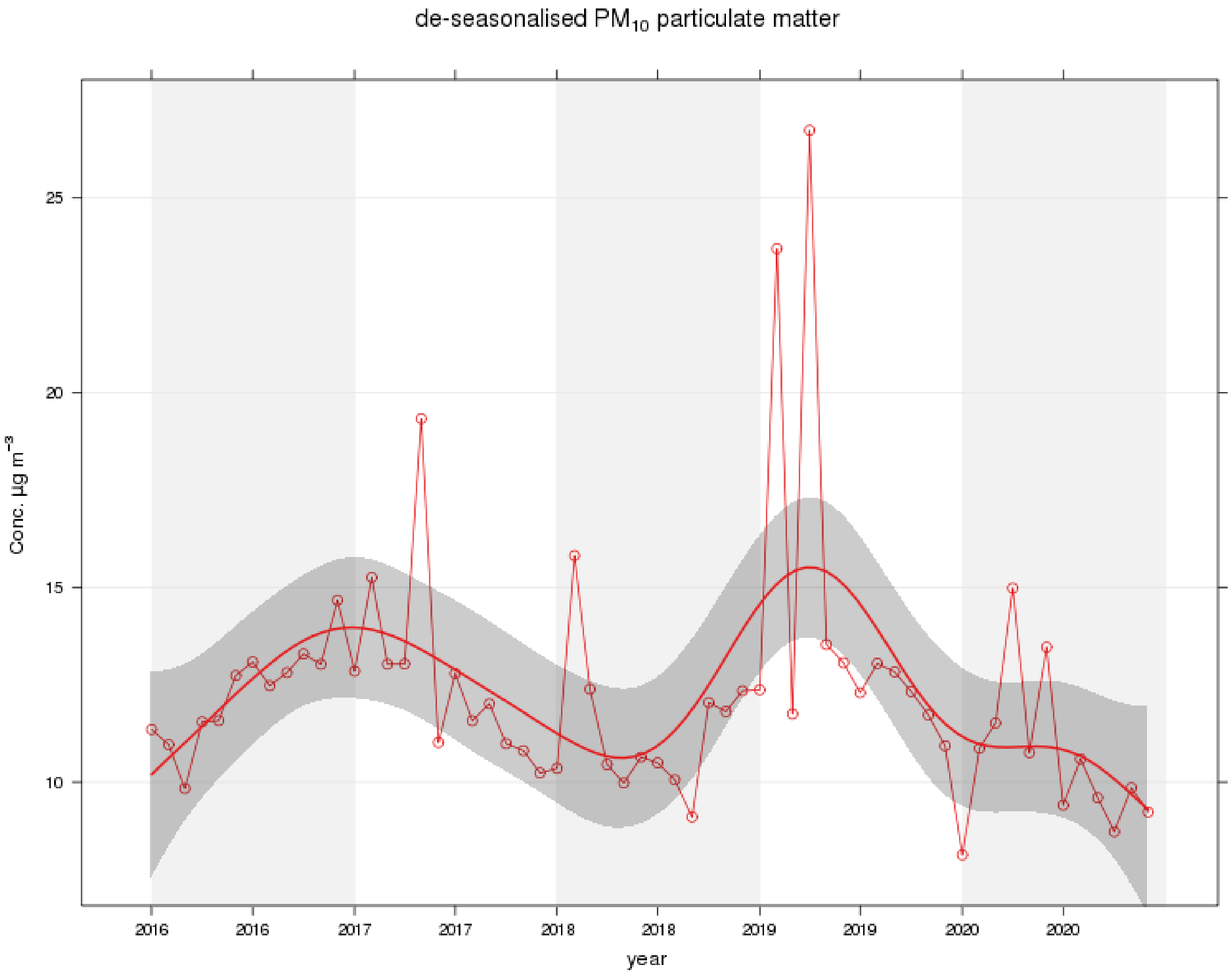


Table A.7 – Annual Mean $PM_{2.5}$ Monitoring Results ($\mu g/m^3$)

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
A4	Falkirk Haggs	29	29					6
A5	Falkirk Hope Street	87	87					5.1
A7	Falkirk West Bridge St	38	38	6	6	6	6	4.4
A8	Grangemouth AURN	94	94	6	6	7	8	6
A10	Grangemouth Municipal Chambers	63	63					4.4
A14	Banknock 3	63	63	n/a	3	4	4.6	3.6
A15	Main Street, Bainsford	80	80					6.2

Notes:

Exceedances of the $PM_{2.5}$ annual mean objective of 10 $\mu g/m^3$ are shown in bold.

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.

(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%).

Figure 15 – A7 Falkirk West Bridge St Long Term $PM_{2.5}$ Concentrations

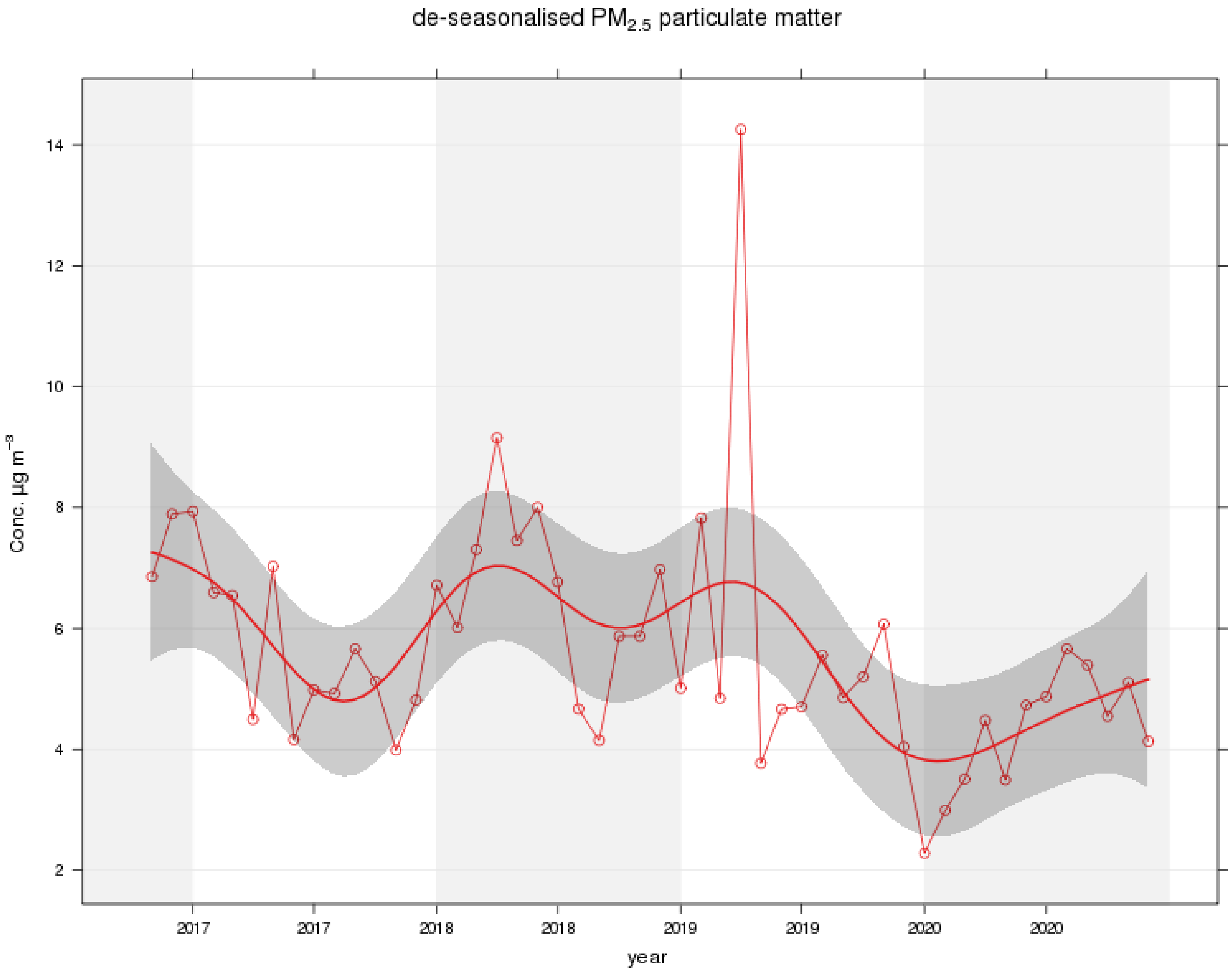


Figure 16 – A8 Grangemouth AURN Long Term $PM_{2.5}$ Concentrations

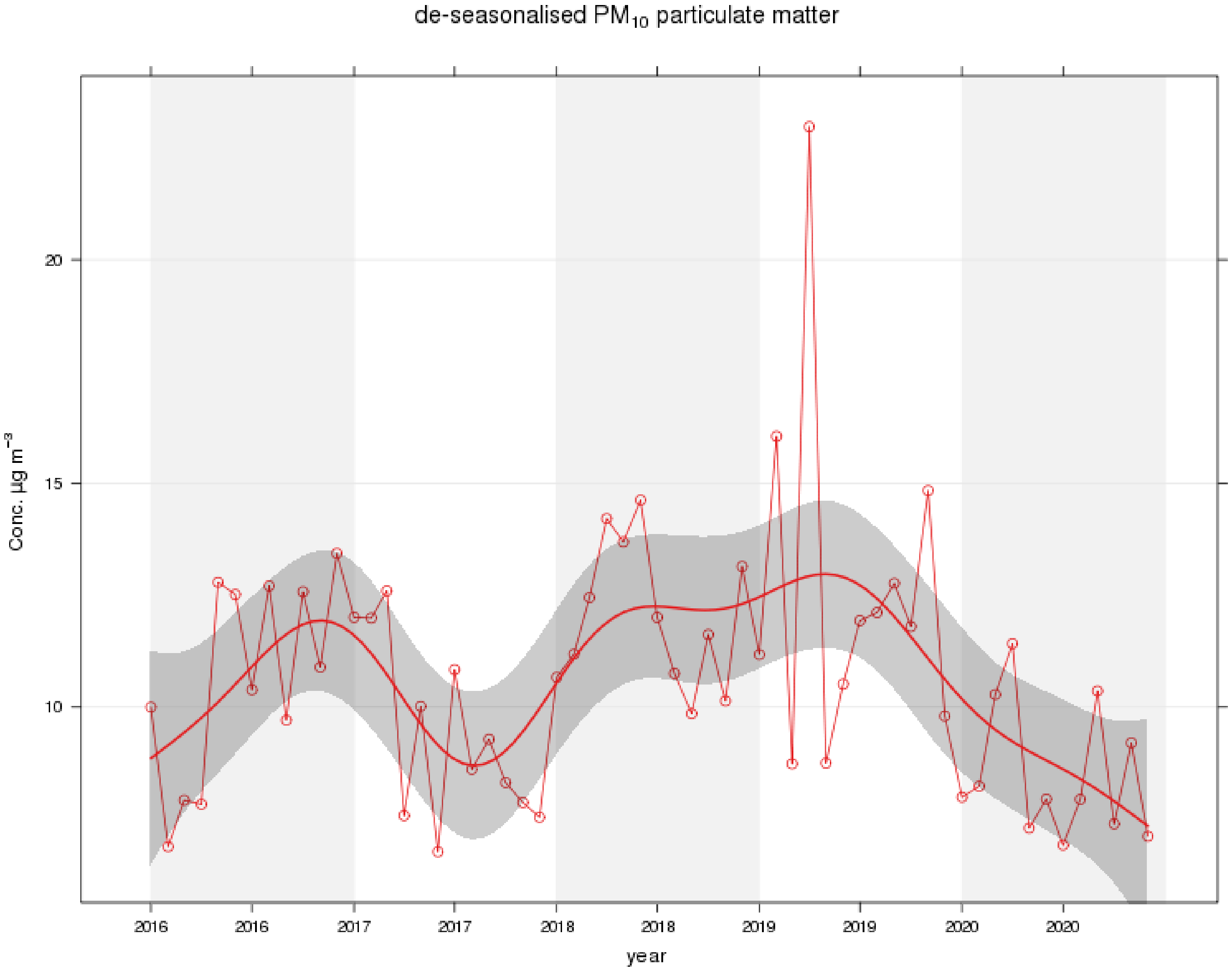


Table A.8 – SO_2 2020 Monitoring Results, Number of Relevant Instances

Site ID	Site Type	Valid Data Capture for monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	Number of 15-minute Means > 266 µg/m	Number of 1-hour Means > 350 µg/m	Number of 24-hour Means > 125 µg/m
A3	Bo’ness	97	97	0	0	0
A5	Falkirk Hope St	94	94	0	0	0
A8	Grangemouth AURN	96	96	6	0	0
A9	Grangemouth Moray	89	89	0	0	0
A10	Grangemouth Municipal Chambers	96	96	0	0	0
A11	Grangemouth Zetland Park	95	95	0	0	0

Notes:

Exceedances of the SO_2 objectives are shown in bold (15-min mean = 35 allowed a year, 1-hour mean = 24 allowed a year, 24-hour mean = 3 allowed a year)

If the period of valid data is less than 85%, the relevant percentiles are provided in brackets (15-Minute means: 99.9th percentile, 1-hour means: 99.7th percentile, 24-hour means: 99.2nd percentile).

(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%).

Figure 18 – A3 Bo'ness Long Term SO_2 Concentrations

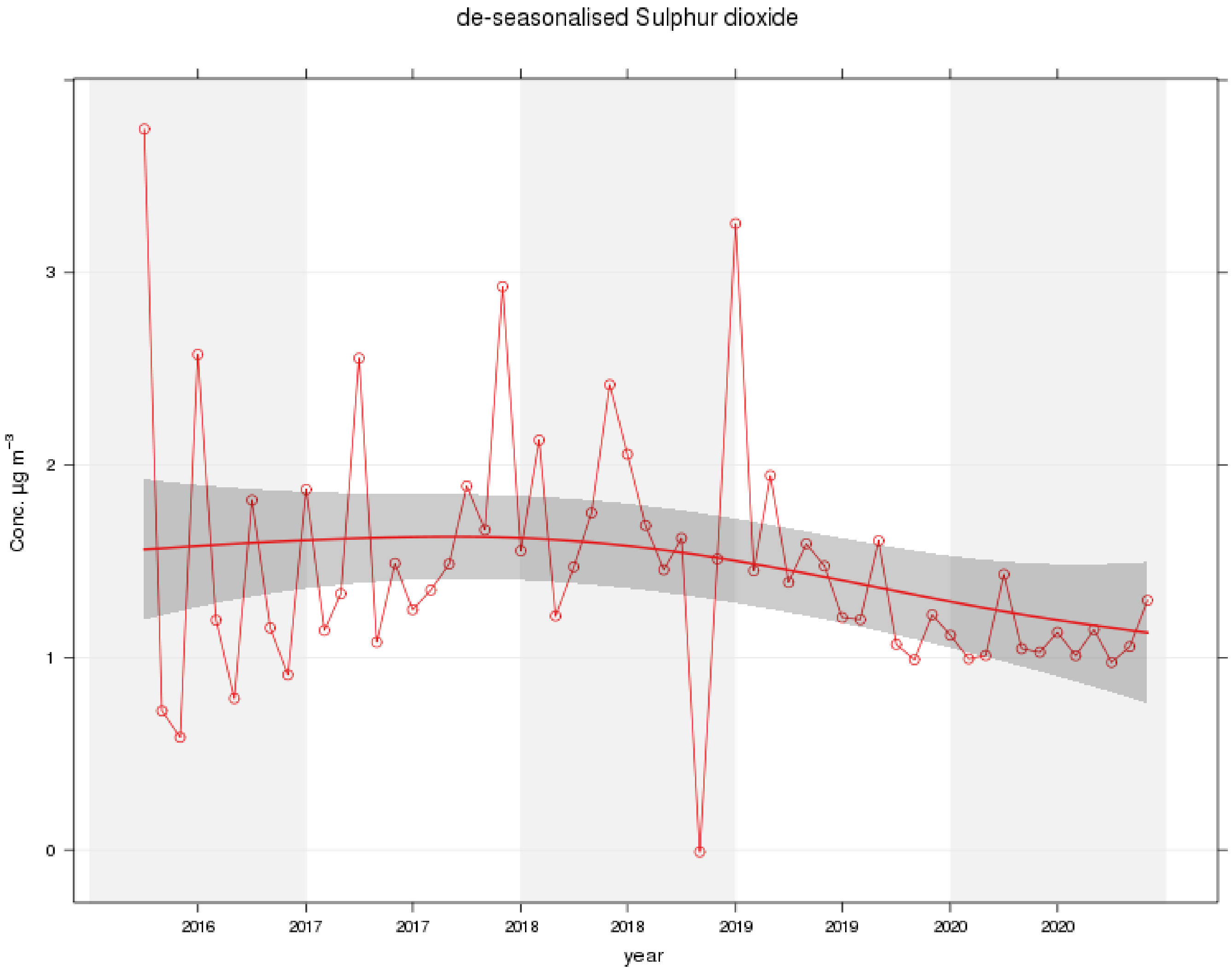


Figure 19 – A5 Falkirk Hope St Long Term SO_2 Concentrations

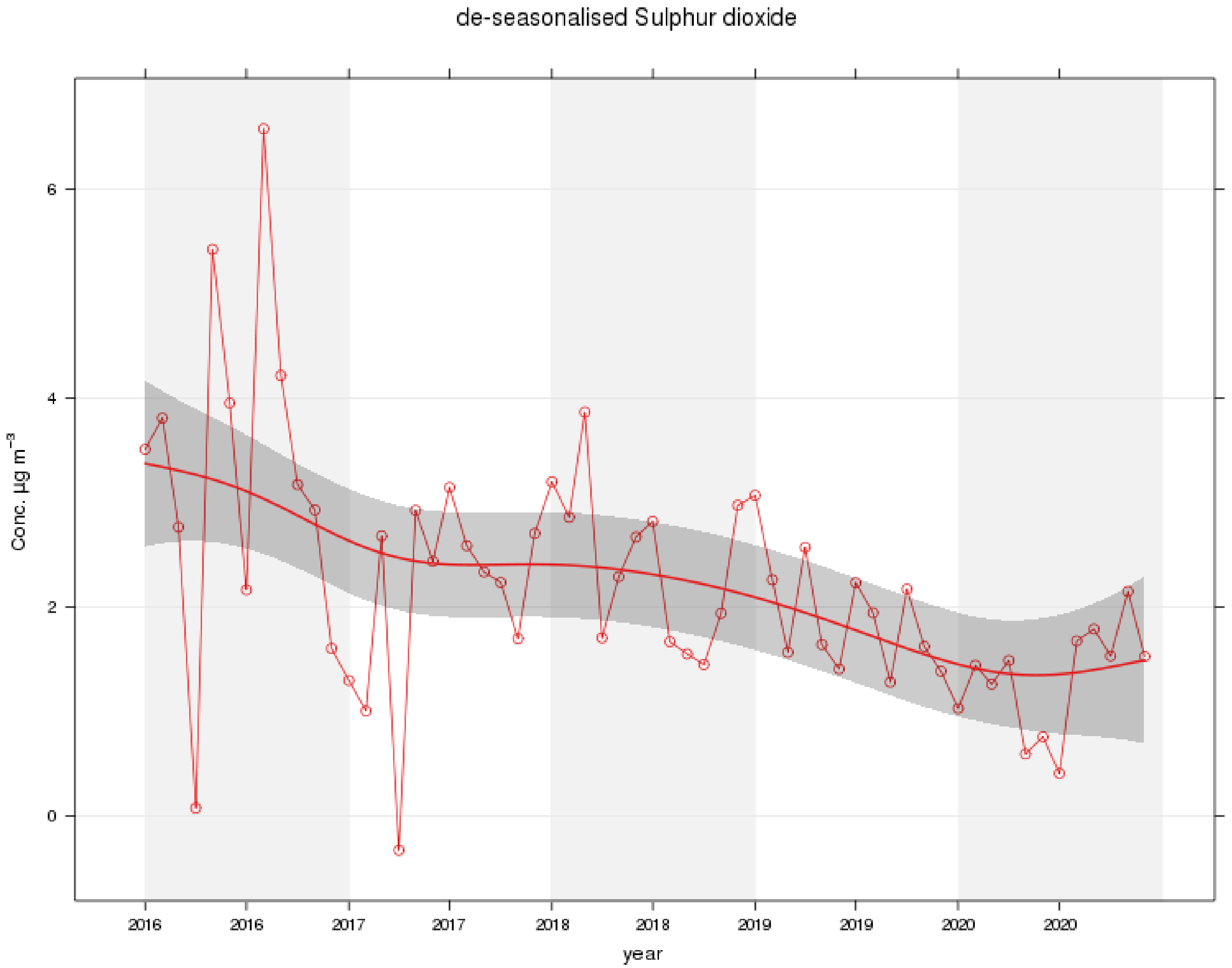


Figure 20 – A8 Grangemouth AURN Long Term SO_2 Concentrations

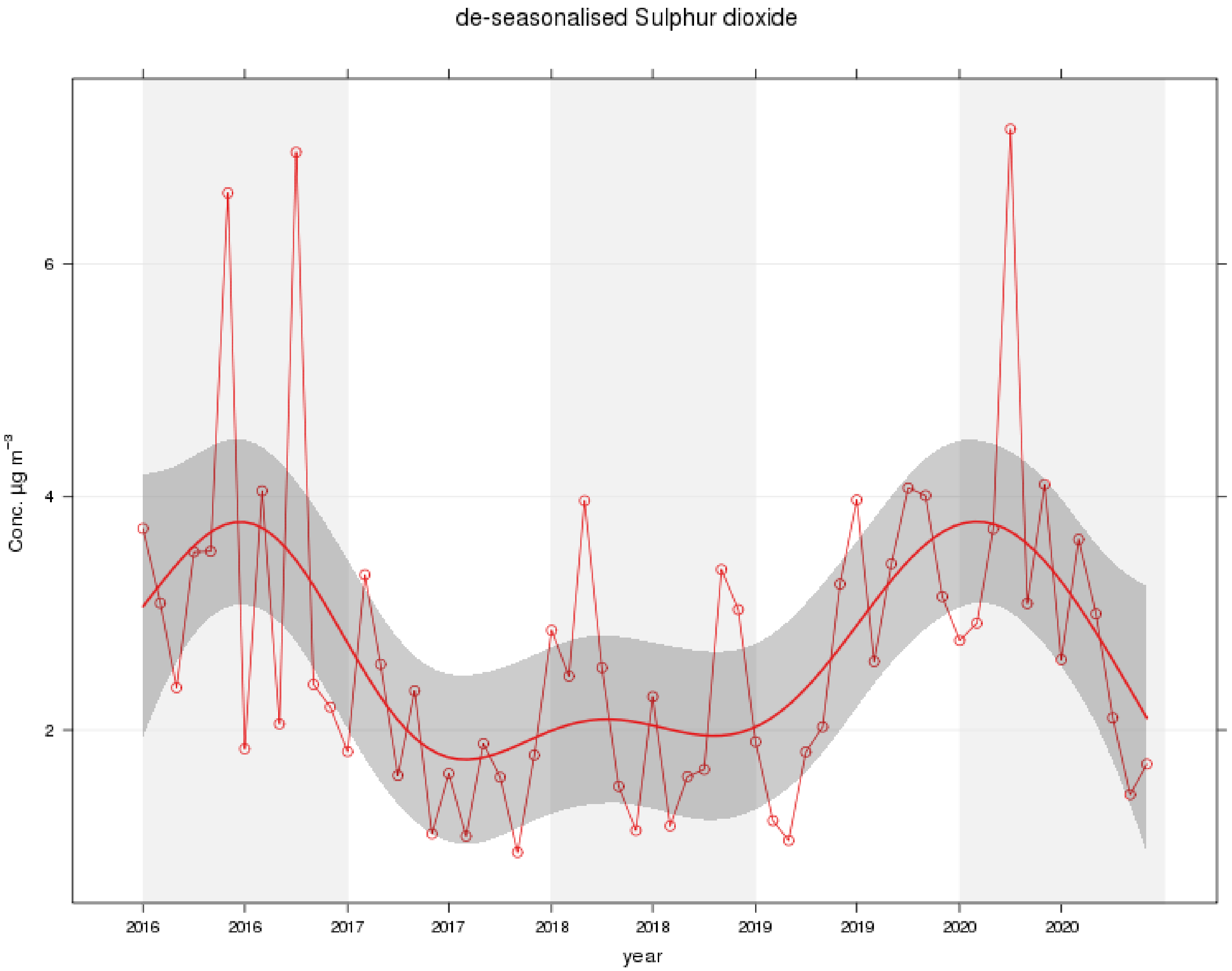


Figure 21 – A9 Grangemouth Moray Long Term SO_2 Concentrations

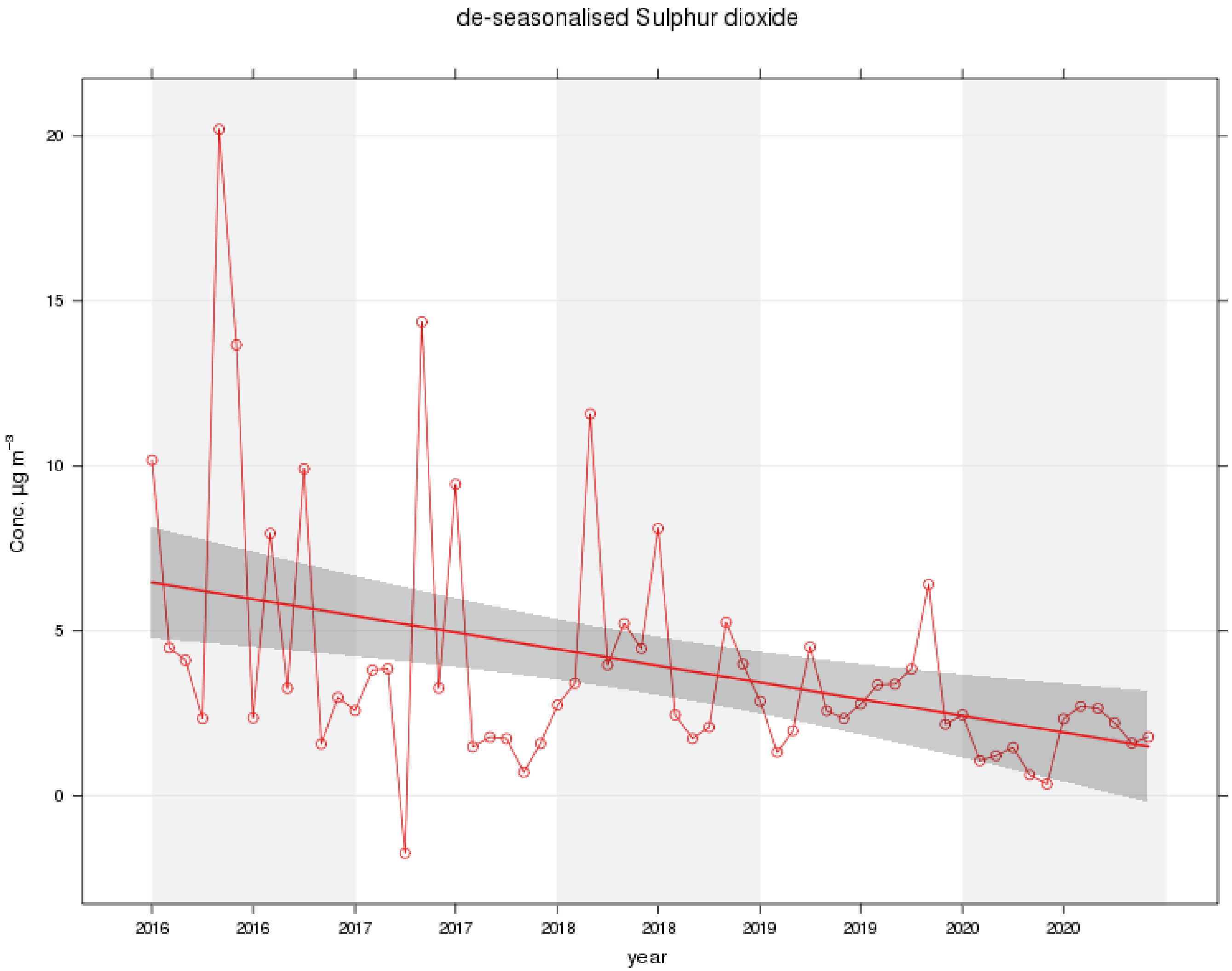


Figure 22 – A10 Grangemouth Municipal Chambers Long Term SO_2 Concentrations

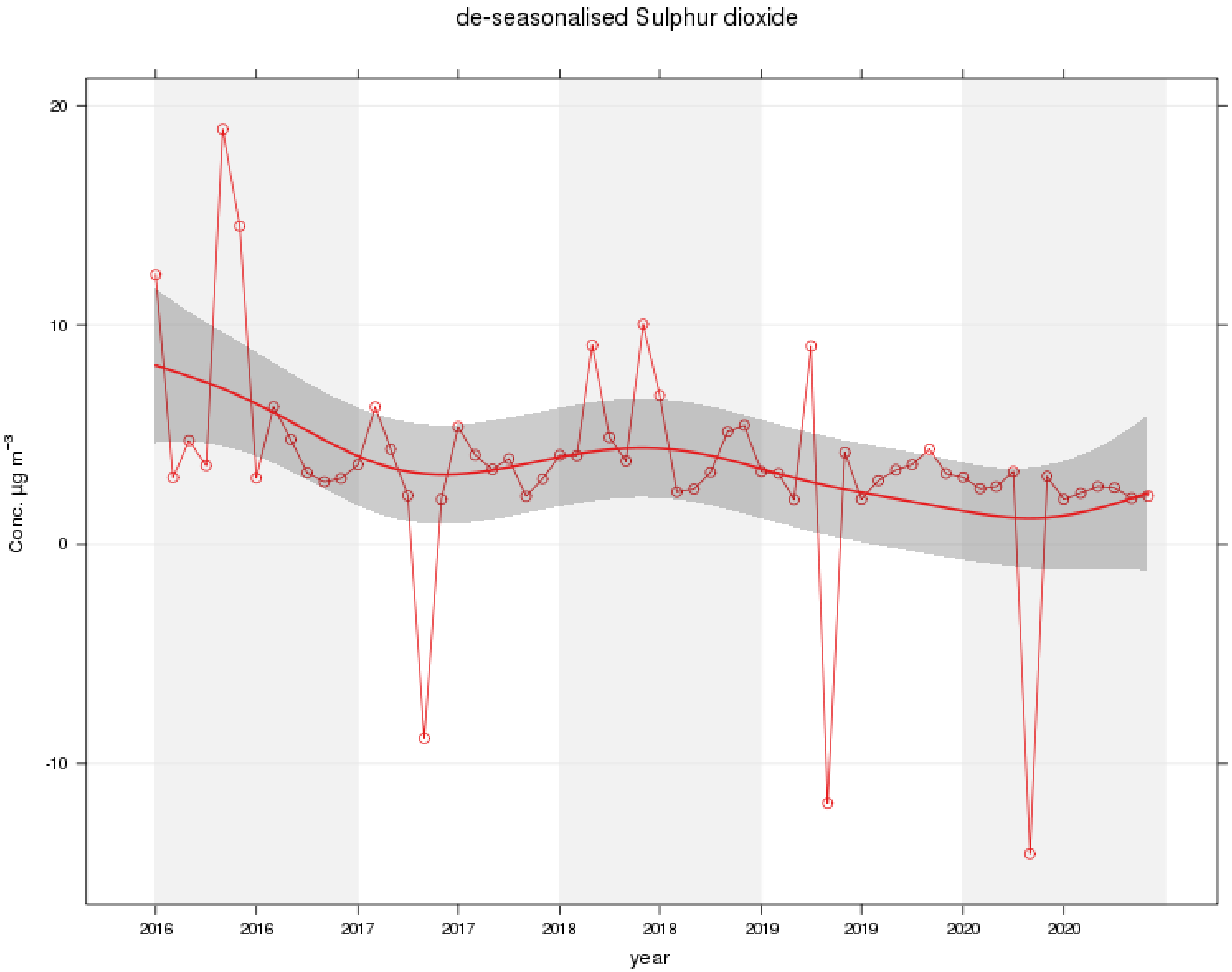


Figure 23 – A11 Grangemouth Zetland Park Long Term SO_2 Concentrations

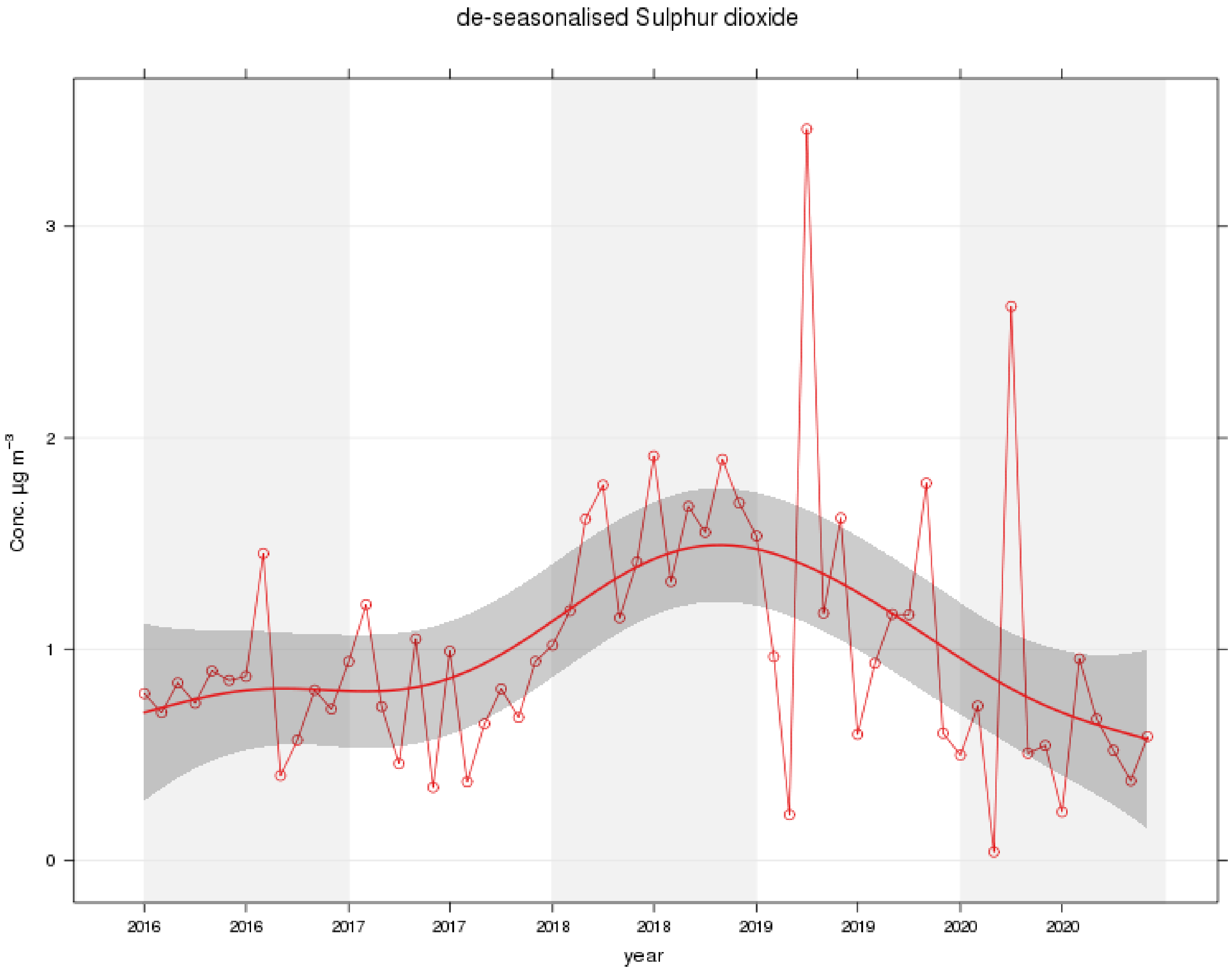
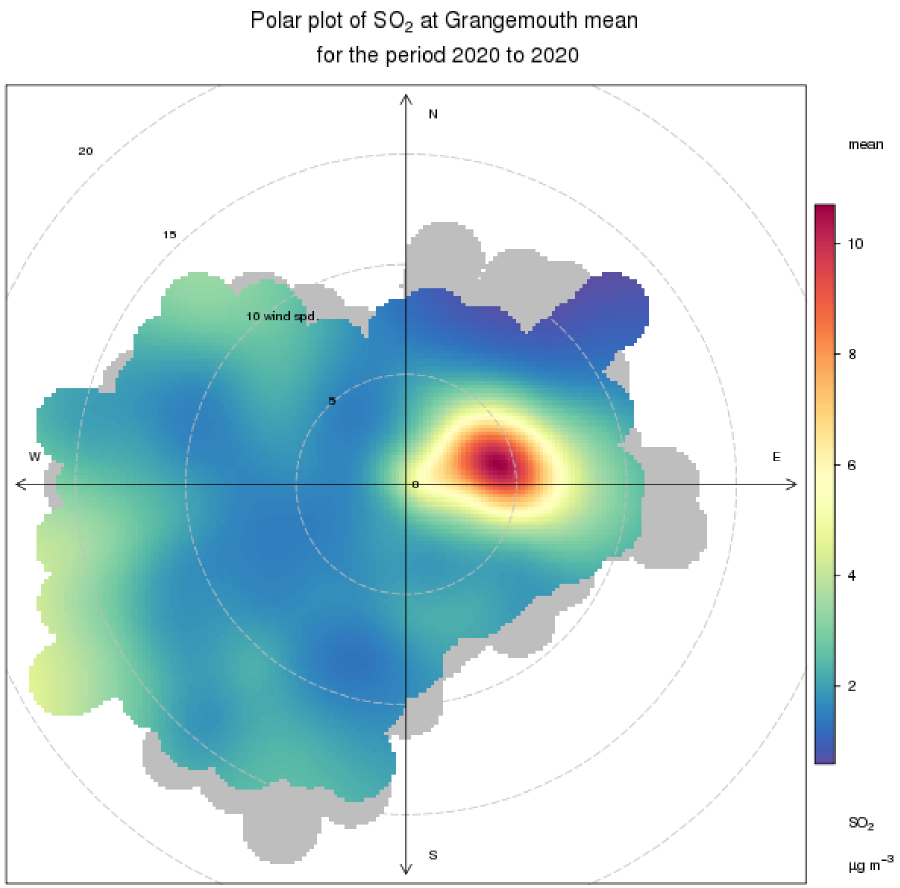
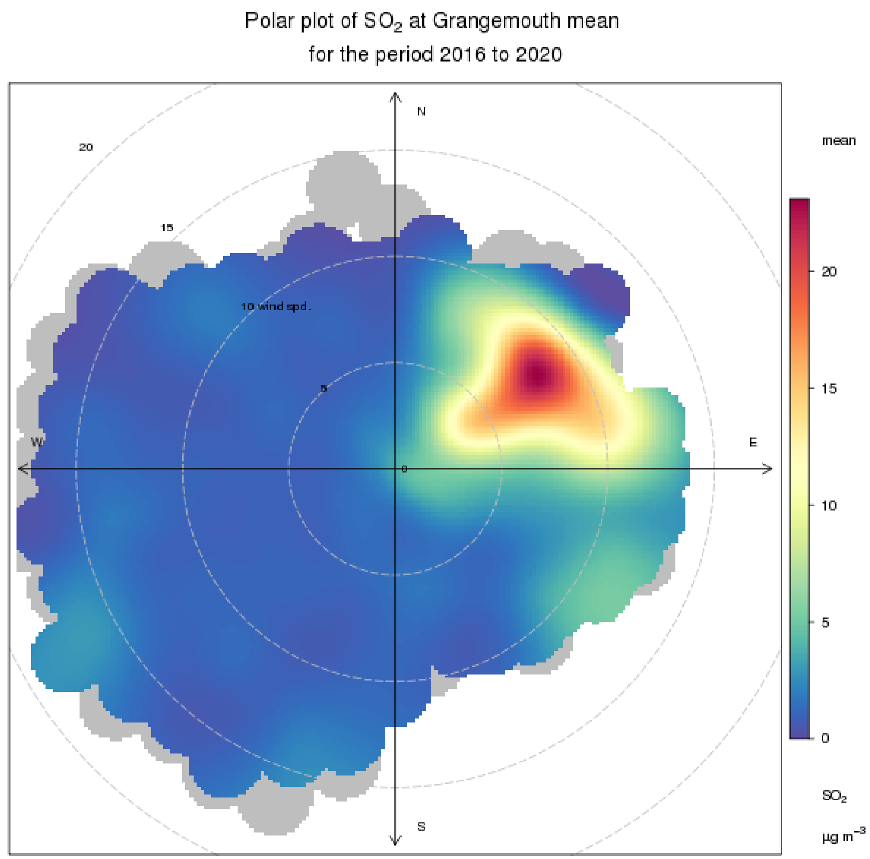


Figure 24 – Polar Plots of Average SO_2 Concentrations Recorded at the Grangemouth Sites

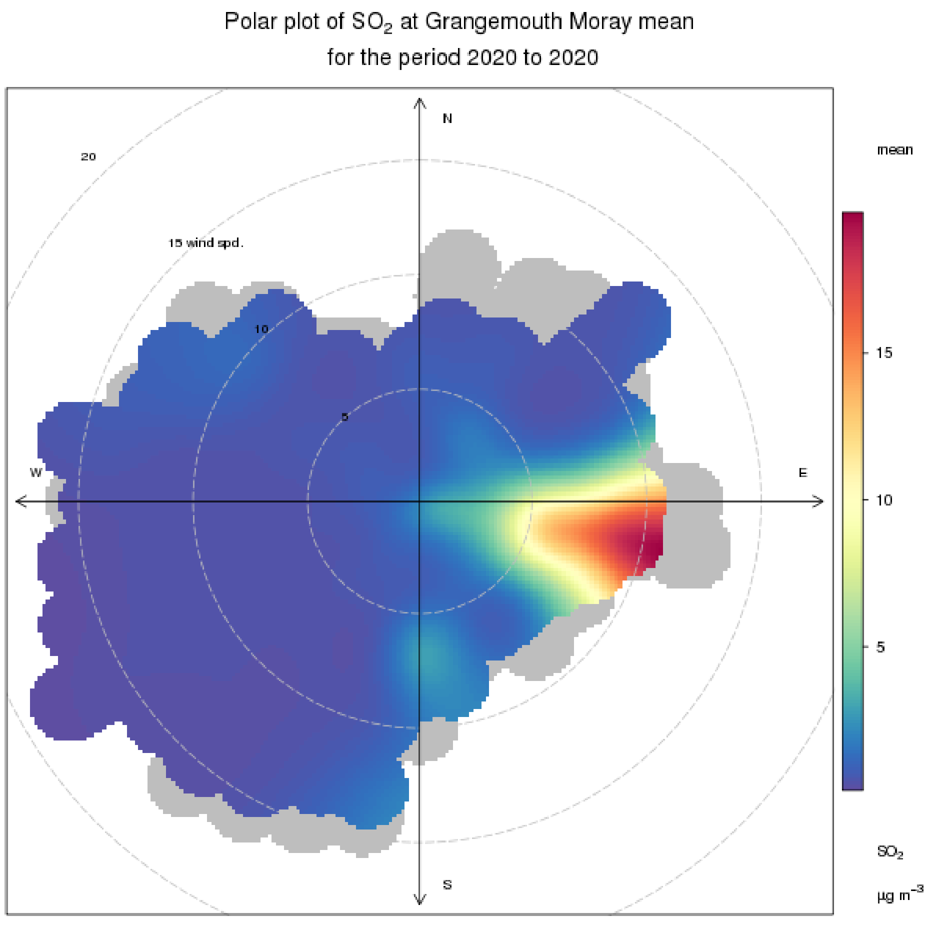
A) Grangemouth AURN: 2020



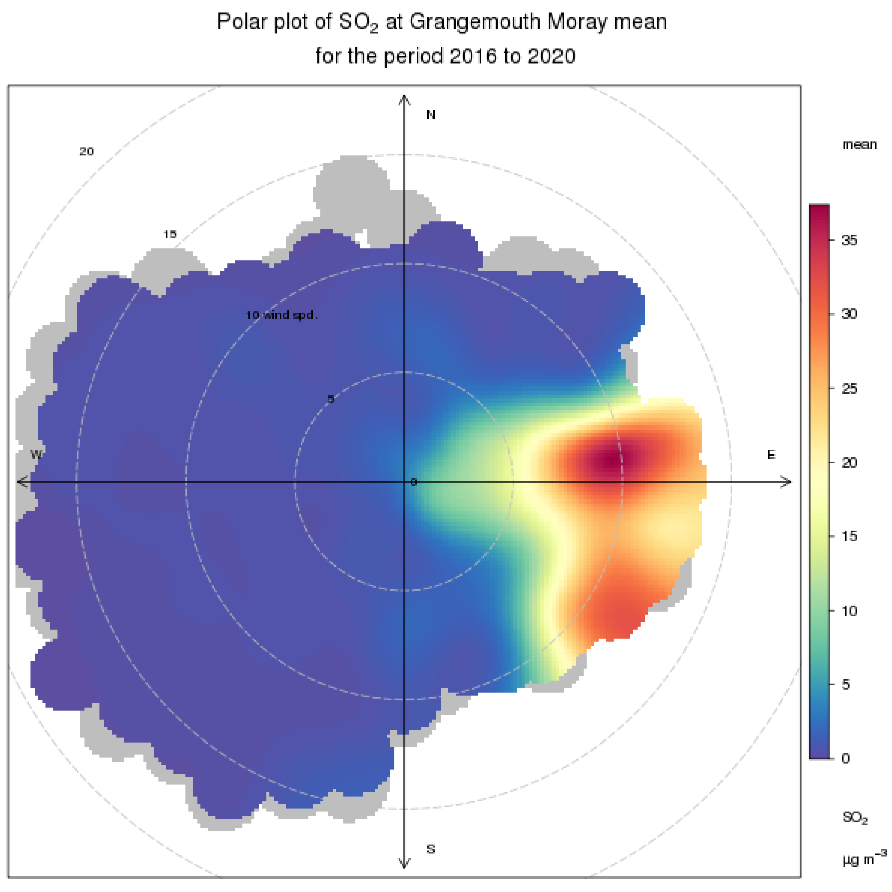
B) Grangemouth AURN: 2016 – 2020



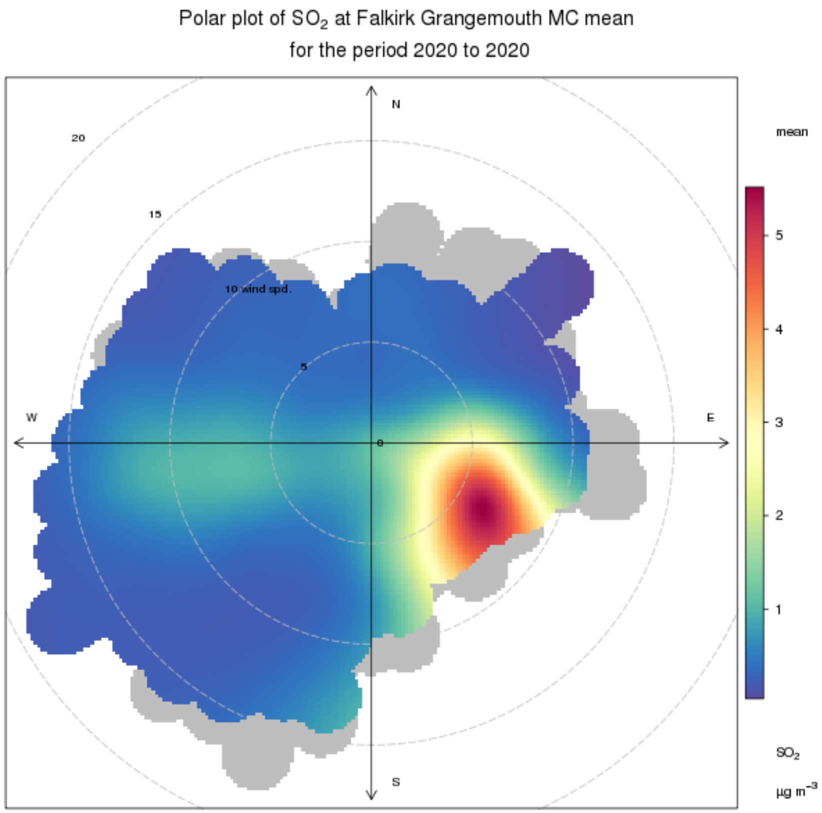
C) Grangemouth Moray: 2020



D) Grangemouth Moray 2016 – 2020



E) Grangemouth Municipal Chambers: 2020



F) Grangemouth Municipal Chambers: 2016 – 2020

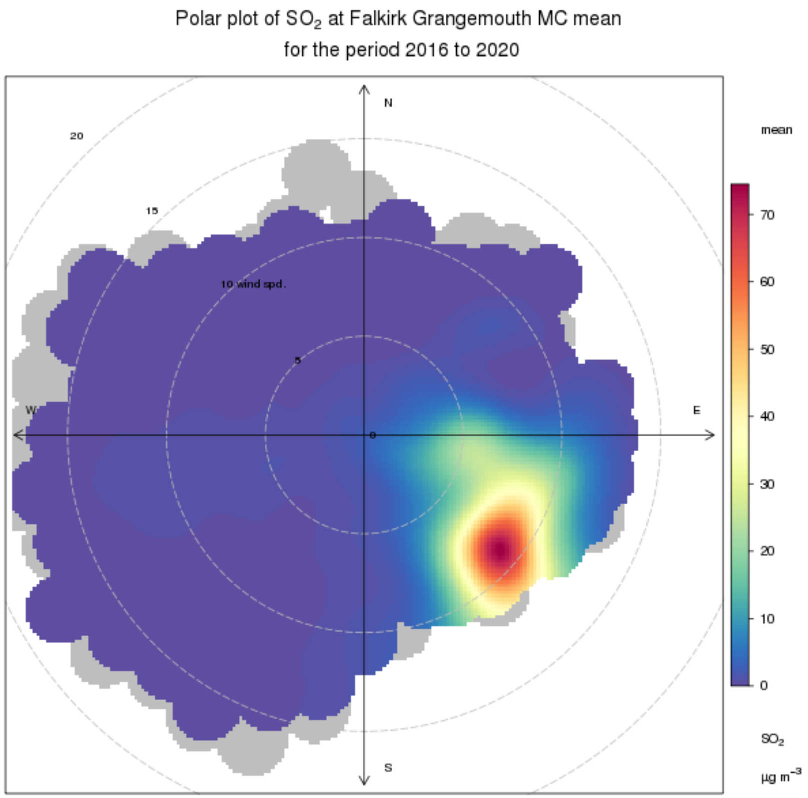


Figure 25 – Exceedances of the 15 Minute SO_2 NAQS Objective Concentration at the Grangemouth Sites 2016 – 2020

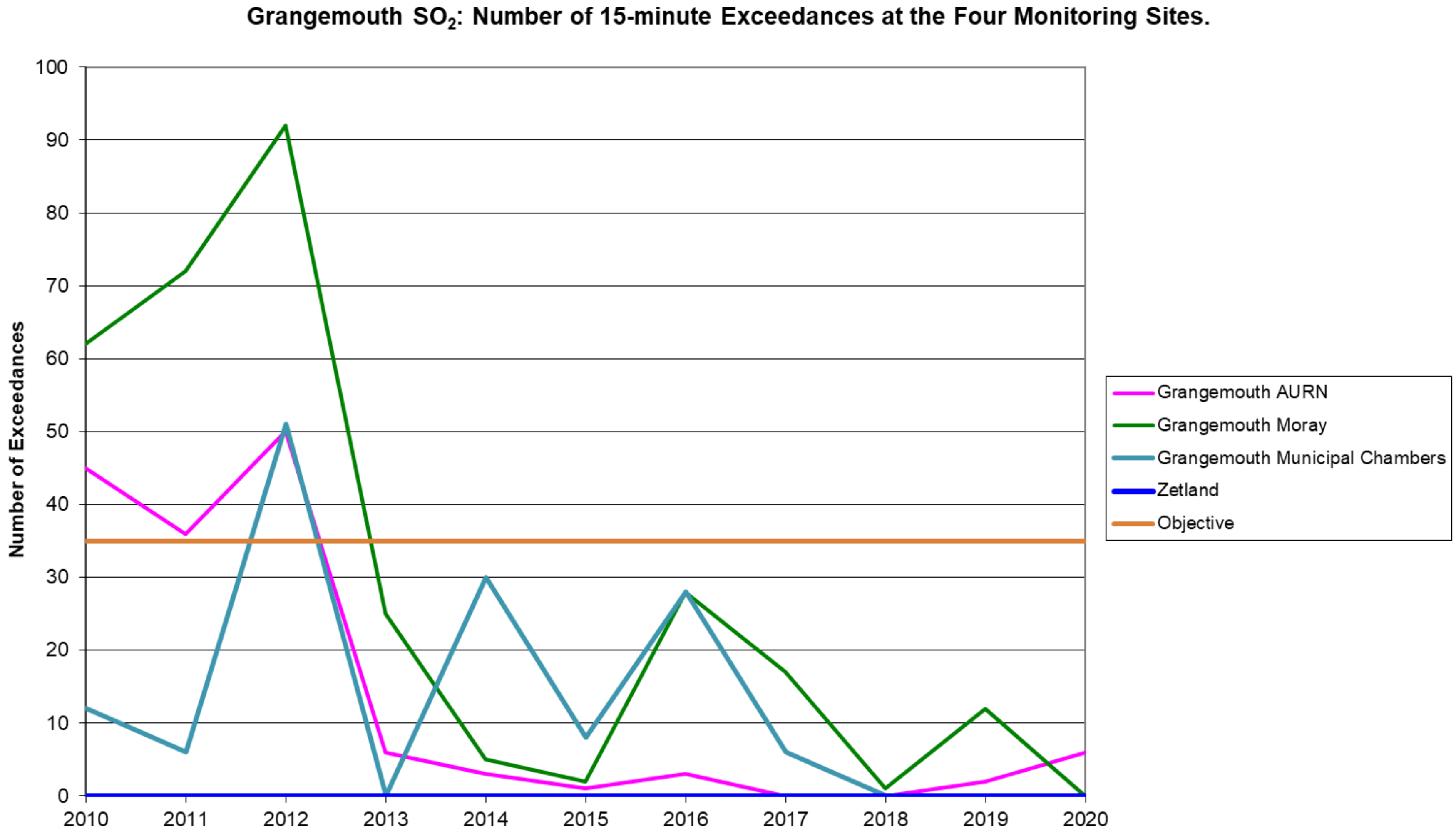


Table A.9 – 1, 3 Butadiene Annual Mean Diffusion Tube Results for 2020

Site ID	Location	Within 1, 3 Butadiene AQMA?	Data Capture in 2020, %. (1)	Annual Mean Concentrations (µg/m^3)				
				2016	2017	2018	2019	2020
NA41	Seaview Place, Bo'ness	N	100	0.10	0.1	0.06	0.05	0.05
NA55	Inchyra Station, Grangemouth	N	100	0.10	0.07	0.07	0.05	0.06
NA104	Powdrake Road, Grangemouth	N	100	0.11	0.1	0.11	0.05	0.05

Note: Exceedances of the 1, 3 butadiene running annual mean NAQS objective are shown in **bold.**

Table A.10 – Benzene Annual Mean Diffusion Tube Results for 2020

Site ID	Location	Within AQMA?	Data Capture in 2020, %. (1)	Annual Mean Concentrations (µg/m^3)				
				2016	2017	2018	2019	2020
NA3	Tinto Drive, Grangemouth	N	91	0.51	0.58	0.66	0.8	0.48
NA21	Grangemouth Road, Falkirk College	N	91	0.46	0.56	0.6	0.65	0.43
NA27	West Bridge Street, Falkirk	N	91	0.78	0.68	0.7	1.07	0.61
NA37	Denny Town House	N	91	0.58	0.56	0.49	0.77	0.43
NA38	Larbert Village Primary School	N	83	0.51	1.01	0.5	0.51	0.45
NA41	Seaview Place, Bo'ness	N	83	1.11	0.82	0.91	0.96	0.63
NA42	Municipal Chambers, Grangemouth	N	91	0.79	0.47	0.63	0.78	0.45
NA44	Harvey Avenue, Polmont	N	83	0.48	0.39	0.52	0.67	0.38
NA55	Inchyra AQ Station, Grangemouth	N	91	0.46	0.52	0.52	0.73	0.49
NA77	Kinnaird Village	N	91	0.44	0.51	0.44	0.59	0.41
NA80	Cow Wynd, Falkirk	N	91	0.56	0.57	0.52	0.66	0.46
NA81	Grahams Road, Falkirk	N	91	0.95	0.7	0.81	0.97	0.62
NA94	A905 (Glensburgh Rd), Grangemouth	N	91	0.78	0.64	0.68	0.77	0.46
NA105	West of Shieldhill	N	83	0.19	0.69	0.3	0.4	0.25
NA116	Kersiebank Avenue, Grangemouth	Y	91	New site for 2019			0.76	0.46
NA117	Oswald Avenue (East), Grangemouth	Y	91	New site for 2019			0.99	0.53

Note: Exceedances of the Benzene running annual mean objective of 3.25µg/m^3 are shown in **bold.**

Table A.11 – Pumped Benzene Annual Mean Results for 2020

Site ID	Location	Within AQMA?	Data Capture in 2020, % (1)	Annual Mean Concentrations ($\mu g/m^3$)				
				2016	2017	2018	2019	2020
A8	Grangemouth AURN	Y	100	0.64	0.65	0.74	0.78	0.53

Note: Exceedances of the Benzene running annual mean objective of 3.25$\mu g/m^3$ are shown in bold.

Table A.12 – Estimated Annual Mean $PM_{2.5}$ Results for 2020

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture in 2020 (%) (2)	Correction Factor	Estimated $PM_{2.5}$ Annual Mean Concentration (µg/m^3) (3)				
					2016	2017	2018	2019	2020
A5 Falkirk Hope St	Roadside (Urban)	87	87	0.55	PM_{10} analyser not operating at this site		**11**	7.1	5.1
A15 Main St, Bainsford	Roadside (Urban)	80	80	0.55	6.00	7.80	**12**	7.7	6.2

Note: Exceedences of the $PM_{2.5}$ annual mean objective of 10µg/m^3 are shown in **bold.**

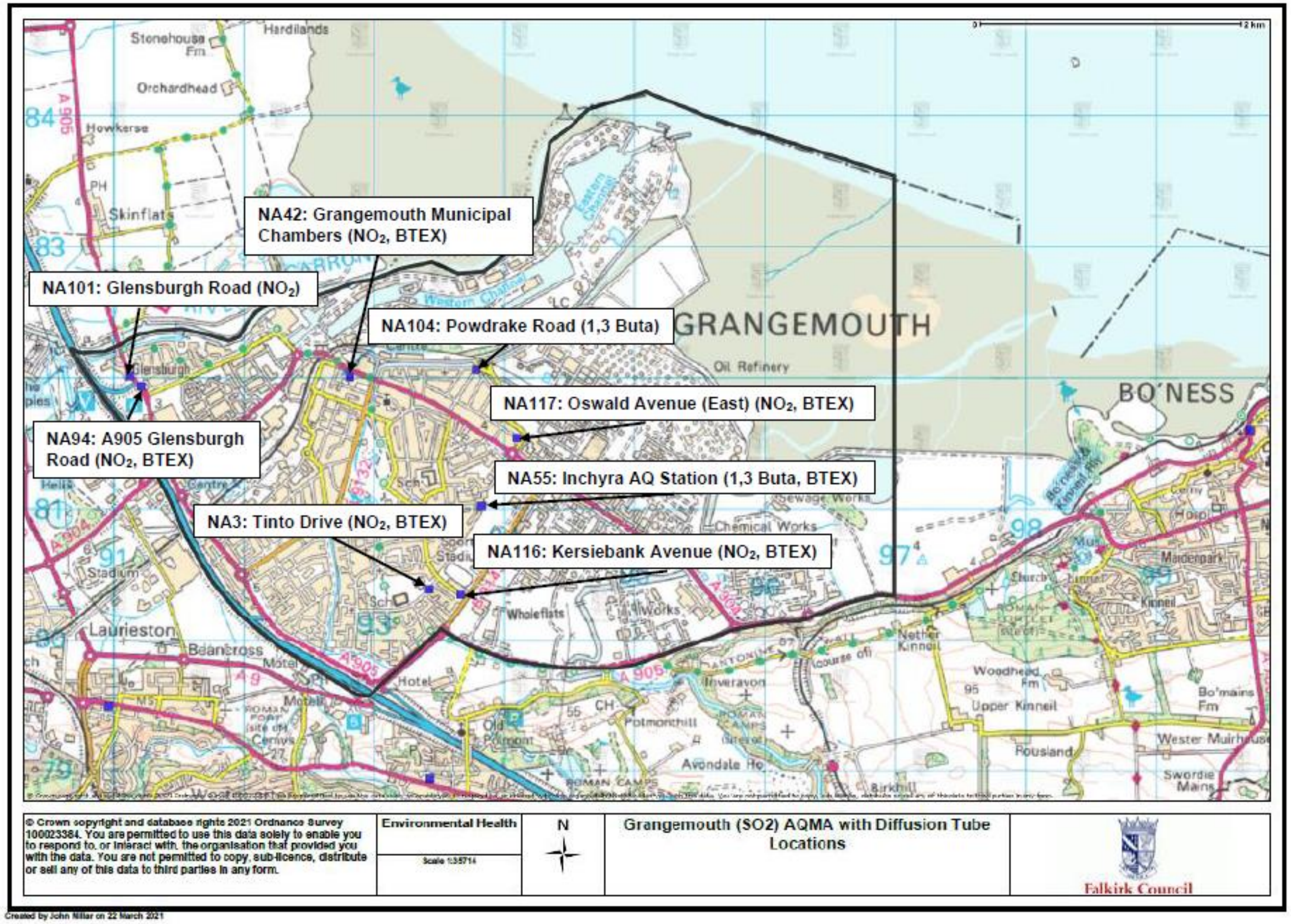
(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(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%)

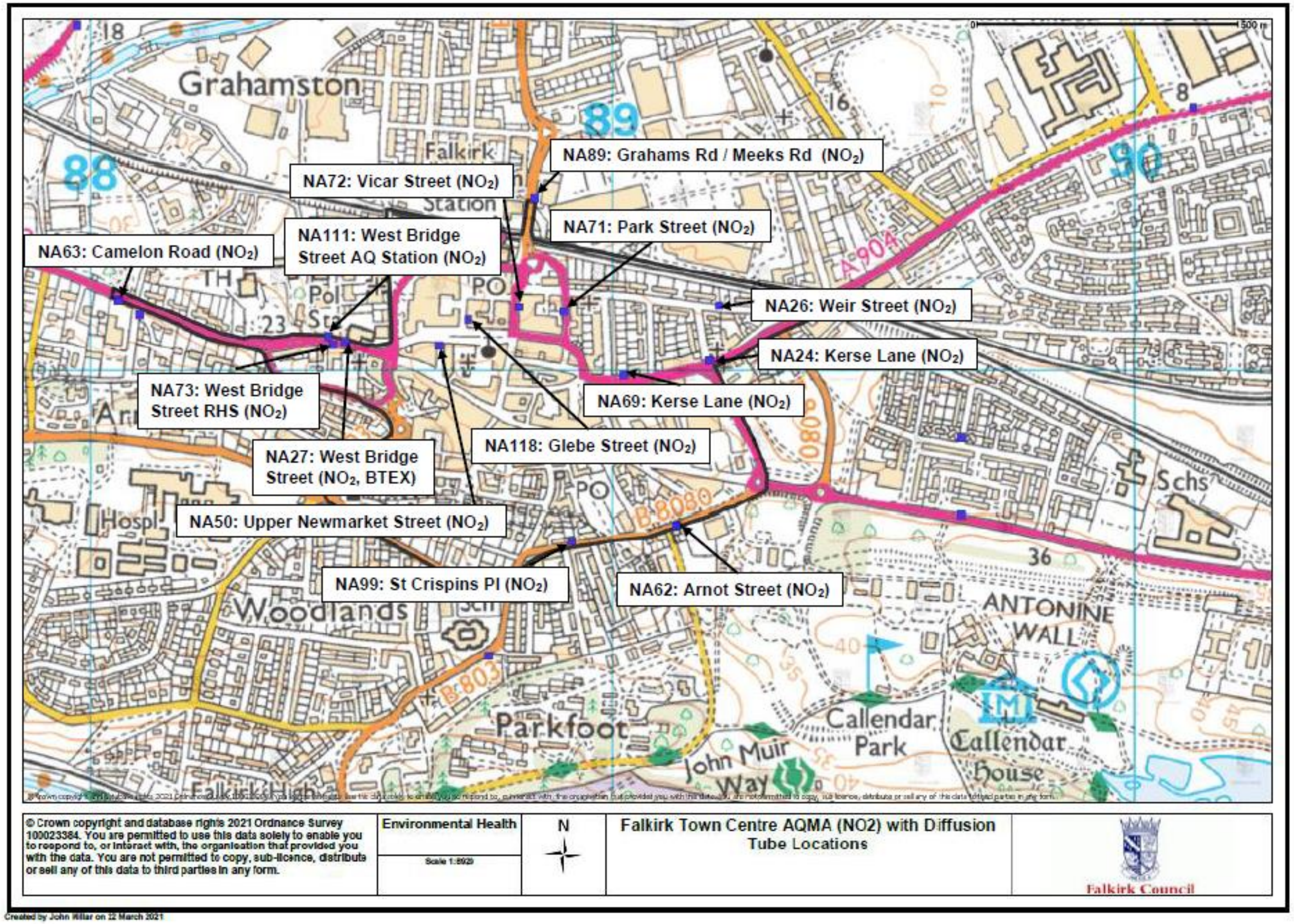
(3) All means have been estimated using a local correction factor as per LAQM.TG (16)[1]. See Appendix C for details.

Figure 26 – Maps of the AQMA Boundaries in the Falkirk Council Area

A) Grangemouth AQMA (SO_2, 15min mean) with relevant diffusion tube locations, declared November 2005



B) Falkirk Town Centre AQMA (NO_2 Annual Mean, PM_{10} annual and 24-hour mean) with relevant diffusion tube locations, declared March 2010



C) Haggs AQMA (NO_2 annual mean), with relevant diffusion tube locations declared March 2010

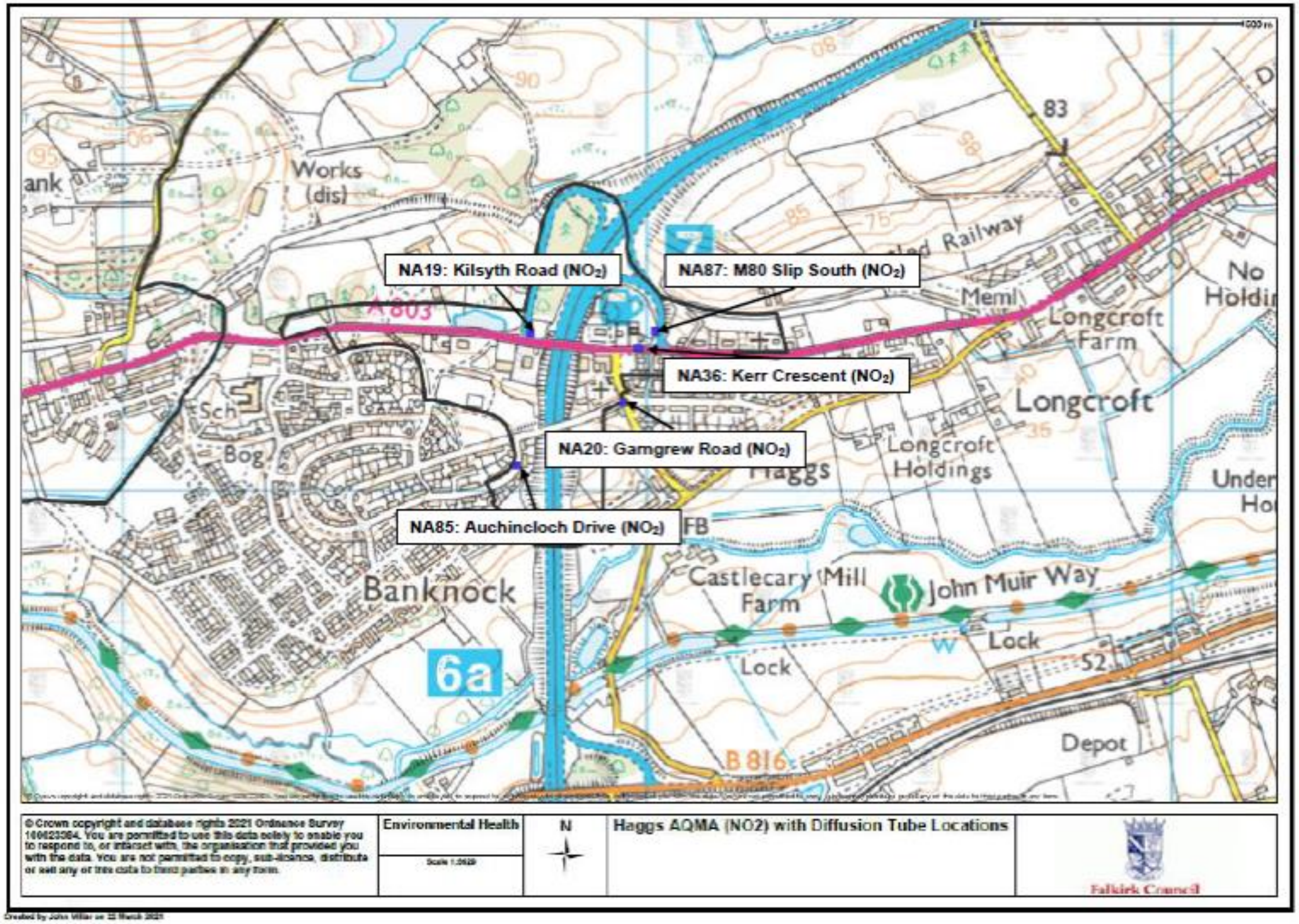
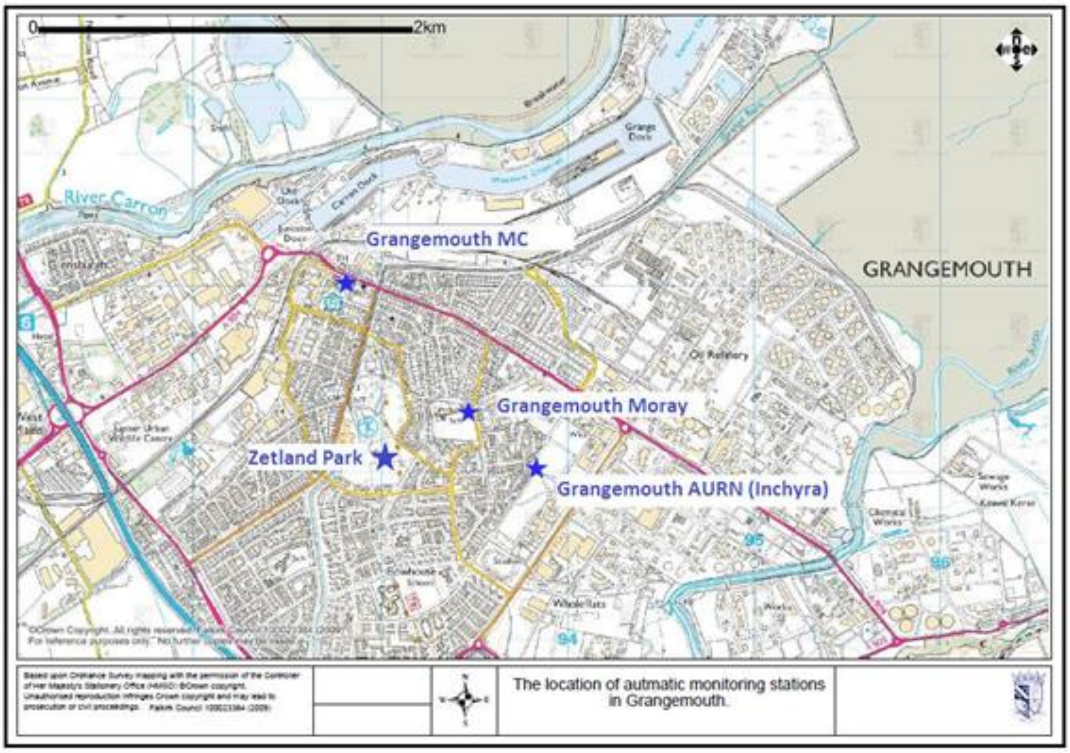
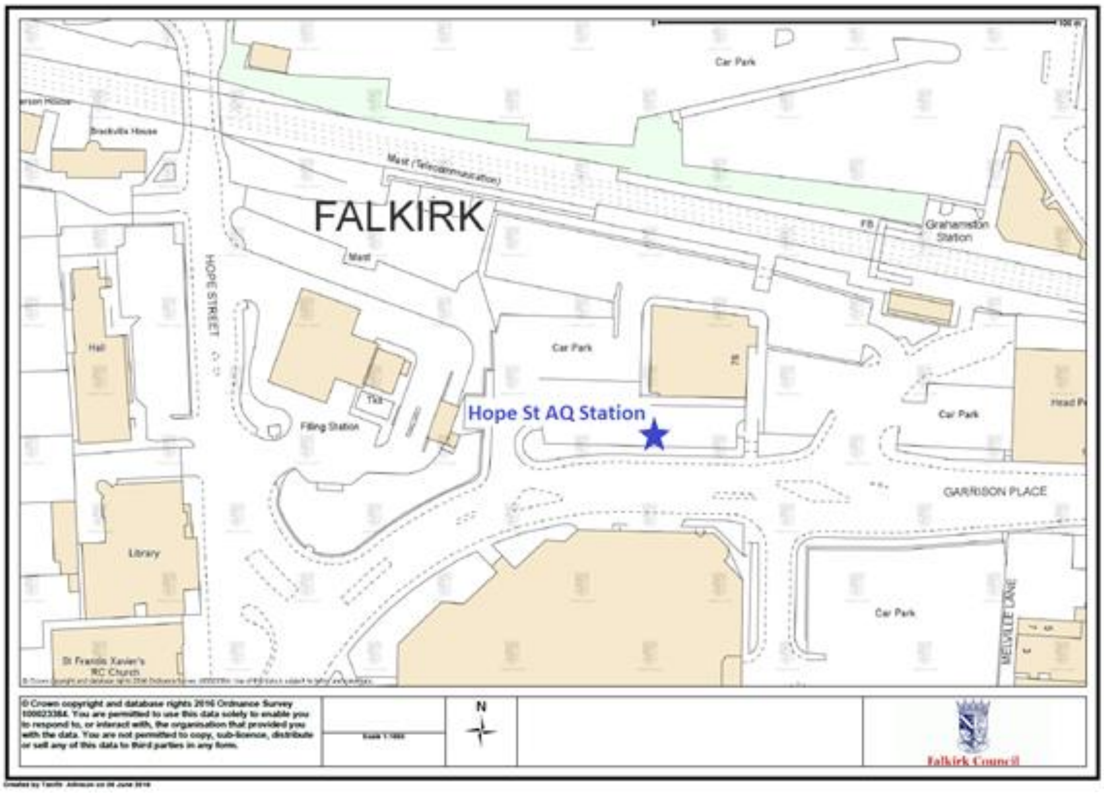


Figure 27 – Maps Showing Automatic Monitoring Locations

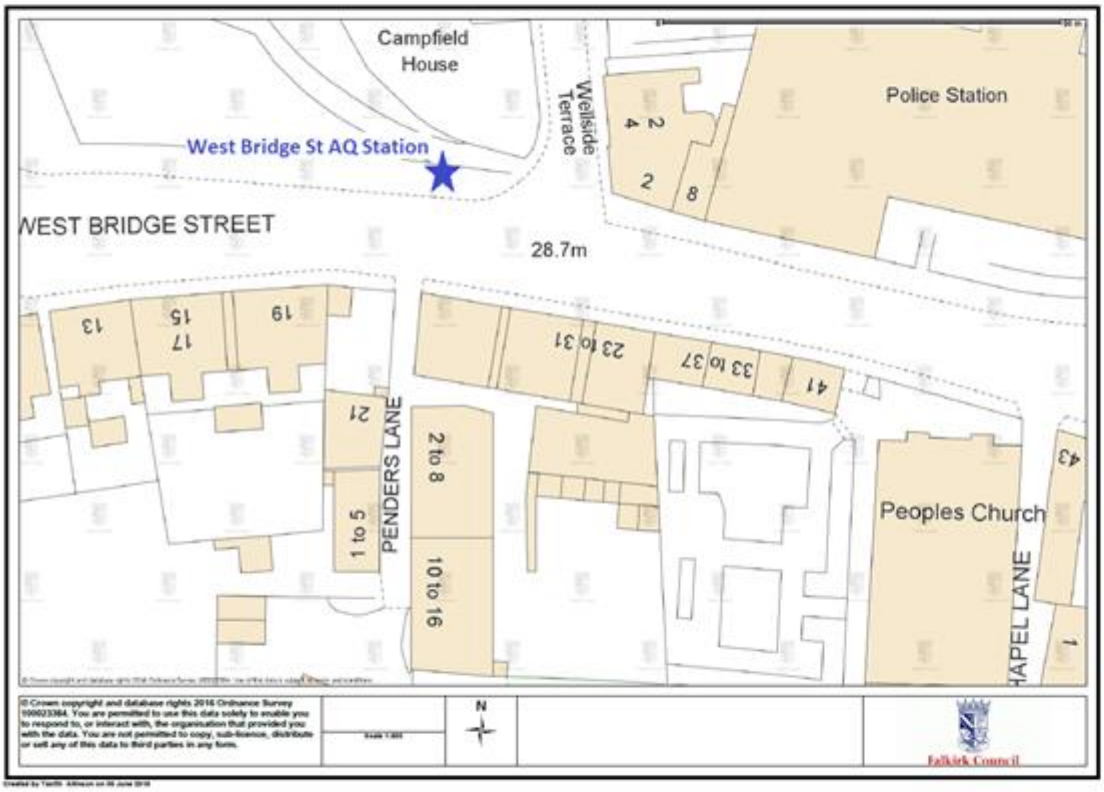
A) Grangemouth Air Quality (AQ) Stations



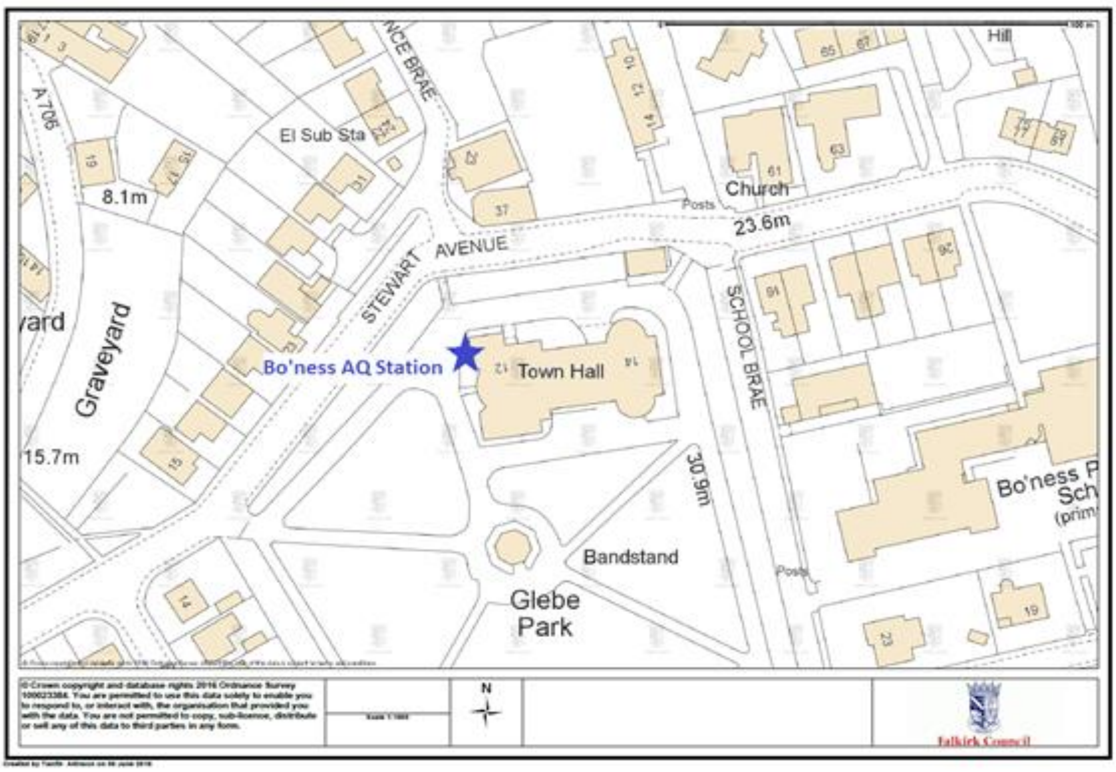
B) Falkirk Hope St AQ Station



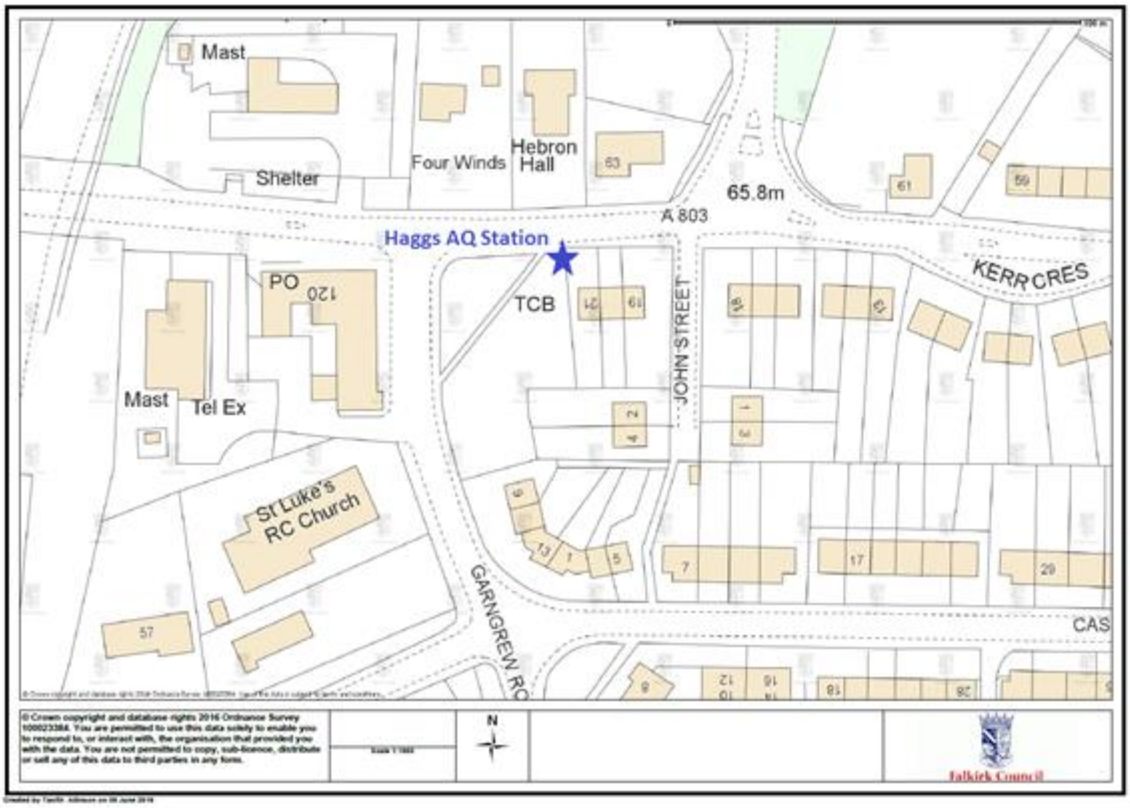
C) Falkirk West Bridge St AQ Station



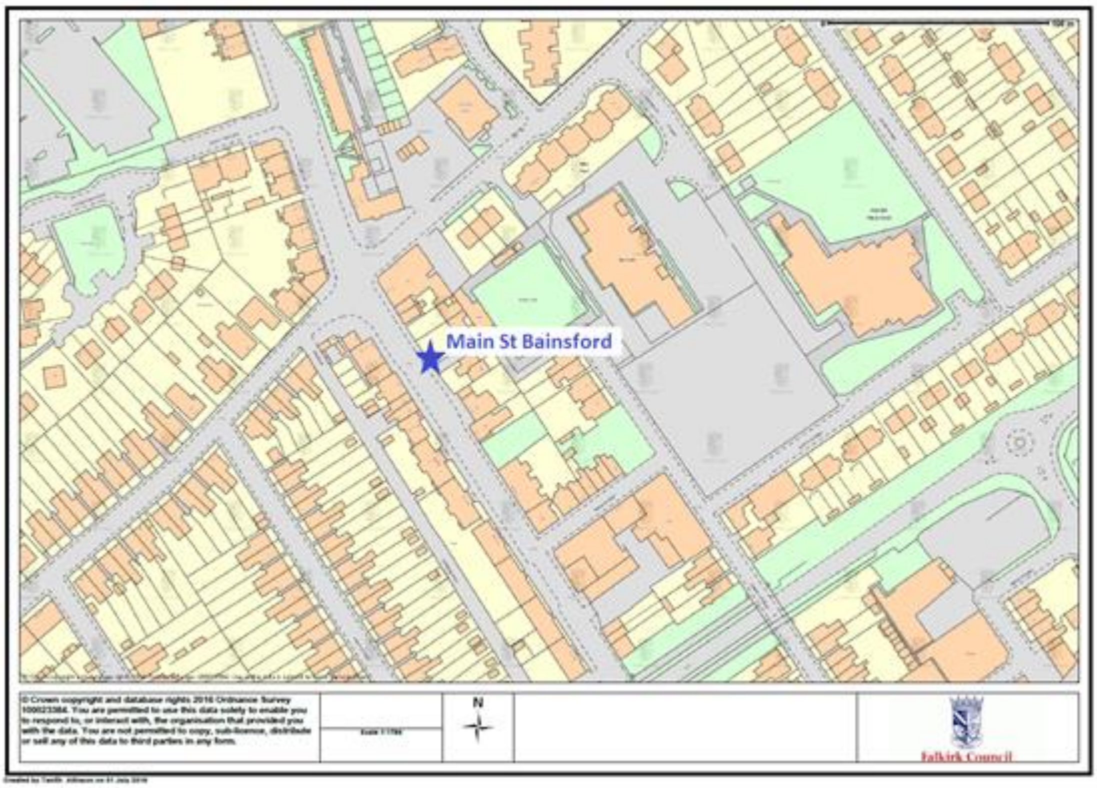
D) Bo'ness AQ Station



E) Falkirk Haggs AQ Station



F) Main St, Bainsford, Falkirk AQ Station



Appendix B: Full Monthly Diffusion Tube Results for 2020

Table B.1 – NO_2 2020 Monthly Diffusion Tube Results ($\mu g/m^3$)

Site ID	Jan	Feb	Mar	Apr [2]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Bias Adjusted [1]
NA3	19.76	16.92	12.02	COVID	10.51	12.22	8.74	14.32	17.28	16.91	22.62	26.85	16	15
NA5	21.85	21.88	16.89	COVID	11.16	15.66	14.32	19.49	22.50	22.69	30.05	28.84	20	19
NA7	-	15.28	11.63	COVID	8.68	11.04	7.96	11.59	12.92	13.50	19.93	19.53	13	12
NA9	28.16	20.74	14.40	COVID	10.77	14.01	13.23	15.43	19.87	23.08	26.73	26.81	19	18
NA19	29.73	25.72	17.19	COVID	14.05	19.64	12.01	20.76	20.10	25.29	27.26	28.85	22	21
NA20	27.30	22.52	14.82	COVID	11.31	13.84	11.49	16.96	16.67	20.78	25.91	28.78	19	18
NA21	23.20	24.25	16.60	COVID	12.47	18.26	-	22.45	21.47	20.73	26.10	32.73	22	21
NA24	29.32	35.09	21.28	COVID	17.98	19.20	23.11	26.59	28.49	29.25	31.26	32.50	27	25
NA26	15.32	14.25	13.97	COVID	7.05	10.49	8.85	13.92	13.61	15.54	24.04	20.22	14	13
NA27	41.46	36.63	31.87	COVID	26.84	31.63	23.14	40.80	39.92	39.40	43.43	51.74	**37**	35
NA29	18.02	16.09	11.58	COVID	8.16	11.94	7.88	12.84	14.08	13.56	18.19	23.72	14	13
NA36	28.37	30.90	21.94	COVID	18.21	26.54	21.98	29.99	29.57	32.49	34.49	40.78	29	27
NA37	19.06	14.60	11.54	COVID	8.09	11.53	7.51	13.04	13.24	15.54	21.37	23.67	14	14
NA38	16.50	15.10	10.36	COVID	7.36	-	6.98	10.18	11.52	14.95	19.67	23.97	14	13
NA41	26.00	19.87	16.63	COVID	13.13	15.19	12.62	-	20.55	22.14	24.85	26.20	20	19
NA42 (3 Tubes)	16.32	16.68	13.71	COVID	9.96	11.04	9.55	12.79	16.34	17.15	23.04	25.30	16	15
	21.07	16.78	14.96	COVID	9.18	10.75	9.37	12.60	16.68	15.67	23.76	26.17		
	21.19	19.41	13.93	COVID	9.78	10.65	9.77	12.71	15.13	18.31	23.69	25.76		
NA44	18.69	17.06	12.13	COVID	9.49	9.76	9.84	13.62	14.78	15.51	18.84	20.14	15	14
NA48	18.22	14.50	15.11	COVID	10.89	14.35	9.57	15.04	15.55	17.57	21.59	23.90	16	15
NA50	19.16	15.17	19.19	COVID	13.19	18.73	11.07	22.54	21.45	21.23	23.92	27.65	19	18
NA51	23.22	17.40	15.41	COVID	12.23	13.82	14.85	19.24	20.66	23.00	23.86	29.32	19	18
NA52	27.23	22.96	15.31	COVID	11.81	15.62	13.83	18.93	22.15	21.94	28.96	30.87	21	20
NA53	-	26.05	19.29	COVID	14.43	22.24	11.53	23.29	21.78	24.67	29.32	29.47	22	21
NA58	19.90	16.18	14.03	COVID	9.77	12.55	9.31	-	17.01	17.98	25.27	24.57	17	16
NA59	31.40	27.99	19.00	COVID	14.10	19.72	15.24	19.65	25.16	23.82	32.97	34.65	24	23

Site ID	Jan	Feb	Mar	Apr (2)	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Bias Adjusted (1)
NA60	30.81	22.91	18.10	COVID	14.01	16.51	13.27	17.31	22.56	26.01	29.89	31.47	22	21
NA61	24.97	22.62	17.10	COVID	12.79	16.81	12.52	19.32	20.68	21.72	25.43	28.49	20	19
NA62	37.78	36.28	23.59	COVID	19.19	20.24	21.58	25.78	28.52	31.13	35.66	34.82	29	27
NA63	38.27	28.34	-	COVID	18.35	13.83	19.90	28.99	28.96	33.60	35.67	44.48	29	27
NA64	9.83	11.18	9.59	COVID	7.93	10.96	7.09	12.07	12.91	14.24	19.52	18.96	12	11
NA65	21.70	20.72	16.93	COVID	14.02	15.57	12.83	18.36	22.10	19.68	28.04	32.38	20	19
NA67	26.42	24.47	18.56	COVID	13.17	16.70	-	22.15	26.39	23.15	30.55	32.64	23	22
NA69	27.76	21.54	21.73	COVID	17.11	20.02	15.87	29.82	27.56	25.38	28.25	33.50	24	23
NA71	37.10	29.89	18.60	COVID	15.83	17.25	20.00	25.04	30.10	29.08	33.46	38.01	27	25
NA72	24.20	24.67	19.70	COVID	13.75	17.73	12.55	24.76	25.77	25.64	35.14	33.70	23	22
NA73	27.52	26.06	24.55	COVID	16.81	24.35	15.80	26.26	27.48	28.23	31.67	35.79	26	24
NA76	24.39	19.91	13.52	COVID	8.90	11.59	10.42	12.66	16.47	15.82	23.82	24.39	17	16
NA77	27.56	22.01	14.52	COVID	9.94	14.43	12.06	16.90	20.01	22.64	25.45	28.80	19	18
NA78	19.35	25.25	18.11	COVID	15.64	18.50	18.08	-	25.08	25.18	29.48	30.31	22	21
NA80	35.63	33.97	19.79	COVID	13.99	16.65	-	32.50	25.08	26.24	33.25	33.94	27	25
NA81	29.57	24.51	20.82	COVID	16.83	23.14	14.59	28.68	24.91	26.83	33.25	36.42	25	24
NA82	19.18	15.68	13.32	COVID	8.70	11.31	8.72	12.98	16.07	17.18	22.49	26.76	16	15
NA83	30.13	34.62	23.03	COVID	17.58	20.68	16.96	23.37	26.21	27.33	33.06	34.71	26	25
NA85	18.53	13.56	12.99	COVID	8.75	13.55	7.61	17.46	13.85	16.96	20.62	25.80	15	14
NA86	12.20	13.40	10.63	COVID	7.60	8.63	6.88	11.29	11.25	13.38	19.29	21.23	12	12
NA87	28.61	28.05	17.97	COVID	14.73	4.20	16.79	23.81	25.13	26.63	27.08	29.05	22	21
NA88	25.32	28.77	18.03	COVID	15.58	17.38	18.98	15.45	22.52	26.24	24.19	26.32	22	20
NA89	28.75	26.88	20.75	COVID	16.04	19.05	13.90	23.14	25.22	23.82	31.64	34.85	24	23
NA94	35.59	32.51	20.34	COVID	16.59	16.07	18.30	20.90	25.96	28.31	34.95	35.21	26	24
NA98	16.46	18.43	14.88	COVID	10.43	21.96	9.58	15.71	15.46	15.69	22.09	26.63	17	16
NA99	27.64	25.12	17.40	COVID	13.80	16.40	14.74	19.80	19.50	22.66	23.51	28.15	21	20
NA101	23.15	21.81	15.01	COVID	10.47	16.02	10.54	18.11	15.27	24.13	24.07	25.59	19	17
NA105	6.82	6.33	5.45	COVID	3.92	5.95	3.63	5.64	6.67	7.39	12.05	9.96	7	6
NA107	30.07	21.81	-	COVID	14.03	20.27	14.76	23.78	27.72	27.19	30.99	35.48	25	23
NA110	20.33	14.93	10.27	COVID	8.05	11.22	9.83	12.90	13.68	15.57	17.74	17.54	14	13
NA111 (3 tubes)	35.20	30.53	29.28	COVID	22.53	29.77	19.86	35.78	34.48	30.91	36.29	44.18	**32**	31
	35.34	37.39	29.29	COVID	23.33	29.69	22.05	36.55	33.91	36.13	36.44	43.44		
	34.01	33.21	31.71	COVID	22.61	30.16	22.11	33.22	34.08	32.41	39.56	45.93		

Site ID	Jan	Feb	Mar	Apr (2)	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Bias Adjusted (1)
NA114	37.77	32.27	25.52	COVID	24.82	28.77	-	-	35.93	36.72	-	40.76	33	31
NA115	18.39	14.23	11.56	COVID	7.39	12.82	7.82	13.68	14.79	15.03	20.52	19.71	14	13
NA116	17.28	16.34	14.54	COVID	11.18	13.45	8.08	18.15	14.36	18.27	20.29	26.92	16	15
NA117	20.29	16.37	13.90	COVID	10.03	12.24	10.22	12.53	16.33	17.74	21.79	27.97	16	15
NA118	23.42	21.93	15.63	COVID	11.32	13.43	9.18	19.28	19.44	20.07	24.15	27.47	19	18
NA119	24.30	20.77	16.70	COVID	13.03	16.58	12.44	18.45	16.51	-	23.80	26.72	19	18

Notes:

(1) See Appendix C for details on bias adjustment

(2) Diffusion tubes not collected during April 2020 due to the ‘Stay at Home’ Scottish Government Coronavirus advice:

https://www.gov.scot/coronavirus-covid-19/

Table B.2 – 1,3 Butadiene Monthly Diffusion Tube Results for 2020 (ppb)

Site ID	Jan	Feb	Mar	Apr (1)	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data (ppb)	Annual Mean: Raw Data ($\mu g/m^3$)
41	0.02	0.02	0.01	COVID	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.05
55	0.02	0.02	0.01	COVID	0.02	0.06	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.06
104	0.02	0.02	0.01	COVID	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.05

(1) Diffusion tubes not collected during April 2020 due to the 'Stay at Home' Scottish Government Coronavirus advice:

https://www.gov.scot/coronavirus-covid-19/

Table B.3 – Benzene Monthly Diffusion Tube Results for 2020 (ppb)

Site ID	Jan	Feb	Mar	Apr (1)	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data (ppb)	Annual Mean: Raw Data (µg/m^3)
3	0.13	0.15	0.15	COVID	0.12	0.14	0.07	0.12	0.15	0.14	0.21	0.25	0.15	0.48
21	0.12	0.12	0.16	COVID	0.10	0.14	0.07	0.11	0.13	0.11	0.20	0.19	0.13	0.43
27	0.20	0.15	0.17	COVID	0.12	0.15	0.09	0.13	0.20	0.18	0.32	0.36	0.19	0.61
37	0.15	0.15	0.17	COVID	0.09	0.12	0.07	0.10	0.15	0.13	0.07	0.26	0.13	0.43
38	0.18	0.14	0.16	COVID	0.09	-	0.07	0.08	0.11	0.11	0.23	0.20	0.14	0.45
41	0.07	-	0.16	COVID	0.13	0.20	0.10	0.15	0.22	0.16	0.37	0.37	0.19	0.63
42	0.06	0.17	0.15	COVID	0.11	0.16	0.07	0.10	0.15	0.12	0.18	0.25	0.14	0.45
44	-	0.09	0.11	COVID	0.09	0.10	0.07	0.09	0.11	0.12	0.18	0.20	0.12	0.38
55	0.13	0.13	0.18	COVID	0.15	0.17	0.07	0.13	0.16	0.12	0.20	0.22	0.15	0.49
77	0.12	0.14	0.16	COVID	0.07	0.12	0.07	0.08	0.11	0.10	0.20	0.21	0.13	0.41
80	0.17	0.10	0.17	COVID	0.11	0.13	0.07	0.09	0.13	0.12	0.21	0.27	0.14	0.46
81	0.20	0.19	0.16	COVID	0.12	0.17	0.14	0.14	0.20	0.12	0.35	0.32	0.19	0.62
94	0.16	0.22	0.16	COVID	0.13	0.16	0.07	0.14	0.13	0.12	0.07	0.21	0.14	0.46
105	0.10	0.10	0.10	COVID	0.06	0.07	0.07	0.05	0.07	0.06	0.09	-	0.08	0.25
116	0.15	0.12	0.15	COVID	0.12	0.14	0.07	0.13	0.14	0.13	0.20	0.21	0.14	0.46
117	0.13	0.13	0.18	COVID	0.13	0.20	0.07	0.16	0.17	0.13	0.24	0.25	0.16	0.53

(1) Diffusion tubes not collected during April 2020 due to the ‘Stay at Home’ Scottish Government Coronavirus advice:

https://www.gov.scot/coronavirus-covid-19/

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

New or Changed Sources Identified Within Falkirk Council During 2020

The only new potential source that may affect air quality within the Falkirk Council area in 2020/21 was a proposed upgrade to a section of road and associated junctions. These road upgrades are proposed to take place between Earlsgate and the Forth Valley College on the A904 and alongside the Helix and Falkirk Football Club along the A9. The proposed development is seeking permission to These upgrades form part of the Falkirk Gateway Masterplan. An initial design has been submitted that involves road widening and general improvements, three new roundabouts, improvement of the existing A9/A904 roundabout, and an iconic pedestrian crossing structure over the existing A9/A904 roundabout. The AQIA was completed by WSP on behalf of Falkirk Council (report ref: WSP-9750-0000-R-007).

Additional Air Quality Works Undertaken by Falkirk Council During 2020

Grangemouth 2020 Emissions Study

Air Quality Modelling Study

Grangemouth Emissions Study

Falkirk Council

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Status / Revisions

Ver.	Date	Status	Reviewed	Approved
01	07/12/20	Draft	EMP	JS
01.1	26/02/21	Final	EMP	JS

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1 Introduction

Sweco UK Ltd (Sweco) have been appointed by Falkirk Council to provide consultancy support on behalf of them and SEPA. The purpose of this report is to provide the Council with a report suitable for submission under the LAQM Review and Assessment process for the following modelling studies:

- Grangemouth traffic emissions modelling assessment and source apportionment analysis
- Review of pollutant emissions within Grangemouth AQMA including dispersion modelling of all industrial emissions

1.1 Background

Grangemouth is a town within the Falkirk local authority area. Falkirk Council declared an AQMA in Grangemouth for the SO_2 15minute mean in 2005 for an area encompassing Grangemouth petrochemical complex and the adjacent area.

Previous assessment work in the AQMA has focussed on the short term SO_2 objectives in isolation. This package of work will consider the following pollutant emissions, Oxides of Nitrogen (NOx/NO_2), Particulates (PM_{10} and $PM_{2.5}$), Sulphur Dioxide (SO_2) and Carbon Monoxide (CO), where data are available. The study area considered within the assessment is presented in Figure 1.1.

Falkirk Council originally wanted the modelling study to provide an overall picture of emissions during 2017. However, on completion of the road traffic modelling study and while compiling the emissions inventory for the industrial emissions we reviewed the 2018 emissions data. These data indicated that the emissions for several sites had reduced from 2017. For some sites this was due to a change in operation under revised permits and / or a reduction in permitted emissions in order that they meet new BAT standards. Therefore, the Council and SEPA agreed that an updated 2018 emission inventory be built for both the industrial emissions and road traffic study be updated to 2018 too. This will be discussed in more detail in the subsequent chapters of this report.

The modelling studies have predicted air pollutant concentrations within Grangemouth and undertaken detailed source apportionment modelling for all sources. This will determine which sources have the greatest influence on air quality concentrations within Grangemouth.

Since previous air quality modelling of sources within Grangemouth, there has been considerable changes to sources and their emissions.

To our knowledge, this assessment is the first assessment where both the road traffic sources and industrial sources within Grangemouth have been modelled together for the assessment of pollutant other than just the short term SO_2 objectives. By combining both the industrial and traffic emissions in a complete assessment, this will provide Falkirk Council with an overall understanding of pollutant concentrations across Grangemouth and inform future management of the AQMA.

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2 Legislation and Policy

2.1 Legislation

Air quality is an issue of potential significance at international, national and local levels. While there are undoubtedly important ramifications for global and national air quality from a wide range of developments, as recognised by numerous international conventions and European Directives, the primary focus of this assessment is the suitability of the application site for residential development and the potential impact of the proposed development on the local air quality.

2.1.1 Environment Act 1995

Part IV of the Environment Act 1995 places a duty on the Secretary of State for the Environment to develop, implement and maintain an Air Quality Strategy with the aim of reducing atmospheric emissions and improving air quality. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (the UK) provides the framework for ensuring the air quality limit values are complied with based on a combination of international, national and local measures to reduce emissions and improve air quality. This includes the statutory duty, also under Part IV of the Environment Act 1995, where local authorities must review and assess air quality in their areas on an annual basis. This review and assessment process in known as Local Air Quality Management (LAQM).

The focus on local air quality is reflected in the air quality objectives (AQOs) set out in the Air Quality Strategy for the UK. The strategy presents measures to control and improve the quality of air in the UK and reflects the increasing understanding of the potential health risks associated with poor air quality and the benefits that can be gained from its improvements.

The UK objectives are at least as stringent as the European Limit Values for the various pollutants. The Limit Values carry legal standing and have been written into UK law through the various Air Quality Standards Regulations. It is worth noting that the Scottish Government has adopted a fine particulate matter (PM_{10}) annual mean objective that is more stringent than the UK or EU standard. The Scottish PM_{10} standard is written into regulation and therefore carries equivalent weight to the Limit Value based standards. In addition, on the 1st of April 2016, the Scottish Government adopted the World Health Organisation (WHO) Guideline Value for ultra-fine particulate matter ($PM_{2.5}$) of 10 µg/m³ as an annual mean objective via the Air Quality (Scotland) Amendment Regulations 2016.

The LAQM framework requires that local authorities who identify exceedances of air quality objectives within their geographical area must designate Air Quality Management Areas (AQMAs) and produce an Air Quality Action Plan setting out measures they intend to take to work towards the objectives.

Table 2.1:Air Quality Standards (AQS) for the protection of human health

Pollutant	Air Quality Standards (µg/m³)	Measured as
Nitrogen Dioxide	40	Annual Mean
	200	One hour mean, not to be exceeded more than 18 times per year (equivalent to the 99.79th percentile of hourly means

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Particulate Matter (PM_{10})	18	Annual Mean
	50	24 hour mean, not to be exceeded more than 7 times a year (equivalent to the 98.08th percentile of 24-hour means)
Particulate Matter ($PM_{2.5}$)	10	Annual Mean
Sulphur dioxide (SO_2)	125 µg/m³ not to be exceeded more than 3 times a year	24 hour mean (99th percentile of 24-hour means)
	350 µg/m³ not to be exceeded more than 24 times a year	1 hour mean (99.7th percentile of 24-hour means)
	266 µg/m³ not to be exceeded more than 35 times a year	15 minute mean (99.9th percentile of 24-hour means)
Carbon monoxide (CO)	10 mg/m³	Running 8 hour mean

2.2 Sensitive locations

The locations where objectives apply are defined in the Air Quality Strategy (AQS) as locations outside buildings or other natural or man-made structures above or below ground where members of the public are regularly present and might reasonably be expected to be exposed over the relevant averaging period of the objectives. Typically, these include residential properties, hospitals and schools for the longer averaging periods (i.e. annual mean) pollutant objectives. Table 2.2 provides a summary of where the AQS objectives should and should not apply.

Table 2.2: Examples of where the Air Quality Objectives should and should not apply

Averaging Period	Objectives should apply at …	Objectives should not generally apply at …
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Averaging Period	Objectives should apply at …	Objectives should not generally apply at …
8-hour and 24-hour Means	All locations where the annual mean objective would apply, together with hotels and gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour Mean	All locations where the annual mean, 24-hour mean and 8-hour mean apply plus: kerbside sites of busy shopping streets; parts of car parks, bus and railway stations, etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more; Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-min mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

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3 Policy and Guidance

3.1 Local Air Quality Management Policy Guidance

This policy guidance[1] provides guidance to help local authorities with their local air quality management duties in line with the Environment Act 1995. The guidance outlines the background and legislative framework to which the local authorities must work to; the principles behind reviews and assessments of air quality and the recommended steps; how local authorities should handle the designation of AQMAs; the development of local air quality strategies and the general principles behind air quality and land use planning.

3.2 Clean Air Strategy, 2019

Published by Defra This Clean Air Strategy sets out the case for action and demonstrates the commitments to improve our air quality. It highlights that some objective levels are even more ambitious than EU requirements to protect human health and exposure to pollutants. The Clean Air Strategy outlines that air quality is the responsibility of the devolved administrations.

3.3 Cleaner Air for Scotland, 2015

Cleaner Air for Scotland is a cross-government strategy which details how the Scottish Government and any partner organisations propose to reduce air pollution and fulfil Scotland's legal requirements. It provides a national framework which allows the public to better understand how the Scottish Government and associated organisations will achieve these goals. The strategy outlines a range of policies and initiatives which include a National Modelling Framework; a National Low Emission Framework; the adoption of World Health Organisation guideline values for particulate matter in Scottish Legislation, and proposals to raise awareness on national air quality.

3.4 National Air Pollution Control Programme, 2019

The National Air Pollution Control Programme (NAPCP) sets out how the UK can meet the legally binding 2020 and 2030 emission reduction commitments (ERCs). These commitments apply for 5 pollutants:

- nitrogen oxides
- ammonia
- non-methane volatile organic compounds
- particulate matter
- sulphur dioxide

3.5 Grangemouth Air Quality Action Plan, 2007

In 2005 Falkirk Council declared an Air Quality Management Area (AQMA) in response to measured exceedances of the 15-minute SO_2 objective in the areas surrounding the large industrial complex in Grangemouth. Following the declaration of the AQMA, A Further Assessment of SO_2 concentrations in the AQMA was undertaken in 2006-2007. The aim of the Further Assessment was to consider emissions in more detail such that the specific source or sources contributing to the measured exceedances could be identified such that the Action Plan

[1] Part IV of the Environment Act 1995: Local Air Quality Management Policy Guidance PG(S) (16) March 2016

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could be targeted. The Further Assessment included a more detailed inventory of emissions from the principal emission sources.

Based upon the findings of the Further Assessment, Falkirk Council published an Air Quality Action Plan (AQAP) in 2007.

4 Baseline Air Quality

4.1 Monitoring data

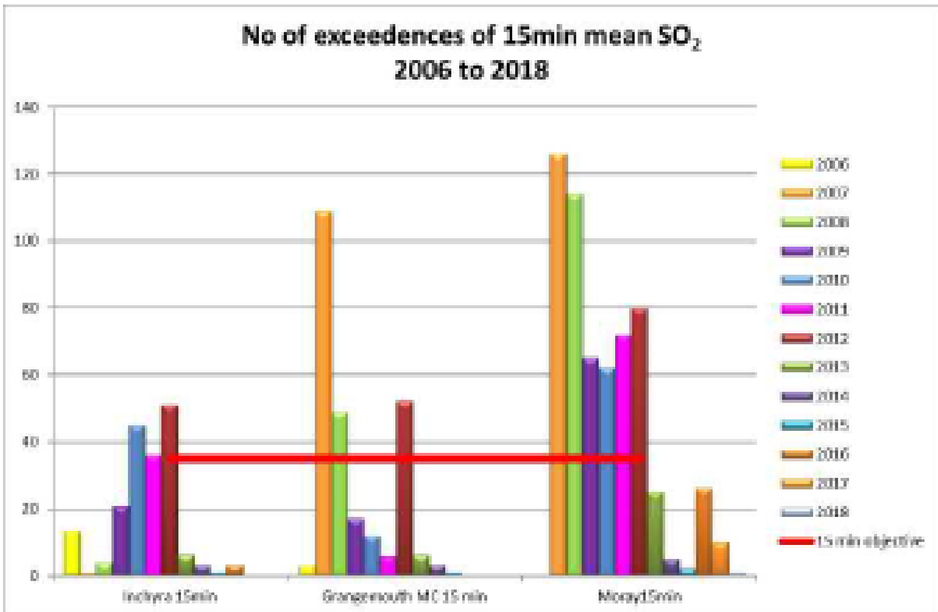
The assessment considers emissions data in 2018 therefore we have used 2018 measurement data to represent the baseline air quality within the modelling assessments.

Falkirk Council undertake monitoring of NO_2, PM_{10}, $PM_{2.5}$ and SO_2 at automatic monitoring sites in Grangemouth. Falkirk Council measures NO_2 using diffusion tubes at several locations in Grangemouth and the surrounding area. Falkirk Council do not undertake any CO monitoring.

4.2 SO_2

The Grangemouth AQMA was declared in 2005 for exceedances of the 15minute mean SO_2 objective. Since the AQMA was decaled the numbers of exceedances have dropped significantly from over 400 at their peak in 2003 to only 1 exceedance at Grangemouth Moray in 2018. A summary of the numbers of exceedances since the AQMA has been in place is shown in Chart 4-1.

Chart 4-1 Numbers of exceedances of 15 min mean SO2 2006 to 2018



The results for 2018 for comparison with all of the SO_2 short term air quality objectives has been provided in Table 4.1.

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Table 4.1: SO_2 NUMBER OF EXCEEDANCES 2018

Site ID	Site	X	Y	In AQMA	15 minute objective (266 µg/m³)	1 hour objective (350 µg/m³)	24 hour objective (125 µg/m³)
A8	Grangemouth AURN	293830	681022	Y	0	0	0
A9	Grangemouth Moray	293469	681321	Y	1	0	0
A10	Grangemouth Municipal Chambers	292816	682009	Y	0	0	0
A11	Zetland	292969	681106	Y	0	0	0

4.3 NO_2

Falkirk Council currently measures NO_2 at three automatic monitoring stations and at 5 further locations using diffusion tubes. There are currently no measured exceedances of the annual mean NO_2 objective at any of the sites in Grangemouth. The highest concentration measured in Grangemouth is 31 µg/m³ measured at site NA94 which is located on the A905.

Due to the extent of the modelling study and for model verification of the road transport component additional monitoring locations out with Grangemouth have also been included these are locations NA21, NA51, NA94 and NA101.

The automatic sites at Grangemouth were deemed unsuitable for model verification as the automatic sites are not roadside locations and therefore not influenced by the road traffic emissions. While the Grangemouth MC is within 20m of Bo'ness Road it is also located within the Councils public carpark. This has meant the site was not suitable for verification as NOx measured at this location would not represent the Road NOx from Bo'ness Road in isolation.

The air quality concentrations measured at Grangemouth over the last 5 years are presented in Table 4.2. The monitoring sites within the study area are presented in Figure 4.1 for automatic sites and Figure 4.2 for diffusion tube monitoring locations.

Table 4.2: NO_2 monitoring results 2014 – 2018 (µg/m³)

Site ID	Site	X	Y	In AQMA	2014	2015	2016	2017	2018
Automatic Monitoring									
A8	Grangemouth AURN	293830	681022	Y	16	14	16	14	14

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Site ID	Site	X	Y	In AQMA	2014	2015	2016	2017	2018
A9	Grangemouth Moray	293469	681321	Y	15	15	18	17	17
A10	Grangemouth Municipal Chambers	292816	682009	Y	19	18	21	17	18
Diffusion Tube Monitoring									
NA3	Tinto Drive, Grangemouth	293427	680386	N	19	20	19	18	18
NA21	Grangemouth Rd, Falkirk College	290112	680500	N	28	28	28	28	28
NA42	Municipal Chambers, Grangemouth	292817	682000	N	19	20	20	17	19
NA51	Mary St, Laurieston	290965	679490	N	25	19	25	22	24
NA57	Inchyra Rd, Grangemouth	294028	680829	N	26	20	23	19	21
NA94	A905 (Glensburgh Rd), Grangemouth	291213	681927	N	31	24	21	30	31
NA101	Glensburgh Rd (2), Grangemouth	291127	682007	N	25	22	21	24	23

4.4 Particulates (PM_{10} and $PM_{2.5}$)

The Council currently monitors PM_{10} at two locations and $PM_{2.5}$ at only the Grangemouth Inchyra AURN site. Measured concentrations are significantly below the air quality objectives for both PM_{10} and $PM_{2.5}$. Measured concentrations for both PM_{10} and $PM_{2.5}$ for the last 5 years have been provided in Table 4.3 and Table 4.4, respectively.

Table 4.3: PM_{10} Monitoring Results 2014 – 2018 (µg/m³)

Site ID	Site	X	Y	In AQMA	2014	2015	2016	2017	2018
Automatic Monitoring									
A8	Grangemouth AURN	293830	681022	Y	12	12	11	9	12
A10	Grangemouth Municipal Chambers	292816	682009	Y	15	13	13	12	12

*rounded to nearest whole number

Table 4.4: $PM_{2.5}$ Monitoring Results 2014 – 2018 (µg/m3)

Site ID	Site	X	Y	In AQMA	2014	2015	2016	2017	2018
Automatic Monitoring									
A8	Grangemouth AURN	293830	681022	Y	8	9	6	6	7
*rounded to nearest whole number									

4.5 Background Maps

The Scottish air quality background map[2] were used to assess current background concentrations of NOx, NO_2 and PM_{10} in the study area. The background map for $PM_{2.5}$ was downloaded from the Defra background maps [3]. Historic (2001) background annual mean CO and SO_2 concentrations were downloaded from the available background information from Defra[4]. This resource provides estimated annual mean background concentrations of key pollutants at a resolution of 1x1km for the UK. Mapped background concentrations from the grid squares within the study area for 2018 are provided in Table 4.5, these have been adjusted to remove the road traffic component and the industrial emissions component that are being explicitly modelled.

[2] http://www.scottishairquality.scot/data/mapping?view=data

[3] 2017 Defra background maps, Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2017

[4] 2001 Defra background maps, Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2001

Table 4.5 Adjusted annual mean background concentrations 2018 (µg/m³)

2018 Grid Square	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO
286500, 684500	15.4	12.2	6.8	6.8	2.4
288500, 677500	9.1	9.5	6.4	5.6	2.5
288500, 6835000	15.4	10.3	10.6	6.1	4.2
289500, 680500	17	10.2	6.1	6.1	3.9
290500, 679500	14.5	9.6	5.9	5.9	3.4
290500, 680500	15.1	11.2	6.4	6.4	3.8
291500, 679500	13.9	10.4	6.2	6.2	4.4
291500, 680500	17.4	11.8	6.6	6.7	3.6
291500, 681500	22.6	12.1	6.8	6.8	4.0
291500, 682500	16.9	11.5	6.4	6.4	5.0
292500, 679500	15.3	10.9	6.4	6.5	4.8
292500, 680500	17.8	10.6	6.4	6.4	4.9
292500, 681500	17.7	10.7	6.3	6.3	5.3
292500, 682500	15.1	10.9	6.4	6.4	8.7
293500, 678500	16.6	10.5	6.1	6.1	5.1
293500, 679500	21.7	11.6	6.6	6.7	4.5
293500, 680500	16.3	10.9	6.4	6.4	5.4
293500, 681500	19.4	10.5	6.4	6.5	5.7
293500, 682500	14.2	9.8	6	6.0	5.7
294500, 678500	19.2	11.2	6.3	6.4	3.8
294500, 679500	16.1	10.6	6.1	6.1	3.7
294500, 680500	17.5	10.8	6.4	6.4	4.1
294500, 681500	18.2	12.6	7.6	7.6	5.2

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5 Methodology

5.1 Dispersion modelling methodology

Dispersion models, which are used to predict ground level pollutant concentrations.

The dispersion models used in this assessment were the most up-to-date version of the model, ADMS-Roads Extra (ADMS ROADS 5.0), was used for the assessment of road traffic emissions Modelling of industrial sources was undertaken in ADMS 5.2.

While ADMS ROADS EXTRA can model point sources simultaneously with road traffic sources it doesn't have some of the functionality of ADMS. Due to the complexity of the industrial points sources being modelled and the need to use additional input files the industrial emissions were modelled separately. Full details of this is discussed in the following sections.

5.1.1 Mapping

The mapping data used within the assessment is mastermap data provided by Falkirk Council. This enabled accurate OS x,y grid references to be obtained for the industrial installation locations and for receptor locations to be accurately identified. All maps within this report contain Ordnance Survey data © Crown copyright and database right 2019.

5.1.2 Meteorological data

Typically, when undertaking an assessment of industrial emissions to obtain the worst case impact you would assess 3 to 5 years of meteorological data. While we did undertake a meteorological sensitivity, the purpose of this assessment is to determine what the pollutant concentrations across Grangemouth were in based on 2018 emissions to provide a total pollutant concentration for all sources in 2018. Therefore only 2018 hourly sequential meteorological data measured at the Edinburgh Gogarbank site was used for the final model predictions.

Previous modelling has shown that the meteorological data has many hours which can be classified as calm and under these conditions ground level concentrations can be greater. Therefore, the Calms module within ADMS was utilised in the modelling of the industrial emissions.

The 2018 wind rose for Gogarbank is presented in Chart 5-1.

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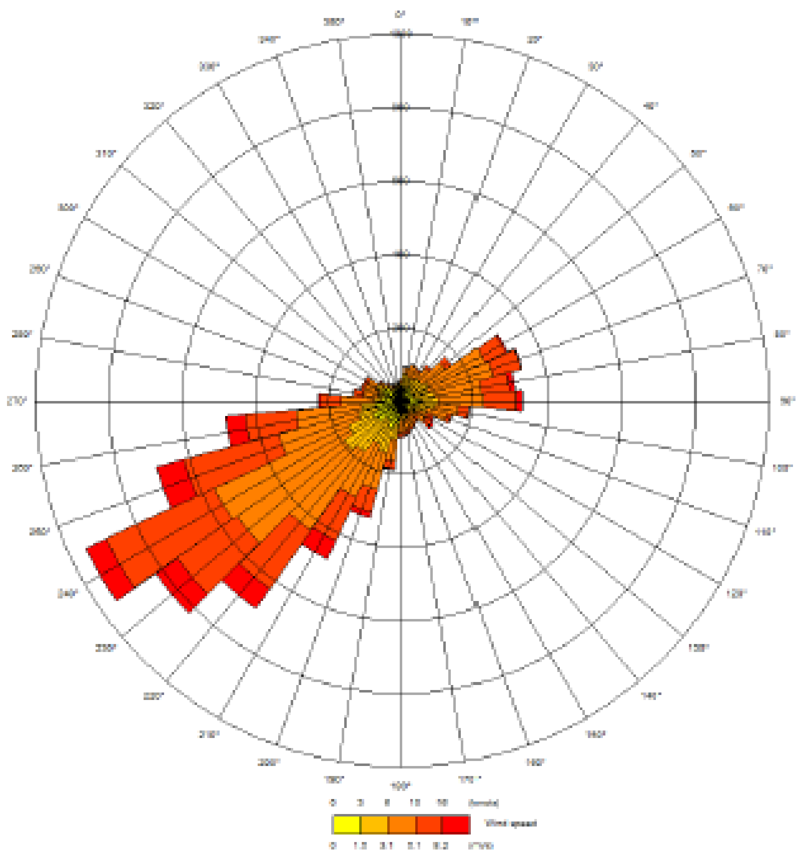
Chart 5-1 2018 Edinburgh Gogarbank meteorological data



5.1.3 Surface roughness and meteorological parameters

A surface roughness of 1m was used to represent the dispersion site within the road traffic model to represent the mixed suburban area. The minimum Monin-Obukhov length (m) was set to 30m, which is representative of mixed urban/industrial.

Due to the complexity of the industrial sites which includes large numbers of buildings and structures it's not possible to include all of these explicitly in the model but they will have an influence on the dispersion as shown in previous modelling assessment of the area. Therefore, a surface roughness of 1.5m was used to represent the dispersion site within the industrial model, due to the built-up nature of the industrial sites within Grangemouth This has been accepted method in previous modelling assessments of the AQMA.

The minimum Monin-Obukhov length (m) was set to 30m, which is representative of mixed urban/industrial.

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At the meteorological site, a surface roughness of 0.02m was used to represent the Edinburgh Gogarbank metrological site. The minimum Monin-Obukhov length (m) was set to 10m.

5.1.4 Terrain

Previous studies have shown that gradient is a key consideration in the assessment of the industrial emissions within the Grangemouth AQMA, Therefore, a terrain file was included in the model.

5.1.5 Model domain and receptor locations

The model has been used to predict pollutant concentrations at a number of specified receptors and across a modelled grid. The modelled grid was set at a resolution of 30m.

The model has been used to predict annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$ at a selection of sensitive receptors within the study area. The receptors are located at the façade of buildings in the model domain where relevant exposure exists. While CO and SO_2 are assessed against the short term objectives it was felt that these receptors were still representative.

The receptors have been modelled at 1.5 m to represent human exposure at ground floor level. The receptors modelled and the model domain are presented in Table 5.1 and Figure 5.1.

Table 5.1: Receptor Locations

Receptor	X	Y	Height (m)	Description
Glensburgh Road 1	291071.6	682110.5	1.5	Residential
Glensburgh Road 2	291192.4	681964.7	1.5	Residential
21 Primrose Avenue	291750.7	680549.5	1.5	Residential
19 Chrisholm Place	291814.9	680731.1	1.5	Residential
Beancross Road 1	292001.1	680485.2	1.5	Residential
Moriston Court 1	293188.4	679818.1	1.5	Residential
Moriston Court 2	293222.1	679852.5	1.5	Residential
Fintry Road 1	293279.7	679910.8	1.5	Residential
Grangemouth Road 1	297363.1	680356.8	1.5	Residential
Boness Road 1	294042.3	681455.6	1.5	Residential
Boness Road 2	293755	681567.9	1.5	Residential
Boness Road 3	293587.6	681732.1	1.5	Residential
103 Boness Road	293260.9	681895.7	1.5	Residential
Forestwood Earls Rd	292062.4	681729.9	1.5	Residential

Receptor	X	Y	Height (m)	Description
Eastcroft Drive 1	294237.7	678785.9	1.5	Residential
Parkside Main Street	294049.8	678746.9	1.5	Residential
Burnbrae Main Street	293791.5	678792	1.5	Residential
Bennett Place 1	293468.7	678877.1	1.5	Residential
Weedingshall Lodge	292540.2	679028.3	1.5	Residential
20 Polmont Road	291512	679408.5	1.5	Residential
Mary Street 1	290988.2	679503	1.5	Residential
Mary Street 2	290949.7	679489.5	1.5	Residential
Grangemouth Road 2	290271.8	680504.3	1.5	Residential
28 Grangemouth Road	289714.1	680346.3	1.5	Residential
Ladysmill 1	289642.9	680256.1	1.5	Residential
Inchyra AQU	293835	681020	1.5	Monitoring site
Moray AQU	293469	681321	1.5	Monitoring site
GMC AQU	292818	682008	1.5	Monitoring site
Inchyra Grange Hotel	293510	679680	1.5	-
West Beancross Farm	292450	679750	1.5	Residential
Docks West	295160	683700	1.5	-
Docks East	295160	683710	1.5	-
Wholeflats	294210	680070	1.5	-
Oil refinery	294360	681820	1.5	-
Grangemouth Stadium	293628	680508	1.5	-
Sports Complex	292826	681146	1.5	-
Beancross Primary	292480	680510	1.5	School
Bowhouse Primary	293350	680450	1.5	School

Receptor	X	Y	Height (m)	Description
Sacred Heart Primary	293120	680630	1.5	School
Zetland Pavillion	292950	681530	1.5	-
Roxburgh St	293520	682010	1.5	Residential
Bo`ness road	294040	681470	1.5	Residential
Albert Avenue	293874	681941	1.5	Residential
Grangemouth High	293198	680312	1.5	School
Grangeburn Road	293430	682055	1.5	Residential
Elizabeth Avenue	293417	681507	1.5	Residential
Cheviot Place	293381	680232	1.5	Residential
Burnbank Road	292638	680511	1.5	Residential
The Inches	286165	684008	1.5	-
Merrick Road 1	293662.69	680321.31	1.5	Residential
Reddoch Road	294353.5	679776	1.5	Residential
Falkirk Stadium	290739.59	680577.81	1.5	-
Old Town 1	291507.6	682037.6	1.5	Residential
Old Town 2	291267.9	681939.1	1.5	Residential
Wood St 1	292055	680935.6	1.5	Residential
Wood St 2	291989.2	680880	1.5	Residential

Figure 5.1: Receptor Locations Grangemouth

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6 Road Traffic Assessment

6.1 Traffic data

Falkirk Council undertake automatic traffic counts (ATC) at a number of road side locations around the Council area on an annual basis. Traffic data were provided in the form of Annual Average Daily Traffic (AADT) flows, which were derived from their ATC count data provided by Falkirk Council representing 2018. Where ATC data were unavailable, traffic data were supplemented with Department for Transport (DfT) traffic data for 2018.

Each road link included in the model also included a detailed fleet split namely: motorcycles; cars, LGV; HGV and buses.

Full details of the traffic data used within the assessment is presented in Table 6.1.

Traffic patterns in urban locations are complex and it is not possible to fully represent the complexities in atmospheric dispersion models. As 24 hour time varying traffic flow data were not available a degree of uncertainty is introduced in the modelling as it uses simple metrics (AADT, average speed and vehicle split composition) to describe the complex traffic patterns. However, any uncertainty in the emissions is modelling assumptions is reduced in the model verification and adjustment process. This is described in detail in Appendix A.

Furthermore, speed data has been estimated from google maps traffic layer, adding uncertainty to the modelled vehicle speeds.

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Table 6.1: Traffic Data used within Assessment

Road	AADT Baseline 2018	Source	%Mcycle	%Car	%LGV	% HGV	%Bus
A905 Skinflats	13738	DfT 10965	0.8	82.2	0.6	16.3	0.1
A905 Glenburgh	12565	Glensburgh Road ATC	2.4	82.1	1.1	12.3	2.1
A904 Earls Road	10141	Earls Road ATC	1.1	77.4	0.8	17.5	3.2
Station Road	10174	DfT 80189	0.4	72.4	1.8	25.3	0.1
A904 Boness Road	10,176	DfT 10964	0.4	72.4	1.8	25.3	0.1
Inchyra Road	18302	Inchyra Road ATC	1.9	82.3	0.7	14.0	1.1
Beancross Road	13097	Beancross Road ATC	0	85.1	0.8	13.0	1.1
A904 Falkirk Road	26703	DfT 74405	0.2	78.3	1.0	16.9	3.6
Wholeflats Road	13990	Wholeflats Road ATC	8.7	83.0	0.6	6.9	0.7
A803 Polmont	7898	DfT 78580	0.2	85.1	1.8	12.8	0.1
M9	Between 38423-67336	DfT various	0.2	75.6	0.3	18.7	5.3
A904 Boness Road	10114	DfT 40965	0.5	70.8	0.3	24.1	4.3
A904 Falkirk Road	17416	DfT 80353	0.6	83.6	2.1	13.5	0.2

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6.2 Vehicle emission factors

The latest version of the Emissions Factors Toolkit (EFT V9.0 May 2019 release) was used in this assessment to calculate pollutant emission factors for each road link modelled. The emissions were calculated in the ADMS-Roads 5.0 model, which has EFT V9.0 built into the model.

Parameters such as traffic volume, speed and fleet composition were entered into ADMS, and an emissions factor in grams of pollutant/kilometre/second was generated for use in the dispersion model. In the latest version of the EFT, NOx and PM emission factors are taken from the European Environment Agency (EEA) COPERT 5 emission calculation tool. These emissions factors are widely used for calculating emissions from road traffic in Europe. Defra recognise these as the current official emission factors for road traffic sources when conducting local, regional and national scale dispersion modelling assessments.

The latest version of the EFT also includes addition of road abrasion emission factors for particulate matter; and changes to composition of the vehicle fleet in terms of the proportion of vehicle km travelled by each Euro standard, technology mix, vehicle size and vehicle category. Much of the supporting data in the EFT is provided by the Department for Transport (DfT), Highways Agency and Transport Scotland.

Vehicle emission projections are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. Any inaccuracy in the projections or the COPERT 5 emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

6.3 Treatment of modelled NO_x road contribution

It is necessary to convert the modelled NO_x concentrations to NO_2 for comparison with the relevant objectives.

The Defra NO_x/NO_2 model was used to calculate NO_2 concentrations from the NO_x concentrations predicted by ADMS-Roads. The model requires input of the background NOx, the modelled road contribution and accounts for the proportion of NO_x released as primary NO_2. For Falkirk in 2018 with the "All Other urban UK Traffic" option in the model, the NO_x/NO_2 model estimates that 27.9% of NO_x is released as primary NO_2.

6.4 Validation of ADMS-Roads Extra

Validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications; this is usually conducted by the model developer.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4, and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and Defra.

7 Industrial Emissions Assessment

At the time of commissioning this package of work 2017 emissions data were to be used for both studies. However, while the 2017 emissions inventory was being built and the models developed, new industrial emissions data were provided by SEPA for 2018. These data showed that emissions had reduced during 2018 due to new permits and BAT. Therefore, the Council and SEPA agreed that an updated 2018 emission inventory be built for both the industrial emissions and road traffic emissions.

An initial screening of the industrial facilities which operate and are permitted within the Grangemouth AQMA was undertaken in collaboration with the Council and SEPA to determine which sites should be taken forward into the study to identify a number of permitted sites. SEPA provided access to their reporting portal[5] which is used by each site to provide annual reporting requirements.

The next stage was to use the emissions inventory to build a dispersion model of all of the point sources identified for each site. For each point source we required all efflux parameters for each stack to allow them to be included in the model and operating in 2018.

While there were a number of point sources identified which did have the key pollutant emissions reported there were no efflux stack parameters reported and therefore these sources could not be modelled at this time.

Based on the information within the SEPA reporting portal we were able to model sources for the following sites which were in operation during 2018:

- Ineos
- Veolia Calachem
- Engie
- Ineos Chemicals

7.1 Operator emissions

SEPA also provided Sweco with a copy of a modelling study undertaken by Golder Associates which had a full breakdown of all of the SO_2 emitting sources assessed as part of the Tail Gas treatment feasibility. These data were used to supplement the data available on the SEPA reporting portal, namely exit temperature and exact stack grid references. The pollutant sources and emissions reported for 2018 are presented in Table 7.1 for Ineos, Table 7.2 for Calachem and Table 7.3 for Engie.

7.1.1.1 Operating Scenarios

The emissions data available from the online web portal, is based upon annual emissions and emissions data gathered as part of stack testing reports. This will be worst case as under stack testing the emissions are at 100% load. It is unlikely that all sources for all sites would run at 100% load for 8760 hours per annum and simultaneously. SEPA were also consulted and advised that annual average hourly emissions rate should be used given the numbers of points sources for this study rather than obtaining time varying hourly emissions data.

[5] https://beta.sepa.org.uk/publicregister/

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Whilst using reported 2018 emissions instead of 2017 presents a more current and up to date reflection of emissions across Grangemouth, the uncertainty of the operating hours is a limitation of the study. Therefore, the assessment is worst case in this aspect.

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Table 7.1: Stack Exit Parameters INEOS

Source	X	Y	Stack Height from Ground (m)	Stack Internal Diameter (m)	Exit Temperature (°C)	Exit Vol Flow (m^3/s)	NO_x (g/s)	PM_{10} (g/s)	SO_2 (g/s)	CO (g/s)
Ineos Boiler 8	294561	681217	65	2.7	136	17.8	2.395	0.004	0.010	0.058
Ineos Boiler 9	294634	681158	91	3.08	162	16.8	4.110	0.013	0.055	0.015
Ineos Boiler 10	294634	681158	91	3.08	166	18.7	4.193	0.025	0.769	0.121
Ineos Boiler 14 east duct	294725	681117	91	2.4	195	29.0	6.397	0.142	3.346	0.015
Ineos Boiler 14 West duct	294725	681117	91	2.4	200	29.1	6.551	0.166	4.562	0.019
Ineos Boiler 15 East duct	294725	681117	91	2.4	195	34.7	10.438	0.136	2.977	0.009
Ineos Boiler 15 West duct	294725	681117	91	2.4	191	30.9	7.747	0.156	3.304	0.024
Inoes CHP, g/s and Vol.flow used and set as NTP	294449	681130	65	5.3	105	352.4	11.100	0.003	1.100	0.300
CDU3/DHT combined (BA-101 & BA-301)	294854	681832	79	3.7	263	28.4	11.859	0.539	25.273	0.761
CRU Main Heater & WHB common stack	294871	681660	95.7	2.7	339	21.0	2.709	0.011	2.457	0.126
CRU 1st Interheater Unit (B-109)	294917	681731	67.5	2.4	190	11.7	1.461	0.006	1.315	0.025
No.1 CDU B1 Heater	294547	681945	42.3	1.37	485	14.0	5.454	0.285	15.094	-
No.1 CDU B1A Heater	294547	681945	56.4	1.58	406	6.4	2.061	0.095	1.205	-
No.2 CDU/No.2 DHT (combined)	294628	681824	61	3.38	379	1.5	0.296	-	0.800	0.012

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Source	X	Y	Stack Height from Ground (m)	Stack Internal Diameter (m)	Exit Temperature (°C)	Exit Vol Flow (m^3/s)	NO_x (g/s)	PM_{10} (g/s)	SO_2 (g/s)	CO (g/s)
Hydrofiner combined heater & stripper boilers	294506	681798	80	1.35	340	3.7	1.617	-	0.602	-
EPFCCU1= FCCU regenerator	294639	681981	70	1.32	220	33.0	14.751	1.643	44.319	0.132
EPHYDX1= S-601 No.2 VDU and HCU heaters (combined)	294619	681378	85	3.5	300	28.8	13.699	0.539	20.865	-
EPHCU2= Mild Vacuum Column Reboiler (Stack H-370)	294779	681373	70	1.5	390	5.7	1.871	0.063	0.698	-
EPHYD2= Hydrogen plan heater (Stack S-602)	294718	681450	84	4.19	230	29.6	10.147	0.317	3.678	-
EPSRU1= H-50704 Sulphur Recovery Unit 5	294795	681535	70	0.91	800	3.6	-	-	0.571	-
EPSRU3= H-60704 Sulphur Recovery Unit 6	294750	681610	70	0.91	800	3.6	-	-	4.630	-
KG4A= KG Furnace 36-F-1A	294924	680223	33.30	1.62	194	14.1	0.961	-	0.002	-
KG4B= KG Furnace 36-F-1B	294927	680209	33.30	1.62	207	14.5	0.894	-	0.002	-
KG4C= KG Furnace 36-F-1C	294929	680195	33.30	1.62	184	13.8	0.717	-	0.001	-
KG4D=KG Furnace 36-F-1D	294931	680180	33.30	1.62	191	14.0	0.961	-	0002	-
KG4E=KG Furnace 36-F-1E	294934	680166	33.30	1.62	205	13.7	1.126	-	0.002	-
KG4F= KG Furnace 36-F-1F	294936	680152	33.30	1.62	171	13.9	0.682	-	0.001	-
KG4G= KGXX Furnace 36-F-1G	294953	680053	33.30	1.62	154	12.3	0.815	-	0.001	-

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Source	X	Y	Stack Height from Ground (m)	Stack Internal Diameter (m)	Exit Temperature (°C)	Exit Vol Flow (m^3/s)	NO_x (g/s)	PM_{10} (g/s)	SO_2 (g/s)	CO (g/s)
KG4H= KGXX Furnace 36-F-1H	294955	680039	33.30	1.62	169	12.7	0.866	-	0.002	-
KG4J=KGXX Furnace 36-F-1J	294958	680025	33.30	1.62	163	12.5	1.012	-	0.002	-
KG6A=Steam Boiler 36-F-501A	294914	680265	30	1.73	114	16.4	2.531	0.004	0.002	-
KG6B=Steam Boiler 36-F-501B	294916	680251	30	1.73	114	16.4	2.427	0.004	-	-

Table 7.2: Stack Exit Parameters Calachem

Source	X	Y	Stack Height from Ground (m)	Stack Internal Diameter (m)	Exit Temperature (°C)	Exit Vol Flow (m^3/s)	NO_x (g/s)	PM_{10} (g/s)	SO_2 (g/s)	CO (g/s)
Calachem Boiler BB02	291780	681392	40	1.3	189	1.4	0.193	-	0.034	-
Calachem Boiler BB03	291780	681392	40	1.3	156	0.9	0.073	-	0.004	0.002
Calachem Boiler BB05	291786.9	681397	40	1.0	131	2.6	0.296	-	0.040	0.001

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Table 7.3: Stack Exit Parameters ENGIE

Source	X	Y	Stack Height from Ground (m)	Stack Internal Diameter (m)	Exit Temperature (°C)	Exit Vol Flow (m^3/s)	NO_x (g/s)	PM_{10} (g/s)	SO_2 (g/s)	CO (g/s)
Engie Cochrane Boiler	295473.7	680367.8	37.8	1.1	153	2.5	0.189	0.001	0.002	0.019
Engie Nebraska 1	295473.7	680367.8	37.8	1.1	153	4.9	0.654	0.009	0.016	0.017
Engie Nebraska 2	295473.7	680367.8	37.8	1.1	158	5.2	0.642	0.001	0.007	0.033

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Figure 7.1 Stack Locations

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7.1.2 Building parameters

Nearby buildings (within five flue heights) can have a significant effect on the dispersion characteristics of a flue plume. The main effect can be to increase concentrations in the immediate vicinity of the building, while reducing concentrations further away. Due to the scale of the modelling assessment and the number of industrial sources modelled, buildings were not added to the model. This was dealt with the higher surface roughness discussed in chapter 5.

7.1.3 NOx to NO_2

As worst case and we have assumed that 100% of NOx has been converted to NO_2 for comparison with the annual mean NO_2 objective.

7.1.4 Addition of process contributions

To assess the impact of emissions on local air quality, modelled concentrations are required to be added to the background concentrations. For long term concentrations the background concentration (BG) is added to the modelled process contribution (PC) to provide the predicted environmental concentration (PEC).

For short term concentrations, double the background concentration (BG) is required to be added to the modelled process contribution (PC) to provide the predicted environmental concentration (PEC).

8 Road traffic emissions results

8.1 Model verification

Model verification is the comparison of modelled results with available local monitoring data. This identifies how well the model is performing. LAQM.TG (16) recommends making the adjustment to the road contribution of the pollutant only. The model is refined as part of the verification process to reduce uncertainties within the modelling.

For this assessment, diffusion tube monitoring sites located within the study area were used for model verification. The modelling results were verified against modelling locations NA21, NA51, NA57 and NA94 and NA101.

8.2 NO_2 verification

The modelled NOx concentrations were verified against monitoring locations NA21, NA51, NA57, NA94 and NA101. Following refinements of the model, the modelled road contribution required an adjustment factor of 1.6304 to bring the predicted Road NOx concentrations in line with the measured Road NOx concentrations at diffusion tube locations NA21, NA51, NA57, NA94 and NA101. The adjustment factor was applied to all modelled road NOx concentrations. Following adjustment, the road NOx was then input into the Defra NOx to NO_2 calculator. A summary of the model pre and post adjustment annual mean NO_2 concentrations are outlined in Table 8.1 below.

Model uncertainty can be estimated by calculating the root mean square error (RMSE). The RSME was 3.2 µg/m³.

Verifying modelling data with diffusion tube data will always be subject to uncertainty due to the limitations in diffusion tube monitoring data, even automatic data has some uncertainties. The model results should be considered in this context. Further information on the verification process including the linear regression analysis are available in **Appendix A**.

Table 8.1: Modelled vs measured annual mean NO_2 concentrations 2018

Measuring Location	Measured (µg/m³)	Modelled (µg/m³)
Pre-Adjustment		
NA21	28	19.8
NA51	24	19.8
NA57	21	20.7
NA94	31	22.9
NA101	23	16.7
Post-Adjustment		
NA21	28	25.6
NA51	24	25.8

NA57	21	26.2
NA94	31	28.1
NA101	23	20.2

8.3 PM verification

There were no roadside monitoring sites which measured PM_{10} that could be used to verify the modelled Road PM_{10} concentrations. LAQM.TG (16) states that in the absence of any PM_{10} data for verification, it is appropriate to apply the road-NOx adjustment to the modelled road-PM_{10}. Therefore, an adjustment factor of 1.6304 was applied to all modelled PM_{10} and $PM_{2.5}$ concentrations.

8.4 Adjusted Modelling Results

Adjusted annual mean concentrations at the specified receptors from the road traffic modelling are discussed within this section. Full details of all predicted pollutant concentrations are provided in **Appendix B**.

The road traffic results are discussed separately from the industrial results before both are combined together.

8.4.1 NO_2 modelling results

No annual mean NO_2 concentrations in excess of the 40 µg/m³ air quality objective were predicted across the study area.

The highest modelled concentration from the road traffic modelling was 26 µg/m³ at Glensburgh Road.

Although all annual mean concentrations were below the objective, The study identified the following areas with the highest concentrations, although still well below the air quality objectives:

- Glensburgh Road
- Beancross Road
- Bo'ness Road

8.5 PM_{10} modelling results

No annual mean PM_{10} concentrations in excess of the 18 µg/m³ air quality objective are predicted at any locations in the study area. The highest modelled concentration from the road traffic modelling was 15 µg/m³ at Primrose Avenue, which borders the M9.

8.6 $PM_{2.5}$ modelling results

Scotland has an annual mean objective set for $PM_{2.5}$ of 10 µg/m³. The highest modelled $PM_{2.5}$ concentration in 2018 was 8.4 µg/m³ Bo'ness Road.

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9 Industrial emissions/ combined modelling results

Modelling of the identified point sources was undertaken for 2018 based upon the annual reported emissions for 2018.

The concentrations predicted by the model is known as the process contribution (PC). However, to compare the predicted concentrations with their respective objective the background concentrations are added to provide the predicted environmental concentrations (PEC). As we have explicitly modelled a number of road sources as part of this package of work the Background concentrations are added in accordance with the steps outlined in Section 4.3.

9.1 NO_2

The model has predicted the NOx concentration at ground level across a number of specified receptors. This has been as worst case been assumed to be 100%NO2. This has been added to the ROAD NO2 and the adjusted background concentrations as presented in Table 4.5. The NO_2 annual mean concentrations at all specified receptor locations are below the annual mean objective of 40 µg/m³.

The 99.8 percentile of 1-hour concentrations are also significantly below the 200 µg/m³ 1-hour objective at all receptors within the study area. The highest 1 hour concentration was at the Inchyra automatic monitoring site. Full details are presented in Appendix B.

9.2 PM

The dispersion model has predicted 24 hour mean and annual mean PM_{10} concentrations at all receptors. The predicted PM_{10} concentrations across all receptors are predicted to be below the both the annual mean and 24 hour mean objective levels.

$PM_{2.5}$ annual mean concentrations are below the Scottish annual mean objective for $PM_{2.5}$ of 10 µg/m³. Full details are presented in Appendix B.

9.3 SO_2

9.3.1 15min objective

The dispersion model has predicted 15min mean concentrations across all receptors. The results have indicated that while no location breeched the 15 min objective of 35 exceedances per year the modelling did show that the objective would be exceeded at multiple locations. A summary of the locations where the maximum15 min mean was over 266 µg/m³ is provided in Table 9.1.

Table 9.1 Results of 15 min SO_2 concentrations

Receptor Name	Max 15 min mean	99.9%ile 15 min mean	No of predicted exceedances
Bo`ness road	400	189	18
Inchyra AQU	398	201	9
Boness Road 1	392	183	18
Boness Road 2	391	201	28

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Receptor Name	Max 15 min mean	99.9%ile 15 min mean	No of predicted exceedances
Elizabeth Avenue	370	201	14
Moray AQU	341	231	18
Reddoch Road	335	151	5
Wholeflats	332	154	5
Grangemouth Stadium	328	140	5
Boness Road 3	317	153	5
Docks West	303	128	5
Oil refinery	302	254	14
Docks East	302	128	5
Bowhouse Primary	284	129	5
Merrick Road 1	271	132	0

The results indicate that based on the emissions data included in the model that the AQMA should stay in place. While the results indicate that there wasn't a breach of the objective, the numbers of exceedances and the numbers of locations where there are exceedances is still significant.

The results indicate that locations on Bo'ness Road may be experiencing higher concentrations than those currently measured at Moray air quality monitoring unit.

The overestimation in numbers of exceedances may be due to the conservative approach in the assessment. Emissions data are based on stack testing which would be done at 100% load and all sources operating at this simultaneously. It also assumes that these emissions are continuous for the full year (8760 hours). Full details are presented in Appendix B.

9.3.2 1 hour mean SO_2

The dispersion model has predicted 1 hour mean concentrations across all receptors. The results have indicated that while these 3 locations have predicted an exceedance of the 1 hour mean, 350 µg/m³ only 1 exceedance was predicted. Full details are presented in Appendix B.

Table 9.2: Results of 1 hour SO_2 concentrations

Receptor Name	Max 1 hour mean	99.73%ile 1 hour mean	No of predicted exceedances
Bo'ness road	375	146	1

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Receptor Name	Max 1 hour mean	99.73%ile 1 hour mean	No of predicted exceedances
Boness Road 1	370	144	1
Inchyra AQU	363	120	1

9.3.3 24 hour mean

The model has predicted 24 hour mean concentrations across all specified receptors. The results indicate that there would be no exceedances of the 24 hour mean at any location. Full details are presented in **Appendix B**.

9.4 CO

The model has predicted 8 hour running mean for all receptors the results show that predicted concentrations are significantly below this air quality standard. Full details are presented in **Appendix B**.

10 Source Apportionment

The study has predicted air pollutant concentrations within Grangemouth for all sources included within the assessment. Source apportionment has been undertaken to determine which sources have the greatest contribution to annual mean concentrations of NOx and PM_{10} within Grangemouth. The source apportionment has considered the different vehicle classes for road traffic sources and the different industrial facilities included in the modelling.

10.1 Road traffic source apportionment

The road traffic source apportionment has considered the contribution from background concentrations, cars, LGV, HGV and buses which have contributed to the modelled concentrations within the assessment. The source apportionment has identified the variation in sources across the study area. The results for NOx and PM_{10} are presented below in Chart 10-1to Chart 10-3

10.1.1 NOx source apportionment

Background concentrations accounted for between 30%-40% of concentrations close to the main traffic routes within Grangemouth such as Glensburgh Road, Bo'ness Road and Beancross Road.

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Chart 10-1 NOx contribution by location

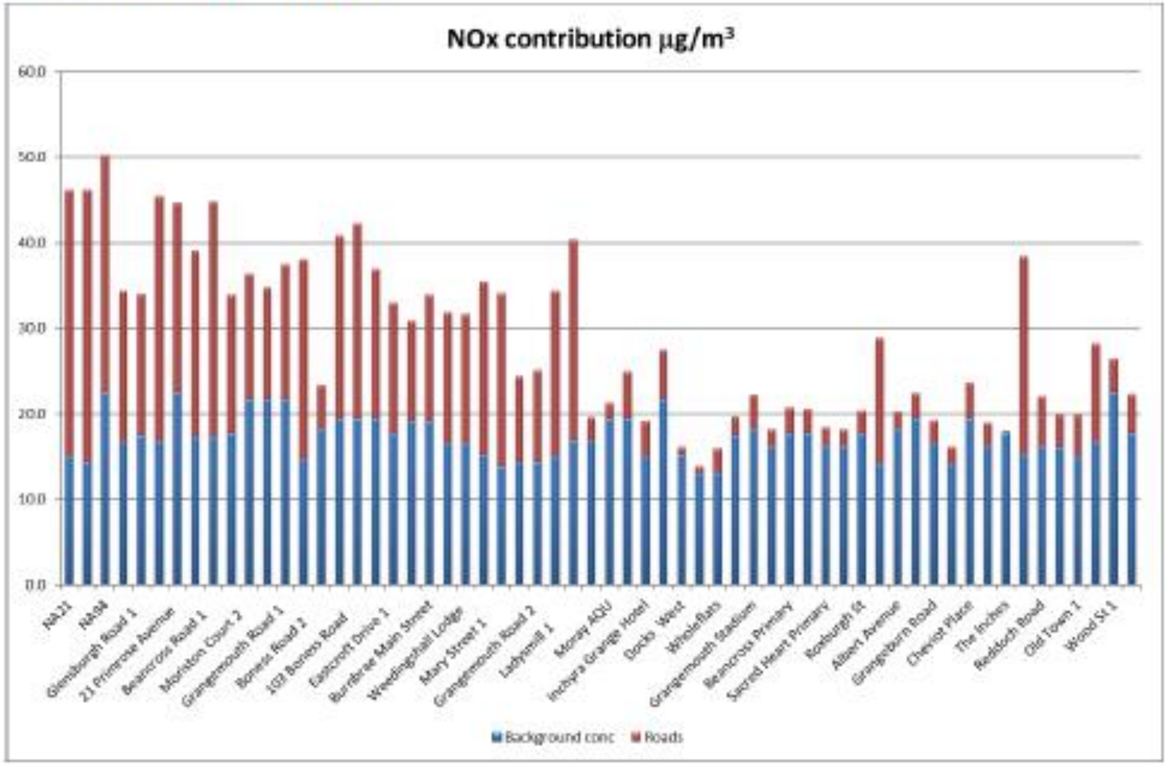

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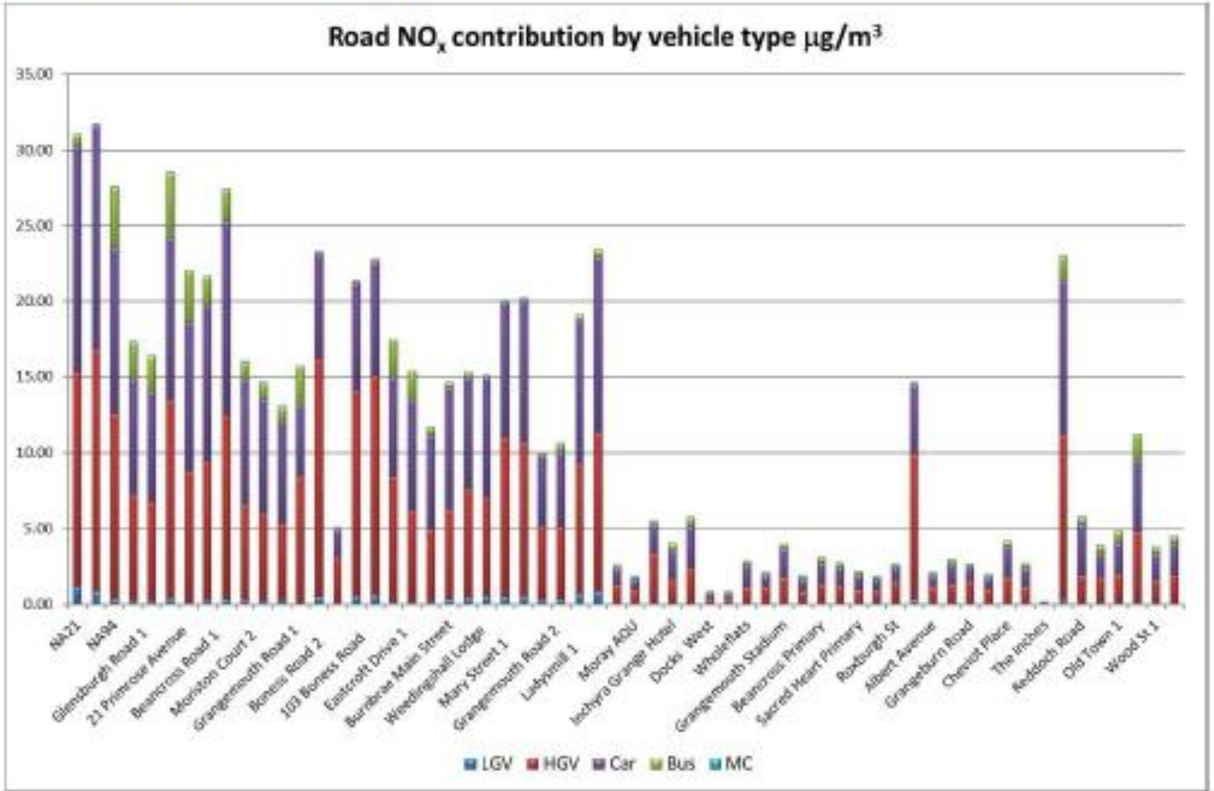
Chart 10-2 Road NOx analysis by vehicle type



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Further analysis of the Road NOx contribution is presented in Figure 10.1. This analysis has identified which vehicle type has the greatest NOx emissions for each road considered in the modelling study.

The road links, shown in blue have HGV vehicles as the highest contribution. These are mainly in line with HGV routes from the motorways to the port and the industrial area in Grangemouth.

The road links shown in red represent those links where emissions from Cars had the greatest emissions on NOx out of all of the vehicle types modelled.

Figure 10.1: Road Link Source Apportionment Analysis

10.1.2 <u>PM_{10} Source Apportionment</u>

Overall background concentrations contribute a large proportion of PM_{10} concentrations. Background concentrations of PM_{10} account for more than 90% of PM_{10} concentrations. Therefore, road sources only account for a small proportion of PM_{10} concentrations.

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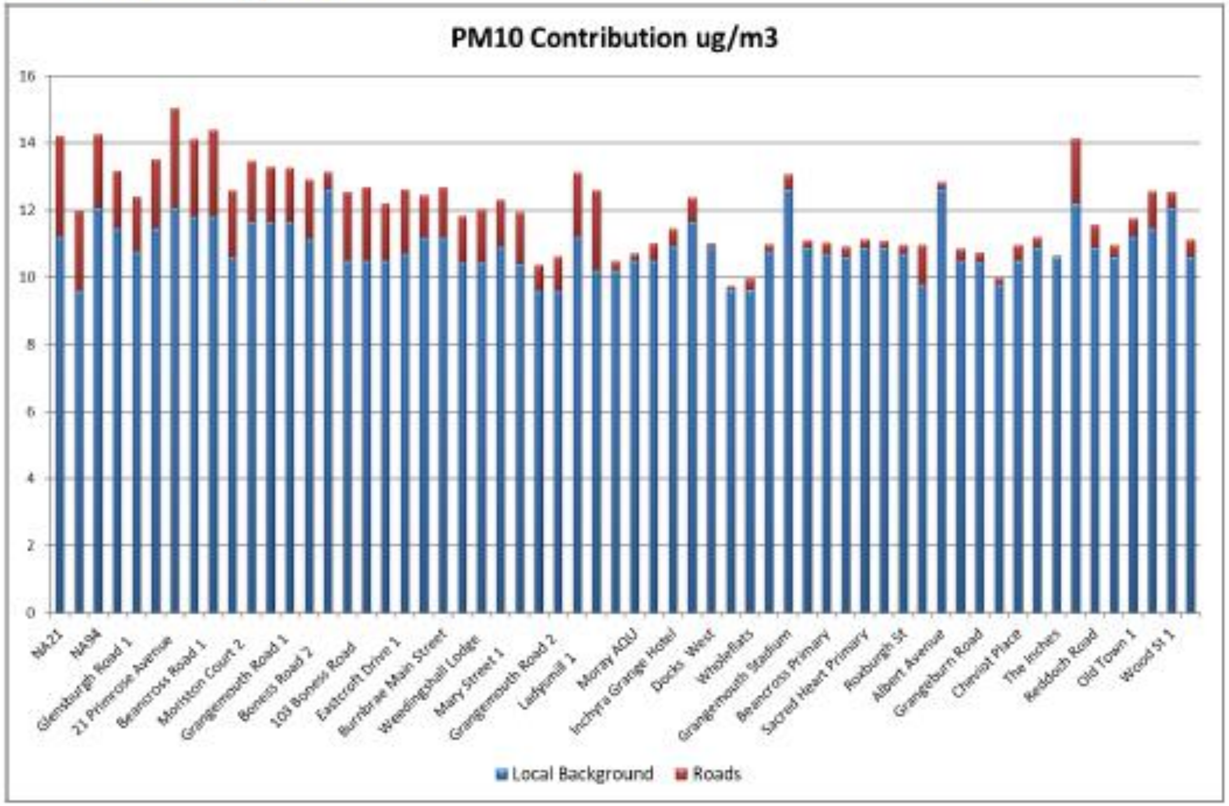
Chart 10-3 PM$_{10}$ source apportionment



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10.2 Industrial emissions source apportionment

The industrial source apportionment has considered the contribution from background concentrations and the Engie, Calachem and Ineos sites which have contributed to the modelled concentrations within the assessment. The source apportionment has identified the variation in sources across the study area. The results for NOx and PM_{10} are presented below.

10.2.1 NOx source apportionment

Background concentrations accounted for between 65%- 85% of concentrations across the study area.

Further analysis of the Industrial NOx contributions has identified that Ineos contributed the greatest to NOx concentrations across the study area.

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Chart 10-4 NOx contribution by location from industrial emissions

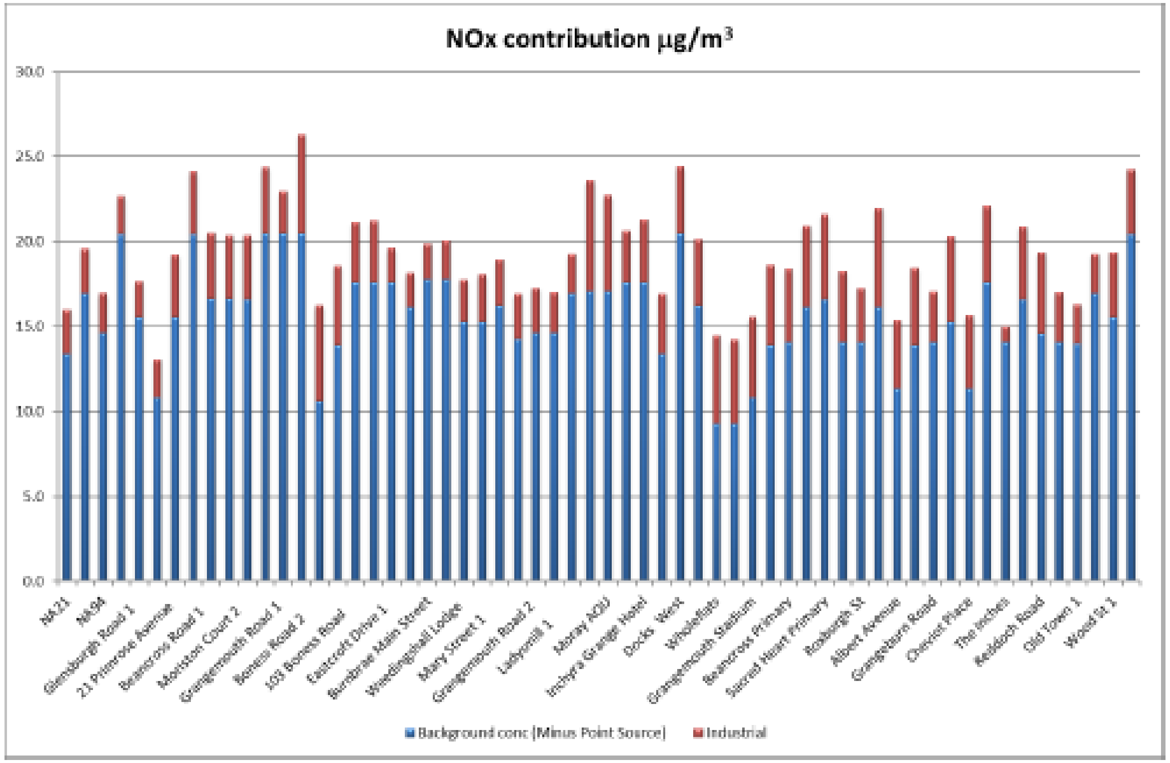
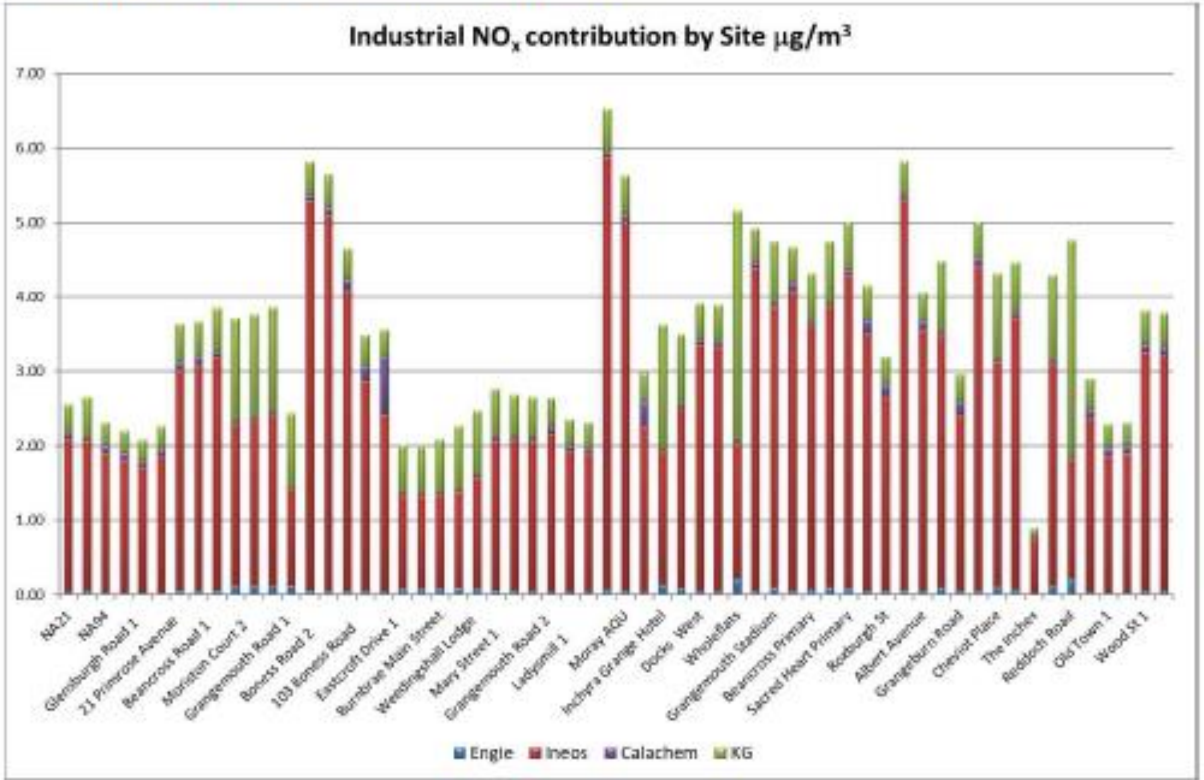


Chart 10-5 NOx contribution contribution by industrial operator



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10.2.2 PM_{10} source apportionment

Overall background concentrations contribute a large proportion of PM_{10} concentrations. Background concentrations of PM_{10} account for more than 95% of PM_{10} concentrations. Therefore, industrial sources only account for a small proportion of PM_{10} concentrations.

10.3 All sources source apportionment

The source apportionment analysis for all sources has reviewed the breakdown across all specified receptors for both NOx and PM_{10} concentration. A summary of this is presented in Chart 10-6.

10.3.1 NOx

Further review of the source apportionment analysis for NOx concentrations from both the road and industrial sources identified that road sources contributed the highest proportion of NOx concentrations at all of the specified receptor locations. The maximum contribution of NOx was seen at Bo'ness Road with 5.8 μg/m³ of NOx which was equivalent to 20% of the total NOx at this location. Industrial sources contributed less than 25% at all specified receptor locations.

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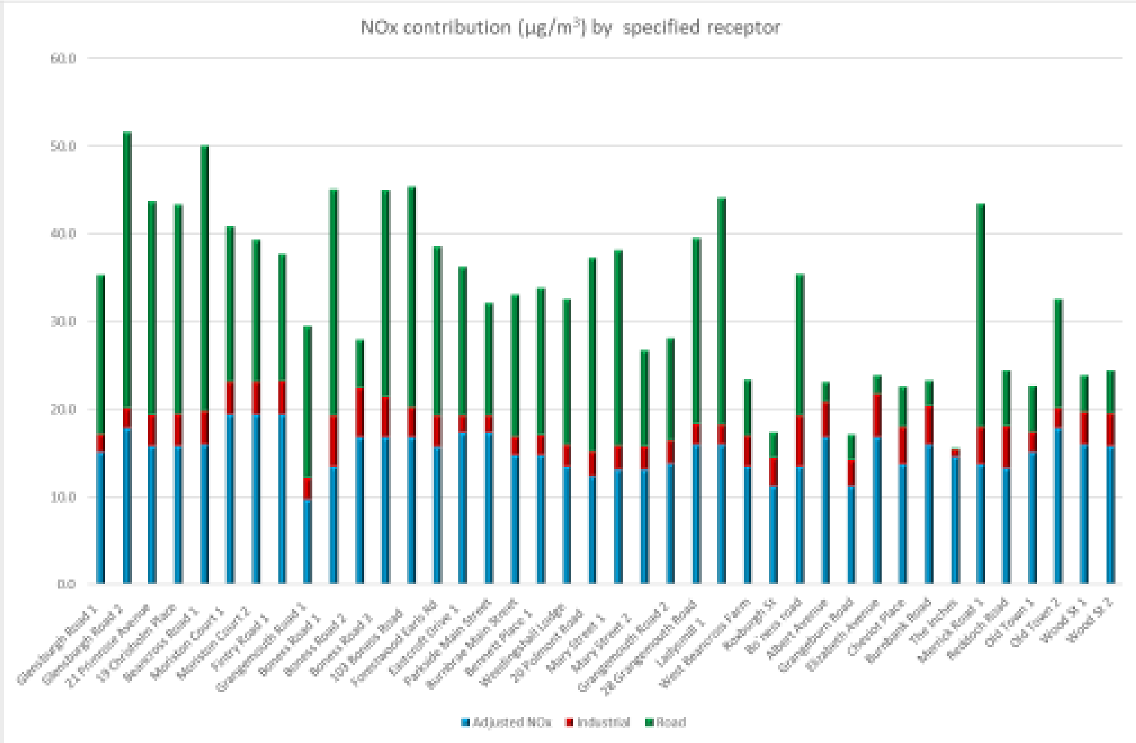
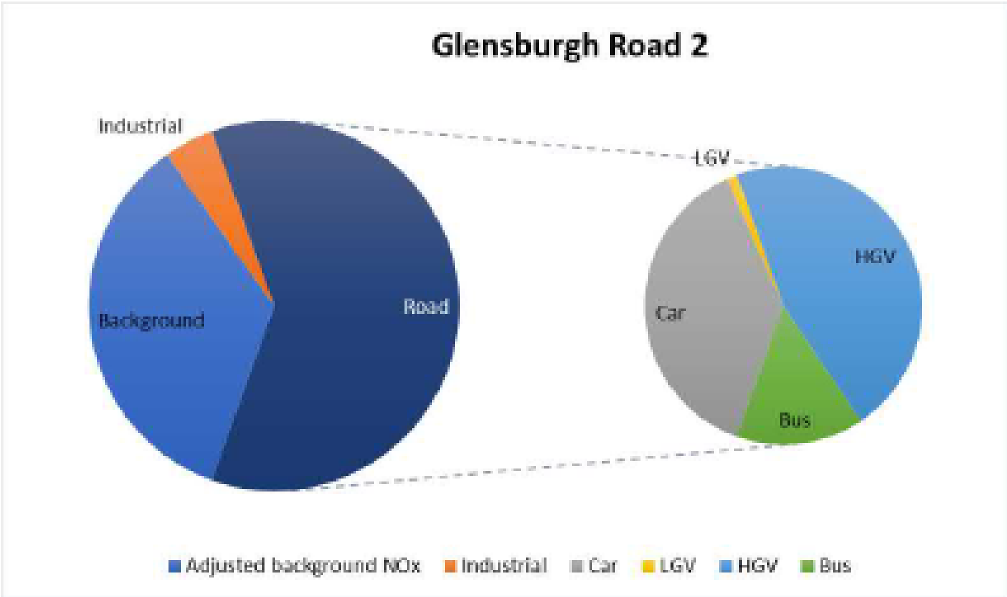
Chart 10-6 NOx (μg/m³)contribution by source for each receptor



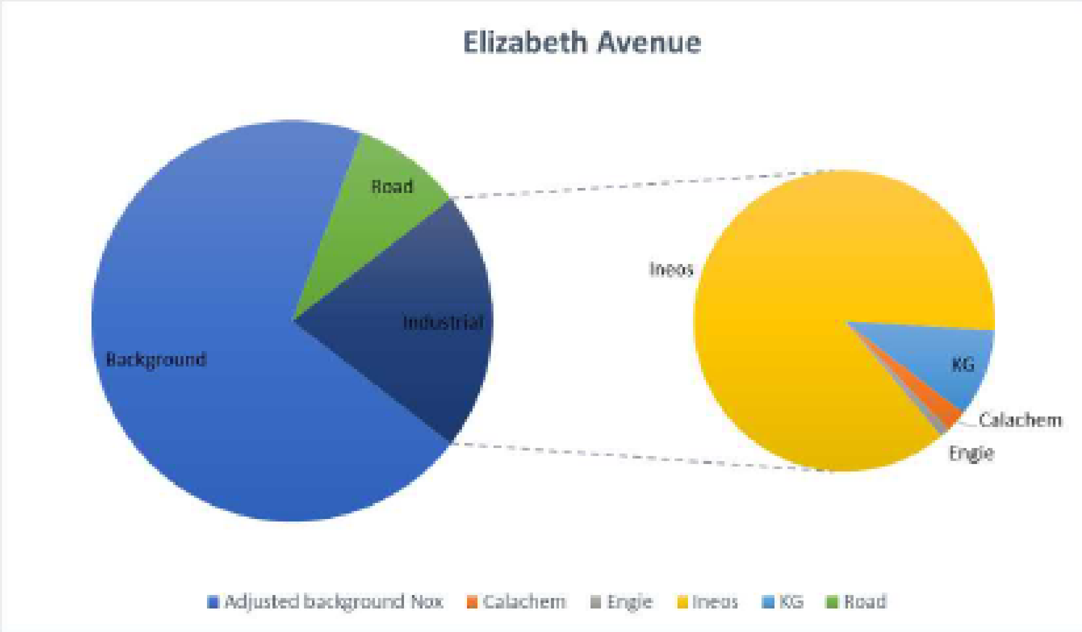
At receptor locations such as Wood Street and Elizabeth Avenue which are set back from the modelled roads, these locations were influenced more by background concentrations. Glensburgh Road 2 was identified as the receptor location where road traffic contributed most to NOx concentrations (61%). Contributions at Glensburgh Road 2 are presented in Chart 10-7

Chart 10-7 NOx specified receptor source apportionment at Glensburgh Road 2 specified receptor source apportionment



Elizabeth Avenue was identified as the location where industrial sources contributed greatest to total NOx concentrations (21%). Contributions at Elizabeth Avenue are presented Chart 10-8.

Chart 10-8 NOx specified receptor source apportionment at Elizabeth Avenue



10.3.2 Combined Source Apportionment PM_{10}

A review of PM_{10} concentrations from both the road and industrial sources identified that background sources contributed the most to PM_{10} concentrations at the specified receptor locations (between 76%-96%).

Industrial sources contributed less than 3% at all specified receptor locations. Road sources contributed between 10%-20% at most receptor locations. Similar to NOx, the greatest contribution to PM_{10} from road traffic sources was at Glenburgh Road 2.

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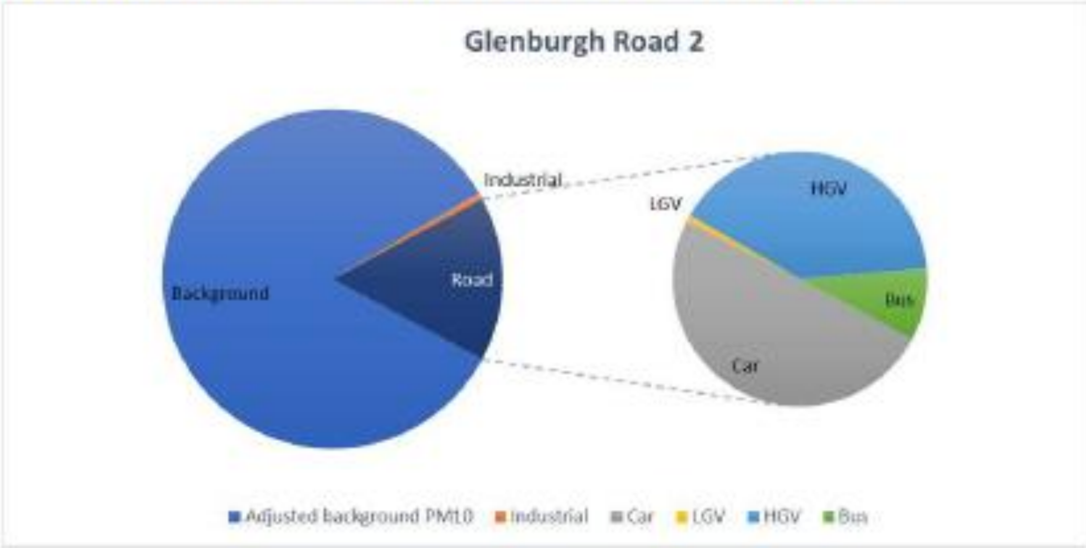
Chart 10-9 PM_{10} specified receptor source apportionment at Glensburgh Road 2



11 Conclusion

The assessment has considered both road sources and industrial sources within Grangemouth.

Previous assessment work in the AQMA has focussed on the short term SO_2 objectives in isolation. This package of work has considered a wider range of pollutants.

The study has predicted air pollutant concentrations within Grangemouth and detailed source apportionment modelling for all sources. This will determine which sources have the greatest influence on air quality concentrations within Grangemouth.

To our knowledge, this assessment is the first assessment where both the road traffic sources and industrial sources within Grangemouth have been modelled together. By combining both the industrial and traffic emissions in a complete assessment, this will give Falkirk Council an overall understanding of all emissions and traffic sources within the Grangemouth area and inform future management of the AQMA.

Road traffic Emissions

The road traffic assessment has used ATC traffic data to model pollutant concentrations in 2018. The road traffic model was verified using available monitoring data within the study area. Modelled concentrations were below the relevant air quality objectives for all pollutants modelled.

Hotspot areas were identified at Glensburgh Road, Bo'ness Road and Beancross Road, which are main routes within Grangemouth. **It is recommended that Falkirk Council undertake further monitoring within these locations to better understand pollutant concentrations.**

Industrial Emissions

The assessment of industrial sources has used annual emissions data for 2018 available on the SEPA web portal for permitted installations. These data showed that emissions had reduced during 2018 due to new permits which imposed new emission limit values.

Emissions data are conservative as test data has been used which is based on 100% load and assumes all sources operating 8760 hours.

The process contribution for each pollutant was added to the background concentrations to obtain the PEC. For NO_2 and PM_{10} the road traffic contribution was also added to predict a combined impact, with an adjusted background to account for the sources being explicitly modelled.

Modelled concentrations were below the relevant air quality objectives at all receptor locations for NO_2, PM_{10}, $PM_{2.5}$ and CO. The highest concentrations were predicted in the Inchyra area.

Source Apportionment

The source apportionment analysis has identified that across Grangemouth background NOx and PM_{10} sources contribute the greatest pollutant concentrations with road traffic emissions the next greatest contributor.

Further analysis of the road traffic emissions has identified that HGV and Car movements are responsible for the greatest source of NOx. However, this switched between the two dependant on the location of the road link. Typically, the routes from the motorway to the port and to the refinery have the highest contributions of NOX from HGV with the remaining links having car emissions as the predominant sources.

Analysis of the pollutant contributions from industrial sources has identified that Ineos contributed the greatest NOx concentrations across the study area.

12 Limitations and next steps

At the time of the study traffic count data were not available for every road in Grangemouth therefore the findings of the report are based only on the data included in the model. Therefore, the road traffic model could be improved by the addition of additional traffic flow data from new surveys around Grangemouth.

A number of point sources were identified in the screening process and compilation of the emissions inventory that unfortunately couldn't be included in the model. Typically, this was due to limitations in available data suitable for dispersion modelling in the SEPA reporting portal, as that level of detail isn't required for permit reporting purposes.

Emissions data which were based on stack testing reports or annual emissions reports, submitted to the SEPA reporting portal, assumed that these emissions data represented emissions for the entire year.

While the background data have been adjusted to remove all industrial NOx and PM_{10} emissions it is likely that this may be an over estimation of the contribution of the emissions being explicitly modelled. However, this is likely to have been balanced with the potential overestimation in the emissions which have been modelled.

The modelling could be improved by getting emissions data from each industrial operator to fill in the incomplete data gathered in the initial emissions inventory.

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Appendix A – Model Verification

As stated in Section 8.1 above, the model was verified using annual mean NO_2 measurements from diffusion tube locations NA21, NA51, NA57, NA94 and NA101. The study area was extended to Polmont to assist with model verification. Details of the monitoring sites used for model verification are detailed below.

Site ID	Site	X	Y	In AQMA	2014	2015	2016	2017	2018
NA21	Grangemouth Rd, Falkirk College	290112	680500	N	28	28	28	28	28
NA51	Mary St, Laurieston	290965	679490	N	25	19	25	22	24
NA57	Inchyra Rd, Grangemouth	294028	680829	N	26	20	23	19	21
NA94	A905 (Glensburgh Rd), Grangemouth	291213	681927	N	31	24	21	30	31
NA101	Glensburgh Rd (2), Grangemouth	291127	682007	N	25	22	21	24	23

The initial comparison of the modelled vs measured Road NOx identified that the model was under-predicting the Road NOx contribution. Following initial review, some refinements were made to the model input to improve the overall model performance.

A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment is presented in Figure A.1.

A primary adjustment factor (PAdj) of 1.6304 was applied to all modelled Road NOx data prior to calculating an NO_2 annual mean.

There was no monitoring site measuring PM_{10} in close proximity to the modelled roads that were suitable to verify the modelled PM_{10} concentrations. LAQM.TG (16) states that in the absence of any PM_{10} data for verification, it is appropriate to apply the road-NOx adjustment to the modelled road-PM_{10}. Therefore, an adjustment factor of 1.6304 was applied to all modelled PM_{10} and $PM_{2.5}$ concentrations.

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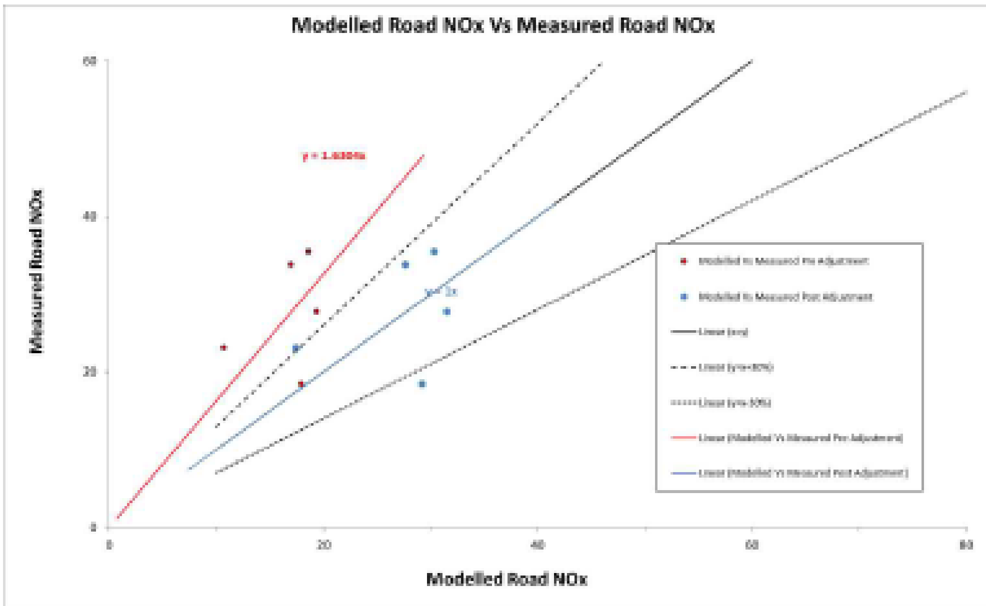
Figure A.1: Modelled vs Measured Road NOx



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Appendix B – Combined Results

Table B.1 presented the results from the road traffic modelling for NO_2, PM_{10} and $PM_{2.5}$. Results from the Industrial sources are presented in Table B.2.

Table B.3 presents the combined results for the road traffic assessment and the industrial sources. These have been combined by using the annual mean road concentrations from the roads assessment and the process contribution from the industrial sources to provide a combined annual mean concentration. Roads and industrial sources were removed from the background concentrations to avoid double counting.

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TABLE B.1: ROAD TRAFFIC MODELLING RESULTS

Receptor	Road Traffic NO_2 Annual mean µg/m^3	Road Traffic PM_{10} Annual mean µg/m^3	Road Traffic $PM_{2.5}$ Annual mean µg/m^3
Glensburgh Road 1	20.1	12.4	7.4
Glensburgh Road 2	25.7	13.5	7.6
21 Primrose Avenue	25.2	15.0	8.4
19 Chrisholm Place	22.5	14.1	7.9
Beancross Road 1	25.2	14.4	8.1
Moriston Court 1	19.9	12.6	7.5
Moriston Court 2	21.3	13.5	7.7
Fintry Road 1	20.5	13.3	7.6
Grangemouth Road 1	21.9	13.3	7.6
Boness Road 1	22.0	12.9	7.3
Boness Road 2	14.5	13.1	7.9
Boness Road 3	23.4	12.5	7.6
103 Boness Road	24.1	12.6	7.7
Forestwood Earls Rd	21.6	12.2	7.4

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Receptor	Road Traffic NO_2 Annual mean µg/m^3	Road Traffic PM_{10} Annual mean µg/m^3	Road Traffic $PM_{2.5}$ Annual mean µg/m^3
Eastcroft Drive 1	19.4	12.6	7.4
Parkside Main Street	18.5	12.4	7.1
Burnbrae Main Street	20.0	12.7	7.2
Bennett Place 1	18.9	11.8	6.9
Weedingshall Lodge	18.7	12.0	7.0
20 Polmont Road	20.7	12.3	7.3
Mary Street 1	20.0	11.9	7.1
Mary Street 2	15.0	10.4	6.3
Grangemouth Road 2	15.5	10.6	6.5
28 Grangemouth Road	20.0	13.1	7.5
Ladysmill 1	23.1	12.6	7.4
Inchyra AQU	12.5	10.5	6.2
Moray AQU	13.4	10.7	6.6
GMC AQU	15.4	11.0	6.7
Inchyra Grange Hotel	12.3	11.4	6.7

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Receptor	Road Traffic NO_2 Annual mean µg/m³	Road Traffic PM_{10} Annual mean µg/m³	Road Traffic $PM_{2.5}$ Annual mean µg/m³
West Beancross Farm	16.7	12.4	7.0
Docks West	10.6	11.0	6.5
Docks East	9.4	9.7	5.9
Wholeflats	10.5	10.0	6.0
Oil refinery	12.5	11.0	6.5
Grangemouth Stadium	13.9	13.1	7.8
Sports Complex	11.7	11.1	6.5
Beancross Primary	13.1	11.0	6.5
Bowhouse Primary	13.0	10.9	6.5
Sacred Heart Primary	11.9	11.1	6.5
Zetland Pavillion	11.7	11.1	6.5
Roxburgh St	12.9	11.0	6.4
Bo'ness road	17.4	11.0	6.7
Albert Avenue	12.9	12.8	7.7
Grangemouth High	14.0	10.9	6.6

Receptor	Road Traffic NO_2 Annual mean µg/m^3	Road Traffic PM_{10} Annual mean µg/m^3	Road Traffic $PM_{2.5}$ Annual mean µg/m^3
Grangeburn Road	12.3	10.7	6.2
Elizabeth Avenue	10.6	10.0	6.1
Cheviot Place	14.7	11.0	6.7
Burnbank Road	12.2	11.2	6.6
The Inches	11.6	10.6	6.4
Merrick Road 1	22.1	14.1	8.0
Reddoch Road	13.9	11.6	6.8
Falkirk Stadium	12.8	11.0	6.3
Old Town 1	12.7	11.7	6.7
Old Town 2	17.0	12.6	7.0
Wood St 1	16.2	12.5	7.0
Wood St 2	14.0	11.1	6.7

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TABLE B.2: INDUSTRIAL SOURCE MODELLING RESULTS

Receptor	Industrial NO_2 Annual mean µg/m³	Industrial NO_2 1 hour 99.79%ile µg/m³	Industrial PM_{10} Annual mean µg/m³	Industrial PM_{10} 98.08%ile 24 hour mean µg/m³
Glensburgh Road 1	14.0	45.6	11.4	22.9
Glensburgh Road 2	19.0	47.0	12.2	23.0
21 Primrose Avenue	16.1	51.9	11.8	23.2
19 Chrisholm Place	16.1	52.0	11.8	23.1
Beancross Road 1	16.4	53.5	10.6	23.2
Moriston Court 1	19.1	54.7	11.6	23.0
Moriston Court 2	19.2	54.4	11.6	23.0
Fintry Road 1	19.3	53.8	11.6	23.0
Grangemouth Road 1	13.1	49.8	10.8	22.8
Boness Road 1	18.4	60.4	11.3	24.2
Boness Road 2	19.3	57.9	10.5	24.3
Boness Road 3	18.3	54.7	10.4	24.1
103 Boness Road	17.1	51.4	10.4	23.8
Forestwood Earls Rd	15.9	50.5	10.6	23.2

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Receptor	Industrial NO_2 Annual mean µg/m³	Industrial NO_2 1 hour 99.79%ile µg/m³	Industrial PM_{10} Annual mean µg/m³	Industrial PM_{10} 98.08%ile 24 hour mean µg/m³
Eastcroft Drive 1	15.4	62.9	11.1	22.8
Parkside Main Street	15.4	58.4	11.1	22.8
Burnbrae Main Street	13.7	55.3	10.3	22.7
Bennett Place 1	13.9	53.5	10.3	22.8
Weedingshall Lodge	14.8	49.5	10.9	22.8
20 Polmont Road	13.6	46.0	10.4	22.9
Mary Street 1	13.6	45.4	9.6	22.9
Mary Street 2	13.6	45.3	9.6	22.9
Grangemouth Road 2	15.1	46.1	11.3	22.9
28 Grangemouth Road	14.7	44.3	10.3	22.9
Ladysmill 1	14.7	43.9	10.3	22.9
Inchyra AQU	20.2	65.2	10.4	23.8
Moray AQU	19.3	59.5	10.5	24.0
GMC AQU	13.8	48.0	10.8	23.2
Inchyra Grange Hotel	19.0	56.5	11.6	22.9

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Receptor	Industrial NO_2 Annual mean µg/m³	Industrial NO_2 1 hour 99.79%ile µg/m³	Industrial PM_{10} Annual mean µg/m³	Industrial PM_{10} 98.08%ile 24 hour mean µg/m³
West Beancross Farm	15.8	53.1	10.9	23.0
Docks West	12.9	57.7	9.4	23.3
Docks East	12.9	57.8	9.4	23.3
Wholeflats	17.1	65.3	10.2	23.0
Oil refinery	17.5	72.9	11.3	24.1
Grangemouth Stadium	16.1	61.7	10.8	23.3
Sports Complex	17.0	60.4	10.7	23.5
Beancross Primary	16.9	54.1	10.6	23.3
Bowhouse Primary	16.1	60.9	10.8	23.2
Sacred Heart Primary	16.4	60.7	10.8	23.5
Zetland Pavillion	16.5	57.6	10.7	23.6
Roxburgh St	13.0	52.7	9.6	23.6
Bo`ness road	18.4	60.2	11.3	24.2
Albert Avenue	17.7	57.9	10.4	24.6
Grangemouth High	15.9	58.9	10.8	23.2

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Receptor	Industrial NO_2 Annual mean µg/m³	Industrial NO_2 1 hour 99.79%ile µg/m³	Industrial PM_{10} Annual mean µg/m³	Industrial PM_{10} 88.08%ile 24 hour mean µg/m³
Grangeburn Road	12.7	51.9	9.6	23.3
Elizabeth Avenue	18.6	58.9	10.4	23.9
Cheviot Place	15.7	57.0	10.7	23.1
Burnbank Road	17.0	56.5	10.7	23.4
The Inches	11.5	37.7	12.2	22.7
Merrick Road 1	15.7	56.2	10.7	23.2
Reddoch Road	16.2	66.3	10.4	23.0
Falkirk Stadium	15.4	47.6	11.3	23.0
Old Town 1	14.2	47.3	11.4	23.0
Old Town 2	19.0	47.7	12.2	23.0
Wood St 1	16.4	54.3	10.6	23.2
Wood St 2	16.2	54.6	11.8	23.2

TABLE B.3: COMBINED ANNUAL MEAN RESULTS

Receptor	Height (m)	Combined NO_2 Annual mean µg/m³	Combined PM_{10} Annual mean µg/m³
Glensburgh Road 1	1.5	22.0	13.0
Glensburgh Road 2	1.5	28.2	14.0
21 Primrose Avenue	1.5	26.7	14.6
19 Chrisholm Place	1.5	26.5	14.0
Beancross Road 1	1.5	29.5	13.0
Moriston Court 1	1.5	23.9	13.4
Moriston Court 2	1.5	25.6	13.3
Fintry Road 1	1.5	24.8	13.1
Grangemouth Road 1	1.5	24.9	12.4
Boness Road 1	1.5	25.4	13.0
Boness Road 2	1.5	17.2	10.9
Boness Road 3	1.5	27.9	12.3
103 Boness Road	1.5	27.4	12.4
Forestwood Earls Rd	1.5	25.0	12.2

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Receptor	Height (m)	Combined NO_2 Annual mean µg/m³	Combined PM_{10} Annual mean µg/m³
Eastcroft Drive 1	1.5	21.6	12.9
Parkside Main Street	1.5	21.0	12.3
Burnbrae Main Street	1.5	22.5	11.8
Bennett Place 1	1.5	21.3	11.6
Weedingshall Lodge	1.5	21.3	12.3
20 Polmont Road	1.5	23.4	11.7
Mary Street 1	1.5	22.6	11.0
Mary Street 2	1.5	17.9	10.3
Grangemouth Road 2	1.5	18.3	12.1
28 Grangemouth Road	1.5	22.6	12.0
Ladysmill 1	1.5	26.2	12.5
Inchyra AQU	1.5	19.7	10.6
Moray AQU	1.5	18.9	10.5
GMC AQU	1.5	18.2	11.2
Inchyra Grange Hotel	1.5	14.6	11.9

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Receptor	Height (m)	Combined NO_2 Annual mean µg/m³	Combined PM_{10} Annual mean µg/m³
West Beancross Farm	1.5	20.7	11.5
Docks West	1.5	14.5	9.5
Docks East	1.5	11.4	9.5
Wholeflats	1.5	13.9	10.5
Oil refinery	1.5	14.2	11.5
Grangemouth Stadium	1.5	15.7	11.1
Sports Complex	1.5	16.0	10.8
Beancross Primary	1.5	17.6	10.9
Bowhouse Primary	1.5	18.1	11.0
Sacred Heart Primary	1.5	16.5	11.0
Zetland Pavillion	1.5	15.5	10.8
Roxburgh St	1.5	16.3	9.9
Bo'ness road	1.5	22.2	12.5
Albert Avenue	1.5	14.0	10.5
Grangemouth High	1.5	18.4	11.0

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Receptor	Height (m)	Combined NO_2 Annual mean µg/m³	Combined PM_{10} Annual mean µg/m³
Grangeburn Road	1.5	15.4	9.8
Elizabeth Avenue	1.5	14.7	10.8
Cheviot Place	1.5	18.8	11.0
Burnbank Road	1.5	16.2	10.5
The Inches	1.5	12.8	14.0
Merrick Road 1	1.5	27.1	11.3
Reddoch Road	1.5	18.2	10.8
Falkirk Stadium	1.5	15.1	11.6
Old Town 1	1.5	15.2	12.4
Old Town 2	1.5	19.5	12.4
Wood St 1	1.5	17.8	11.0
Wood St 2	1.5	18.0	11.7

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Appendix C – A3 FIGURES

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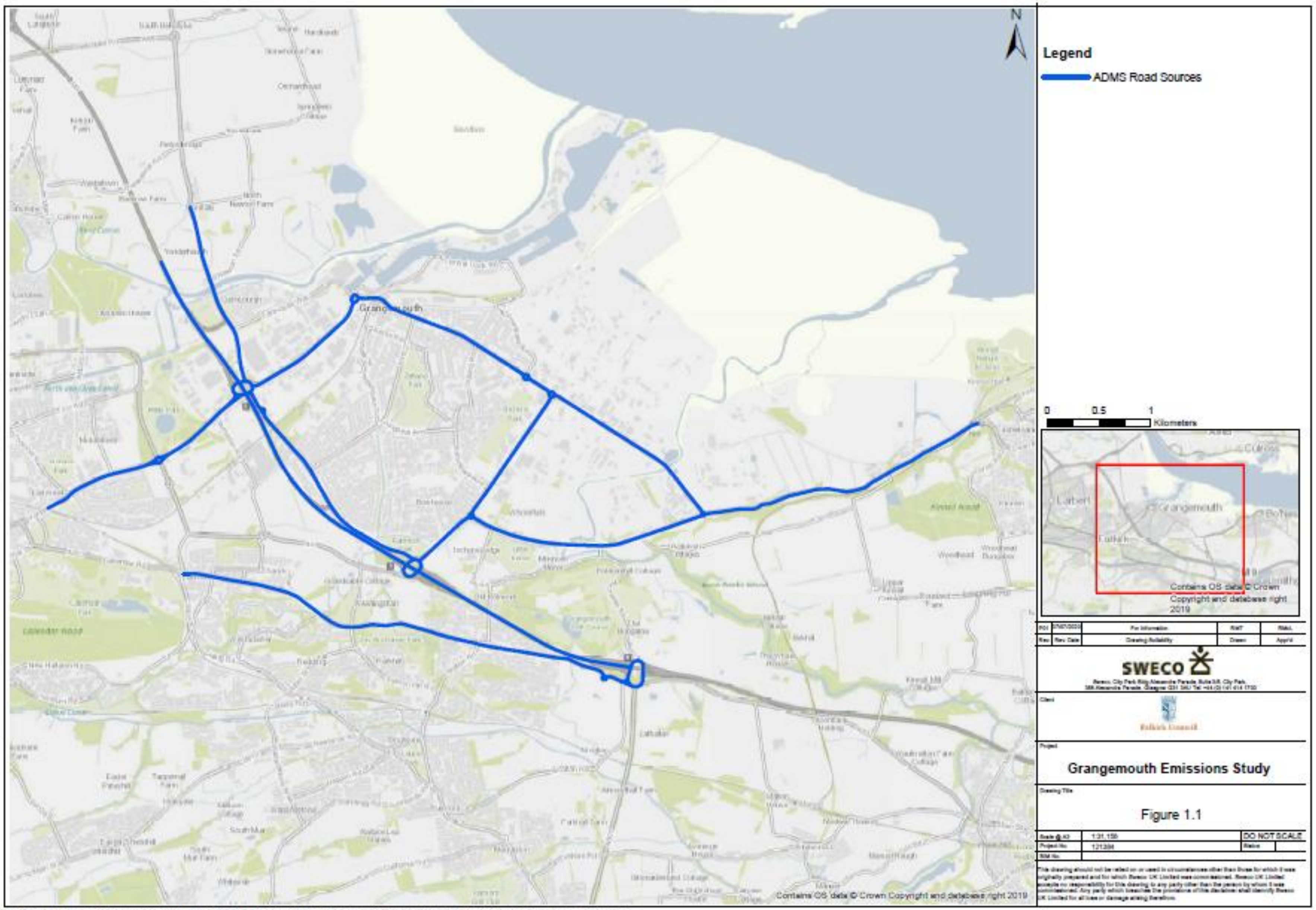

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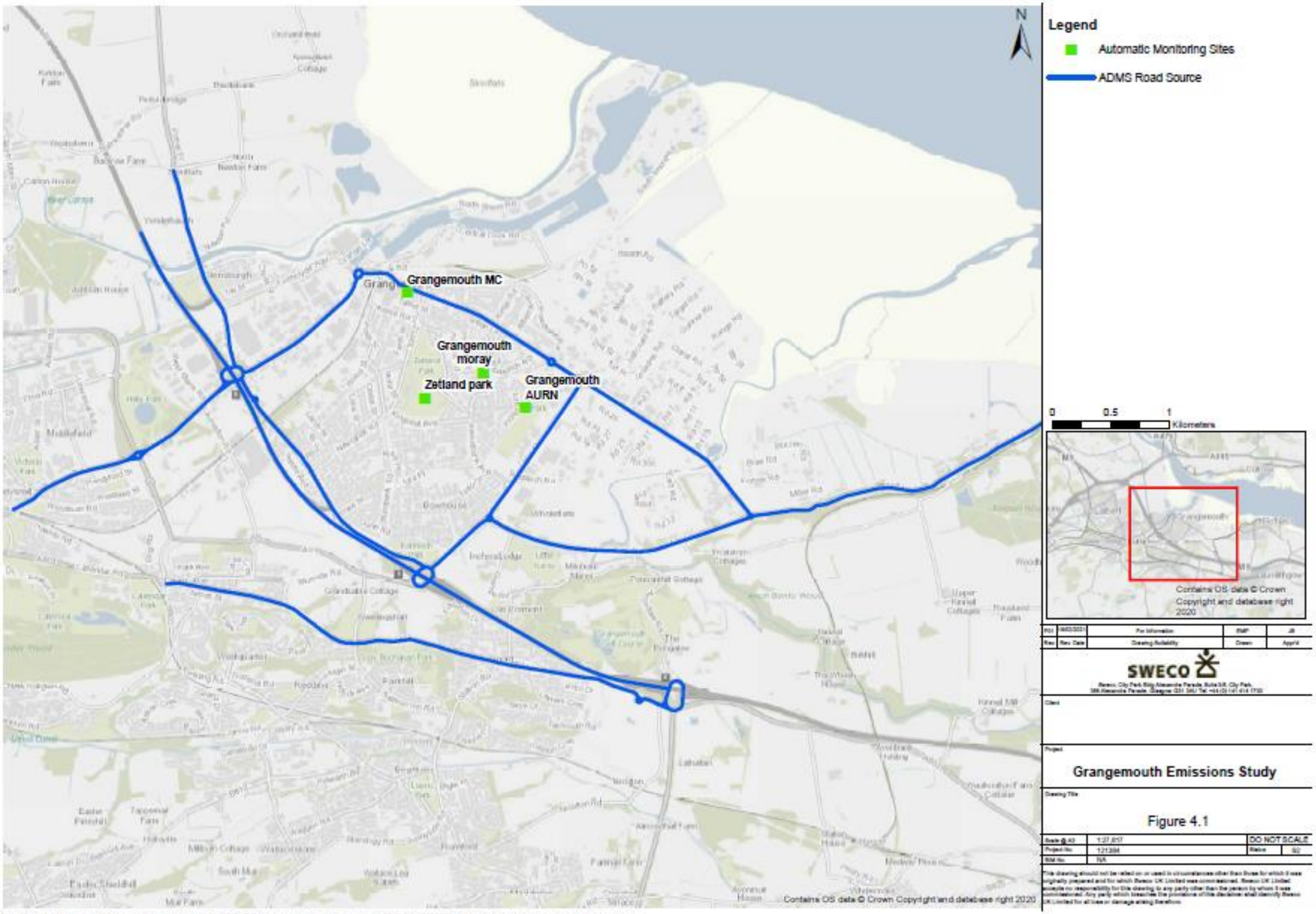
Legend
Automatic Monitoring Sites
ADMS Road Source
Grangemouth MC
Grangemouth moray
Zetland park
Grangemouth AURN
0 0.5 1 Kilometers
SWECO
Grangemouth Emissions Study
Figure 4.1
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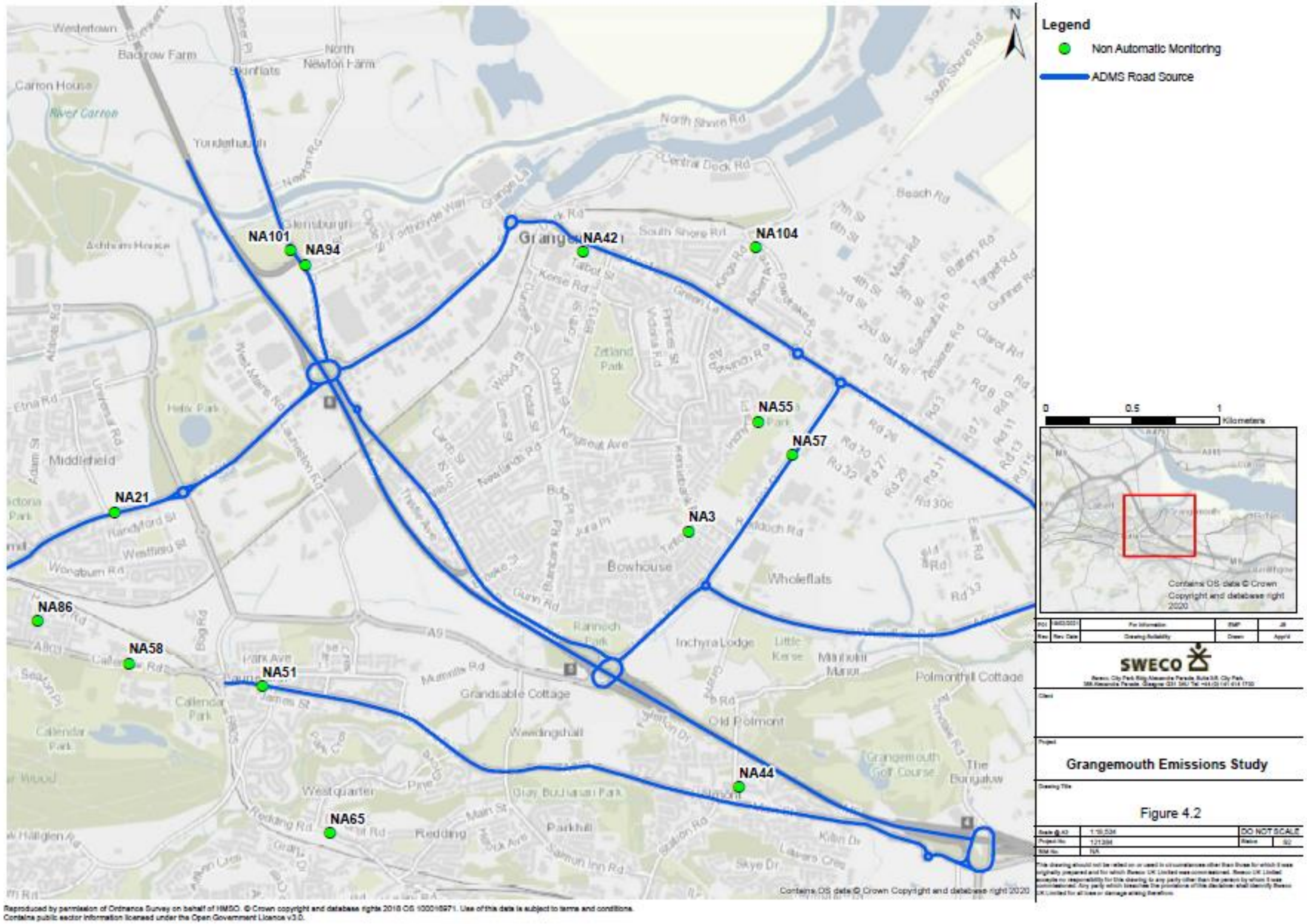
Legend
Non Automatic Monitoring
ADMS Road Source
NA101
NA94
NA42
NA104
NA55
NA57
NA21
NA3
NA86
NA58
NA51
NA44
NA65
0 0.5 1 Kilometers
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SWECO
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Figure 4.2
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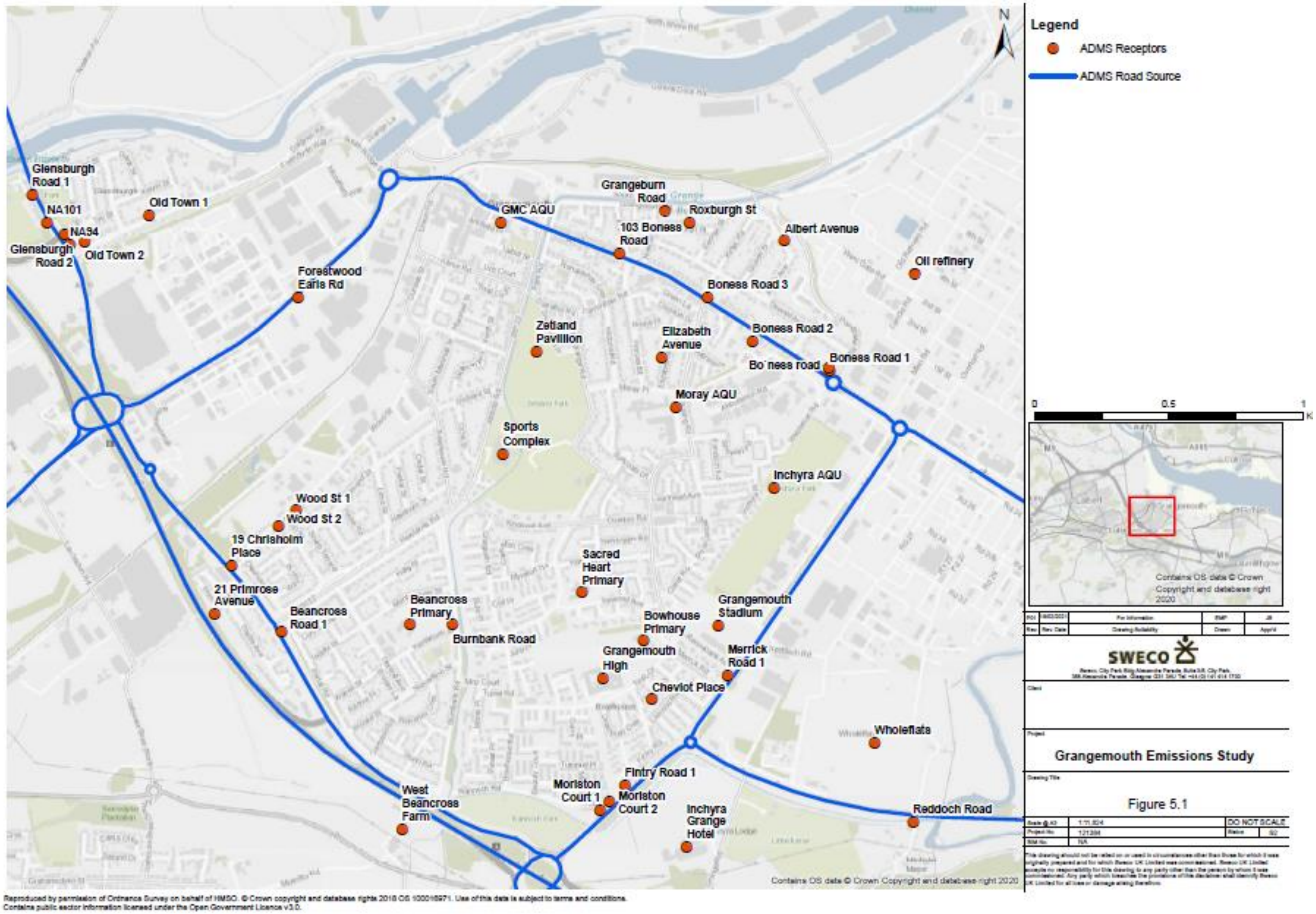
Legend
ADMS Receptors
ADMS Road Source
Glensburgh Road 1
NA101
NA94
Glensburgh Road 2
Old Town 1
Old Town 2
Forestwood Earls Rd
GMC AQU
Grangeburn Road
Roxburgh St
103 Boness Road
Albert Avenue
Oil refinery
Boness Road 3
Zetland Pavillion
Elizabeth Avenue
Boness Road 2
Bo'ness road
Boness Road 1
Moray AQU
Sports Complex
Inchyra AQU
Wood St 1
Wood St 2
19 Chrisholm Place
Sacred Heart Primary
21 Primrose Avenue
Beancross Road 1
Beancross Primary
Burnbank Road
Grangemouth Stadium
Bowhouse Primary
Grangemouth High
Merrick Road 1
Cheviot Place
Wholeflats
Fintry Road 1
Moriston Court 1
Moriston Court 2
West Beancross Farm
Inchyra Grange Hotel
Reddoch Road
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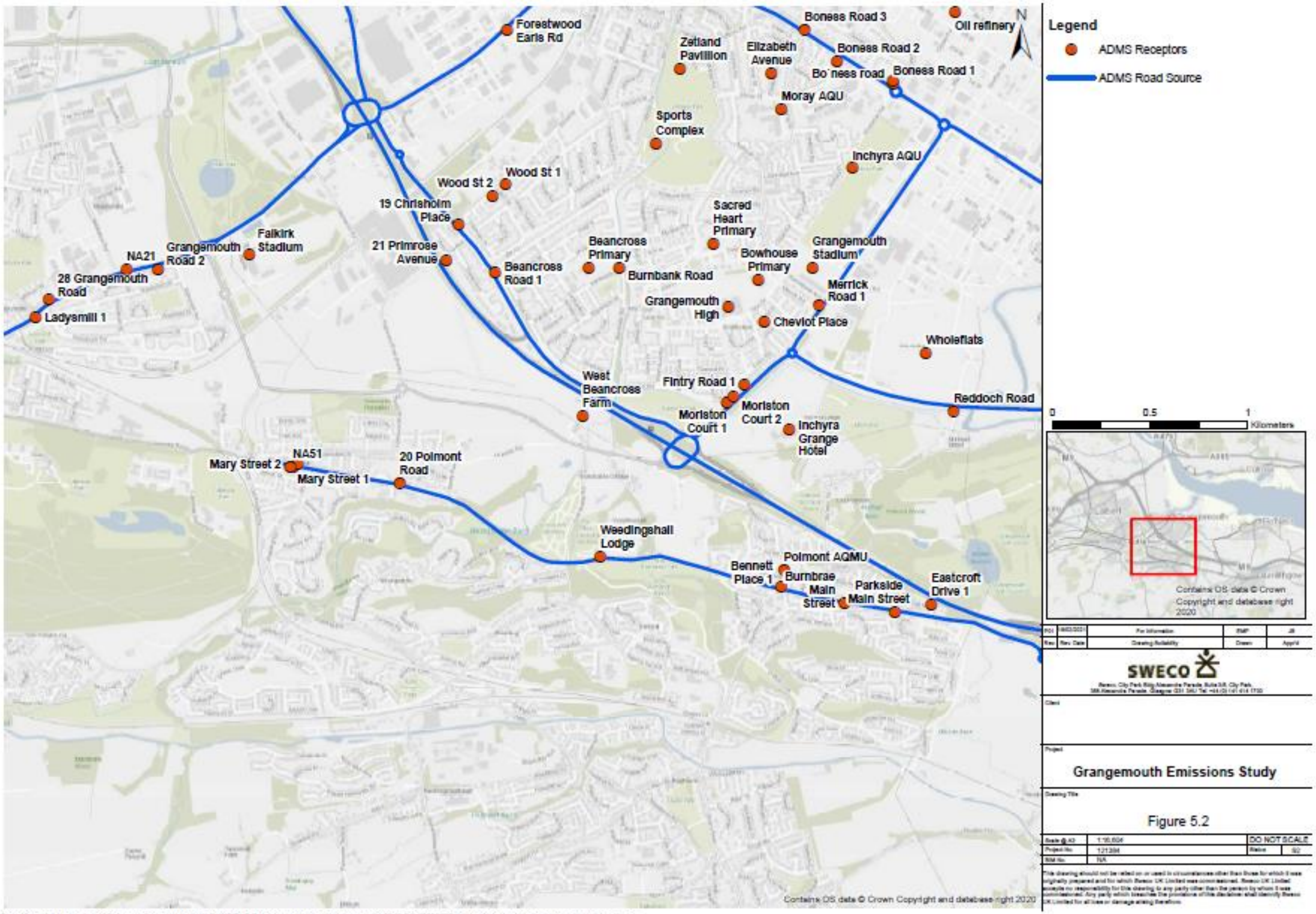
Forestwood Earls Rd
Zetland Pavilion
Elizabeth Avenue
Boness Road 3
Boness Road 2
Bo'ness road
Boness Road 1
Oil refinery
N
Legend
ADMS Receptors
ADMS Road Source
Moray AQU
Sports Complex
Inchyra AQU
Wood St 1
Wood St 2
19 Chrisholm Place
Sacred Heart Primary
Falkirk Stadium
Grangemouth Road 2
NA21
21 Primrose Avenue
Beancross Primary
Beancross Road 1
Burnbank Road
Bowhouse Primary
Grangemouth Stadium
Merrick Road 1
28 Grangemouth Road
Ladysmill 1
Grangemouth High
Cheviot Place
Wholeflats
West Beancross Farm
Fintry Road 1
Morlston Court 1
Morlston Court 2
Inchyra Grange Hotel
Reddoch Road
0
0.5
1
Kilometers
NA51
Mary Street 2
Mary Street 1
20 Polmont Road
Weedingshall Lodge
Polmont AQMU
Bennett Place 1
Burnbrae Main Street
Parkside Main Street
Eastcroft Drive 1
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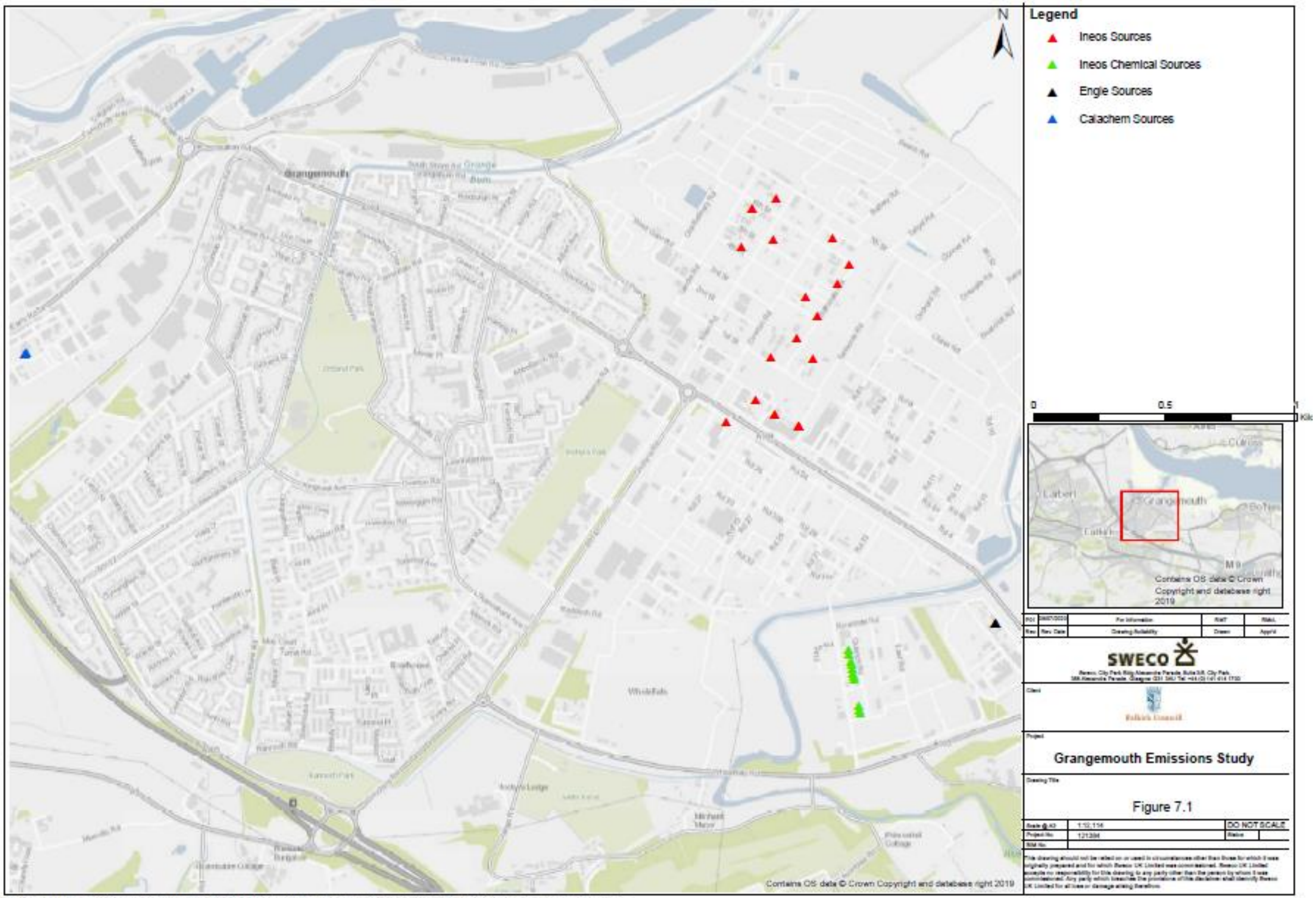

N
Legend
Ineos Sources
Ineos Chemical Sources
Engie Sources
Calachem Sources
0
0.5
1
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SWECO
Falkirk Council
Grangemouth Emissions Study
Figure 7.1
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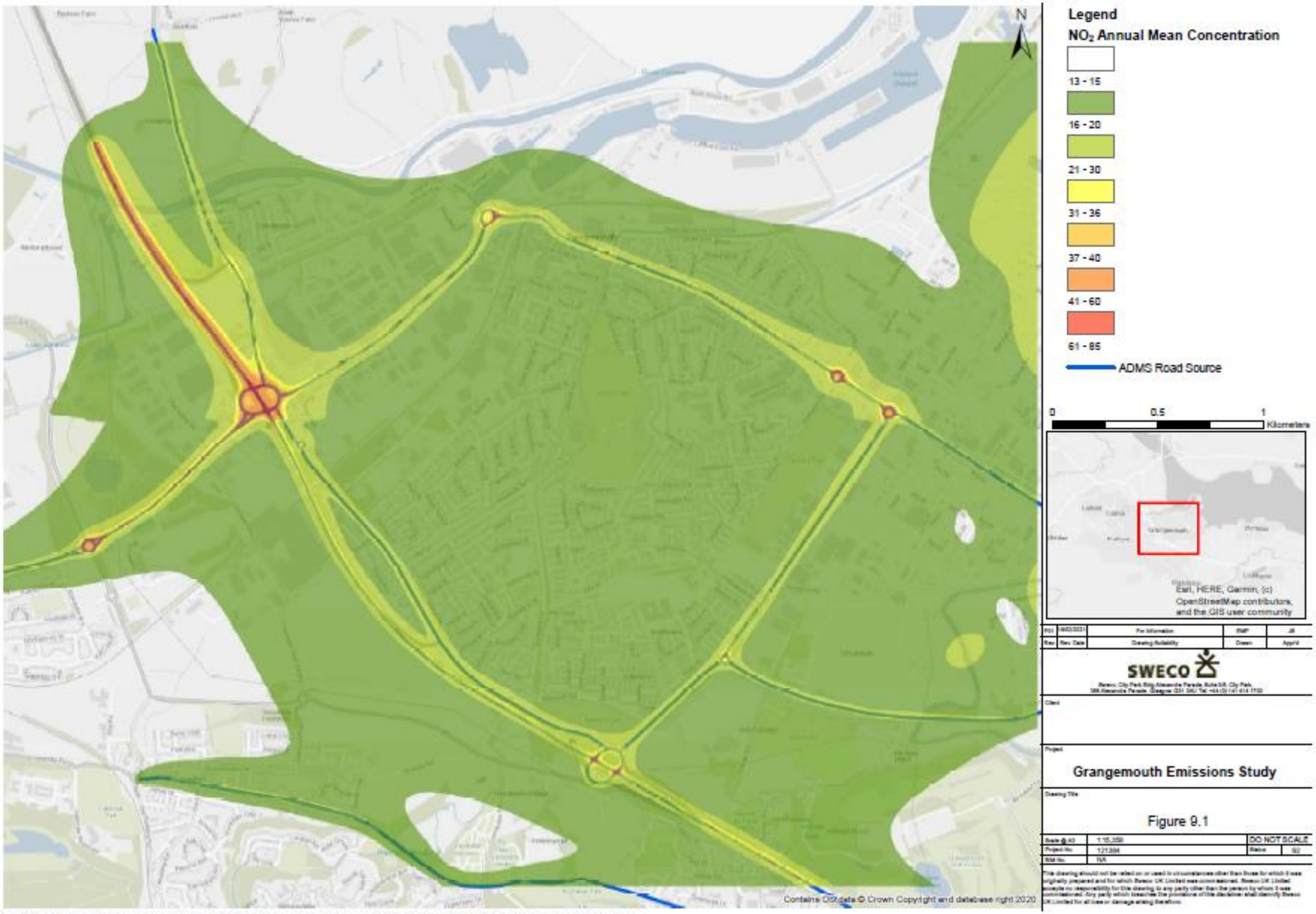
N
Legend
NO_2 Annual Mean Concentration
13 - 15
16 - 20
21 - 30
31 - 36
37 - 40
41 - 60
61 - 85
ADMS Road Source
0
0.5
1
Kilometers
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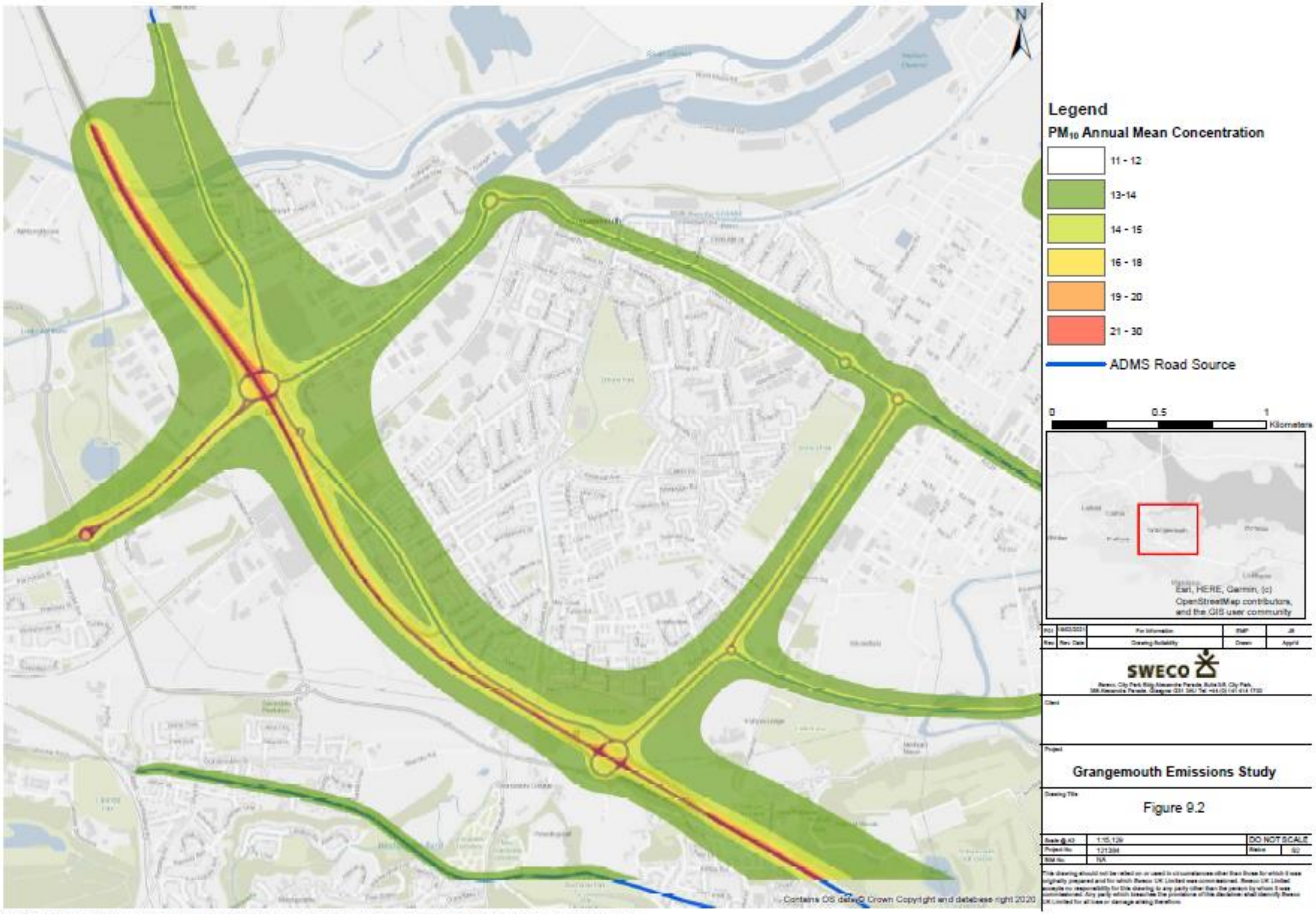
SWECO
Grangemouth Emissions Study
Figure 9.1
DO NOT SCALE


N
Legend
PM10 Annual Mean Concentration
11 - 12
13-14
14 - 15
16 - 18
19 - 20
21 - 30
ADMS Road Source
0
0.5
1
Kilometers
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
SWECO
Grangemouth Emissions Study
Figure 9.2
1:15,129
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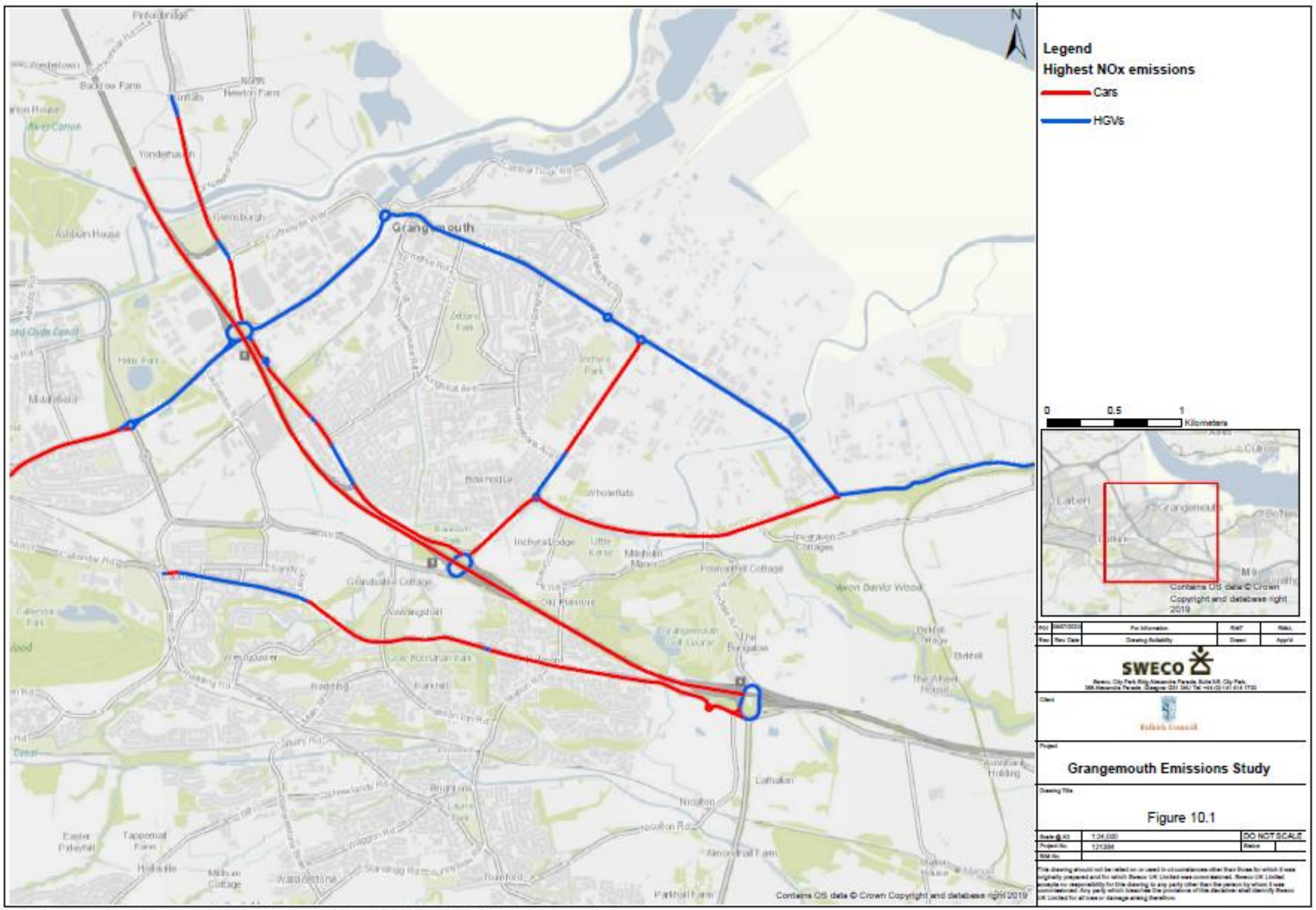
N
Legend
Highest NOx emissions
Cars
HGVs
0
0.5
1
Kilometers
Grangemouth
SWECO
Grangemouth Emissions Study
Figure 10.1
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Falkirk Council Proposal for Revocation of Haggs AQMA

Falkirk Council

Proposal for Revocation of Haggs Air Quality Management Area (AQMA)

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

2021

Haggs AQMA Revocation Proposal

Local Authority Officer	Author: John Millar (Air Quality Specialist) Reviewed by: David Gray (Env. Protection Co-ordinator)
Department	Environmental Health, Development Services
Address	Abbotsford House, David's Loan, Falkirk, FK2 7YZ
Telephone	01324 504873
E-mail	JohnA.Millar@falkirk.gov.uk
Report Ref:	Revocation Proposal, Haggs AQMA
Status	Final
Date	16/04/2021

Table of Contents

Falkirk Council

1. Introduction

The Environment Act 1995 (HM Government) required the preparation of a National Air Quality Strategy (NAQS) setting Air Quality Objectives (AQOs) for specified pollutants and outlining measures to be adopted by local authorities through the system of Local Air Quality Management (LAQM) and by others to work in pursuit of the achievement of these objectives. The NAQS was published in 1997 and subsequently reviewed and revised in 2000, and an addendum to the Strategy published in 2002. The current Strategy[1] was published in July 2007 (Welsh Assembly Government, Scottish Executive, Department for Environment, Department for Environment Food and Rural Affairs).

The AQOs which are relevant to LAQM in Scotland and have been set into regulations, namely the Air Quality (Scotland) Regulations 2000[2], the Air Quality (Scotland) Amendment Regulations 2002[3] and the Air Quality (Scotland) Amendment Regulations 2016[4] (Scottish Government).

Falkirk Council has a responsibility to comply with the above regulations when managing local air quality. The Council completes its LAQM duties by managing an extensive air quality monitoring network, assessing results and reporting on areas of existing or anticipated poor air quality - declared via Air Quality Management Areas (AQMA).

One of the areas identified which was subject to historic poor air quality was Haggs, situated on Falkirk Council's western boundary. This is shown in section 8. Figures - Map 1 Haggs Area within Falkirk Council Boundary.

2. Air Quality Management Area – Nitrogen Dioxide (Annual Mean)

The Council's Detailed Assessment[5] of air quality in Haggs (published in July 2008) detailed NAQS exceedances for nitrogen dioxide (NO_2) (annual mean). This Detailed Assessment and further air quality data analysis led to a declaration of the AQMA on 18th March 2010 following extensive public consultation. Table 1 displays the pollutant of relevance for this AQMA revocation proposal, and the Scottish NAQS objective which must be met for the protection of human health.

Table 1 – Scottish NAQS Objective for Applicable for this Proposal

Pollutant	Concentration	Measured as
Human Receptors		
Nitrogen Dioxide (NO_2)	40µg/m^3	Annual Mean

The Detailed Assessment and subsequent Further Assessment[6] of local air quality in Haggs identified that road traffic (specifically the upgrade and expansion of the A80 road to M80 motorway) and local quarry site traffic (Cowdenhill quarry located at Banknock) had been significant sources of NO_2 which affected relevant receptors. The AQMA within Haggs is shown in section 8. Figures – Map 2 – Haggs AQMA.

3. Local Pollution Sources

M80 Stepps to Haggs Motorway Expansion

The new 18-kilometre section of motorway was completed in August 2011 which connected the existing M80 at Junction 2 (Robroyston) to the area immediately north of Haggs. The road was partially expanded from an 'A' road to motorway.

The Transport Scotland road upgrade scheme included linking the Moodiesburn Bypass (bypassing the communities of Muirhead, Chryston and Moodiesburn) with the previously upgraded Auchenkilns Junction in North Lanarkshire. Some of the benefits of this project (as described by Transport Scotland) include delivering significant economic, environmental and safety benefits, by improving road safety and access to the north and south of the country[7].

The roadworks during the above major route expansion works led to altered traffic flows both on the A80 and on the A803 Kilsyth Road (the main road through Haggs) which was connected via two (one on, one off) slip roads. During 2009 a 40mph (65 km/hr) speed limit was established on the A80 using average speed cameras for enforcement. The speed limit during normal operation of this section of the A80 following completion of the roadworks were the national speed limit (112 km/hr).

The M80 (Stepps to Haggs) motorway road upgrade has now been fully completed and has been operational since 2011. There are no current, major motorway roadworks planned in the Haggs area (with any associated speed reduction restrictions) which could adversely affect local air quality through congestion.

Local Quarry Operations

There has been an operational quarry at Cowdenhill, Banknock since as early as 1926, and this was operated by Stirlingshire County Council in the 1940's. The site has since been used intermittently for quarrying, with the Skene Group operating the quarry under modern working conditions from 2000 until July 2011. Falkirk Council Application F/99/0026 remains a live permission, allowing for the extraction of aggregate material from the site until 2024.

A nearby quarry called Tomfyne has been planned within the North Lanarkshire area which is awaiting approval. Falkirk Council is a statutory consultee on this.

At present, there are no plans to extract further aggregate materials from these quarries. Further details of these quarries, their operation and effect on local air quality can be found in the Falkirk Council '2020 Banknock AQMA Revocation Proposal Report'[8]

4. Monitoring Equipment

The following air quality monitoring equipment has been deployed in the Haggs area since 2007 until present:

Table 2: Haggs AQMA Automatic Air Quality Monitoring Station and Associated Equipment

AQ Monitoring Site ID:	Falkirk Haggs
Site Type:	Roadside (Automatic)
Address:	Kerr Crescent, Haggs, FK4 1HN
OS Grid Ref (X / Y):	278977 / 679271
Equipment:	Monitor Labs ML 9041 (NO_x) (Operating from 09/11/2007 - 23/10/2018)
	API Teledyne T200 (NO_x) (23/10/2018 - Present)
	R&P 1400 TEOM (PM_{10}) (09/11/2007 - 04/06/2020)
	Palas FIDAS 200 (PM_{10}) (04/06/2020 - Present)
Monitoring Technique:	Monitor Labs ML 9041: Chemiluminescence
	API Teledyne T200: Chemiluminescence
	R&P 1400 TEOM: Gravimetric
	Palas FIDAS 200: Optical, light-scattering
Date Site Installed:	09/11/2007
Date Site Removed:	Roadside station still operational

The location of the Haggs automatic monitoring station can be shown in section 8. Figures - Map 3 – Automatic Monitoring Station Location.

The current Haggs monitoring station and equipment can be shown in Appendix 1 – Photos.

Table 3: Haggs AQMA Non-Automatic Air Quality Monitoring Diffusion Tube Locations

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 collocated with a Continuous Analyser?
NA19	Kilsyth Rd, Banknock	Roadside	278779	679301	NO_2	Y	<2	2.2	N
NA20	Garngrew Rd, Haggs	Urban Background	278957	679172	NO_2	N (On AQMA boundary)	<5	1.5	N
NA36	Kerr Crescent, Haggs	Roadside	278985	679273	NO_2	Y	<5	2.1	N
NA85	Auchincloch Dr, Banknock	Roadside	278752	679049	NO_2	Y	<2	0.8	N
NA87	M80 Slip South, Haggs	Roadside	279017	679305	NO_2	Y	<2	1.6	N

The locations of the above non-automatic diffusion tubes located within the Haggs AQMA can be shown in section 8. Figures – Map 4 – Non-Automatic Monitoring Stations

5. Monitoring Data

Falkirk Council monitors NO_2 and other pollutants at several locations throughout the Council area using both automatic and passive (non-automatic) sampling methods. The automatic monitoring data displayed below has been fully ratified in accordance with the Scottish Air Quality Database Quality Assurance / Quality Control (QA/QC) process[9]. Non-automatic monitoring (NO_2 diffusion tube) analysis displayed below was completed by Gradko International Ltd. Gradko adheres to the Department of Environment Food and Rural Affairs (DEFRA) guidance for the preparation and analysis of the NO_2 diffusion tubes. All the results relating to the concentration of NO_2 present on the diffusion tube are within the scope of Gradko's United Kingdom Accreditation Service (UKAS) accreditation. Further details of diffusion tube analysis including local and national NO_2 bias adjustment can be found in the most recent Falkirk Council APR: https://www.falkirk.gov.uk/services/environment/environmental-policy/air-quality/

The Council currently operates one automatic monitoring station located within the Haggs AQMA (as detailed in Table 2).

The NO_2 (annual mean) monitoring data (as extracted from Falkirk Council's 2020 APR[10]) are displayed in Table 4.

Table 4: Measured Automatic NO_2 Annual Mean Results 2015 – 2019

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration (µg/m³)				
				2015	2016	2017	2018	2019
A4	Falkirk Haggs	94	94	30	33	28	28	27

Notes: Exceedances of the NO_2 annual mean objective of 40µg/m³ 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%).

Table 5: Measured Non-Automatic (Diffusion Tube) NO_2 Annual Mean Results 2015 – 2019

Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration (µg/m³)(3)				
				2015	2016	2017	2018	2019
NA19	Kilsyth Rd, Banknock	83	83	26	33	26	28	27
NA20	Garngrew Rd, Haggs	100	100	23	24	22	22	22
NA36	Kerr Crescent, Haggs	91	91	37	38	35	37	35
NA85	Auchincloch Dr, Banknock	100	100	20	16	17	19	20
NA87	M80 Slip South, Haggs	100	100	32	30	27	28	31

Notes: Exceedances of the NO_2 annual mean objective of 40µg/m³ 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) 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%.

6. Conclusion

The Haggs AQMA was declared on the 18th March 2010 following National Air Quality Objective (NAQS) exceedances for NO_2 (annual mean). Since the AQMA was declared, measured concentrations (using automatic and non-automatic monitoring methods) of NO_2 have complied with the NAQS objectives consistently over the past five years (since 2015).
The Detailed[5] and Further[6] Assessments identified that road traffic (specifically the upgrade expansion of the A80 to M80 Stepps to Haggs motorway) and local quarry site traffic (Cowdenhill quarry at Banknock) had been significant sources of NO_2 which affected relevant receptors within the Haggs area. It is understood that the M80 (Stepps to Haggs) road upgrade has now been fully completed and there are no further major motorway roadworks planned in the Haggs area (with any speed reduction restrictions). There are no current plans to operate any aggregate quarries within the Banknock area.

As a result of the ongoing automatic and non-automatic air quality monitoring within the Haggs AQMA, the Council has demonstrated that the annual mean concentrations of NO_2 complies with the relevant NAQS objective. It is understood that the opening of the M80 motorway and the reduction in quarry operations in this area has led to a reduction in overall NO_2 concentrations and thus compliance with the NAQS objectives.

As stated within the Air Quality in Scotland (LAQM) website in relation to AQMA Revocation:
'Where a local authority feels that it has sufficient evidence to justify the need to amend/revoke an AQMA at any time, it should submit that evidence to the Scottish Government for appraisal. For those authorities that have continuous monitoring, the Scottish Government would expect them to keep the AQMA under regular review, and to take action where necessary, rather than await the next round of reviews and assessments.'

Falkirk Council will continue to have a NO_2 (and PM_{10}) monitoring capability within this area until 2024 when the live planning consent of the Cowdenhill quarry expires. It is anticipated that the automatic monitoring equipment within the Haggs area could be used to focus on other areas of poor air quality within the region.

Falkirk Council is requesting the permission of the Scottish Government and Scottish Environment Protection Agency (SEPA) to revoke the Haggs AQMA (thus reducing Falkirk Council's AQMAs from three to two). Pending permission approval, Falkirk Council will notify all other statutory consultees and publicise the revocation through local / social media, so the public and local businesses are fully aware of the situation.

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7. References

1. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1, July 2007, Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Norther Ireland)

2. The Air Quality (Scotland) Regulations 2000 (31st March 2000, The Scottish Government)

3. The Air Quality (Scotland) Amendment Regulations 2002 (11th June 2002, The Scottish Government)

4. The Air Quality (Scotland) Amendment Regulations 2016 (1st April 2016, The Scottish Government)

5. Local Air Quality Management Detailed Assessment of NO_2 Concentrations at Banknock and Haggs (July 2008, BMT Cordah for Falkirk Council, Report Ref: E_FAL_026 / Report 5, shown in Appendix 2)

6. Haggs / Banknock Further Assessment of Air Quality (March 2011, BMT Cordah for Falkirk Council, Report Ref: G.FAL.033.HAGGS, shown in Appendix 3)

7. M80 Stepps to Haggs Project (Transport Scotland, https://www.transport.gov.scot/projects/m80-stepps-to-haggs/m80-stepps-to-haggs/)

8. Falkirk Council '2020 Banknock AQMA Revocation Proposal Report' (https://www.falkirk.gov.uk/services/environment/environmental-policy/air-quality/docs/air-quality/10%202020%20Banknock%20AQMA%20Revocation%20Proposal%20Report.pdf?v=202010220950)

9. The Scottish Air Quality Database QA/QC Process (28th March 2012, AEA Ricardo / The Scottish Government)

10. 2020 Annual Progress Report (November 2020, Falkirk Council)

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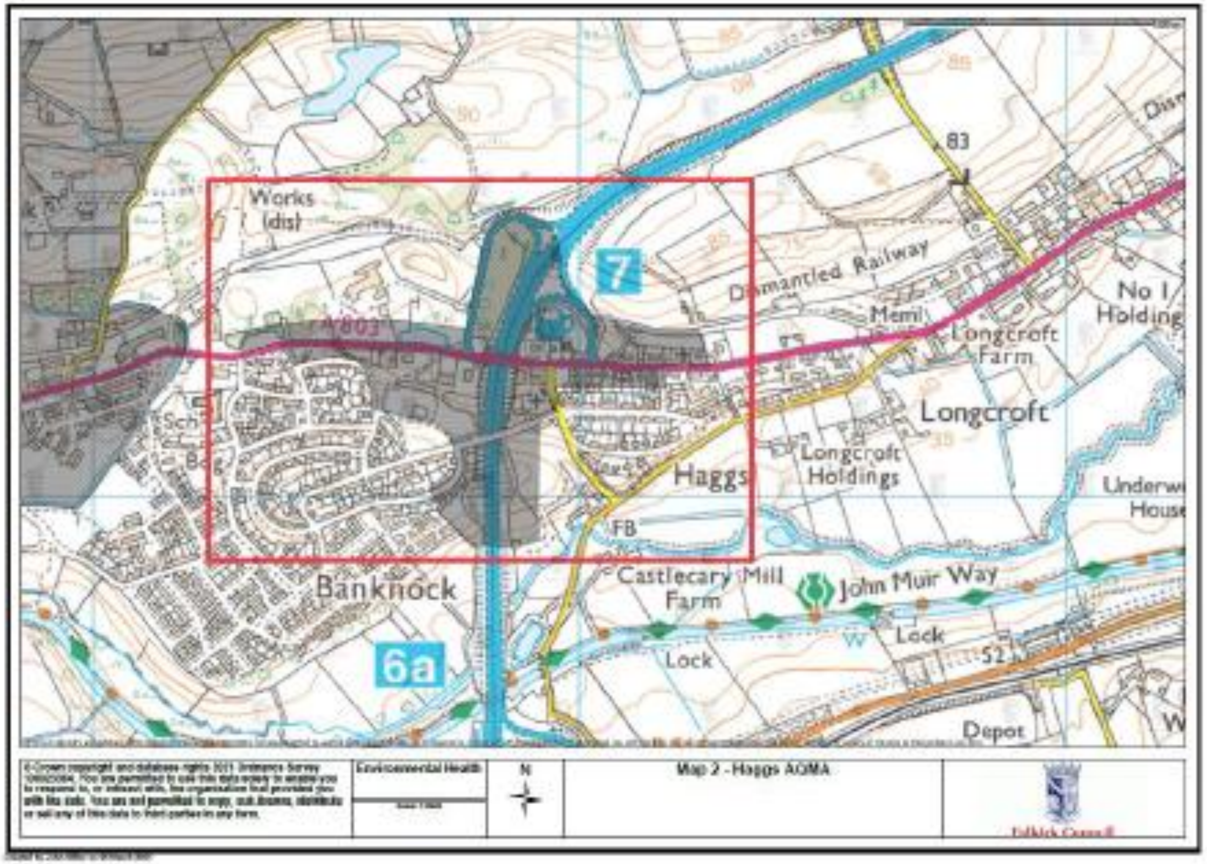
8. Figures - Map 1 - Haggs Area within Falkirk Council Boundary

Map 2 - Haggs AQMA



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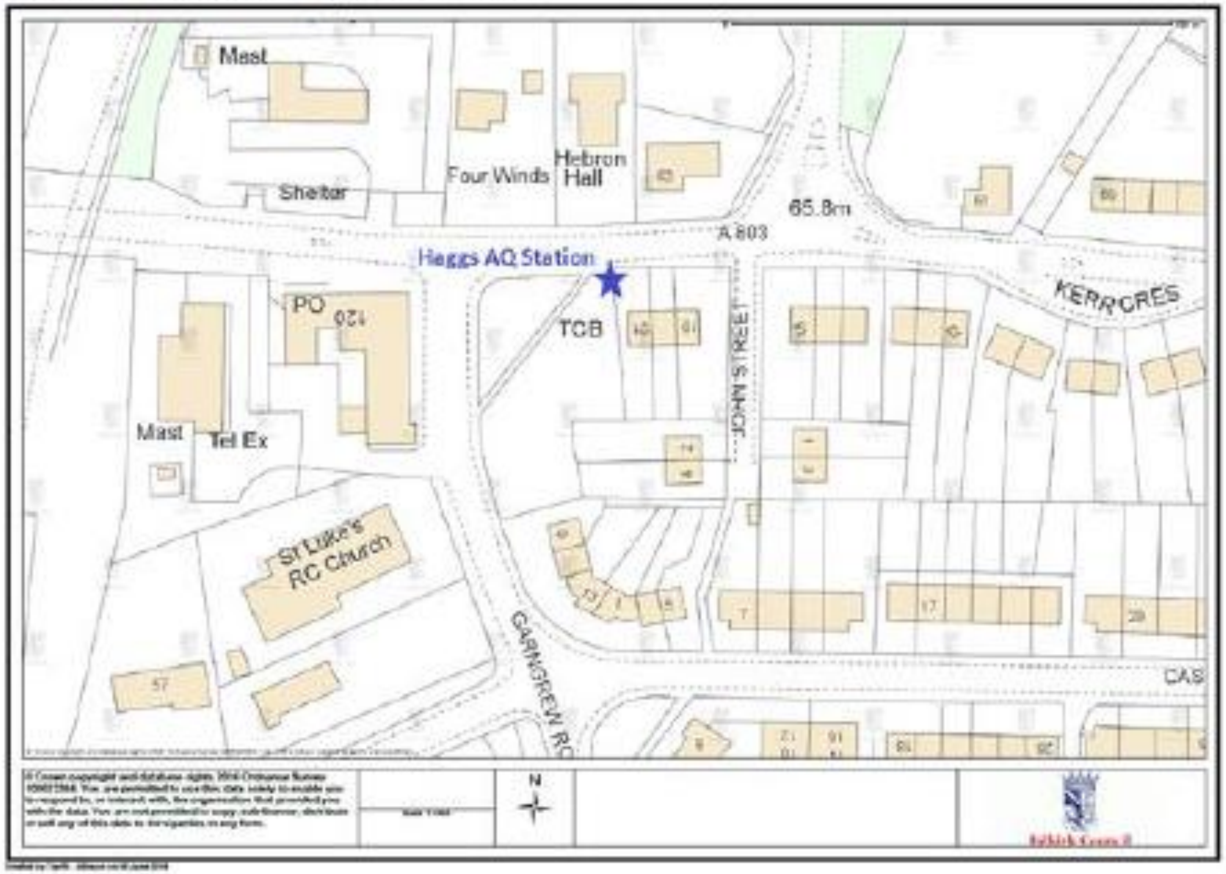
Map 3 – Haggs Automatic Monitoring Station Location



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Haggs AQMA Revocation Proposal

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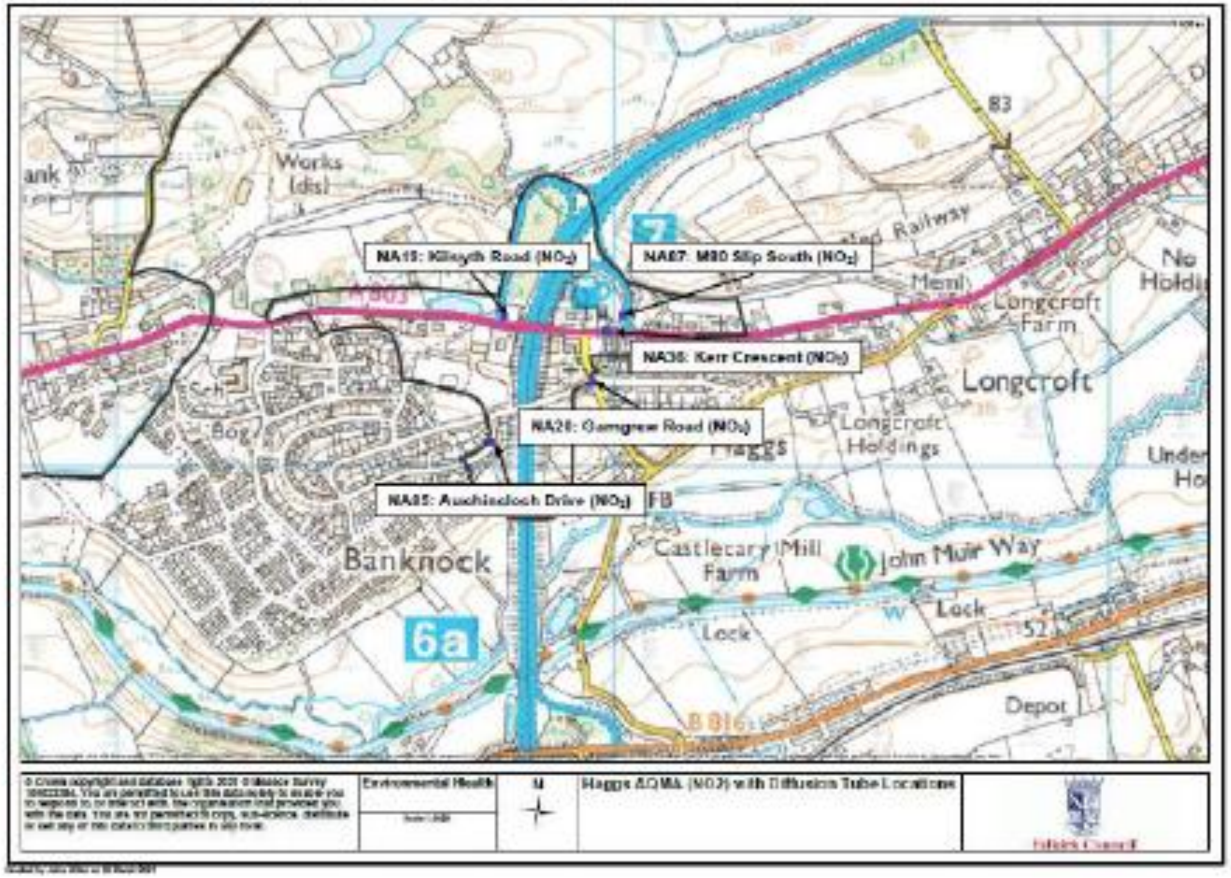
Map 4 – Haggs Non-Automatic Diffusion Tube Monitoring Locations



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Haggs AQMA Revocation Proposal

9. Appendix 1: Photo 1 – Haggs Automatic Roadside Station

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Photo 2 – Haggs Automatic Roadside Station

Appendix 2: Local Air Quality Management Detailed Assessment of NO_2 Concentrations at Banknock and Haggs by BMT Cordah for Falkirk Council, July 2008

Local Air Quality Management Detailed Assessment of NO_2 Concentrations at Banknock and Haggs

Prepared by

BMT Cordah Limited

In Partnership with

Falkirk Council

July 2008

Falkirk Council

BMT Cordah

A part of BMT in Energy and Environment

BMT Cordah

Detailed Assessment of NO2 concentrations in Banknock

Client: Falkirk Council
Report no.: E_FAL_026 / Report 5
Date: 15 July 2008
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Draft 1	12/03/08		C Taylor
Draft 2	14/07/08	Inclusion of comments from Falkirk Council	C Taylor

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Figure 6: Maximum predicted 99.79[th] percentile of 1 hour mean NO_2 concentrations (baseline scenario)

EXECUTIVE SUMMARY

Air quality monitoring in Banknock in both 2006 and 2007 indicated that annual average concentrations of nitrogen dioxide (NO_2) were in excess of the annual mean objective at roadside locations. The monitoring was, however, undertaken using a screening method of measuring pollutant concentrations, therefore to determine the accuracy of the monitoring data an automatic analyser was located in Banknock in 2007 and dispersion modelling of road traffic emissions has been undertaken to determine pollutant concentrations at locations of relevant public exposure.

The dispersion modelling study predicted pollutant concentrations at both existing monitoring locations and at locations of relevant public exposure. The results of the modelling study indicated that the annual mean NO_2 objective would be exceeded at on-site road locations and at one of the monitoring sites, however, no exceedences of the objective were predicted at locations of relevant public exposure. Furthermore, no exceedences of the 1-hour mean objective were predicted at areas of relevant public exposure.

It is therefore considered unnecessary to declare an Air Quality Management Area within Banknock at this time although monitoring should be continued until a full year of data is available and the measured annual mean concentration re-evaluated with reference to the results presented in this report.

1 INTRODUCTION

BMT Cordah Limited has been commissioned by Falkirk Council to conduct their Local Air Quality Management (LAQM) Detailed Assessment of nitrogen dioxide (NO_2) concentrations in Banknock. The Detailed Assessment forms part of the LAQM framework which requires local authorities to review and assess air quality within their area on a regular basis.

The assessment uses updated information for industrial, transport, commercial and domestic atmospheric emissions, combined with current monitoring data to identify if there is potential for exceedence of the air quality objectives contained within the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 (NAQS)[1].

The report follows guidance set out in LAQM.TG(03) technical guidance[2], LAQM.PG(04) policy guidance[3] and subsequent guidance amendments[4].

1.1 LAQM review and assessment framework

The Environment Act 1995 and subsequent regulations require local authorities to assess compliance of air quality in their area with the standards and objectives set out in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 (NAQS). For local authorities within Scotland further regulations are set out in the *Air Quality (Scotland) Regulations 2000* and *Air Quality (Scotland) Amendment Regulations 2002*.

The LAQM framework requires that local authorities carry out regular reviews of air quality. The first round of Review and Assessment commenced in 1998 and comprised a four stage approach to the assessment of air quality.

The Review and Assessment process was revised in 2003 and now comprises two phases. The first phase of the Review and Assessment is an Updating and Screening Assessment (U&SA). The U&SA considers any changes that have occurred in pollutant emissions and sources since the last round of Review and Assessment that may affect air quality. The second phase is either a Detailed Assessment or a Progress Report depending upon the outcome of the Updating and Screening Assessment.

[1] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Working together for clean air, Defra, July 2007.
[2] Part IV of the Environment Act 1995, Local air quality management technical guidance, LAQM.TG(03), Defra et al, January 2003.
[3] Part IV of the Environment Act 1995, Local air quality management policy guidance, LAQM.PG(04), Defra et al, January 2004.
[4] Part IV of the Environment Act 1995, Local air quality management technical guidance update, LAQM.TG(03) – update: January 2006, Defra et al, January 2006.

The LAQM guidance requires that where a risk of exceedence of an air quality objective at a location with relevant public exposure is identified then a Detailed Assessment is undertaken. A Detailed Assessment will consider any risk of exceedence of an objective in greater depth in order to determine whether it is necessary to declare an Air Quality Management Area (AQMA).

1.2 Air quality standards and objectives

The air quality standards and objectives which local authorities are required to meet are outlined in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland. The air quality objectives for NO_2 which are applicable in Scotland are presented in Table 1.

Table 1 Pollutant Objectives outlined in the NAQS

Pollutant	Air Quality Objective			Date to be achieved by
	Concentration	Measured as	Equivalent percentile	
Nitrogen dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times per year	1-hour mean	99.79th percentile of 1-hour mean concentrations	31/12/2005
	40 µg/m^3	annual mean	-	31/12/2005

1.3 Previous Assessments

Several assessments have previously been completed to investigate air quality within the Falkirk Council area. Previous assessments have primarily focussed on air quality around the industrial complex in Grangemouth and in Falkirk town centre, culminating in the declaration of an AQMA in Grangemouth in 2005.

An U&SA was undertaken in 2006[4], which highlighted four areas where air quality was a concern and the possibility of exceeding air quality objectives was identified:

- NO_2 concentrations in Falkirk town centre;
- NO_2 concentrations in Banknock at the M80 slip road junction;
- predicted background PM_{10} concentrations in Grangemouth; and
- PM_{10} emissions from Cowdenhill Quarry in Banknock.

The requirement to assess NO_2 concentrations in Banknock further was identified due to high measured NO_2 concentrations in the area.

[4] LAQM Updating and Screening Assessment, BMT Cordah Ltd report ref. E_FAL_025, March 2006

A Detailed Assessment of each area has therefore been undertaken. Each assessment has been undertaken separately as it was considered that there was no direct link between any of the areas, however the assessment of PM_{10} emissions from Cowdenhill Quarry identified that heavy goods vehicles entering and leaving the quarry had a greater influence on ambient air quality than emissions from the quarry itself. Emissions from vehicles passing through Banknock heading to or from the quarry have also, therefore, been included in this study.

2 LOCAL ENVIRONMENT

The factors influencing local air quality in and around Banknock include: local terrain and climate conditions; local land use; emission sources in the area; and pollutant concentrations in neighbouring areas.

2.1 Description of local area

Banknock is located in central Scotland in the west of the Falkirk Council area close to the administrative boundary with North Lanarkshire Council. A map of Banknock and the Falkirk Council area is presented in Figure 1.

Banknock has a population of approximately 2,500 and the adjoining village of Haggs has a population of approximately 400. The two villages are situated on either side of the M80 and are predominantly residential in nature with a few amenities and commercial operations located in Banknock. To the south of the assessment area is Cumbernauld and to the north-east is Denny, both of which are relatively large urban areas with a mixture of residential, commercial and industrial land uses.

2.2 Emission sources

The principal sources of atmospheric emissions in the Banknock area are road traffic emissions from the M80 passing north-south between Haggs and Banknock, and the A803 which passes east-west through the two settlements.

Other minor local emissions sources include boats on the Forth and Clyde Canal and rail traffic on the main Edinburgh to Glasgow rail link which both pass east-west to the south of Banknock. There will be emissions of NO_X due to combustion from motorised boats using the canal and diesel trains using the rail line.

There is also a small airport located to the north of Cumbernauld within 1.5km of Banknock. There are several companies operating small planes and helicopters from the airport, which is open daily for lessons and private aircraft and chartered flights. There will be emissions of NO_X from combustion gases emitted from the aircraft, although it is unlikely that they will significantly impact on NO_2 concentrations in Banknock, therefore, no aircraft emissions were directly included in the model.

There are several permitted industrial processes operating in the assessment area, however, the processes located in the vicinity of Banknock are timber, quarrying and petroleum processes. It is considered unlikely that there will be significant direct emissions of NO_x from these sources.

There are several small industrial and commercial processes operating in Ward Park Industrial Estate located within the assessment area to the north of Cumbernauld. Some of these facilities will generate emissions of NO_x, mainly from combustion associated with heating systems.

2.3 Local climate conditions

Meteorological conditions, such as wind direction, wind speed, temperature and precipitation levels have an influence on the dispersion of atmospheric emissions and hence local air quality.

Wind speed and direction have a significant affect upon atmospheric pollution dispersion determining the distance and direction in which pollutants are transported from the source. Precipitation and temperature also have an affect upon the concentration of atmospheric pollutants. During periods of precipitation pollutant concentrations are typically reduced as the pollutants are washed out of the atmosphere. Increases in temperature can act as a catalyst to chemical reactions between pollutants and also create localised thermal air currents that generally result in an increased dispersion of pollutants.

As is the case for the majority of the UK, there is a dominance of south-westerly winds across the area, although there are a significant proportion of easterly winds indicating the influence of the weather systems over the North Sea and the channelling effect of the Firth of Forth. The mean temperature in the Banknock area is approximately 8.5°C, which is average for the UK. The area has low to medium rainfall and hours of sunshine compared to the rest of the UK.

The low levels of rainfall in the area are likely to result in a lower pollutant wash out rate. Combined with average temperatures and low sunshine hours the typical meteorological conditions for the area are likely to lead to a lower level of atmospheric turbulence from convection.

2.4 Local terrain influences

In general, complex terrain acts to increase the atmospheric turbulence and thus increase dispersion. The terrain surrounding the assessment area comprises the Carron Glen and upper Forth valley to the north-east and the Kilsyth Hills to the north-west. To the south the land is comparatively flat with a mixture of agricultural and wooded land use. To the south-west of Banknock is the large urban area of Cumbernauld. To the north and east the upland areas comprise both open moorland and forest. The complex terrain mix generally results in a greater surface friction and thus there is a greater influence of mechanical turbulence in the northern part of the assessment area than the flatter landscapes to the south.

3 LOCAL MONITORING DATA

Falkirk Council currently operates an extensive network of sixty-six passive diffusion tube (PDT) sites and seven automatic monitoring sites measuring concentrations of NO_2 throughout the Falkirk Council area. A list of monitoring sites within the Banknock area is presented in Table 2 and the monitoring site locations are identified in Figure 2.

Table 2 Air Quality monitoring locations

Site No.	Monitoring location	Monitoring method	Pollutant	Site Description
18	A80 North Bound C/way, Banknock	PDT	1,3-butadiene, Benzene, NO_2	Roadside
19	Kilsyth Road, Banknock	PDT	NO_2	Roadside
20	Garngrew Road, Haggs	PDT	NO_2	Urban background
38	Kerr Crescent, Haggs	PDT	NO_2	Roadside
10a	Kerr Cresent, Haggs	Chemiluminescence Analyser	NOx & NO_2	Roadside

3.1 NO_2 diffusion tube monitoring

The laboratory analysis of the passive diffusion tubes used by Falkirk Council is undertaken by Harwell Scientific Services. Harwell Scientific Services is a UKAS accredited laboratory with documented QA/QC procedures for diffusion tube analysis. The laboratory prepares the diffusion tubes using the 50% TEA (triethanolamine) in acetone method.

Following the advice in the LAQM technical guidance, the measured NO_2 concentrations have had a laboratory "bias adjustment" factor applied to them. The bias adjustment factor is calculated by comparing results from co-located NO_2 diffusion tubes and an automatic NO_2 monitoring station.

Falkirk Council operates three co-location studies within the Council area. These are at Municipal Chambers, Grangemouth; Hope Street, Falkirk; and Park Street, Falkirk. Three diffusion tubes are co-located with the Municipal Chambers automatic analyser and two diffusion tubes are co-located with the Hope Street and Park Street automatic analysers. These local bias adjustment factors are reported on the LAQM helpdesk website[4] and are presented in Table 4. This website also reports bias adjustment factors for a number of other co-location studies across the UK that also use Harwell Scientific Services to analyse the diffusion tubes.

[4] University of the West of England (2007). Nitrogen dioxide diffusion tube bias adjustment http://www.uwe.ac.uk/aqm/review/index.html

Table 3 Local bias adjustment factors for Falkirk Council area

Site type	Length of study (months)	Tube precision	Bias adjustment factor (2006)
Roadside	12	Good	0.74
Roadside	11	Good	0.54
Urban background	12	Poor	0.73
Overall adjustment factor for 12 Harwell Scientific Services co-location studies			0.78

The overall adjustment factor of 0.78 has been applied to the 2006 monitoring data in preference to the local bias adjustment factors. The local bias adjustment factors have not been applied as the precision of the 0.73 factor was poor and the difference between the 0.74 and 0.54 factors was too great to make a reasonable judgment on the most accurate factor to apply. The 0.78 factor has been applied as it was deemed to be more accurate due to the number of studies it is based on. Use of this factor also gives a 'worst case' prediction of NO_2 concentrations.

The results of the NO_2 diffusion tube monitoring from 2004 to 2006 are presented in Table 4. The measured 2006 annual mean concentrations are reported along with the bias adjusted annual mean concentrations for 2004 and 2005.

Table 4 NO_2 passive diffusion tube monitoring results

Site No.	Monitoring location	2006 data capture rate (%)	Raw 2006 annual mean concentrations (µg/m^3)	Adjusted annual mean concentrations (µg/m^3)			
				2004 (0.74)	2005 (0.71)	2006 (0.78)	2007 (0.81)
18	A80 North Bound C'way, Banknock	100	115	77	78	89	99
19	Kilsyth Road, Banknock	100	44	27	29	33	37
20	Garngrew Road, Haggs	100	32	22	23	25	27
36	Kerr Crescent, Haggs	100	52	36	38	41	46

The monitoring location at the A80 North Bound Carriageway is not at a location of relevant public exposure, therefore the monitoring location simply indicates the elevated NO_2 concentrations close to the roadside. The monitoring site at Kerr Crescent is, however, relevant in terms of public exposure as it is located adjacent to residential properties. The adjusted annual mean NO_2 concentration in 2006 was therefore in excess of the NAQS objective.

3.2 NO_2 automatic monitoring

Falkirk Council installed an automatic analyser at Kerr Crescent, Banknock on the 9th November 2007 in response to the results of the 2006 Updating and Screening Assessment. The monitored concentrations are presented in Table 5.

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Table 6 Monitored NO_2 concentrations, November 2007 – June 2008, Banknock, µg/m^3

Month	Average Concentration (µg/m^3)	Number 1-hour Mean Concentrations >200µg/m^3	Data Capture Rate (%)
November	34.6	0	71%
December	47.4	0	99%
January	41.0	0	99%
February	43.9	0	99%
March	34.4	0	99%
April	39.4	0	99%
May	39.6	0	99%
Period	40.1	0	94%

The measured concentrations indicate the NO_2 concentrations over the period were marginally in excess of the annual mean objective. The period of monitoring encompassed the winter period where pollutant concentration would be expected to be higher than during the summer period. To determine the influence that seasonal factors have had on the monitoring data the monitoring result over the period have been compared with the data from local diffusion tubes which have been located for a longer period. The results are presented in Table 6.

Table 6 Banknock monitoring data seasonal influence analysis

Location	Period mean concentration Nov 07 – May 08 (µg/m^3)	Annual mean concentration Jun 07 – May 08 (µg/m^3)	Ratio
A80 North Bound C/way, Banknock	136	132	1.0282
Kilsyth Road, Banknock	50	45	1.1117
Carrigrow Road, Haggs	42	36	1.1614
Kerr Crescent, Haggs	65	59	1.1054
		Average	1.1062

The results therefore indicate that, on average, the period mean concentration is approximately 11% higher than the equivalent annual mean concentration. For the purposes of the assessment the annual mean concentration at the monitoring location is therefore assumed to be 36µg/m^3.

4 DISPERSION MODELLING STUDY

In order to determine the ambient NO_2 concentrations across the wider area of Banknock an atmospheric dispersion modelling study of road traffic emissions was undertaken. The atmospheric dispersion model predicts pollutant concentrations based upon the traffic volume, street geometry, traffic composition, traffic speed and meteorological and topographical conditions of the area.

4.1 Atmospheric dispersion model

The atmospheric model used in the assessment was ADMS-Roads version 2.2. ADMS-Roads is a new generation dispersion model which has been validated and verified in numerous studies which are summarised in the user guide, and has been declared fit for the purpose of local air quality assessment by DEFRA and the devolved administrations.

4.2 Area of assessment and sensitive receptors

Modelling predictions were undertaken over a modelled domain consisting of a regular 1.5km by 1.5km Cartesian grid pattern. The number of calculation points was set at 50 by 50 which provides predicted concentrations every 30m. The option of "intelligent gridding" was selected whereby the model predicts pollutant concentrations at a higher spatial density close to the emission sources and at a lower spatial density at background locations.

The model has the capability of predicting concentrations at specific locations to determine pollutant concentrations at locations of relevant public exposure. Twelve locations within the assessment area, at points of relevant public exposure, were selected to represent specific receptors. The locations of specific receptors are presented in Table 7 and Figure 2.

Table 7 Location of specific receptors

Receptor	Category	Location (NGR)	Height (m)
Banknock automatic monitor	Monitoring site	278976 679272	1
A80 North Bound C'way, Banknock	Monitoring site	278929 679514	2
Kilsyth Road, Banknock	Monitoring site	278771 679302	2
Garngrew Road, Haggs	Monitoring site	278975 679155	2
Kerr Crescent, Haggs	Monitoring site	278949 679273	3
Receptor 1	Residential property	279063 679260	0
Receptor 2	Residential property	278963 679296	0
Receptor 3	Residential property	279007 679260	0
Receptor 4	Residential property	278594 679303	0
Health Centre	Location of public exposure	278950 679265	0
Bankview Care Home	Location of public exposure	278560 679434	0
School	Location of public exposure	278248 679204	0

4.3 Topographical data and terrain sensitivity analysis

The model is capable of simulating the effect of local topography on air flows and hence pollutant dispersal, which is significant for sites where the area of assessment has gradients of 1 in 10 or greater. The Campsie Fells are located approximately 12km to the west of Banknock. It is therefore possible that the terrain will have an impact upon the dispersion of the pollutants. In order to determine the impact of the terrain on final modelling predictions, a sensitivity analysis was carried out. A terrain grid of 10km by 10km derived from OS panorama 1:50,000 height data for the map tiles NS66, NS69, NS96 and NS90 was used.

A simplified model was run with and without the terrain file for specified receptors only. The results of the sensitivity analysis are presented in Table 8. In general, differences of +/- 10% are considered to be significant. The results of the sensitivity analysis indicate that there is not a significant difference between the predicted annual mean concentrations with topographical data and with flat terrain. The greatest difference in annual mean concentrations occurred at the Bankview Care Home receptor location where the predicted concentration with topographical data was 4.7% higher than with flat terrain. The greatest difference in predicted 99.79th percentile concentrations occurred at Receptor 3 where the predicted concentration was 3.6% higher with topographical data than with flat terrain.

Overall, the use of topographical data in the model run resulted in slightly higher predicted concentrations at the majority of locations. However, the difference in predicted concentrations was not considered to be significant enough to substantially change the results of the model run. Considering the fact that pollutants from road sources generally do not disperse over large areas, it was decided to model with flat terrain.

Table 8 Results of the terrain sensitivity analysis

Receptor	Annual mean ($\mu g/m^3$)			99.79th percentile of 1 hour mean concentrations ($\mu g/m^3$)		
	Flat terrain	Topographical data	% difference	Flat terrain	Topographical data	% difference
Receptor 1	24.4	24.9	2.4	88.8	90.1	1.4
Receptor 2	23.2	24.0	3.2	85.7	87.7	2.3
Receptor 3	23.5	24.4	3.6	88.9	90.1	3.6
Receptor 4	23.1	24.0	3.5	85.8	87.8	2.4
Health centre	22.0	22.4	2.0	86.8	85.5	-1.5
Bankview Care Home	20.2	19.5	-3.9	80.8	78.3	-3.2
Receptor 5	22.4	22.9	1.9	89.0	88.6	-0.4
School	18.2	18.1	-0.3	78.2	77.7	-0.6
Banknock automatic analyser	23.4	24.1	3.1	86.6	87.0	0.5
A80 North bound cway diffusion tube	23.7	24.0	1.4	89.9	88.1	-2.1
Kilsyth Road diffusion tube	23.9	24.4	2.1	88.1	87.9	-0.2
Garngrew Road diffusion tube	21.8	22.9	4.7	84.7	86.3	1.8
Kerr Crescent diffusion tube	23.7	24.6	3.8	89.3	90.9	1.8

Receptor	Annual mean (µg/m³)			99.79[th] percentile of 1 hour mean concentrations (µg/m³)		
	Flat terrain	Topographical data	% difference	Flat terrain	Topographical data	% difference
Average			2.1			0.4

4.4 Meteorological data

The model requires a minimum input of six meteorological parameters for hourly sequential or statistical data. The six parameters included in the meteorological data are surface temperature (in °C), wind speed (in m/s), wind direction (as degrees from north), relative humidity (as a %), cloud cover (in oktas) and precipitation (in mm).

A review of meteorological data was carried out to determine the most appropriate set of meteorological parameters available. The closest meteorological stations to Banknock, recording the full suite of meteorological parameters required by the model, are Glasgow Airport (Bishopton) and Edinburgh Airport (Gogarbank).

Gogarbank meteorological station is a lowland site located approximately 35km southeast of Banknock an altitude of 57m m.a.s.l. The station is close to the Firth of Forth and located in predominantly suburban surroundings.

Bishopton meteorological station is located approximately 40km southwest of Banknock at an altitude of 59m m.a.s.l. The area surrounding the meteorological site comprises suburban and rural with some industrial and commercial sites nearby. The station is located less than 2km from the Firth of Clyde. The terrain around the meteorological station is relatively flat owing to the flood plain upon which it sits.

It was determined that the meteorological parameters from Gogarbank would be the most appropriate for use in the atmospheric dispersion assessment due to the fact that the meteorological site is located in the Forth Valley and is likely to give a closer representation of the conditions in Banknock.

Meteorological data from Edinburgh for 2006 was used in the final modelling assessment to allow direct comparison with monitored concentrations and provide verification for the model. A wind rose of 2006 meteorological data from Edinburgh Gogarbank meteorological site is presented in Figure 3.

4.4.1 Other meteorological parameters

The surface albedo represents the ratio of incident to reflected short-wave radiation from the Earth's surface. For land with no snow cover the surface albedo is approximated at 0.23 and this value was used in the assessment.

The Monin-Obukhov length provides a measure of the atmospheric stability being modelled. For unstable conditions the Monin-Obukhov length is negative and represents the height at which convective turbulence is more important than mechanical turbulence caused by friction at the earth's surface. For stable conditions the Monin-Obukhov length is positive and represents the height above which vertical turbulent motion is inhibited by the stable stratification of the atmosphere. For small towns and rural areas a typical Monin-Obukhov length would be 10m, for industrial, mixed urban and larger towns a typical length would be 30m. Due to the mixture of land uses within the assessment area a Monin-Obukhov length of 10m was used to represent conditions in Banknock and a Monin-Obukhov length of 10m to represent the meteorological site.

The Priestly-Taylor parameter represents the surface moisture available for evaporation. For moist grassland areas a parameter of 1 is used and for dry bare earth a parameter of 0. A Priestly-Taylor parameter of 1 has been used in the modelling study for both the assessment area and the meteorological site.

4.5 Surface roughness data

The surface roughness length is used in dispersion modelling in order to characterise the surface of the surrounding area and the frictional effects caused by the interaction between land surface and wind speed. The effect is a key component in the generation of atmospheric turbulence, which influences dispersion patterns. The land use surrounding the development site is urban with some industrial sites nearby. The frictional effects within the area of the site will be greater than those in more rural areas.

A surface roughness factor of 0.2 - 0.3 is recommended for areas with predominantly agricultural land use, 0.5 for parkland and open sub-urban land usage and 1 to 10 for built up regions. Due to the mixed land use of the assessment area a surface roughness factor of 0.5 was used to represent conditions in Banknock and a surface roughness factor of 0.5 to represent the meteorological site.

4.6 Background pollutant concentrations and chemistry schemes

ADMS-Roads has the facility to model the photochemical reactions which occur between oxides of nitrogen (NO_x), ozone and hydrocarbons present in the atmosphere. It is important to include chemical reactions since NO_2 emissions generally account for only around 10-20% of total NO_x emissions from motor vehicles. ADMS Roads uses a chemistry scheme known as the Generic Reaction Set which simplifies the chemical reactions which occur between NO_x, NO_2, VOC's and ozone to eight reactions. The chemistry module requires background data for NO_x, NO_2, and O_3 to be included in the model.

When modelling a network of roads in a rural area it is recommended that background concentrations from a local rural site away from the roads being modelled is used in order to avoid double counting emissions. There are two options for obtaining background data. The UK air quality archive[7] provides background concentrations of pollutants on a 1km by 1km grid square basis. These background concentrations have been estimated using sources within the National Atmospheric Emissions Inventory (NAEI) and are provided by Defra for use in air quality assessments. The UK Air Quality Archive contains estimates of background atmospheric concentrations of NO_X and NO_2 within the Falkirk Council area. The background NO_X and NO_2 concentrations used in the assessment were taken from were taken from grid squares surrounding Banknock and Haggs in order to avoid double counting the effect of the roads, particularly the M80.

Measured hourly background concentrations can also be obtained from rural automatic monitoring sites and it is necessary to obtain ozone concentrations from an automatic monitoring site. Ozone concentrations are generally higher in rural areas than in town centres and so it is necessary to use a rural monitoring location. The closest rural automatic monitoring sites to Banknock are Glasgow Waulkmillglen and Bush Estate, Penicuik. Measured ozone concentrations at both sites were very similar with Waulkmillglen measuring 55µg/m^3 and Bush Estate measuring 55µg/m^3. It was decided to use 55µg/m^3 in this assessment as the presence of ozone in the atmosphere works to oxidise NO to NO_2 and a lower ozone concentration would therefore result in higher NO_2 concentrations.

The background concentrations used in the assessment are presented in Table 9.

Table 9 Background concentrations

Year	NO_X (µg/m^3)	NO_2 (µg/m^3)	Ozone (µg/m^3)
2008	14.4	11.7	55
2010	11.1	9.7	55

4.7 Building effects and street layout

ADMS-Road does not allow buildings to be included explicitly but allows various street parameters to be input to simulate the local flow around buildings and other obstacles in the vicinity of the road. The street parameters included in the model are road width, street canyon height and road elevation.

Street canyons can be included in the model for roads where there are high rise buildings on either side which act as barriers to the air flow and can channel wind along the road or cause localised air circulations that trap pollutants at street level. Canyon effects are significant for streets where the height of the buildings is equivalent to the width of the street. There were no street canyons in the study area, therefore none were included in the model assessment.

The road layout within Banknock is such that the A80/M80 passes below the town. There is, therefore one section of Kilsyth Road which passes over the motorway. It is not possible to model a negative elevation in ADMS Roads and it was not deemed appropriate to put elevation on the section of Kilsyth Road which passes over the motorway. Placing elevation on Kilsyth Road would result in an under prediction of the impact of emissions from this section because the emissions

[7] http://www.airquality.co.uk/archive/laqm/tools.php?tool=background04

would be released higher than ground level. All roads were, therefore, modelled with no elevation. The modelled parameters for each street included in the model are presented in Table 10.

Table 10 Road dimensions

Road	Width (m)	Elevation (m)	Link length (m)
M80 J4-J5 - north	8	0	2060
M80 J4-J5 - south	8	0	2060
M80 J5-J6 - north	8	0	815
M80 J5-J6 - south	8	0	815
A80 J3-J4 - north	8	0	2150
A80 J3-J4 - south	8	0	2150
Glasgow road	6	0	2165
Kilsyth Road 85	6	0	284
Kilsyth Road 86	6	0	759
Kilsyth Road 87	6	0	2330
Slip road north bound	6	0	564
Slip road south bound	6	0	277

4.8 **Road traffic data**

The atmospheric dispersion model uses the annual average hourly (AAHT) traffic flow, vehicle split and traffic speed to determine the emission of each pollutant for each section of road input into the model. The road traffic data used in the assessment are presented in Table 11. The locations of the assessed roads are presented in Figure 4.

Table 11 Road traffic data

Road	AAHT LGV's	LGV speed (k.p.h)	AAHT HGV's	HGV speed (k.p.h)	% HGV's
		2006 traffic flows			
M80 J4-J5 - north	1284	110	97	95	7
M80 J4-J5 - south	1294	110	99	95	7
M80 J5-J6 - north	747	110	56	95	7
M80 J5-J6 - south	751	110	57	95	7
A80 J3-J4 - north	1372	110	103	95	7
A80 J3-J4 - south	1345	110	101	95	7
Glasgow road	444	50	33	45	7
Kilsyth Road 85	458	40	34	35	7
Kilsyth Road 86	508	50	38	45	7
Kilsyth Road 87	286	95	22	80	7
Slip road north bound	87	45	7	40	7
Slip road south bound	111	45	8	40	7

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4.8.1 Diurnal profiles

The model requires traffic data to be input as an average vehicle flow per hour. The accuracy of the traffic flow information can be improved by use of time varying emissions factors which details the diurnal profile of the road. The time varying factors allow the average hourly traffic flow to be multiplied by a factor representative of the expected traffic flow at each hour of the day. The traffic flow factors are calculated as a ratio between the hourly flow and the average flow.

Detailed hourly traffic flow data were available for Kilsyth Road and a diurnal profile was calculated for this road. The profile was calculated for weekdays i.e. Monday to Friday, Saturday and Sunday traffic flows. The profile was applied to all roads included in the model as diurnal profiles generally follow a similar pattern. The same diurnal profiles were used in both modelling scenarios. The diurnal profile used in the model is presented in Table 12.

Table 12 Diurnal profile for Kilsyth Road

Hour	Monday – Friday	Saturday	Sunday
1	0.07	0.26	0.36
2	0.03	0.15	0.19
3	0.02	0.07	0.10
4	0.02	0.04	0.07
5	0.05	0.05	0.06
6	0.21	0.13	0.17
7	0.86	0.26	0.23
8	2.31	0.73	0.48
9	2.34	0.91	0.55
10	1.34	1.16	0.81
11	1.10	1.48	1.12
12	1.16	1.86	1.76
13	1.16	2.10	2.06
14	1.27	2.14	2.36
15	1.39	1.98	2.20
16	1.85	1.84	2.09
17	2.27	1.97	2.19
18	2.59	1.89	1.98
19	1.67	1.63	1.70
20	0.89	1.19	1.30
21	0.61	0.73	0.94
22	0.48	0.50	0.64
23	0.32	0.49	0.35
24	0.18	0.36	0.22

4.9 Primary NO_2 adjustment

The traffic count data required some further manipulation to take account of aspects of road traffic emissions which are not included in ADMS Roads. These aspects have only become apparent in recent years and have been highlighted in recent reports by the Air Quality Expert Group (AQEG) on primary NO_2[6].

The primary NO_2 reports concern recent understanding that changes in the national vehicle fleet and use of pollution abatement systems has led to an increase in the proportion of nitrogen oxides (NO_x) that are released directly as NO_2 from vehicle exhausts. It is now know that the proportion of total NO_x emitted as NO_2 has risen from 10% to between 15-20% (the higher end being applicable to London). The NO_2 emission from ADMS Roads has therefore been adjusted following advice from model developers CERC) with an assumption that, 15% of total NO_x from vehicle exhausts is emitted as NO_2.

4.10 Other emissions sources

Information on other emissions sources within the vicinity of Banknock was obtained from the National Atmospheric Emissions Inventory (NAEI). The NAEI is a national atmospheric emissions database which holds data on emissions from a variety of sources on a 1km by 1km grid square basis. Emissions are reported in tonnes/year. Emissions for NO_x within the Falkirk Council area were obtained from the NAEI website[7] for the most recent available year, i.e. 2005. The additional sources were modelled as 1km by 1km square volume sources. In order to avoid double counting emissions from road traffic, the road traffic data was input into EMIT to determine the total NO_x emission from all specifically modelled roads. The emissions from the modelled roads were then subtracted from total NAEI estimated emission from the relevant grid square to determine the emission from road traffic sources not specifically modelled. The estimated additional NO_2 emission from each grid square is presented in Table 13.

Table 13 Additional emissions sources within Banknock

Volume source	Grid square (central point)	NOx emission (tonnes/year)	NOx emission (g/m³/s)
Volume source 1	277500 678500	4.79	1.5177×10^{-8}
Volume source 2	278500 678500	4.95	1.5726×10^{-7}
Volume source 3	279500 678500	3.40	3.1353×10^{-8}
Volume source 4	277500 679500	40.59	1.3795×10^{-8}
Volume source 5	278500 679500	55.90	1.7753×10^{-7}
Volume source 6	279500 679500	1.04	1.6014×10^{-7}
Volume source 7	277500 680500	3.90	1.2606×10^{-8}

[6] Air Quality Expert Group, 2007. Trends in Primary Nitrogen Dioxide in the UK.
[7] Defra et al, (2007). Data warehouse. http://www.naei.org.uk/data_warehouse.php

Volume source	Grid square (central point)	NOx emission (tonnes/year)	NOx emission ($g/m^3/s$)
Volume source 8	276500 680500	50.58	3.292×10^{-6}
Volume source 9	276500 680500	12.27	3.8808×10^{-6}

5 MODEL VERIFICATION

In order to determine the accuracy of modelling predictions, it is useful to verify the predicted concentrations against monitored data. Ideally modelling verification must be carried out using monitoring data, meteorological data and traffic flow data from the same time period. Originally, the study used 2006 monitoring data, 2006 meteorological data and 2006 traffic flow data were used, however the automatic monitoring results from Banknock (measured 2007-08) have been included to provide a more accurate verification of modelling results. It is not expected that the use of 2006 modelling predictions against 2007 monitoring data will be significant. The model verification results are presented in Table 14.

Table 14 Model verification results

Monitoring location	Measured annual mean concentration (bias adjusted) ($\mu g/m^3$) (2006)	Predicted annual mean concentration	Model over/under prediction (%)
Banknock Automatic Analyser	36	32.9	-8.6
A80 North Bound C/way, Banknock	69	40.3	-54.6
Kilsyth Road, Banknock	35	35.0	0
Garngrew Road, Haggs	25	28.4	13.6
Kerr Crescent, Haggs	41	32.2	-21.5

The predicted annual mean concentrations at diffusion tube monitoring locations indicate some variability in model performance in comparison to measured concentrations.

The greatest difference between measured and predicted concentrations occurred at the A80 north bound carriageway diffusion tube with a difference of 54.6%. The A80 diffusion tube is situated approximately 4m from the north bound carriageway and is not at a location of relevant public exposure. It is possible that this tube is being affected by the vehicles are travelling along the north bound carriageway. At this section of the A80 the road widens from two lanes to three lanes which allows traffic to overtake and accelerate. There is also an incline on this section of road which can increase the emissions from vehicles as the engines are forced to work harder. The tube is also situated close to the off ramp which leads into Banknock. There are, therefore, many HGV movements on the off ramp which may contribute to the high measured concentrations at this site. The model cannot account for variations in vehicle emissions caused by rapid acceleration or deceleration. The model verification will not be compared against this tube due to the fact that the tube is not at a location of relevant public exposure and because there is the possibility of factors being present which the model cannot account for.

The results suggest that the model has over estimated concentrations at Garngrew Road, which is an urban background site, but under estimated concentrations at Kerr Crescent, which is a roadside site. This would suggest that the model has not accurately replicated the impact of road traffic emissions, most probably as a result of under estimating road traffic emissions. Predicted concentrations at the site at Kilsyth Road were exactly in agreement with measured concentrations.

The predicted concentrations at Kerr Crescent diffusion tube site demonstrate an under prediction of 21.5% when compared to measured concentrations. Caution must also be taken when verifying modelling results against diffusion tubes due to the inherent inaccuracies with this monitoring technique. It is always preferable to compare modelling predictions against measured concentrations from an automatic analyser in order to have the greatest confidence in the results.

The predicted annual mean NO_2 concentration at the automatic monitoring site is approximately 9% below the measured concentration. An agreement of +/- 10% can be considered to be a good approximation.

Given the variability in predicted concentrations in comparison with diffusion tube results it is not considered appropriate to adjust the modelling predictions using this data. The modelling predictions of annual mean concentrations have therefore been verified using the data the automatic analyser only, although the trends noted from each of the monitoring sites have been noted. No adjustment of 1-hour mean concentrations has been undertaken.

6 MODELLING RESULTS

The predicted NO_2 concentrations at receptor locations are presented in Table 13. Contour plots of predicted annual mean and 1 hour mean NO_2 concentrations are presented in Figures 5 and 6.

The modelling results indicate that there is only one location with predicted concentrations in excess of the annual mean objective of 40µg/m^3, namely, the A80 north bound carriageway diffusion tube site. As mentioned, this tube is not situated at a location of relevant public exposure and so the air quality objectives do not apply at this site. There are no sites with predicted concentrations in excess of the 1-hour mean NO_2 objective.

The predicted concentration at Kerr Crescent was below the measured concentration at this site and also below the annual mean objective. If the modelling predictions are factored up by the average under-prediction of 15.1%, the point at Kerr Crescent just exceeds the objective with a predicted concentration of 40.5µg/m^3.

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Due to the inherent inaccuracies, assumptions and simplifications present within dispersion modelling software, and the inherent inaccuracies present within diffusion tube monitoring techniques, it is recommended that any decision to declare an Air Quality Management Area within Banknock is postponed until a full year's worth of monitoring data from the automatic monitor at Kerr Crescent has been gathered.

Table 16: Baseline scenario modelling results

Receptor name	Predicted annual mean concentrations ($\mu g/m^3$)	Adjusted annual mean concentrations for under prediction of 9% ($\mu g/m^3$)	Predicted 99.79[th] percentile of 1 hour mean concentrations ($\mu g/m^3$)
Receptor 1	30.9	33.7	91.5
Receptor 2	31.5	34.3	92.2
Receptor 3	29.7	32.4	88.1
Health centre	30.0	32.7	87.6
Bankview	27.9	30.9	78.9
Receptor 4	30.3	33.0	87.7
School	24.7	26.9	69.5
Kilsyth Road PDT	35.0	38.2	114.6
Banknock automatic analyser	32.9	35.9	104.2
Kerr Crescent PDT	32.2	35.1	100.0
Garngrew Road PDT	28.4	31.0	93.9
A80 north bound carriageway PDT	40.2	43.8	147.3

7 CONCLUSION

In both 2006 and 2007 monitoring at Banknock has indicated that annual average NO_2 concentrations were in excess of the annual mean objective at roadside locations. The monitoring was, however, undertaken using passive diffusion tubes, which are a screening method of measuring pollutant concentrations. In order to determine the accuracy of the monitoring data an automatic analyser was located in Banknock in 2007 and dispersion modelling of road traffic emissions has been undertaken to determine pollutant concentrations at locations of relevant public exposure.

The dispersion modelling study predicted pollutant concentrations at both existing monitoring locations and at locations of relevant public exposure. Comparison of modelling predictions with local monitoring data indicated that the model was under-predicting pollutant concentrations. The modelling predictions were, therefore, adjusted to account for the under-prediction.

The results of the modelling study indicated that the annual mean NO_2 objective would be exceeded at on-site road locations and at one of the monitoring sites, however, no exceedences of the objective were predicted at locations of relevant public exposure. Furthermore, no exceedences of the 1-hour mean objective were predicted at areas of relevant public exposure.

It is therefore not considered necessary to declare an Air Quality Management Area within Banknock at this time. It is recommended that the automatic monitoring at Banknock be continued until a full year of data is available and the measured annual mean concentration evaluated with reference to the results presented in this report.

Appendix 3: Haggs/Banknock Further Assessment of Air Quality by BMT Cordah for Falkirk Council

BMT Cordah

A part of BMT in Energy and Environment

Haggs/Banknock Further Assessment of Air Quality

Client: Falkirk Council
Report no.: G.FAL.033.HAGGS
Date: March 2011
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Client	Falkirk Council
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Executive Summary

BMT Cordah Limited has been commissioned by Falkirk Council to conduct a Further Assessment of air quality within its Air Quality Management Area (AQMA) at Haggs. The assessment aims to build on the review and assessment of air quality already conducted for this location which identified that nitrogen dioxide (NO_2) concentrations were in excess of the United Kingdom air quality objectives. The assessment considers the pollutants NO_2 and PM_{10} which are the main pollutants emitted by road traffic.

Analysis of the available automatic monitoring data has shown that annual mean concentrations measured at Haggs were in excess of the NAQS NO_2 objectives in 2008 and decreased in 2009 to less than the objective. Annual mean NO_2 concentrations measured using diffusion tubes have however remained fairly constant at most of the tube locations over the last three years with only small fluctuations observed.

To examine the spatial extent of any exceedance of NAQS objectives, a dispersion modelling study of local emissions sources has been undertaken. The dispersion modelling study utilised emissions data compiled in an inventory of local emissions sources. Analysis of the emissions inventory has identified that the majority of NO_x and PM_{10} emissions at Haggs are attributable to road traffic emissions.

The results of the dispersion modelling study have indicated that the NO_2 annual mean objective of 40 $\mu g/m^3$ is predicted to be exceeded at ground level locations up to approximately 75m from the M80 roadside and up to 30m from the Kilsyth Road close to the roundabout. As several residential properties are present close to the roads modelled, this represents many locations of relevant human exposure. The dispersion modelling has therefore confirmed that the declaration of the existing NO_2 AQMA is valid and that the boundary that has been set should be maintained.

The predicted annual mean PM_{10} concentrations in 2010 indicate that the Scottish objective of 18 $\mu g/m^3$ may be exceeded at residential properties on Kilsyth Road near the roundabout. The predicted concentrations have not however been verified with monitoring data, and have been adjusted upwards using the correction factor derived for road NO_x which may not be representative of what is actually happening at this location. Based on this, monitoring of PM_{10} concentrations is recommended to establish if PM_{10} should be considered in any future air quality assessment work at this location.

Modelling of future scenarios accounting for traffic volume growth and reductions in vehicle emissions has indicted that a reduction in overall NO_2 and PM_{10} concentrations is predicted at most receptors, the reductions are, however, insufficient to enable the NAQS objective for annual mean NO_2 concentrations to be met. A reduction in road traffic emissions via other action plan measures is therefore required to enable future compliance with the NO_2 air quality objective at this location.

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1 INTRODUCTION

BMT Cordah Limited has been commissioned by Falkirk Council to conduct a Further Assessment of air quality within its *Air Quality Management Area* (AQMA) at Haggs. The assessment aims to build on the review and assessment of air quality already conducted for this location which identified that nitrogen dioxide (NO_2) concentrations were in excess of the United Kingdom air quality objectives. The assessment considers the pollutants NO_2 and PM_{10} which are the main pollutants emitted by road traffic.

1.1 LAQM review and assessment framework

The Environment Act 1995 and subsequent regulations require local authorities to assess compliance of air quality in their area with the standards and objectives set out in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 (NAQS). For local authorities within Scotland further regulations are set out in the Air Quality (Scotland) Regulations 2000 and Air Quality (Scotland) Amendment Regulations 2002.

The LAQM framework requires that local authorities carry out regular reviews of air quality. The first round of Review and Assessment commenced in 1998 and comprised a four stage approach to the assessment of air quality.

The Review and Assessment process was revised in 2003 and comprises a phased approach. The first phase of the Review and Assessment is an Updating and Screening Assessment (U&SA). The U&SA considers any changes that have occurred in pollutant emissions and sources since the last round of Review and Assessment that may affect air quality. The second phase is the completion of a Progress report which is required to be completed annually, apart from the years when an U&SA is being completed.

The LAQM guidance requires that where the U&SA or Progress Report has identified a risk of exceedance of an air quality objective at a location with relevant public exposure is identified then a Detailed Assessment is undertaken. A Detailed Assessment will consider any risk of exceedance of an objective in greater depth in order to determine whether it is necessary to declare an Air Quality Management Area (AQMA).

When a new AQMA has been declared, local authorities are required to complete a Further Assessment within 12 months of designating the AQMA. The Further Assessment is intended to supplement the information provided in the Detailed Assessment. It should aim to confirm the exceedance of the objectives; define what improvement in air quality, and corresponding reduction in emissions is required to attain the objectives; and provide information on source contributions. The information on source contributions can be used to help develop an Air Quality Action Plan, and assist in the targeting of appropriate measures.

1.2 Air quality standards and objectives

The air quality standards and objectives which local authorities are required to work towards achieving are outlined in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland. The air quality objectives for NO_2 and PM_{10} which are applicable in Scotland are presented in Table 1.

Table 1: Scottish Air Quality Objectives

Pollutant	Air Quality Objective			Date to be achieved by
	Concentration	Measured as	Equivalent percentile	
Nitrogen dioxide (NO_2)	200 µg/m³ not to be exceeded more than 18 times per year	1-hour mean	99.79th percentile of 1-hour mean concentrations	31/12/2005
	40 µg/m³	Annual mean	-	31/12/2005
Fine particulates (PM_{10})	50 µg/m³ not to be exceeded more than 7 times per year	24-hour mean	98th percentile of 24-hour mean concentrations	31/12/2010
	18 µg/m³	Annual mean	-	31/12/2010

1.3 Previous assessments

July 2008: Detailed Assessment of NO_2 concentrations at Banknock and Haggs[1]

NO_2 concentrations measured using passive diffusion tubes at several locations in Haggs and Banknock exceeded the annual mean NAQS objective during 2006. An automatic analyser was subsequently installed at Kerr Crescent in Haggs during 2007.

A Detailed Assessment of the area was undertaken reviewing the available monitoring data and included a dispersion modelling study of road traffic emissions from the surrounding road network in 2008. The dispersion modelling study and automatic monitoring data predicted NO_2 annual mean concentrations in excess of the NAQS objective at roadside locations but not at locations of relevant public exposure. It was therefore concluded that an AQMA was not required and that monitoring should continue.

May 2009: Revised Detailed Assessment of Banknock[2]

Following the Scottish Government's appraisal of the original Banknock Detailed Assessment, a revised detailed assessment was undertaken. Following completion of a full year of automatic NO_2 monitoring at Kerr Crescent in Haggs, to allow verification of the

[1] LAQM Detailed Assessment of NO_2 concentrations at Banknock and Haggs, BMT Cordah Ltd report E_FAL_028 (5), July 2008

[2] LAQM Detailed Assessment Banknock, BMT Cordah Ltd report G_FAL_031-04-02-01, May 2009

modelling predictions, a revised modelling assessment was undertaken. This considered emissions of PM_{10} and NO_2 from road traffic sources in Haggs and Banknock.

The monitoring results and modelling assessment indicated that there were annual mean NO_2 concentrations in excess of the objective at locations of relevant exposure in Haggs and Banknock. There were no predicted concentrations in excess of the annual mean or 24-hour mean objectives for PM_{10}. It was recommended that the automatic analyser at Kerr Crescent be maintained and additional diffusion tube monitoring is undertaken on the north side of Kilsyth road. It was also concluded that there was a requirement for an AQMA at this location to reflect the exceedances of the annual mean NO_2 objective.

Following the revised detailed assessment an AQMA for NO_2 was declared in March 2010. The boundary of the AQMA is presented on Figure 1.

2 METHOD OF ASSESSMENT

The Further Assessment is a detailed review and assessment of air quality within the AQMA to verify that the decision to declare the AQMA remains valid, and that the boundary of the AQMA is appropriate. The Further Assessment also includes an analysis of the local emission sources which may be contributing to pollutant concentrations that are in excess of the NAQS objective. This provides supporting evidence which can be used to advise the Air Quality Action Plan.

The Further Assessment comprises of:

- A review of local monitoring data obtained since the 2008 Detailed Assessment was conducted. The data was reviewed in comparison with historic monitored data to determine any trends in the data and compared with the dispersion modelling predictions undertaken as part of the Detailed Assessment to verify that the AQMA is still required.
- A baseline emissions inventory for the Haggs AQMA has been compiled. Emissions inventory is the generic term used to describe the process of estimating emissions from various sources. The data held in the emissions inventory has been used to represent the local background emission sources in a dispersion modelling study of air quality at Haggs. Results from the modelling study have been used to verify the requirement for the AQMA and its boundaries.
- Predictions of pollutant concentrations in future years have been undertaken to determine future compliance with the objective without including any Action Plan measures. The emissions inventory and modelling studies were undertaken such that the relative contribution of various sources to air quality levels can be determined.

3 CURRENT CHANGES TO TRAFFIC FLOWS AT HAGGS

Major road works are currently taking place on the A80 at Haggs with the road being upgraded to Motorway standard. The road works may have an impact upon atmospheric pollutant concentrations until September 2011 when the project is planned to be completed. The effects of the road works on traffic speeds and flows are described further in Section 7.6.

4 LOCAL MONITORING DATA

Falkirk Council currently operates an extensive network of eighty-five passive diffusion tube (PDT) sites and eleven automatic monitoring sites throughout the Falkirk Council area, of which seven measure NO_x.

A map showing the relative locations of the monitoring locations at Haggs is presented on Figure 1.

4.1 Automatic monitoring

Automatic monitoring of NO_2 commenced at Kerr Crescent, Haggs during 2007, the monitoring site is located at GB OS grid reference 275975 679257. A summary of the 2008 and 2009 results is presented in Table 2. The Haggs automatic monitoring site was affiliated to the Scottish Air Quality Network in January 2009.

The NO_2 concentrations measured at the automatic monitoring site were below the NAQS NO_2 objectives in 2009 and have decreased when compared to 2008. This reduction may be attributable to the altered traffic flows on the A80 and A803 caused by the road works for the M80 Stepps to Haggs project. The reduction may also be attributable to missing data affecting the annual mean as there has not been a similar reduction in the annual mean concentrations measured using diffusion tubes.

Table 2: Haggs AQMA Automatic monitoring data

Pollutant	Air Quality Objective	2008		2009	
		Conc. (µg/m³)	Data capture (%)	Conc. (µg/m³)	Data capture (%)
Nitrogen dioxide (NO_2)	Annual mean	44.7	91.2%	37.6	85.7%
	Number of 1-hour mean concentrations greater than 200 µg/m³	2		1	

4.2 NO_2 diffusion tube monitoring

Diffusion tube measurements of NO2 are conducted at 4 locations at Haggs. Details of the tube location are presented in Table 3. A summary of recent years results are presented in Table 4.

Table 3: NO_2 diffusion tube locations in Haggs

Site ID	Location	Site Type	Within AQMA?	GB OS Grid Ref	
NA18	A80 Northbound c/way, Bankrock.	Roadside	N	278924	679513
NA19	Kilsyth Rd, Bankrock.	Roadside	Y	278779	679301
NA20	Garngrew Rd, Haggs.	Urban background	N	278979	679155
NA36	Kerr Crescent, Haggs.	Urban background	Y	278991	679271
NA65	Auchinloch Drive, Bankrock	Roadside	Y	278752	679049
NA67	M80 slip south, Haggs	Roadside	Y	279017	679305

Table 4: NO_2 diffusion tube results 2007 - 2009

Site ID	Location	Data Capture 2009 (%)	Annual mean NO_2 concentrations (μgm^{-3})		
			2007	2008	2009
NA18	A80 Northbound c/way, Bankrock.	33%	99	101	129*
NA19	Kilsyth Rd, Bankrock.	83%	37	35	37
NA20	Garngrew Rd, Haggs.	92%	37	35	37
NA36	Kerr Crescent, Haggs.	100%	46	42	49
NA65	Auchinloch Drive, Bankrock	100%	-	24	28
NA67	M80 slip south, Haggs	58%	-	-	32*

* Result adjusted from period mean to annual mean due to low data capture.

Annual mean NO_2 concentrations measured using diffusion tubes have remained fairly constant at most of the tube locations over the last three years with only small fluctuations observed. Annual mean concentrations in excess of the NAQS objective of 40 $\mu g/m^3$ were measured at Kerr Crescent and at the A80 Northbound carriageway.

A significant increase in measured concentrations at Kerr Crescent has occurred from 2008 to 2009. The site is located close to the roundabout where congestion is known to occur. The observed increase may reflect increased traffic flows at this location over the last year.

The result at the A80 Northbound c/way has also increased significantly when compared with previous years which may also reflect altered traffic flows at this location; it is however

not representative of relevant human exposure and monitoring is no longer carried at this site.

5 ATMOSPHERIC EMISSIONS INVENTORY

An emissions inventory for the Falkirk Council area was compiled using the atmospheric emissions database package EMIT[3], which aggregates emissions into 1km by 1km grid squares. The inventory includes emissions from the following sources:

- Road traffic;
- Commercial and domestic combustion;
- Industrial combustion;
- Industrial processes;
- Large industrial sources;
- Other transport;
- Waste treatment and disposal;
- Solvent use;
- Agriculture; and
- Nature

Road traffic data were obtained from Falkirk Council and Transport Scotland, while data from all other sources were obtained from the National Atmospheric Emissions Inventory (NAEI). The NAEI is a national atmospheric emissions database which holds data on emissions from a variety of sources in 1km by 1km grid squares. Emissions are reported in tonnes per year. The NAEI data can be downloaded from the NAEI website[4] for individual local authority areas, so the emissions are directly attributed to each authority. While the Falkirk emissions inventory is based on 2008 emissions, the most recent NAEI data available at the time of compiling this inventory were for 2007. The study assumed that 2007 emissions from the NAEI remain unchanged in 2008, 2009 and 2010.

5.1 NAEI road traffic data

Road traffic emission sources are present in Haggs with the A80 trunk road passing close to the village and the A803 and Glasgow road passing through the village. Road traffic related emission data aggregated over 1km^2 grid squares are available from the NAEI. As all of the roads in the Haggs area were being specifically modelled it was not necessary to

[3] EMIT Atmospheric Emissions Inventory Toolkit, version 2.2, Cambridge Environment Research Consultants, February 2006

[4] www.naei.org.uk/datawarehouse

include the NAEI roads emissions data in the modelling study. Full details of the specifically modelled roads data can be found in Section 6.5.

5.2 NAEI Commercial and domestic combustion

The NAEI contains data on emissions from commercial and domestic combustion, a group which includes stationary combustion sources in agriculture, domestic combustion, small scale industrial combustion, commercial combustion and public sector combustion. Commercial and domestic combustion is often highest in urban areas with a high concentration of public sector, commercial and domestic buildings. Like road traffic data, emissions are aggregated over the $1km^2$ grid squares.

5.3 NAEI Industrial combustion and industrial processes

The NAEI holds data on the emission of pollutants from large industrial combustion sources. The sources in this group include combustion associated with ammonia production, cement production, iron and steel production, and lime production. Emissions data from sources in this group is often obtained using data submitted to SEPA through IPPC (Integrated Pollution Prevention and Control) process. Emissions are aggregated over the $1km^2$ grid squares.

A second group within the NAEI contains emissions data for industrial production processes. The sources in this group include nitric acid use in the chemical industry, primary aluminium production and solid smokeless fuel production. Emissions are aggregated over the $1km^2$ grid squares.

5.4 NAEI Other transport

The "other transport" group covers emissions from air, rail and marine transport. It also includes emissions from off road vehicles. Two railway lines pass approximately 1km to the south of Haggs. Rail transport includes emissions from freight, intercity and regional. The emissions from 'other transport' have been aggregated into the $1km^2$ grid squares

5.5 NAEI Waste treatment and disposal

The NAEI contains a group with emission data from waste treatment and disposal activities. Sources included in this group are crematoria, incineration of animal carcasses, chemical waste and clinical waste, offshore oil and gas flaring and small-scale waste burning. Emissions from these sources are aggregated into the $1km^2$ grid squares.

5.6 NAEI Solvents use

The NAEI also contains a group with emission data from solvent use associated with paints, glues, detergents and industrial processes. This data is often obtained from SEPA who regulate processes involving solvents. As for other pollutant sources, solvent emissions are aggregated into the $1km^2$ grid squares.

5.7 NAEI Agriculture

The NAEI also contains a group with emission data from all agricultural livestock, poultry and agricultural off road machinery. Emissions from these sources are aggregated into the 1km² grid squares.

5.8 NAEI Nature

The NAEI also contains a group with emission data from naturally occurring emissions from woodlands, mines, quarries and opencast mines. There are some quarries located close to Banknock and Haggs with Cowdenhill quarry located approximately 2km to the west.

Emissions from these sources are aggregated into the 1km² grid squares.

6 EMISSIONS TOTALS

The total atmospheric emissions from the 1km grid squares covering the Haggs AQMA in 2008 are presented in Table 5 with the totals broken down by source in Charts 1 and 2.

Chart 1 indicates that the majority of NO_X emissions are attributable to road transport with other transport, commercial/residential combustion and agriculture account for the remainder. Chart 2 indicates that the dominant source of PM_{10} in Haggs is road transport with a range of other sources accounting for the remainder of emissions.

Table 5: Emissions inventory totals at Haggs AQMA

Source	NO_x emitted (tonnes)	PM_{10} emitted (tonnes)
Agriculture	0	0.11
Commercial, Institutional and Residential Combustion	6.14	0.08
Energy Production	0	0
Industrial Combustion	0.80	0.08
Industrial Processes	0	0.07
Nature	0.02	0.14
Other Transport	12.97	0.40
Road Transport	124.60	5.58
Solvent use	0	0.30
Waste Treatment	0	0.37
Total	**144.53**	**7.12**

Chart 1: Haggs AQMA: NO_x emission sources

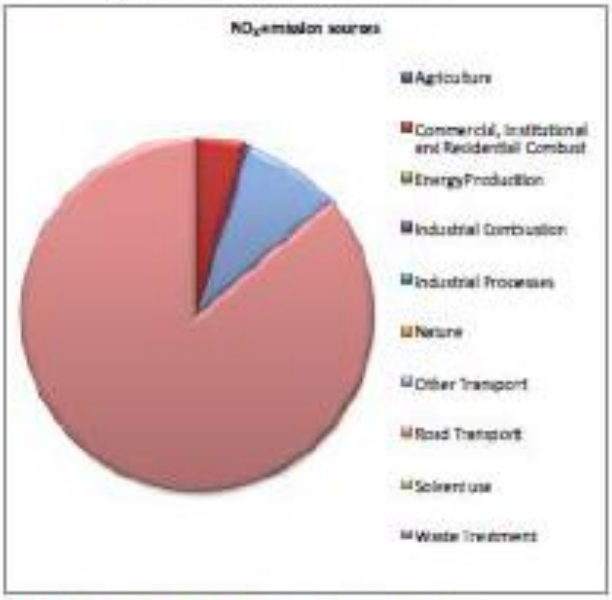
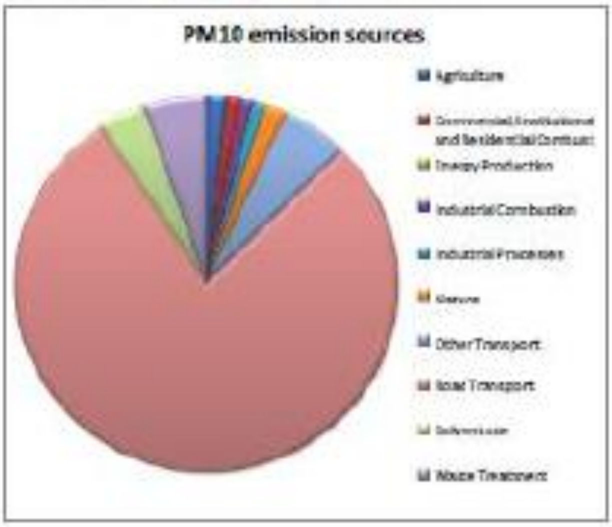


Chart 2: Haggs AQMA: PM_{10} emission sources



7 ATMOSPHERIC DISPERSION MODELLING

To predict the ambient NO_2 and PM_{10} concentrations at the Haggs AQMA, an atmospheric dispersion modelling study of road traffic emissions was undertaken. The atmospheric dispersion model predicts pollutant concentrations based upon the traffic volume, street geometry, traffic composition, traffic speed, background sources and meteorological and topographical conditions of the area.

Road traffic emissions have been modelled for both 2008 and 2009 as a baseline scenario with which to verify the results when compared with pollutant concentrations measured in those years. Future years have also been modeled to provide an indication of the reduction in road traffic emissions required to attain the air quality objective within the designated AQMA at Haggs with various traffic flow reduction scenarios.

7.1 Atmospheric dispersion model

The atmospheric model used in the assessment was ADMS-Roads version 2.3. ADMS-Roads is a new generation dispersion model which has been validated and verified in numerous studies which are summarised in the user guide, and has been declared fit for the purpose of local air quality assessment by DEFRA and the devolved administrations.

7.2 Area of assessment and Receptors

Modelling predictions were undertaken over a modelled domain consisting of a 2km by 1.6km Cartesian grid pattern which encompasses the Haggs and Banknock area. The number of calculation points was set at 100 by 80 which provides predicted concentrations at an approximate minimum resolution of 20m. The option of "intelligent gridding" was selected whereby the model predicts pollutant concentrations at a higher spatial density (finer resolution) close to the emission sources and at a lower spatial density at background locations.

The model can also predict pollutant concentrations at specific locations where relevant public exposure may occur and at monitoring locations which are used to verify the model predictions. Nine locations within the assessment area were specified as receptors. The receptor locations are presented in Table 6 and annotated on Figure 2.

Table 6: Location of specified receptors

Receptor	Category	Location (NGR)	
		Easting	Northing
Haggs automatic monitor	Monitoring site	278976	679272
Kilsyth Road, Banknock	Monitoring site	278770	679301
Garngrew Road, Haggs	Monitoring site	278970	679155
Kerr Crescent, Haggs	Monitoring site & residential	278995	679273
Receptor 1	Residential	279063	679290
Receptor 2	Residential	278993	679298
Receptor 3	Residential	279027	679250
Receptor 4	Residential	278594	679303
Health Centre	Location of public exposure	278850	679295
Bankview Care Home	Location of public exposure	278560	679434
School	Location of public exposure	278248	679204

7.3 Topographical data and terrain sensitivity analysis

The model is capable of simulating the effect of local topography on air flows and hence pollutant dispersal, which is significant for sites where the area of assessment has gradients of 1 in 10 or greater. The Campsie Fells are located approximately 12km to the west of Banknock. It is therefore possible that the terrain will have an impact upon the dispersion of the pollutants. In general, differences of +/- 10% are considered significant.

In order to determine the impact of the terrain on final modelling predictions a sensitivity analysis was conducted for the 2009 Detailed Assessment[5]. The results of the sensitivity analysis indicated that there is not a significant difference between the predicted annual mean concentrations when modelled with topographical data or with flat terrain.

Overall, the use of topographical data in the model run resulted in slightly higher predicted concentrations at the majority of locations. However, the difference in predicted concentrations was not considered significant enough to substantially change the results of the model run.

The effects of terrain were not therefore included in the dispersion modelling assessment.

7.4 Meteorological data

The model requires a minimum input of six meteorological parameters for hourly sequential or statistical data. The six parameters included in the meteorological data are surface temperature (°C), wind speed (m/s), wind direction (degrees from north), relative humidity (%), cloud cover (oktas) and precipitation (mm).

[5] BMT Cordah (2009) LAQM Detailed Assessment Banknock; Client: Falkirk Council; Report ref g FAL.031.04.00.01; 6[th] May 2009

A review of meteorological data was carried out to determine the most appropriate set of meteorological parameters available. The closest meteorological stations to Haggs and Banknock, recording the full suite of meteorological parameters required by the model, are Bishopton (Glasgow) and Gogarbank (Edinburgh).

Gogarbank meteorological station is a lowland site located approximately 36km southeast of Banknock at an altitude of 57m above sea level (a.s.l). The station is close to the Firth of Forth and located in predominantly suburban surroundings.

Bishopton meteorological station is located approximately 40km southwest of Banknock at an altitude of 59m a.s.l. The area surrounding the meteorological site comprises suburban and rural with some industrial and commercial sites nearby. The station is located less than 2km from the Firth of Clyde. The terrain around the meteorological station is relatively flat owing to the flood plain upon which it sits.

It was determined in the 2009 Detailed Assessment that the meteorological parameters from Gogarbank would be the most appropriate for use in the atmospheric dispersion assessment due to the fact that the meteorological site is located in the Forth Valley and is likely to give a closer representation of the conditions in Banknock.

Meteorological data from Gogarbank for 2008 and 2009 were used in the modelling assessment. A wind rose of the 2008 and 2009 meteorological data from the Gogarbank meteorological site is presented in Figure 3.

7.5 Surface roughness

The interaction of wind flow with the earth's surface generates turbulence, influencing pollutant dispersion. The strength of this turbulence is dependent on the land use, with built-up areas generating more turbulence than open countryside. The ADMS-Roads user guide indicates that a surface roughness length of 0.5m is suitable for parkland and open suburbia. Haggs mainly comprises of residential properties with gardens, open parkland and wooded areas; a surface roughness of 0.5m was therefore considered appropriate for the dispersion site. A surface roughness factor of 0.2m was used to represent the agricultural land around the meteorological site at Gogarbank.

7.6 Road traffic emissions

The ADMS Roads atmospheric dispersion model uses the annual average hourly (AAHT) traffic flow, vehicle split and traffic speed to determine the pollutant emission rates for each section of road modelled.

Traffic count data for the A80 during 2008 and 2009 were provided by Transport Scotland. All other local road traffic counts were provided by Falkirk Council from either temporary automatic counters or manual traffic counts conducted during 2009 and 2010. Traffic volumes were projected forward and backward where necessary using the National Road Traffic Forecast (NRTF) central growth factor[6] for urban roads.

The traffic data collated for the modelling study is considered more representative of actual traffic flows at this location than the data used for the original Detailed Assessment[7]. The original assessment used only single lanes of traffic on the A80 and used estimated traffic count data. The currently available traffic dataset does however have its limitations. This is due to a lack of available count data on the slip roads on and off the A80; particularly from the southbound carriageway where congestion is known to occur during busy periods as traffic leaves the A80 and queues at the Haggs roundabout.

The current road works on the A80 at this location have led to altered traffic flows both on the A80 and on the A803 Kilsyth Road. During 2009 a 40 mph (65 km/hr) speed limit was in force on the A80 using average speed cameras. The speed limit during normal operation of this section of the A80 following completion of the road works will be the UK national speed limit of 70 mph (112 km/hr).

To account for the difference in traffic flows over 2008 and 2009, two baseline models using the A80 automatic traffic count data captured during 2008 and 2009 have been run separately. This allows modelling results from each year to be compared with the measured NO_2 concentrations for each year and will provide an indication of the effect of the current traffic restrictions and altered flows on air quality during 2009. The 2008 traffic dataset year is however considered the most appropriate to factor forward for future year projections as it should be representative of the traffic flows that will occur following completion of the A80 construction work.

The road sources modelled in the assessment and the traffic flow data are presented for 2008 in Table 7 and for 2009 in

Table 8. The traffic counts on the A80 have shown an overall reduction in traffic of approximately 11% on the southbound lane and 4% on the northbound lane from 2008 to 2009. This may reflect a reduction in use of the road due to the current road works and speed restrictions, or may reflect less commercial vehicle and commuter usage of the road due to recent recessionary effects. The locations and extent of the roads modelled are presented on Figure 4.

[6] DETR (1997) National Road Traffic Forecasts (Great Britain) 1997

[7] BMT Cordah (2009) LAQM Detailed Assessment Banknock Report ref. C.FAL.031 27th April 2009

Table 7: Modelled road sources data 2008

Road	Road width (m)	AAHT LGVs (veh/hr)	LGV speed (kph)	AAHT HGVs (veh/hr)	HGV speed (kph)	% HGVs
A80 J3–J4 – north inside lane	3.5	496	110	203	100	29.0%
A80 J3–J4 - north outside lane	3.5	667	110	78	100	10.5%
A80 J3–J4 - south inside lane	3.5	469	110	230	100	32.9%
A80 J3–J4 - south outside lane	3.5	748	110	75	100	9.2%
Glasgow Rd WB	3	209	50	8	50	3.5%
Glasgow Rd EB	3	191	50	7	50	3.6%
Kilsyth Rd (Over A80) EB	3.5	165	50	21	50	11.1%
Kilsyth Rd (over A80) WB	3.5	177	50	13	50	6.9%
Kilsyth Rd (West of A80) EB	3.5	173	50	13	50	6.9%
Kilsyth Rd (West of A80) WB	3.5	168	50	21	50	11.1%
A80 NB off ramp	7	51	65	3	65	5.6%
A80 NB on ramp	7	52	65	4	65	7.1%
Slip NBD	8	100	65	7	65	6.4%
Slip SBD	8	63	65	48	65	42.9%

Table 8: Modelled road source data 2009

Road	Road width (m)	AAHT LGVs (veh/hr)	LGV speed (kph)	AAHT HGVs (veh/hr)	HGV speed (kph)	% HGVs
A80 J3–J4 – north inside lane	3.5	503	65	208	65	29.0%
A80 J3–J4 - north outside lane	3.5	677	65	79	65	10.5%
A80 J3–J4 – south inside lane	3.5	496	65	240	65	32.9%
A80 J3–J4 - south outside lane	3.5	759	65	77	65	9.2%
Glasgow Rd WB	3	212	50	8	50	3.5%
Glasgow Rd EB	3	194	50	7	50	3.5%
Kilsyth rd (Over A80) EB	3.5	168	50	21	50	11.1%
Kilsyth rd (over A80) WB	3.5	179	50	13	50	6.9%
Kilsyth rd (West of A80) EB	3.5	178	50	13	50	6.9%
Kilsyth rd (West of A80) WB	3.5	169	50	21	50	11.1%
A80 NB off ramp	7	52	65	3	65	5.6%
A80 NB on ramp	7	53	65	4	65	7.1%
Slip NBD	8	105	65	7	65	6.4%
Slip SBD	8	64	65	48	65	42.9%

7.6.1 Diurnal traffic profiles

The ADMS Roads model requires traffic data to be input as an average vehicle flow per hour. The accuracy of the traffic flow information can be improved by use of time varying emissions factors which details the diurnal profile of the road. The time varying factors allow the average hourly traffic flow to be multiplied by a factor representative of the expected traffic flow at each hour of the day. The traffic flow factors are calculated as a ratio between the hourly flow and the average flow.

Detailed hourly traffic flow data were available for all of the roads modelled and a diurnal profile was calculated for each road. The profile was calculated separately for weekday i.e. Monday to Friday, Saturday and Sunday traffic flows. Each diurnal profile was applied to each respective road. The diurnal profiles used in the model are presented in Appendix A.

7.6.2 Queuing traffic

Traffic is known to become congested when approaching the roundabout at Haggs during peak commuting hours in the morning and early evening. A method of modelling queuing traffic using ADMS-Roads proposed by model developers CERC has been used to represent the periodic congestion at the junction. The method assumes that during congested periods a representative traffic flow rate must be estimated.

Assuming that the vehicles are travelling at the lowest speed that can be modelled using ADMS-Roads (5 km/hr), with an average vehicle length of 4m, and are positioned close to each other during congested periods. The annual average hourly traffic (AAHT) flow is calculated by dividing the speed of the vehicles by the average vehicle length, which gives a representative AAHT of 1250 vehicles per hour during congested periods. The AAHT is then factored by the respective composition percentages of light and heavy vehicle types.

Queuing traffic road sections of 50m length were included for all roads approaching the roundabout. A time varying profile was applied to each queue section to account for the twice-daily congestion periods during weekdays. The congested periods were assumed to occur from 07:00 - 10:00 and from 16:00 - 19:00. Queues were also included on Saturdays between 11:00 - 13:00 to represent a busy period at the weekend.

The queue road section modelled in the assessment and the traffic flow data are presented in Table 9.

Table 9: Modelled queue road sections data

Road	Road width (m)	AAHT LGVs	LGV speed (kph)	AAHT HGVs	HGV speed (kph)	% HGVs
Glasgow Rd WB Queue	3	1206	5	44	5	3.5%
Kilsyth rd (Over A80) EB Queue	3.5	1111	5	139	5	11.1%
Slip SBD Queue section	4	714	5	536	5	42.9%

7.6.3 Non-exhaust traffic emissions

ADMS-Roads calculates pollutant emission rates from vehicles based on exhaust emissions only; additional road traffic sources were included to represent PM_{10} emissions from non-exhaust emissions. Road traffic processes other than fuel combustion include tyre wear, brake wear, clutch wear, road surface wear, corrosion of chassis, body and other vehicle components, all contributing collectively to road dust. Non-exhaust emissions for each road segment were calculated using PM_{10} emission factors in g km^{-1} from the National Atmospheric Emissions Inventory (NAEI) and the number of vehicles per day.

7.6.4 Projected traffic emissions

For comparison with the 2010 air quality objective, it is necessary to assess PM_{10} concentrations using traffic flows projected forward to 2010. Traffic emissions for 2010 were calculated by projecting the available historical road traffic data forward to 2010. Traffic flow rates on each road were increased by 1.53% each year, based on published estimated traffic growth factors[8]. Projected emission factors for vehicles in 2010 are contained in the DMRB emissions database which is used by the ADMS Roads model to calculate mass pollutant emissions per kilometre per second.

7.6.5 Other local sources

Sources from the emissions inventory, described in Section 0 above, were included in the model to represent the local non-road background sources of NO_2 and PM_{10}. The local background sources were modelled as volume sources. Emissions in a volume source are expressed in $g/m^3/s$. The area of the volume source was chosen to match the size of the emission inventory grid squares. The depth of the volume source was chosen to be 10 m as it was considered that the vast majority of pollutants emitted from the other sources (commercial and domestic, industrial processes, etc) would be emitted within 10 m from the ground. Emissions from four 1km x 1km grid squares covering Haggs and Banknock were included in the study.

[8] DETR (1997) National Road Traffic Forecasts (Great Britain) 1997

7.6.6 Chemistry scheme and background concentrations

ADMS-Roads has an optional chemistry scheme which can model the photochemical reactions that occur between oxides of nitrogen (NO_x), ozone and hydrocarbons leading to the formation of NO_2. The chemistry scheme within ADMS-Roads also models the conversion of sulphur dioxide (SO_2) to sulphate particles, which influence PM_{10} concentrations.

It is important to include chemical reactions when modelling road traffic emissions as NO_2 emissions generally account for only around 10-20% of total NO_x emissions from motor vehicles. While there are numerous reactions which occur between these compounds, the Chemical Reaction Scheme in ADMS-Roads simplifies this to eight reactions known as the Generic Reaction Set. ADMS roads uses a default 10% of total NO_x to NO_2 relationship from motor vehicles, however the primary fraction of NO_2 emitted by road traffic is now known to be greater than this and was estimated at approximately 15% for urban roads outside of London. Recently published estimations of primary NO_2 emission rates from motor vehicles in the UK projected over the next twenty years are available from the UK Air Quality Archive website[9]. Primary NO_2 emissions from motor vehicles in the Falkirk Council area are predicted to range from 17% to 25% from 2008 to 2015. The modelling study predicted both total NO_x and NO_2 concentrations.

The chemistry module of ADMS-Roads requires hourly averaged background concentrations of NO, NO_2, O_3, PM_{10} and SO_2. The background concentrations used in the study were taken from the rural background automatic monitoring site at Waulkmillglen Reservoir near Glasgow. As well as providing the information required by the chemistry module of ADMS-Roads, the Waulkmillglen measurements also represent the regional background contribution (from sources outside the study area) to atmospheric pollutant concentrations in Haggs. The annual mean background concentrations measured in Waulkmillglen in 2009 are presented in Table 10.

Table 10: Waulkmillglen 2008-09 annual mean background pollutant concentrations

Year	NO_x ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	Ozone ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)
2008	21.7	12.1	56.1	14.2	2
2009	18.3	11.1	51.8	12.3	3.6

[9] www.airquality.co.uk/laqm/tools.php

7.7 Model results

7.7.1 Model Verification

To verify the performance of the modelling assessment, predictions of pollutant concentrations were compared against measured pollutant concentrations. The model verification methodology followed the technical guidance TG (09). The verification will be discussed in the following sections.

As described above, to account for the difference in traffic flows over 2008 and 2009 due to the current construction work on the A80, two baseline models using the A80 automatic traffic count data captured during 2008 and 2009 have been run separately.

This allows modelling results from each year to be compared with the measured NO_2 concentrations for each year and provides an indication of the effect of the current traffic restrictions and altered flows on air quality during 2009. The 2008 traffic dataset year is however considered the most appropriate to factor forward for future year projections as it should be representative of the traffic flows following completion of the A80 construction work.

7.7.1.1 NO_2 verification

Modelled predictions of annual mean NO2 concentrations were compared with local monitoring data to examine the correlation between the modelled and measured annual mean concentrations of NO2. The results of the comparison using the 2008 traffic count data are presented in Table 11 and Chart 3; and for the 2009 traffic data in

Table 12 and Chart 4.

Table 11: 2008 Comparison of modelled and monitored NO_2 concentrations

Receptor Name	Monitor type	Site type	Site description	Background NO_2 ($\mu g/m^3$)	Monitored total NO_2 ($\mu g/m^3$)	Modelled total NO_2 ($\mu g/m^3$)	% difference
Haggs automatic monitor	CM	R	Urban	12.1	44.7	28.1	-37%
Kilsyth Rd PDT	DT	R	Urban	12.1	35	26.8	-23%
Kerr crescent PDT	DT	R	Urban	12.1	42	28.3	-33%
Garngrew rd PDT	DT	UB	Urban	12.1	25	23.3	-7%
Auchinloch drive PDT	DT	UB	Urban	12.1	24	23.3	-3%

Chart 3: 2008 NO_2 verification – monitored vs modelled concentrations

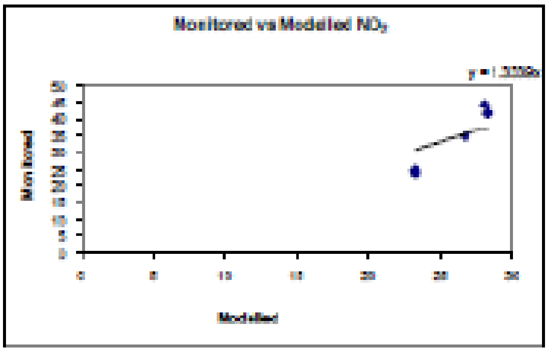
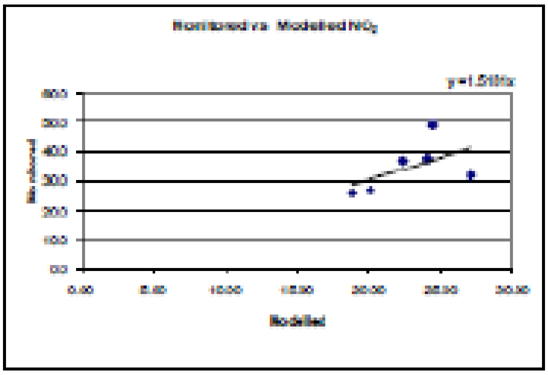


Table 12: 2009 Comparison of modelled and monitored NO_2 concentrations

Receptor Name	Monitor type	Site type	Site description	Background NO_x ($\mu g/m^3$)	Monitored total NO_2 ($\mu g/m^3$)	Modelled total NO_2 ($\mu g/m^3$)	% difference
Haggs automatic monitor	CM	R	Urban	11.1	37.6	24.2	-36%
Kilsyth Rd PDT	DT	R	Urban	11.1	37.0	22.5	-39%
Kerr crescent PDT	DT	R	Urban	11.1	49.0	24.5	-50%
Garngrew rd PDT	DT	UB	Urban	11.1	27	20.2	-25%
Auchinloch drive PDT	DT	UB	Urban	11.1	26	19	-27%
M80 Slip south PDT	DT	R	Urban	11.1	32	27.2	-15%

Chart 4: 2009 NO_2 verification – monitored vs modelled concentrations



The comparison indicates that the model is under predicting NO_2 concentrations at all monitoring locations using both the 2008 and 2009 traffic datasets. The comparison also indicates that the 2009 model is, on average, underestimating NO_2 concentrations by a greater amount than the 2008 model.

The under prediction of NO_2 concentrations may be due to a number of uncertainties relating to the model input data, for example:

- estimated background concentrations may be incorrect;
- meteorological data may not accurately represent local conditions;
- uncertainties may exist in source activity data, such as traffic flows and emission factors;
- inherent uncertainties or limitations in model input parameters, such as surface roughness length, or minimum Monin-Obukhov length; and
- uncertainties associated with the monitoring data.

It can be observed from Table 11 that the model results using the 2008 dataset at the two Urban Background diffusion tube locations are under-estimating NO_2 concentrations by much less than at the roadside diffusion tube locations. The model is therefore performing reasonably well at the urban background tube locations but not at the roadside tube locations. This indicates that the volume source emissions (which represent the local background contribution) and the regional background NO_2 are fairly representative of actual NO_2 concentrations in the study area. It also indicates that the road source emissions of NO_2 are being underestimated.

Although it is considered that the model input data used for the study is the best available data with which to conduct the study, assumptions have been made when compiling the traffic flow data. A review of the model input data was therefore undertaken.

Following review, the model input data was considered to be the best currently available data with which to represent the local environment and traffic emissions.

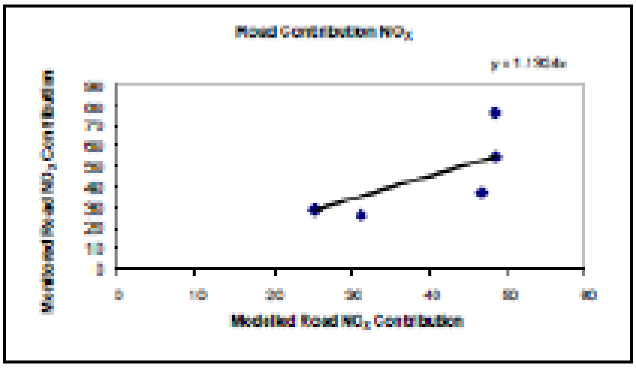
To account for the model under-prediction of NO_2 concentrations, it is necessary to apply model adjustment to the road source contribution of NO_2 concentrations i.e. excluding background which includes the Waulkmillglen rural background and the local background volume source contributions. Adjustment has been applied to the NO_2 concentrations modelled using the 2008 traffic dataset only.

The model adjustment follows the method suggested in TG(09). Annual mean NO_2 concentrations measured using diffusion tubes have been converted to NO_X concentrations using the NO_2 to NO_X calculator provided on the LAQM tools site[10]. Modelled NO_x

[10] DEFRA (2010) NOX to NO2 calculator, Available at http://laqm1.defra.gov.uk/review/tools/monitoring/calculator.php ; accessed July 2010

concentrations have been compared with the respective measured NO_X concentrations at monitoring locations and a linear regression analysis conducted to derive the correction factor. A comparison of the measured and modelled NO_X concentrations is presented in Table 13 and the scatter plot presented in **Error! Reference source not found.** below.

Chart 5: **Ratio of monitored vs. Modelled road contribution NO_X**

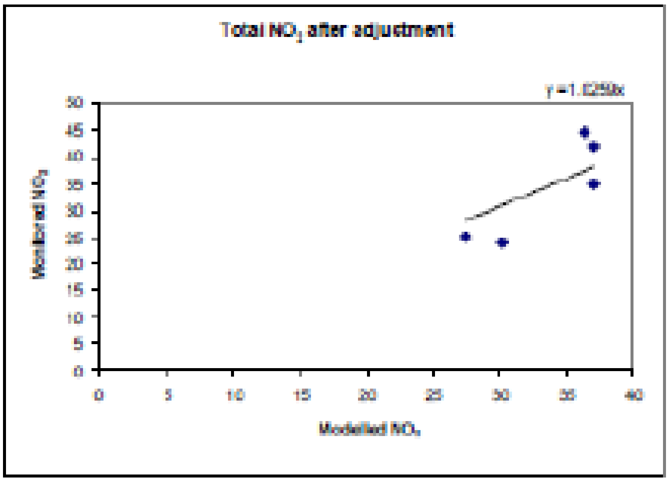


A NO_X correction factor of 1.1324 was derived and has been applied to all modelled road contribution NO_X concentrations.

The next step of the adjustment process was to apply the NO_X correction factor to the modelled road contribution NO_X concentrations at each monitoring location, and then convert the predicted NO_X concentrations to annual mean NO_2 concentrations for comparison with the measured values. The results are presented in Table 14. The percentage differences between the adjusted modelled NO_2 concentrations and the measured concentrations at the monitoring locations are within 15% at all locations, with the exception of Auchinloch Drive, indicating reasonable confidence in the model output.

A comparison of the adjusted modelled and measured NO_2 concentrations is presented on Chart 6. On average the monitored concentrations are now 2.6% higher than the measured ones; whereas, prior to adjustment, the montored concentrations were 33.4% higher than the measured ones. This overall increase in modelled concentrations has caused the model results at Auchinloch Drive and Garngrew Road to increase significantly, as at these locations the model was underestimating NO_2 concentrations by only a small amount due to these locations being away from the main roads being modelled. When considering the adjusted results across the modelled domain, the predicted results at locations away from the roadside should be considered in context with this over-estimation caused by the model verification/adjustment process.

Chart 6: Monitored vs modelled NO_2 after model adjustment



Finally, the adjustment factor was applied to the modelled NO_x concentrations at all of the specified receptors in the study and across the modelled grid and then converted to NO_2 concentrations. The adjusted results are presented in Section 7.7.2.

7.7.1.2 PM_{10} verification

No local monitoring data were available to allow a verification of predicted PM_{10} concentrations. TG (09) paragraph A3.244 recommends that in the absence of any PM_{10} data for verification, it may be appropriate to apply the road NO_X adjustment to the modelled road PM_{10}. If this identifies exceedances of the objective then it would be appropriate to monitor PM_{10} to confirm the findings. The road NO_X adjustment factor of 1.1324 was therefore applied to the predicted road PM_{10} using a similar method to that described for the NO_2 adjustment above.

Table 13: Comparison of modelled and monitored NO_2 concentrations 2008

Site	Monitored Total NO_2	Monitored Total NO_x	Waulkmilglen average background NOx (regional background)	Waulkmilglen average background NOx (regional background)	Volume source background NO_x (regional + local background)	Volume source background NO_x (regional + local background)	Monitored road NO_2 (total - background)	Monitored road NO_x (total - background)	Modelled Road NO_x	Modelled road contribution NO_x (excludes background)
Haggs automatic monitor	44.7	59.6	12.1	21.7	14.2	22.3	32.60	36.8	66.04	46.04
Kilsyth Rd PDT	35.0	76.44	12.1	21.7	14.1	22.2	22.90	54.74	70.66	48.48
Karr Crescent PDT	42.0	98.33	12.1	21.7	14.2	22.3	29.90	76.03	70.71	48.41
Garngrew Rd PDT	25.0	49.97	12.1	21.7	14.2	22.5	12.90	26.27	47.74	25.24
Auchinloch Drive PDT	24.0	47.58	12.1	21.7	14.2	22.7	11.90	25.68	53.86	31.16

Table 14: Calculation of adjusted modelled total NO_2 from adjusted modelled total NO_x 2008

Receptor name	Ratio of monitored road contribution NO_x/ modelled road contribution NO_x	Adjustment factor for modelled road contribution	Adjusted modelled road contribution NO_x	Adjusted modelled total NO_x (inc. background NO_x)	Modelled total NO_2 (based on empirical NO_x/NO_2 relationship)	Monitored total NO_2	% difference [(modelled - monitored)/monitored] x 100
Haggs automatic monitor	0.8	1.1324	52.6	75.1	36.49	44.7	-10%
Kilsyth Rd PDT	1.1	1.1324	54.9	77.1	37.1	35.0	6%
Karr Crescent PDT	1.6	1.1324	54.8	77.1	37.11	42.0	-12%
Garngrew Rd PDT	1.1	1.1324	28.6	51.1	27.46	25.0	10%
Auchinloch drive PDT	0.8	1.1324	35.3	58.0	31.22	24.0	30%

7.7.2 Baseline scenario modelling results

Contour plots showing predicted ground level annual mean NO_2 concentrations are presented on Figure 5. The predicted 99.79[th] percentile of 1-hour mean concentrations is presented on Figure 6. Contour plots showing the predicted ground level annual mean PM_{10} concentrations in 2010 are presented on Figure 7 and the 90[th] percentile of 24-hr means presented in Figure 8.

The annual mean PM_{10} concentrations in 2010 and the NO_2 annual concentrations in 2008 at the correct height of the specified receptors are presented in Table 15. When the predicted pollutant concentrations at elevated receptors are compared with the predicted ground level concentrations at the corresponding locations on the contour plots; it can be observed that the ground level concentrations are higher than the concentrations at the elevated height of the receptors. This demonstrates the reduction in predicted pollutant concentrations with height from the road.

Table 15: Baseline scenario-Predicted pollutant concentrations at specified receptors

Receptor	Height (m)	Annual mean NO_2 concentration 2008 ($\mu g/m^3$)	Annual mean PM_{10} concentration 2010 ($\mu g/m^3$)
Haggs automatic monitor	1.5m	49.9	17.8
A80 North Bound C'way, Banknock	2m	61.8	19.9
Kilsyth Road, Banknock	2m	49.9	17.2
Garngrew Road, Haggs	2m	35.8	15.6
Kerr Crescent, Haggs	2m	49.9	17.1
Receptor 1	1m	42.5	17.0
Receptor 2	1m	47.4	17.6
Receptor 3	1m	42.4	16.6
Receptor 4	1m	32.8	15.7
Health Centre	1m	32.4	15.5
Bankview Care Home	1m	43.3	14.6
School	1m	30.5	14.5

7.7.3 Discussion of results and validation of NO_2 AQMA boundary

NO_2

The modelled predictions of annual mean NO_2 concentrations in 2008 have been used to validate the existing NO_2 AQMA boundary. Model verification has identified that the model has under-estimated NO_2 concentrations at roadside locations but was more accurate at locations away from the main roads. The modelled NO_2 results have subsequently been adjusted upwards so that, on average across the monitoring locations, they are in close agreement with the 2008 monitoring results. This has however increased the predicted NO_2 concentrations at locations away from the main roads, the predicted concentrations should therefore be considered in this context.

Analysis of the contour plot in Figure 5 indicates that the NO_2 annual mean objective of 40 µg/m^3 is predicted to be exceeded at ground level locations up to approximately 75m from the M80 roadside and up to 30m from the Kilsyth Road close to the roundabout. As several residential properties are present close to the roads modelled, this represents many locations of relevant human exposure which are close to the roads assessed.

The area over which NO_2 annual mean concentrations in excess of the objective are predicted is within the existing boundary of the AQMA at many locations. The decision to declare the AQMA for NO_2 and the current boundary are therefore considered to remain valid.

PM_{10}

Examination of the contour plot in Figure 7 showing the predicted spatial variation of annual mean PM_{10} concentrations in 2010 indicates that the Scottish objective of 18 µg/m^3 may be exceeded at residential properties on Kilsyth Road near the roundabout.

Ground level PM_{10} concentrations over the annual mean objective are predicted at locations up to 20m from the Kilsyth Road which includes residential properties and their gardens. The predicted PM_{10} concentrations have not however been verified against local monitoring data, and in accordance with the TG(09) model verification guidance, have been adjusted upwards using the correction factor derived for road NO_X. The predicted PM_{10} concentrations may not therefore be representative of what is actually happening at this location. Based on the predicted PM_{10} concentrations in excess of the 2010 annual mean objective at some locations of relevant human exposure, monitoring of PM_{10} concentrations is recommended to establish if PM_{10} should be considered in any future air quality assessment work at this location.

For both the NO_2 and PM_{10} predicted annual mean concentrations it is apparent that the most likely area where concentrations in excess of the air quality objectives will occur is close to the Kilsyth Road on the south side of the A80. This is likely to be attributable to the congestion which occurs as traffic approaches the roundabout during busy periods.

8 FUTURE SCENARIOS

Future road traffic scenarios have been modelled to investigate the effect of expected increases in traffic flows and reductions in vehicle emissions in future years. The years which have been assessed are 2012 which is when the A80 Stepps to Haggs road project is expected to be completed and 2015 which represents 5 years into the future.

Traffic volumes are predicted to grow by 1.48% per year[11] from 2011 - 2015. Emission factors for NO_2 and PM_{10} from vehicles are expected to reduce annually due to technological advances in vehicle and engine design combined with older, more polluting vehicles being removed from the UK vehicle fleet, these changes to the vehicle fleet are accounted for in the vehicle emission factors for each year in the ADMS Roads model.

Modelling predicted traffic growth and the expected reduction on vehicle pollutant emissions represents a "do-nothing" scenario with respect to managing road traffic flows and emissions in Haggs. No traffic management measures that can be assessed using dispersion modelling have been considered.

The predicted annual mean NO_2 and PM_{10} concentrations across the study area are presented in Table 13 and Table 14 respectively. A reduction in overall NO_2 and PM_{10} concentrations is predicted at most receptors, which reflects the expected reduction in vehicle emissions despite increased traffic flows. The reductions are, however, small and not sufficient to enable the NAQS objective for annual mean NO_2 concentrations to be met at all locations of relevant exposure.

Table 15: NO_2 annual mean predictions 2008, 2012 and 2015 ($\mu g/m^3$)

Receptor	Height	2008	2012	2015	Reduction
Haggs automatic monitor	1.5m	43.3	41.9	40.9	2.4
Kilsyth Road, Banknock	2m	43.3	42.4	41.7	1.6
Garngrew Road, Haggs	2m	35.6	34.8	34.2	1.4
Kerr Crescent, Haggs	2m	43.9	42.5	41.5	2.4
Receptor 1	1m	42.5	40.9	40.0	2.5
Receptor 2	1m	47.4	45.8	44.4	3
Receptor 3	1m	42.4	40.8	39.8	2.6
Receptor 4	1m	32.8	32.7	32.7	0.1
Health Centre	1m	32.4	32.1	32.0	0.4
Bankview Care Home	1m	43.3	28.8	28.7	14.6
School	1m	26.5	26.8	27.0	0.5

[11] DETR (1997) National Road Traffic Forecasts (Great Britain) 1997

Table 17: PM_{10} annual mean predictions 2010, 2012 and 2015 ($\mu g/m^3$)

Receptor	Height	2010	2012	2015	Reduction
Haggs automatic monitor	1.5m	17.0	16.8	16.7	0.3
Kilsyth Road, Banknock	2m	17.2	17.1	17.1	0.1
Garngrew Road, Haggs	2m	15.6	15.5	15.5	0.1
Kerr Crescent, Haggs	2m	17.1	17.0	16.9	0.2
Receptor 1	1m	17.0	16.8	16.7	0.3
Receptor 2	1m	17.6	17.4	17.2	0.4
Receptor 3	1m	16.8	16.6	16.5	0.3
Receptor 4	1m	16.7	16.7	16.7	0
Health Centre	1m	15.5	15.4	15.4	0.1
Bankview Care Home	1m	14.8	14.8	14.7	0.1
School	1m	14.5	14.5	14.5	0

9 SOURCE APPORTIONMENT

A source apportionment study has been undertaken to investigate the fraction of total NO_2 attributable to different sources at the Haggs AQMA. This was conducted using the "Groups" feature of ADMS-Roads; separate groups are created to include different sources, the model then predicts pollutant concentrations as a result of emissions from each group. The groups which were included in the model were:

- All sources
- Volume sources only (local non road traffic emissions)
- Roads only (no queuing traffic)
- Roads only (with queues)

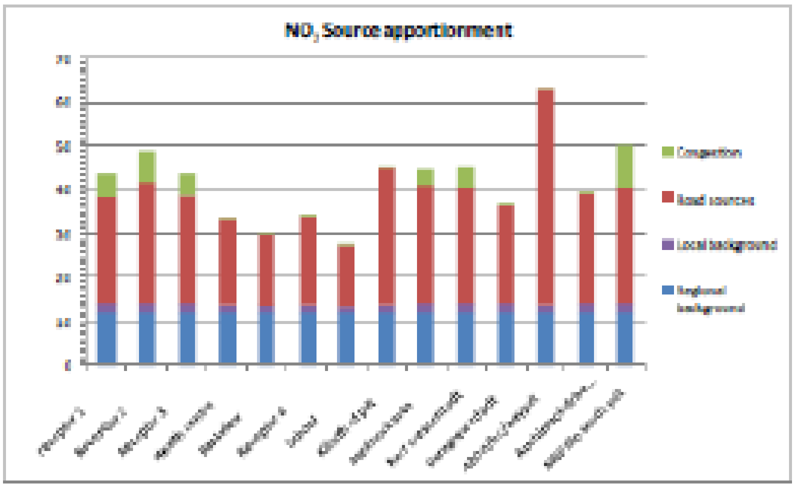
This allowed calculation of the fraction of the total predicted NO_2 annual mean attributable to the following sources:

- Regional background
- Volume sources (i.e. local non-road traffic sources)
- Road sources only (with queuing traffic excluded); and
- Queuing traffic only

To demonstrate the contribution of each source to annual mean NO_2 concentrations at the receptors specified in the study, NO_2 concentrations attributable to each source are presented in the bar chart below.

The chart indicates that a large contribution to the total NO_2 concentrations at the specified receptor locations are attributable to road traffic emissions.

The effect of queuing or congested traffic is greatest at the receptor locations closest to the roundabout and is negligible at locations away from the modelled queues. The source apportionment study demonstrates that reduction of road traffic emissions by up to approximately 20% is required to enable compliance with the NO_2 air quality objectives at receptor locations at Haggs.



10 CONCLUSIONS

Following the declaration of an AQMA for NO_2 at Haggs in March 2010 a Further Assessment of air quality has been conducted. Both NO_2 and PM_{10} concentrations have been assessed.

Analysis of the available automatic monitoring data has shown that annual mean concentrations measured at Haggs were in excess of the NAQS NO_2 objectives in 2008 and decreased in 2009 to less than the objective. Annual mean NO_2 concentrations measured using diffusion tubes have however remained fairly constant at most of the tube locations over the last three years with only small fluctuations observed. Annual mean concentrations in excess of the NAQS objective were measured at the Kerr Crescent roadside location. PM_{10} concentrations are not currently measured at Haggs.

To examine the spatial extent of any exceedance of NAQS objectives a dispersion modelling study of local emissions sources has been undertaken. The dispersion modelling study utilised emissions data compiled in an inventory of local emissions sources. Analysis of the emissions inventory has identified that the majority of NO_X and PM_{10} emissions at Haggs are attributable to road traffic emissions.

Due to current road works on the A80 at this location, which have led to altered traffic flows both on the A80 and on the A803 Kilsyth Road, a baseline model was run for both 2008 and 2009 traffic flows. This aimed to allow modelling results from each year to be compared with the measured NO_2 concentrations for each year and provide an indication of the effect of the current traffic restrictions and altered flows on air quality during 2009. The 2008 traffic flow data were considered most appropriate to factor forward for future year projections as they should be representative of the traffic flows that will occur following completion of the A80 construction work.

The results of the dispersion modelling study have indicated that the NO_2 annual mean objective of 40 µg/m^3 is predicted to be exceeded at ground level locations up to approximately 75m from the M80 roadside and up to 30m from the Kilsyth Road close to the roundabout. As several residential properties are present close to the roads modelled, this represents many locations of relevant human exposure. The dispersion modelling has therefore confirmed that the declaration of the existing NO_2 AQMA is valid and that the boundary that has been set should be maintained.

The predicted annual mean PM_{10} concentrations in 2010 indicate that the Scottish objective of 18 µg/m^3 may be exceeded at residential properties on Kilsyth Road near the roundabout. The predicted concentrations have not however been verified with monitoring data, and have been adjusted upwards using the correction factor derived for road NO_x which may not be representative of what is actually happening at this location. Based on this, monitoring of PM_{10} concentrations is recommended to establish if PM_{10} should be considered in any future air quality assessment work at this location.

Modelling of future scenarios accounting for traffic volume growth and reductions in vehicle emissions has indicated that a reduction in overall NO_2 and PM_{10} concentrations is predicted at most receptors, the reductions are, however, insufficient to enable the NAQS objective for annual mean NO_2 concentrations to be met. A reduction in road traffic emissions via other action plan measures is therefore required to enable future compliance with the NO_2 air quality objective at this location.

Falkirk Council

APPENDIX A

Diurnal profiles used for the dispersion modelling

Diurnal profile for Kilsyth Road

Eastbound				Westbound			
Hour	Mon – Fri	Sat	Sun	Hour	Mon – Fri	Sat	Sun
1	0.09	0.18	0.29	1	0.04	0.24	0.30
2	0.02	0.09	0.20	2	0.04	0.11	0.20
3	0.03	0.06	0.14	3	0.03	0.08	0.13
4	0.10	0.07	0.11	4	0.04	0.05	0.06
5	0.25	0.15	0.18	5	0.15	0.09	0.08
6	1.09	0.43	0.25	6	0.66	0.43	0.19
7	3.39	0.94	0.57	7	1.65	0.73	0.39
8	2.71	1.28	0.72	8	1.84	0.91	0.48
9	1.67	1.47	1.09	9	1.13	1.14	0.74
10	1.23	1.91	1.76	10	0.98	1.41	1.03
11	1.19	2.02	1.91	11	1.01	1.79	1.47
12	1.21	2.01	2.05	12	1.19	1.87	2.13
13	1.29	1.96	2.07	13	1.30	2.06	2.01
14	1.34	1.63	2.02	14	1.49	1.66	1.83
15	1.55	1.58	1.72	15	1.76	1.80	2.07
16	1.79	1.45	1.76	16	2.65	1.89	2.32
17	1.93	1.32	1.70	17	2.54	1.90	2.30
18	1.47	1.42	1.73	18	1.80	1.49	1.87
19	0.97	1.15	1.20	19	1.09	1.35	1.56
20	0.68	0.81	0.95	20	0.82	0.78	1.15
21	0.58	0.70	0.67	21	0.59	0.77	0.81
22	0.35	0.51	0.47	22	0.43	0.60	0.54
23	0.23	0.47	0.32	23	0.25	0.42	0.24
24	0.12	0.39	0.13	24	0.12	0.43	0.11

Diurnal profile for Glasgow Road

Eastbound				Westbound			
Hour	Mon – Fri	Sat	Sun	Hour	Mon – Fri	Sat	Sun
1	0.04	0.31	0.43	1	0.04	0.24	0.31
2	0.05	0.21	0.25	2	0.03	0.14	0.21
3	0.03	0.12	0.19	3	0.05	0.11	0.19
4	0.08	0.13	0.17	4	0.07	0.13	0.08
5	0.13	0.14	0.15	5	0.37	0.20	0.18
6	0.47	0.22	0.14	6	1.13	0.48	0.30
7	1.15	0.49	0.27	7	2.12	0.81	0.55
8	1.60	0.68	0.43	8	2.00	1.23	0.68
9	1.22	0.91	0.58	9	1.25	1.37	1.19
10	1.09	1.27	0.94	10	1.05	1.65	1.60
11	1.18	1.64	1.34	11	1.11	1.78	1.68
12	1.28	2.02	1.83	12	1.13	2.21	2.23
13	1.34	2.15	2.10	13	1.25	2.03	2.21
14	1.51	1.73	2.08	14	1.29	1.60	2.07
15	1.60	1.96	2.06	15	1.53	1.59	1.67
16	2.14	1.74	2.26	16	2.26	1.58	1.79
17	2.48	1.68	2.11	17	2.47	1.49	1.89
18	1.93	1.58	2.08	18	1.57	1.39	1.57
19	1.42	1.40	1.44	19	1.11	1.28	1.27
20	1.08	0.96	1.16	20	0.80	0.70	1.03
21	0.90	0.77	0.92	21	0.65	0.60	0.69
22	0.69	0.64	0.56	22	0.34	0.61	0.38
23	0.33	0.52	0.28	23	0.24	0.44	0.21
24	0.20	0.48	0.18	24	0.12	0.37	0.15

Glossary of Terms

AADT	Annual average daily total
AAHT	Annual average hourly total
AQMA	Air Quality Management Area
DEFRA	Department for Environment, Food and Rural Affairs
HGV	Heavy goods vehicle
LAQM	Local Air Quality Management
LGV	Light Goods Vehicle
NAEI	National Atmospheric Emissions Inventory
NAQS	National Air Quality Strategy
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
PM_{10}	Particulate matter with a diameter of 10μm or less
SEPA	Scottish Environment Protection Agency
SO_2	Sulphur dioxide

QA/QC of Diffusion Tube Monitoring

In 2020 the nitrogen dioxide (NO_2), benzene and 1, 3-butadiene ambient air diffusion tubes deployed by Falkirk Council were supplied and analysed by Gradko International Ltd. The analysis method used for the NO_2 tubes is 50% tri-ethanolamine (TEA) and 50% acetone. The benzene tube type is Carbograph 1TD (thermal desorption / gas chromatography) and for 1, 3-butadiene the tube type is Carbopack X (ATD) with analysis using TD-GCMS. The diffusion tube monitoring has been completed in adherence with the DEFRA 2020 Diffusion Tube Calendar . The March 2020 sampled diffusion tubes were not changed as normal in early April 2020 due to the Scottish Government 'Stay at Home' Scottish Coronavirus (COVID-19) advice[Ref 1].

Nitrogen Dioxide Diffusion Tubes

In 2020, the NO_2 diffusion tube analysis was completed by Gradko International Ltd. Gradko adheres to the DEFRA guidance for the preparation and analysis of the NO_2 diffusion tubes. All the results relating to the concentration of NO_2 present on the diffusion tube are within the scope of Gradko's United Kingdom Accreditation Service (UKAS) accreditation.

The full set of monthly NO_2 diffusion tube results are shown in Table B.1 in Appendix B.

1, 3-Butadiene Diffusion Tubes

Gradko International Ltd. Performed the quantitative analysis of 1, 3-butadiene on diffusion tubes by TD-GCMS. Analysis has been completed in accordance with in-house method GLM 13-6 under UKAS fixed scope accreditation.

The full set of monthly 1, 3-butadiene diffusion tube results are shown in Table B.2 in Appendix B.

Benzene Diffusion Tubes

Gradko International Ltd. Analysed Falkirk Council's benzene diffusion tubes by ATD-GC-MS. Analysis has been completed in accordance with Gradko's in-house method 'GLM 4' under UKAS fixed scope accreditation. The full set of monthly Benzene diffusion tube results are shown in Table B.3 in Appendix B.

Diffusion Tube Annualisation

All diffusion tube monitoring locations within Falkirk Council recorded data capture of 75% therefore it was not required to annualise any monitoring data. In addition, any sites with a data capture below 25% do not require annualisation.

Diffusion Tube Bias Adjustment Factors

Falkirk Council have applied a local bias adjustment factor of 0.94 to the 2020 monitoring data. A summary of bias adjustment factors used by Falkirk Council over the past five years is presented in C.1.

Table C.1 – Bias Adjustment Factor

Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2020	Local	-	0.94
2019	Local	-	0.94
2018	Local	-	0.88
2017	Local	-	0.93
2016	National	03/17 V2	1.03

NO_2 Diffusion Tube Bias Adjustment Factor (Local and National)

In accordance with LAQM TG16[Ref 2], a locally derived Bias Adjustment Factor has been calculated for the 2020 NO_2 diffusion tube results based on the following two co-location sites: NA42 Grangemouth Municipal Chambers and NA111 Falkirk West Bridge Street. The local results have been submitted to the LAQM Helpdesk to contribute to the national bias factor.

The results of the locally derived bias adjustment factor spreadsheets are shown in Figure 27 A) and B)

The national diffusion tube bias adjustment factor spreadsheet is displayed in Figure 28 for comparison purposes. The overall national bias factor in 2020 was **0.82.**

A comparison in summary form of the local and national bias factor summary is shown in table C.2.

Table C.2 – Comparison of Local vs National Bias Factor Summary

Local NO_2 Bias Adjustment Factor	**0.94**
National NO_2 Bias Adjustment Factor	**0.82**
Difference	**-0.12**

In accordance with LAQM TG16[Ref 2] Box 7.11 – data quality checks of the local bias adjustment spreadsheet have been assessed as 'good' for both co-location sites. Falkirk Council have a full years' worth of co-location data at the representative locations (A10 Grangemouth Municipal Chambers: Urban background / Industrial – typical off-street urban location that is likely to measure traffic and industrial emissions. A7 West Bridge Street: roadside – traffic related, elevated NO_2 levels at typical daytime peak traffic periods).

Using the above reasons, it has been decided to apply the locally derived bias adjustment factor for the 2020 NO_2 diffusion tube results.

NO_2 Fall-off with Distance from the Road

No diffusion tube NO_2 monitoring locations within Falkirk Council required distance correction during 2020.

Figure 28 – NO_2 Locally Derived Bias Adjustment Factor Spreadsheets

A) A10 Grangemouth Municipal Chambers

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	08/01/2020	04/02/2020	16.3	21.1	21.2	20	2.8	14	6.9	15	95	Good	Good
2	05/02/2020	03/03/2020	16.7	16.8	19.4	18	1.5	9	3.8	15	97	Good	Good
3	04/03/2020	31/03/2020	13.7	15.0	13.9	14	0.7	5	1.7	15	99	Good	Good
4	01/04/2020	28/04/2020								9	98		Good
5	29/04/2020	02/06/2020	10.0	9.2	9.8	10	0.4	4	1.0	8	77	Good	Good
6	03/06/2020	30/06/2020	11.0	10.8	10.7	11	0.2	2	0.5	7	92	Good	Good
7	01/07/2020	28/07/2020	9.6	9.4	9.8	10	0.2	2	0.5	5	100	Good	Good
8	29/07/2020	01/09/2020	12.8	12.6	12.7	13	0.1	1	0.2	7	99	Good	Good
9	02/09/2020	29/09/2020	16.3	16.7	15.1	16	0.8	5	2.0	11	100	Good	Good
10	30/09/2020	03/11/2020	17.2	15.7	18.3	17	1.3	8	3.3	12	97	Good	Good
11	04/11/2020	01/12/2020	23.0	23.8	23.7	23	0.4	2	1.0	16	99	Good	Good
12	02/12/2020	05/01/2021	25.0	26.2	25.8	26	0.6	2	1.4	21	99	Good	Good
13													
										Overall survey -->		Good precision	Good Overall DC

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

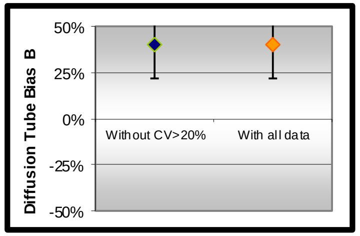
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Grangemouth Municipal Chambers

Precision 11 out of 11 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 11 periods of data
Bias factor A 0.75 (0.66 - 0.87)
Bias B 34% (15% - 53%)
Diffusion Tubes Mean: 16 μgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 12 μgm^{-3}
Data Capture for periods used: 96%
Adjusted Tubes Mean: 12 (11 - 14) μgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 11 periods of data
Bias factor A 0.75 (0.66 - 0.87)
Bias B 34% (15% - 53%)
Diffusion Tubes Mean: 16 μgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 12 μgm^{-3}
Data Capture for periods used: 96%
Adjusted Tubes Mean: 12 (11 - 14) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

B) A7 Falkirk West Bridge St

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	08/01/2020	04/02/2020	35.2	35.3	34.0	35	0.7	2	1.8	24	99	Good	Good
2	05/02/2020	03/03/2020	30.5	37.4	33.2	34	3.5	10	8.6	27	100	Good	Good
3	04/03/2020	31/03/2020	29.3	29.3	31.7	30	1.4	5	3.5	28	100	Good	Good
4	01/04/2020	28/04/2020								22	100		Good
5	29/04/2020	02/06/2020	22.5	23.3	22.6	23	0.4	2	1.1	16	88	Good	Good
6	03/06/2020	30/06/2020	29.8	29.7	30.2	30	0.3	1	0.6			Good	
7	01/07/2020	28/07/2020	19.9	22.1	22.1	21	1.3	6	3.2	17	81	Good	Good
8	29/07/2020	01/09/2020	35.8	36.6	33.2	35	1.7	5	4.3	29	100	Good	Good
9	02/09/2020	29/09/2020	34.5	33.9	34.1	34	0.3	1	0.7	28	100	Good	Good
10	30/09/2020	03/11/2020	30.9	36.1	32.4	33	2.7	8	6.7	30	100	Good	Good
11	04/11/2020	01/12/2020	36.3	36.4	39.6	37	1.8	5	4.6	28	100	Good	Good
12	02/12/2020	05/01/2021	44.2	43.4	45.9	45	1.3	3	3.2	35	100	Good	Good
13													
											Overall survey -->	Good precision	Good Overall DC

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

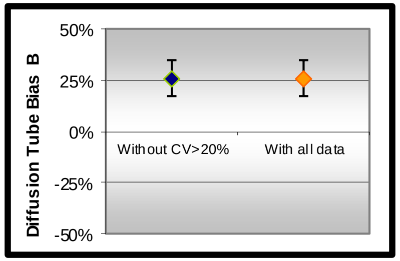
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Falkirk West Bridge Street

Precision 11 out of 11 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 10 periods of data
Bias factor A 0.8 (0.75 - 0.86)
Bias B 25% (16% - 34%)
Diffusion Tubes Mean: 33 μgm^{-3}
Mean CV (**Precision**): 5
Automatic Mean: 26 μgm^{-3}
Data Capture for periods used: 97%
Adjusted Tubes Mean: 26 (25 - 28) μgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 10 periods of data
Bias factor A 0.8 (0.75 - 0.86)
Bias B 25% (16% - 34%)
Diffusion Tubes Mean: 33 μgm^{-3}
Mean CV (**Precision**): 5
Automatic Mean: 26 μgm^{-3}
Data Capture for periods used: 97%
Adjusted Tubes Mean: 26 (25 - 28) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

C) Calculation of Two Colocation Results: A10 Grangemouth Municipal Chambers and A7 Falkirk West Bridge St

	FWBS (%)	GMC (%)	Average (%)	2 Locations Factor	Inverse to give Bias Adjustment factor
Bias Factor B	**25**	**34**	**29.5**	**1.065**	**0.94**

QA/QC of Automatic Monitoring

Table C. 3 – Details of the QA / QC at the Automatic Monitoring Stations in 2020

QA / QC in 2020		
Site	**Analyser**	**Network**
A3. Bo’ness	SO_2	SAQN
A4. Falkirk Haggs	NO_x	SAQN
	$PM_{10+2.5}$ (Fidas)	
A5. Falkirk Hope St	NO_x	SAQN
	SO_2	
	$PM_{10+2.5}$ (Fidas)	
A7. Falkirk West Bridge St	NO_x	SAQN
	$PM_{10+2.5}$ (Fidas)	
A8. Grangemouth AURN (Inchyra)	NO_x	AURN
	PM_{10} (BAM)	
	$PM_{2.5}$ (BAM)	
	SO_2	

A9. Grangemouth Moray	NO_x	AURN
	SO_2	SAQN
A10. Grangemouth Municipal Chambers	NO_x	SAQN
	$PM_{10+2.5}$ (Fidas)	
	SO_2	
A11. Grangemouth Zetland Park	SO_2	SAQN
	$PM_{10+2.5}$ (Fidas)	
A14. Banknock 3	$PM_{10+2.5}$ (Osiris)	Local
A15 Main St Bainsford	NO_x	SAQN
	$PM_{10+2.5}$ (Fidas)	SAQN

Local sites:

- Analyser data is downloaded, and a flow check is completed on a fortnightly basis.

- A filter change is completed on an approximate four weekly basis, although this is dependent on the weather and filter loading. The filters are retained for analysis.

- As with the other sites all LSO site visits are completed by Falkirk Council staffs that are audited to AURN standards.

- The Turnkey Osiris at Banknock 3 site is serviced on an annual basis and covered by a service agreement for any breakdowns, both are completed off-site.

AURN and Scottish AQ network sites:

- All NO_x and SO_2 analysers receive fortnightly zero and span checks and filter changes.

- TEOM heads are cleaned and the filter changed on a four weekly basis or more frequently if the filter loading increases above 90%.

- BAM PM_{10} and $PM_{2.5}$ nozzles are cleaned and tapes are changed every eight weeks.

- All LSO site visits are carried out by Falkirk Council staffs that are audited to AURN standards.

- Analysers are covered by an emergency callout contract and receive a service every six months.

- QA / QC are conducted to AURN / 'national' standards.

- Falkirk Council also checks the data on its internal systems and is in regular communication with Ricardo to ensure the best data quality is collected / presented. Unscaled data is supplied by Falkirk Council to Ricardo for the Scottish AQ Network sites on a six-monthly basis to improve data capture

PM_{10} and $PM_{2.5}$ Monitoring Adjustment

All PM_{10} R&P TEOM data from 2008 onwards has been adjusted using the King's College London Volatile Correction Method (VCM). This was carried out by Ricardo for the sites affiliated to the Scottish Air Quality Network in 2015 as part of the Scottish Government's contract.

The PM_{10} monitor at the A8 Grangemouth AURN site has been a FDMS since April 2009 and so no correction factor has been applied to the data after this date. The VCM has been applied to the 2008 and 2009 AURN TEOM data by King's College under contract to DEFRA. A PM_{10} Met One 1020 BAM analyser has replaced the R&P TEOM FDMS at the A8 Grangemouth AURN site on 06/06/2018 and no correction factor has been applied to this PM_{10} data since the installation of this analyser.

Estimating $PM_{2.5}$ from PM_{10} Measurements

LAQM TG (16) [Ref 2] describes two methodologies for estimating $PM_{2.5}$ from PM_{10} measurements. Method one is to apply a locally derived correction ratio calculated from local sites measuring both PM_{10} and $PM_{2.5}$. The second is to apply a nationally derived correction ratio of **0.7**. The national correction ratio should only be used where no appropriate local sites measuring both PM_{10} and $PM_{2.5}$ are available. The locally derived correction ratio should only be used at sites of the same classification.

In 2020, Falkirk Council had five local sites monitoring both PM_{10} and $PM_{2.5}$ these were the A4 Haggs, A7 Falkirk West Bridge St, A8 Grangemouth AURN, A10 Grangemouth Municipal Chambers and A14 Banknock 3 sites.

Using the guidance stated in LAQM TG (16)[Ref 2] the $PM_{2.5}$ / PM_{10} ratios were calculated for the A5 Falkirk Hope Street and A15 Main Street Bainsford sites only as although these sites now have a combined $PM_{10+2.5}$ analyser (Palas Fidas 200) installed in early 2021 there is insufficient data available for 2020 as these sites operated with R&P TEOM analysers. The ratio derived from the A4 Haggs data was applied to sites classified as 'roadside (non-urban)', the ratio derived from the A8 Grangemouth AURN data was applied to sites classified as 'urban background / industrial' and the ratio derived from the A7 Falkirk West Bridge St data was applied to sites classified as 'roadside (urban)'.

The local correction ratios were used to estimate $PM_{2.5}$ from PM_{10} measurements at the following sites: A5 Falkirk Hope Street and A15 Main St Bainsford. Results are shown in Table A12 in Appendix A. Table C. 1 displays how the local ratios have been derived.

Table C.2 – Locally Derived $PM_{2.5}$ / PM_{10} Correction Ratio

Site	Site Type	Annual Average PM_{10} ($\mu g/m^3$), 2020	Annual Average $PM_{2.5}$ ($\mu g/m^3$), 2020	Ratio
A4 Haggs	Roadside (Non-urban)	**10**	**5**	**0.5**
A7 Falkirk West Bridge St	Roadside (Urban)	**7**	**4**	**0.57**
A8 Grangemouth AURN	Urban Background / Industrial	**9**	**6**	**0.67**

Automatic Monitoring Annualisation

From assessing all automatic and non-automatic monitoring results, the sites and associated pollutants that required annualisation are as follows:

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	NO_2 Annual Mean Concentration (µg/m^3) (3)				
					2016	2017	2018	2019	2020
A15	Main St, Bainsford	Automatic	65	65	24	23	22	25	20.8

Annual Mean PM_{10} Monitoring Results (µg/m^3)								
Site ID	**Site Type**	**Valid Data Capture for Monitoring Period (%) (1)**	**Valid Data Capture 2020 (%) (2)**	**2016**	**2017**	**2018**	**2019**	**2020**
A4	Falkirk Haggs	56	56	14	12	14	14	10
A7	Falkirk West Bridge St	38	38	15	10	6	11	8.4
A10	Grangemouth Municipal Chambers	63	63	13	12	12	14	9.6
A14	Banknock 3	63	63	n/n	7	6.9	7.9	7.8
Annual Mean $PM_{2.5}$ Monitoring Results (µg/m^3)								
Site ID	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
A4	Falkirk Haggs	29	29					5
A7	Falkirk West Bridge St	38	38	6	6	6	6	4.4
A10	Grangemouth Municipal Chambers	63	63					4.4
A14	Banknock 3	63	63	n/a	3	4	4.6	3.6

NO_2 Fall-off with Distance from the Road

No automatic NO_2 monitoring locations within Falkirk Council required distance correction during 2020.

Table C.2 – Annualisation Summary (concentrations presented in µg/m³)

NO_2 Annual Mean Concentration (µg/m³)						
Site ID	**Annualisation Factor: A4 Haggs**	**Annualisation Factor: A7 Falkirk West Bridge St**	**Average Annualisation Factor**	**Raw Data Annual Mean**	**Annualised Annual Mean**	**Comments**
A15 Main Street Bainsford	1.3	1.3	1.3	16	20.8	Period Mean: Jan – Sep 2020
Annual Mean PM_{10} Monitoring Results (µg/m³)						
Site ID	**Annualisation Factor: A5 Falkirk Hope St**	**Annualisation Factor: A8 Grangemouth AURN**	**Average Annualisation Factor**	**Raw Data Annual Mean**	**Annualised Annual Mean**	**Comments**
A4 Haggs	1	1	1	10	10	Period Mean: Jan-Apr, Sep-Dec
A7 Falkirk West Bridge Street	1.2	1.1	1.2	7	8.4	Period Mean: Jan, Sep-Dec
A10 Grangemouth Municipal Chambers	1.1	1.2	1.2	8	9.6	Period Mean: May - Dec
A14 Banknock 3	0.9	1	1	7.8	7.8	Period Mean: Jan - Aug
Annual Mean $PM_{2.5}$ Monitoring Results (µg/m³)						
Site ID	**Annualisation Factor: A8 Grangemouth AURN**		**Average Annualisation Factor**	**Raw Data Annual Mean**	**Annualised Annual Mean**	**Comments**
A4 Haggs	**1.2**		**1.2**	**5**	**6**	Grangemouth AURN was the only site in 2020 to achieve above 85% data capture. Period Mean: Aug - Dec
A7 Falkirk West Bridge Street	1.1		1.1	4	4.4	““Period Mean: Jan, Sep-Dec

NO2 Annual Mean Concentration (µg/m³)						
Site ID	**Annualisation Factor: A4 Haggs**	**Annualisation Factor: A7 Falkirk West Bridge St**	**Average Annualisation Factor**	**Raw Data Annual Mean**	**Annualised Annual Mean**	**Comments**
A10 Grangemouth Municipal Chambers	1.1		1.1	4	4.4	""Period Mean: May - Dec
A14 Banknock 3	0.9		0.9	4	3.6	""Period Mean: Jan - Aug

Table C.3 – Local Bias Adjustment Calculations

	Local Bias Adjustment Input 1 – Falkirk West Bridge Street	**Local Bias Adjustment Input 2 – Grangemouth Municipal Chambers**
Periods used to calculate bias	11	11
Bias Factor A	0.8 (0.75 – 0.86)	0.75 (0.66 – 0.87)
Bias Factor B	25% (16% - 34%)	34% (15% - 53%)
Diffusion Tube Mean (µg/m³)	33	16
Mean CV (Precision)	5	5
Automatic Mean (µg/m³)	26	12
Data Capture	97%	96%
Adjusted Tube Mean (µg/m³)	26 (25 – 28)	12 (11 – 14)

Notes:

A combined local bias adjustment factor of **0.94** has been used to bias adjust the 2020 diffusion tube results.

Glossary of Terms

Abbreviation	Description
AADT	Annual Average Daily Traffic – total volume of vehicle traffic on a highway or road for a year divided by 365 days.
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	Annual Progress Report in relation to air quality
AURN	Automatic Urban and Rural Network (UK air quality monitoring network)
BAM	Beta Attenuation Monitor
CAFS	Cleaner Air for Scotland
DEFRA	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges – Air quality screening tool produced by Highways England
ECSVEP	East Central Scotland Vehicle Emissions Partnership
EfW	Energy from Waste
EIA	Environmental Impact Assessment
EPUK	Environmental Protection UK
EU	European Union
FEL	Forth Environment Link
FDMS	Filter Dynamics Measurement System
FPS	Flood Prevention Scheme
GCMS	Gas Chromatography–Mass Spectrometry - analysis method
HDV	Heavy Duty Vehicle

IAQM	Institute of Air Quality Management
LAQM	Local Air Quality Management
LDV	Light Duty Vehicle
MCPD	Medium Combustion Plant Directive
NAQS	National Air Quality Strategy
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
PDU	Public Display Unit
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
PV	Photovoltaic (in relation to solar energy)
QA/QC	Quality Assurance and Quality Control
SEA	Supporting Environmental Appraisal
SEPA	Scottish Environment Protection Agency
SO_2	Sulphur Dioxide
TD	Thermal Desorption – Analysis Method
TEOM	Tapered Element Oscillating Microbalance
TGT	Tail Gas Treatment

References

1. https://www.gov.scot/coronavirus-covid-19/ The Scottish Government ‘Coronavirus (Covid-19) in Scotland’ Information, 11 May 2021.

2. https://laqm.defra.gov.uk/technical-guidance/ DEFRA and Devolved Administrations, April 2021.

3. Civil Aviation Authority, UK Airport Statistics, CAA, Accessed June 2021.

4. Institute of Air Quality Management (IAQM) 'Guidance on the Assessment of Dust from Demolition and Construction'. Version 1.1, February 2014.

5. IAQM Land-Use Planning & Development Control: Planning for Air Quality January 2017