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

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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 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/m^3)				
				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/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%).

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/m^3)(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/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) 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 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.

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)

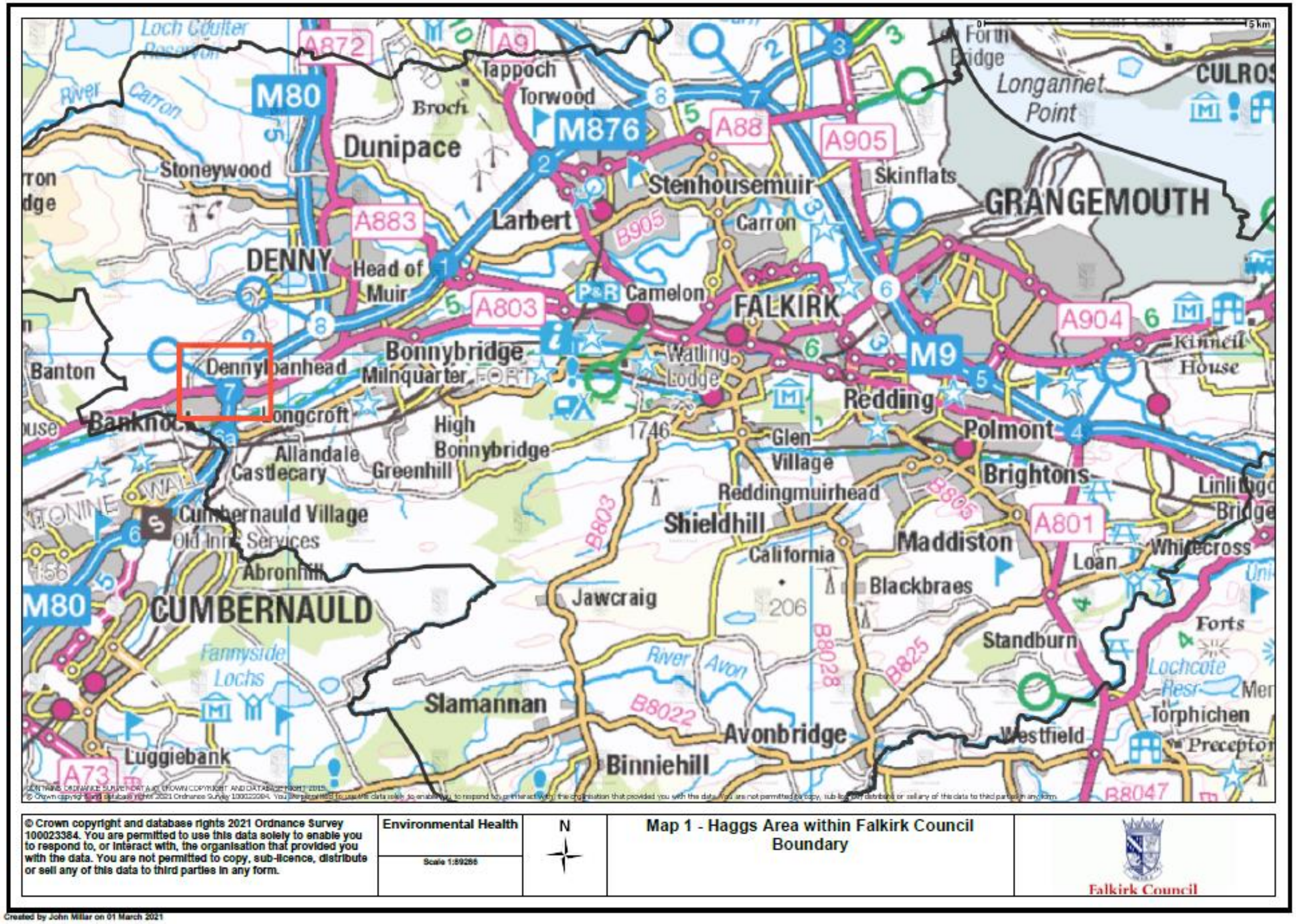
7. M80 Stepps to Haggs Project (Transport Scotland, https://www.transport.gov.scot/projects/m80-stepps-to-haggs/m80-stepps-to-haggs/)

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)

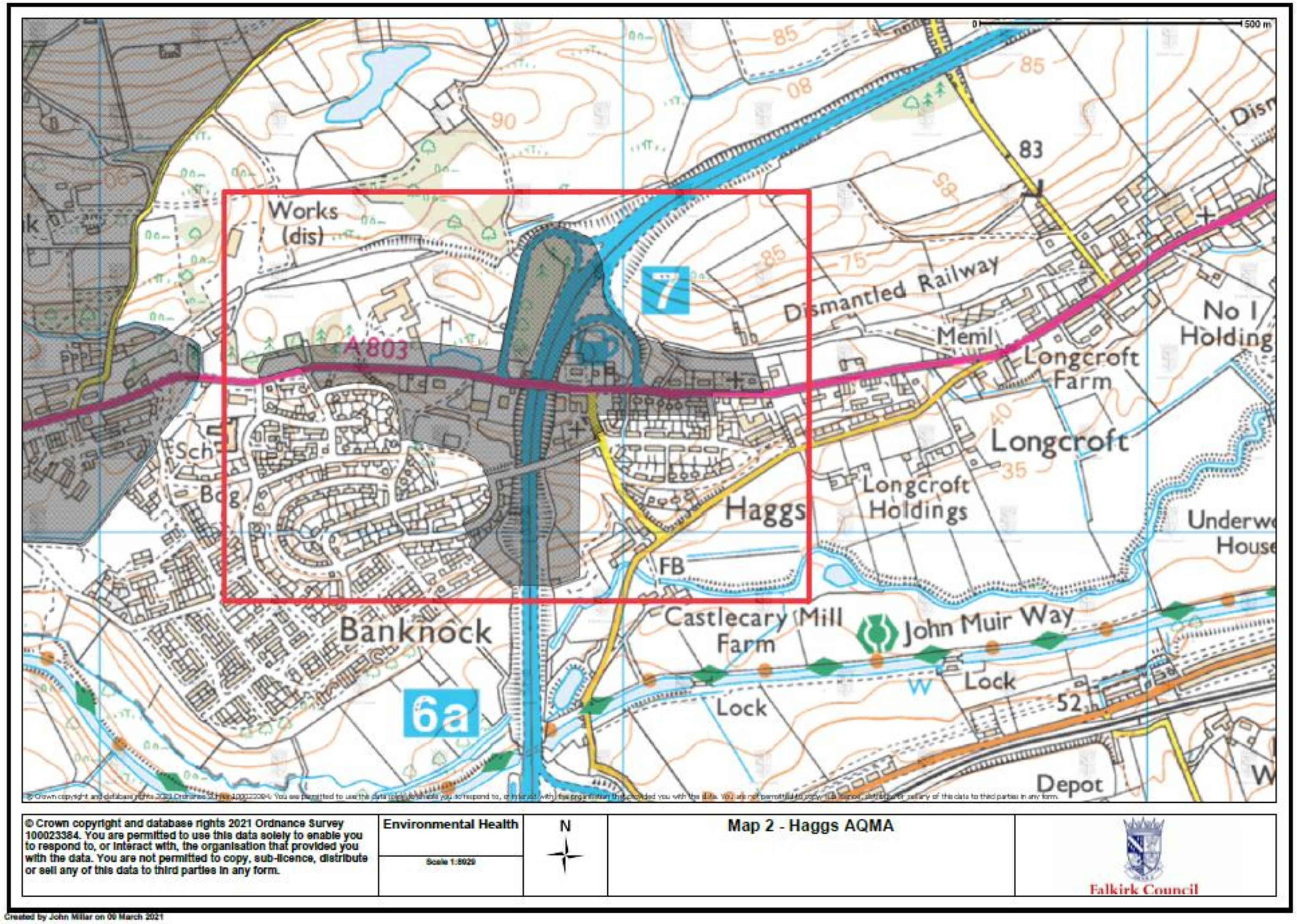
8. Figures - Map 1 - Haggs Area within Falkirk Council Boundary



Created by John Millar on 01 March 2021

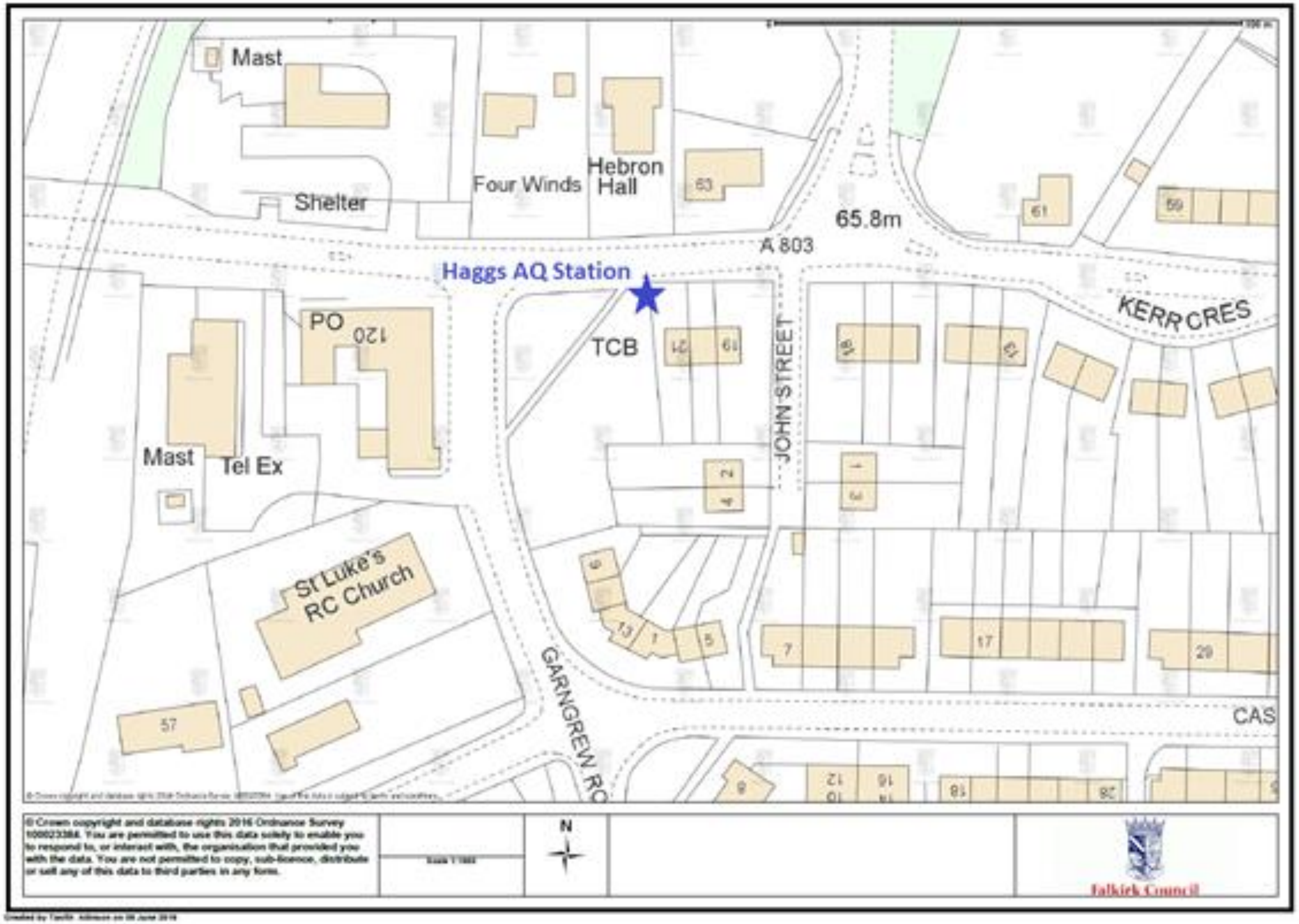
Falkirk Council

Map 2 - Haggs AQMA

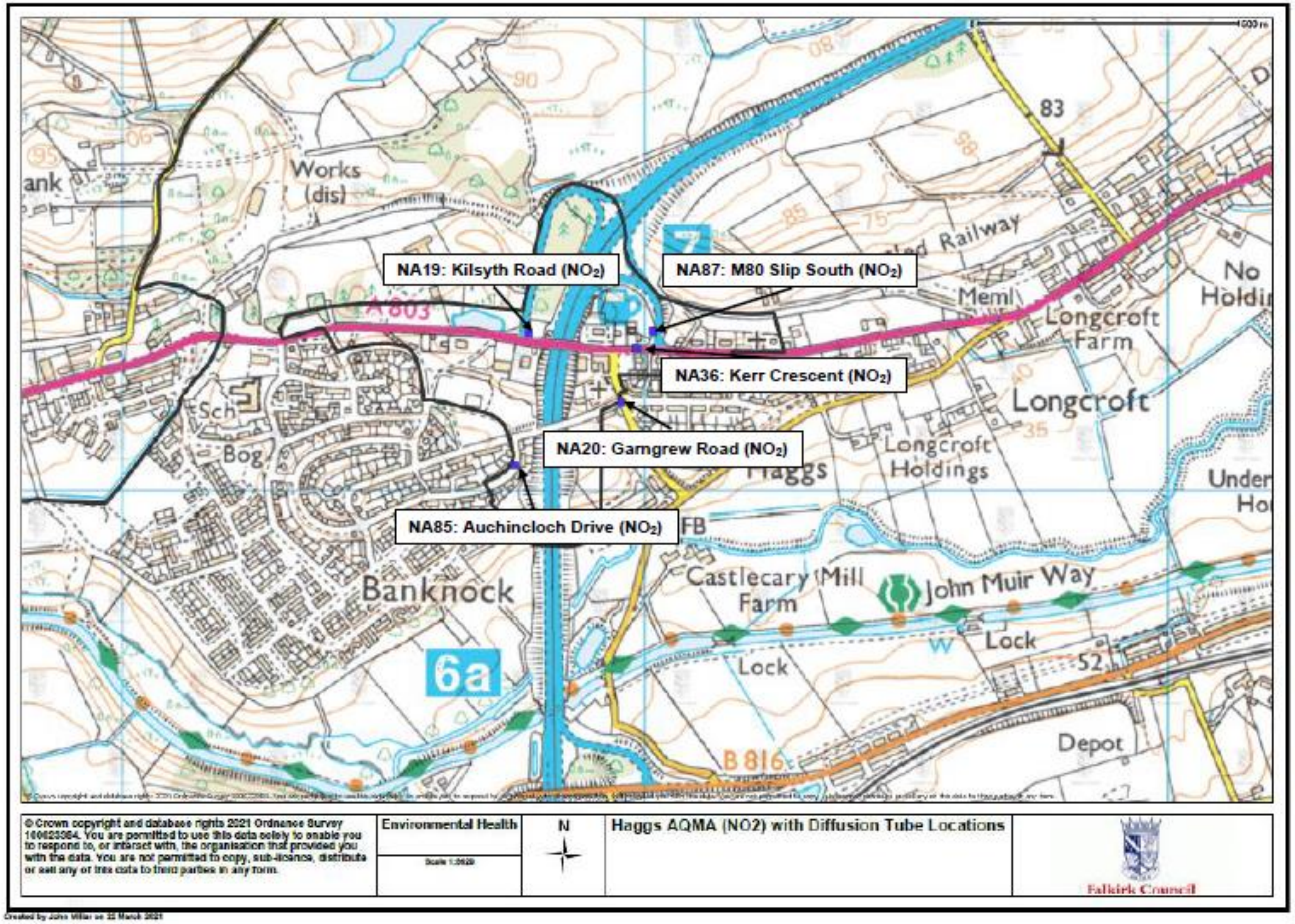


Created by John Millar on 09 March 2021

Map 3 – Haggs Automatic Monitoring Station Location

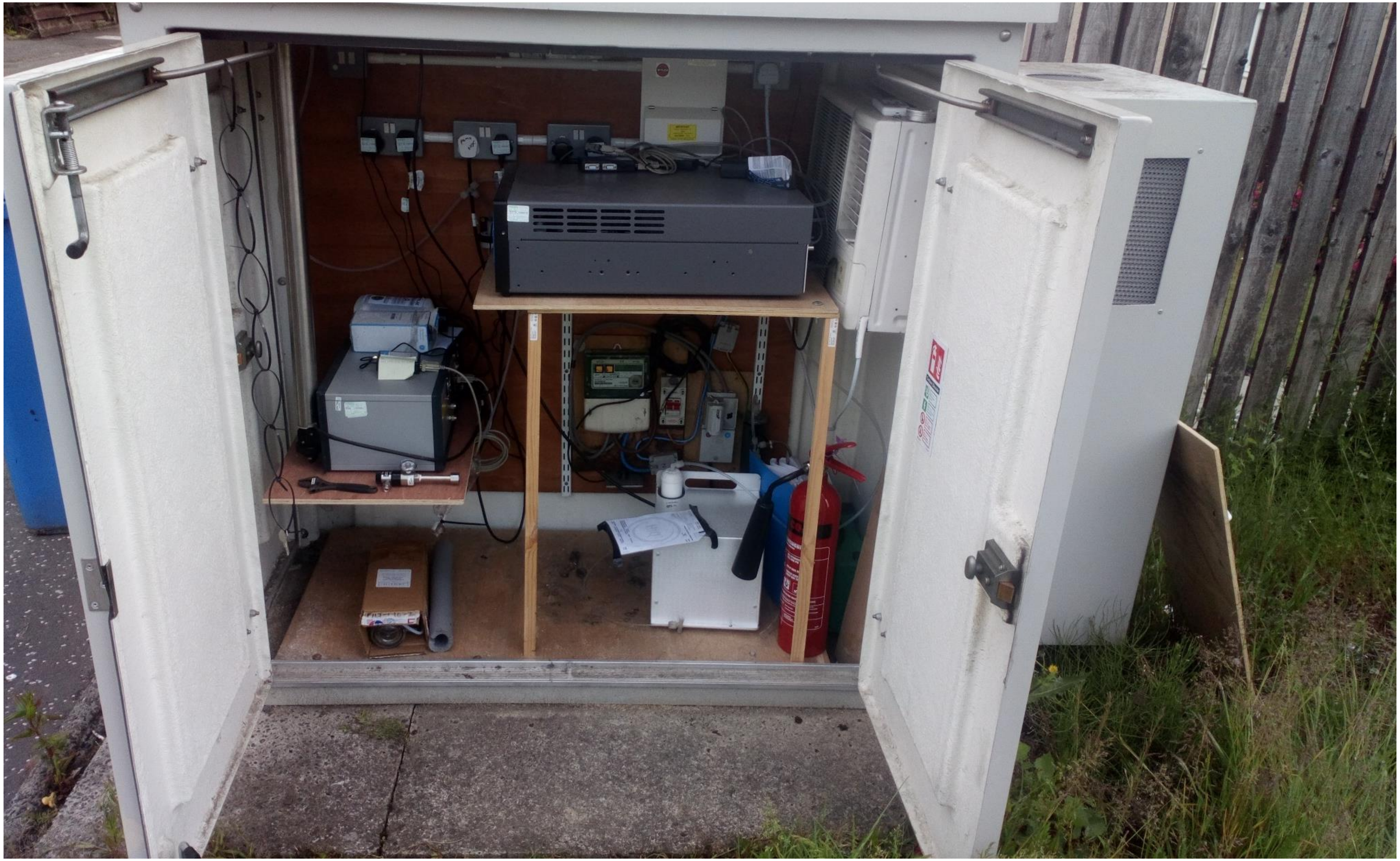


Map 4 – Haggs Non-Automatic Diffusion Tube Monitoring Locations



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

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

BMT Cordah

A part of BMT in Energy and Environment

Detailed Assessment of NO2 concentrations in Banknock

Client: Falkirk Council
Report no.: E_FAL_026 / Report 5
Date: 15 July 2008
Confidential

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Report Title	Detailed Assessment of NO2 concentrations in Banknock
Client	Falkirk Council
BMT Cordah Report No:	E_FAL_026 / Report 5
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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[5], 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.

[5] 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_2 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
36	Kerr Crescent, Haggs	PDT	NO_2	Roadside
10x	Kerr Cresent, Haggs	Chemiluminesence 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[8] 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.

[8] 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/m³)	Adjusted annual mean concentrations (µg/m³)			
				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	35	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.

Table 5 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	1.0262
Kilsyth Road, Banknock	50	45	1.1117
Garngrew Road, Haggs	42	35	1.1814
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
Gamgrew Road, Haggs	Monitoring site	278978 679155	2
Kerr Crescent, Haggs	Monitoring site	278989 679273	2
Receptor 1	Residential property	279063 679290	0
Receptor 2	Residential property	278993 679298	0
Receptor 3	Residential property	279027 679260	0
Receptor 4	Residential property	278594 679303	0
Health Centre	Location of public exposure	278650 679295	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, NS68, NS86 and NS88 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	86.9	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	1.8	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 o/way 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	3.6	89.3	90.8	1.6

Receptor	Annual mean (µg/m³)			99.79th 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 ºC), 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 Walkmillglen and Bush Estate, Penicuik. Measured ozone concentrations at both sites were very similar with Walkmillglen measuring 55µg/m³ and Bush Estate measuring 58µg/m³. It was decided to use 55µg/m³ 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/m³)	NO_2 (µg/m³)	Ozone (µg/m³)
2006	14.4	11.7	55
2010	11.1	8.7	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	1234	110	93	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	506	50	38	45	7
Kilsyth Road 87	286	96	22	80	7
Slip road north bound	87	45	7	40	7
Slip road south bound	111	45	8	40	7

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	0.06	0.08
6	0.21	0.13	0.17
7	0.86	0.38	0.28
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	1.15	1.88	1.76
13	1.18	2.10	2.06
14	1.27	2.14	2.36
15	1.39	1.96	2.20
16	1.65	1.84	2.09
17	2.27	1.97	2.19
18	2.59	1.88	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	0.43	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[8].

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[9] 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_x 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 ($g/m^3/s$)
Volume source 1	277500 678500	4.79	1.5177×10^{-8}
Volume source 2	278500 678500	4.35	1.5728×10^{-7}
Volume source 3	279500 678500	0.40	3.1353×10^{-8}
Volume source 4	277500 679500	49.59	1.3795×10^{-8}
Volume source 5	278500 679500	55.99	1.7753×10^{-7}
Volume source 6	279500 679500	1.04	1.6014×10^{-7}
Volume source 7	277500 680500	9.89	1.2828×10^{-8}

[8] Air Quality Expert Group, 2007. Trends in Primary Nitrogen Dioxide in the UK.
[9] 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	278500 680500	50.50	3.292x10[illegible]
Volume source 9	279500 680500	12.27	3.8906x10[illegible]

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	89	40.2	-54.8
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 54.8%. 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 15.7%, the point at Kerr Crescent just exceeds the objective with a predicted concentration of 40.5µg/m^3.

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 15: Baseline scenario modelling results

Receptor name	Predicted annual mean concentrations (µg/m^3)	Adjusted annual mean concentrations for under-prediction of 9% (µg/m^3)	Predicted 99.79th percentile of 1 hour mean concentrations (µg/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	27.8	30.3	78.8
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	83.9
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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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_026 (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_2.

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 278975 679267. 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. ($\mu g/m^3$)	Data capture (%)	Conc. ($\mu g/m^3$)	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 $\mu g/m^3$	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, Banknock.	Roadside	N	278924	679513
NA19	Kilsyth Rd, Banknock.	Roadside	Y	278779	679301
NA20	Garngrew Rd, Haggs.	Urban background	N	278979	679155
NA38	Kerr Crescent, Haggs.	Urban background	Y	278991	679271
NA85	Auchinloch Drive, Banknock	Roadside	Y	278752	679049
NA87	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 ($\mu g/m^3$)		
			2007	2008	2009
NA18	A80 Northbound c/way, Banknock.	33%	99	101	129*
NA19	Kilsyth Rd, Banknock.	83%	37	35	37
NA20	Garngrew Rd, Haggs.	92%	27	25	27
NA38	Kerr Crescent, Haggs.	100%	48	42	49
NA85	Auchinloch Drive, Banknock	100%	-	24	26
NA87	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 $1km^2$ 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 $1km^2$ 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	5.56
Solvent use	0	0.30
Waste Treatment	0	0.37
Total	**144.53**	**7.12**

Chart 1: Haggs AQMA: NO_x emission sources

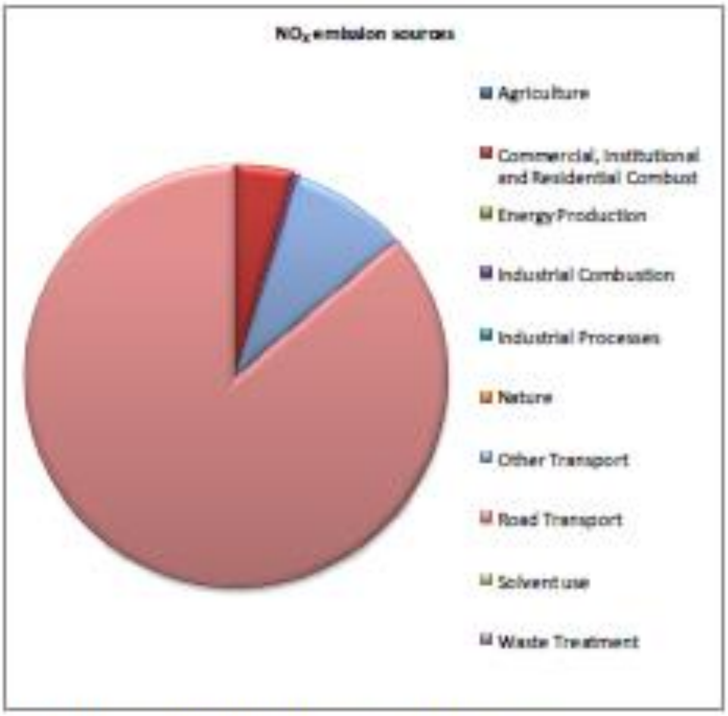
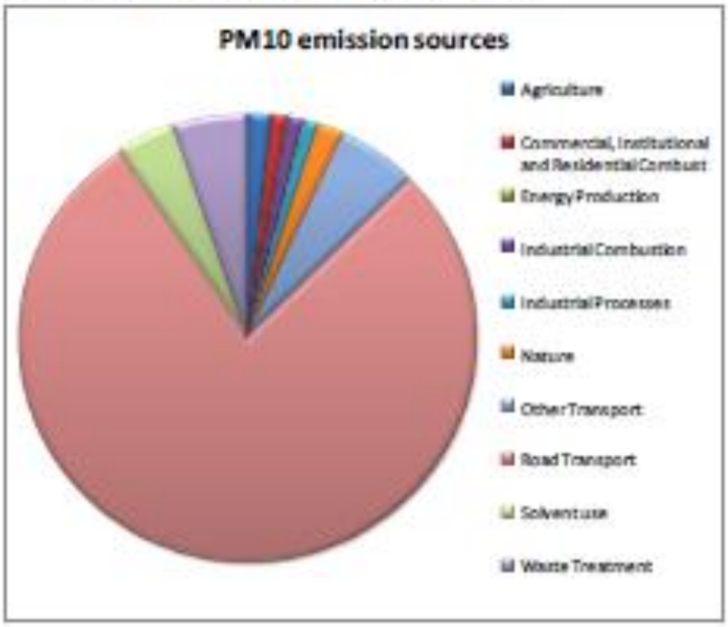


Chart 2: Haggs AQMA: PM_{10} emission sources



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 modelled 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	278779	679301
Garngrew Road, Haggs	Monitoring site	278979	679155
Kerr Crescent, Haggs	Monitoring site & residential	278985	679273
Receptor 1	Residential	279063	679290
Receptor 2	Residential	278993	679298
Receptor 3	Residential	279027	679260
Receptor 4	Residential	278594	679303
Health Centre	Location of public exposure	278650	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.031-04-02-01; 6th 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 35km 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. G.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	489	110	236	100	32.6%
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	3.5%
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	165	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	103	65	7	65	6.4%
Slip SBD	8	63	65	48	65	42.8%

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	206	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	32.6%
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	176	50	13	50	6.9%
Kilsyth rd (West of A80) WB	3.5	168	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	42.8%

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 26% 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 (µg/m³)	NO_2 (µg/m³)	Ozone (µg/m³)	PM_{10} (µg/m³)	SO_2 (µg/m³)
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

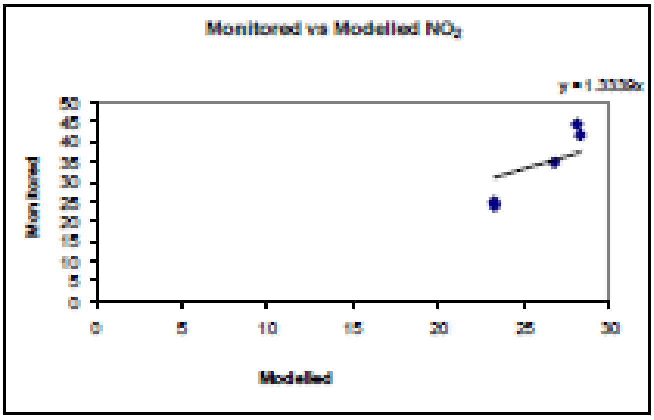
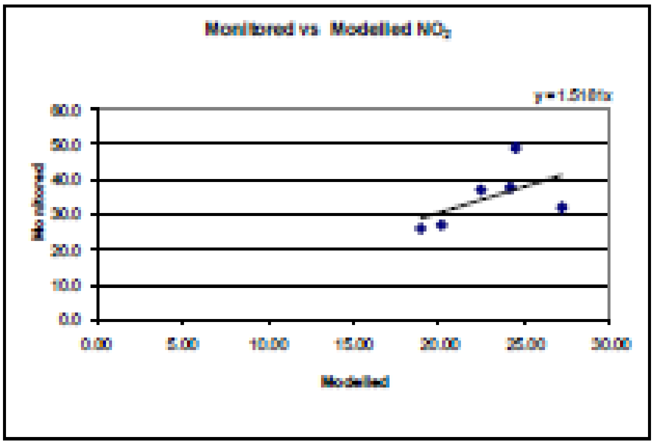


Table 12: 2009 Comparison of modelled and monitored NO_2 concentrations

Receptor Name	Monitor type	Site type	Site description	Background NO_2 (µg/m^3)	Monitored total NO_2 (µg/m^3)	Modelled total NO_2 (µg/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.

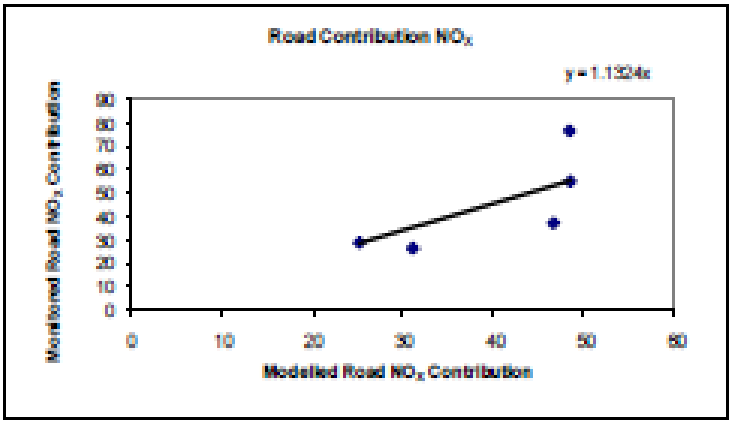
To account for the model under-prediction of NO_2 concentrations, it is necessary to apply model adjustment to the road source contribution of NO_2 concentrations i.e. excluding background which includes the Waulkmillglen rural background and the local background volume source contributions. Adjustment 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

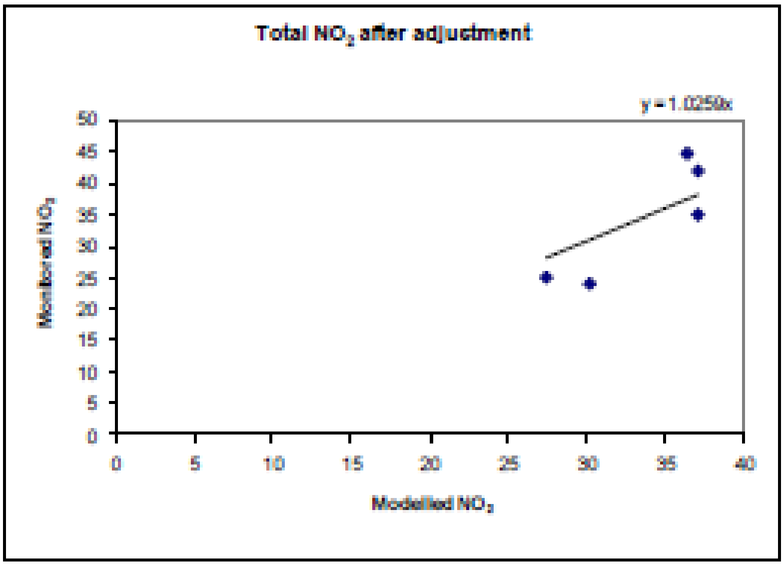


A NO_X correction factor of 1.1324 was derived and has been applied to all modelled road contribution NO_X concentrations.

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 25% 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 monitored 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_x concentrations 2008

Site	Monitored Total NO_2	Monitored Total NO_x	Waulkmilglen average background NO_2 (regional background)	Waulkmilglen average background NO_x (regional background)	Volume source background NO_2 (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	58.5	12.1	21.7	14.2	22.3	32.60	36.8	68.94	46.64
Kilsyth Rd PDT	35.0	76.44	12.1	21.7	14.1	22.2	22.90	54.74	70.68	48.48
Kerr Crescent PDT	42.0	98.33	12.1	21.7	14.2	22.3	29.90	76.63	70.71	48.41
Garngrew Rd PDT	25.0	49.97	12.1	21.7	14.2	22.5	12.90	28.27	47.74	25.24
Auchinloch Drive PDT	24.0	47.58	12.1	21.7	14.2	22.7	11.90	25.88	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_2/ modelled road contribution NOx	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 NOx/NO2 relationship)	Monitored total NO_2	% difference [(modelled - monitored)/monitored] x 100
Haggs automatic monitor	0.8	1.1324	52.8	75.1	36.43	44.7	-19%
Kilsyth Rd PDT	1.1	1.1324	54.9	77.1	37.1	35.0	6%
Kerr 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	27.48	25.0	10%
Auchinloch drive PDT	0.8	1.1324	35.3	58.0	30.22	24.0	26%

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 99.79th 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 98th 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	43.3	17.0
A80 North Bound C/way, Banknock	2m	61.6	19.9
Kilsyth Road, Banknock	2m	43.3	17.2
Garngrew Road, Haggs	2m	35.6	15.6
Kerr Crescent, Haggs	2m	43.9	17.1
Receptor 1	1m	42.5	17.0
Receptor 2	1m	47.4	17.6
Receptor 3	1m	42.4	16.8
Receptor 4	1m	32.8	15.7
Health Centre	1m	32.4	15.5
Bankview Care Home	1m	43.3	14.8
School	1m	26.5	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 $\mu g/m^3$ 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 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 $\mu g/m^3$ 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 16: 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	34.6	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	45.6	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	28.6	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 (µg/m³)

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	15.7	15.7	15.7	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)

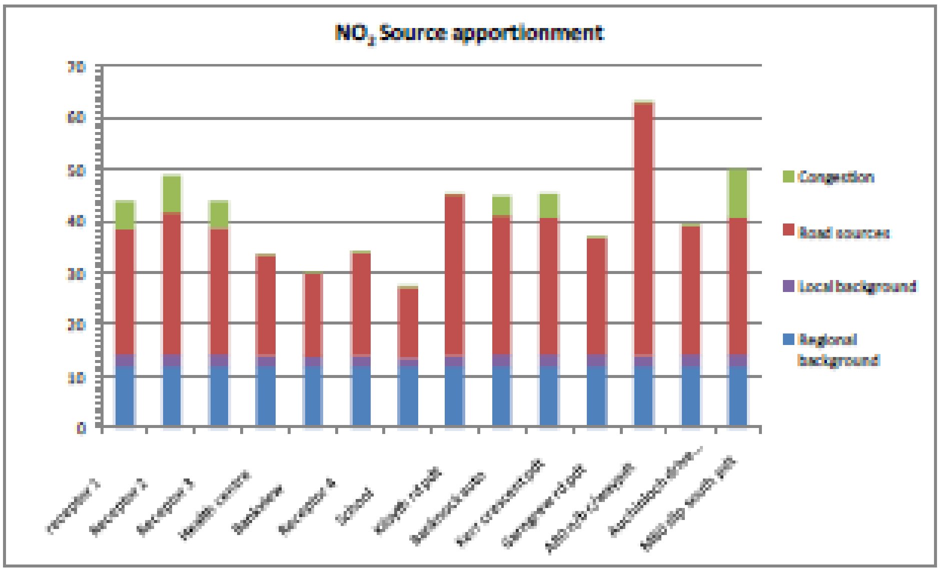
This allowed calculation of the fraction of the total predicted NO_2 annual mean attributable to the following sources:

- 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 $\mu g/m^3$ 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.

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	0.02	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	2.39	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	1.57	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	1.78	1.47
12	1.21	2.01	2.05	12	1.19	1.87	2.13
13	1.20	1.95	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	2.84	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	0.55	0.70	0.67	21	0.69	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	0.06	0.12	0.17	4	0.07	0.13	0.08
5	0.13	0.14	0.15	5	0.27	0.20	0.16
6	0.47	0.22	0.14	6	1.13	0.46	0.30
7	1.15	0.49	0.27	7	2.12	0.81	0.55
8	1.60	0.85	0.43	8	2.00	1.25	0.66
9	1.22	0.91	0.59	9	1.25	1.37	1.19
10	1.09	1.27	0.94	10	1.05	1.65	1.60
11	1.18	1.54	1.34	11	1.11	1.78	1.68
12	1.26	2.02	1.82	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	1.80	1.95	2.05	15	1.53	1.59	1.67
16	2.14	1.74	2.32	16	2.36	1.56	1.73
17	2.48	1.88	2.11	17	2.47	1.49	1.89
18	1.93	1.58	2.09	18	1.57	1.39	1.57
19	1.42	1.40	1.44	19	1.11	1.28	1.27
20	1.08	0.95	1.16	20	0.80	0.70	1.03
21	0.90	0.77	0.92	21	0.66	0.60	0.69
22	0.59	0.64	0.55	22	0.34	0.61	0.36
23	0.33	0.52	0.28	23	0.24	0.44	0.21
24	0.20	0.46	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