2009 Air Quality Updating and Screening Assessment for *Glasgow City Council*

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

April, 2009

Local Authority Officer	Dom Callaghan

Department	Public Health Unit
Address	231 George Street, Glasgow G1 1RX
Telephone	0141 287 6628
e-mail	Dom.callaghan@glasgow.gov.uk

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Executive Summary

Local Authorities are required to regularly review and assess the air quality within their area. These reviews and assessments are the basis of local air quality management and are intended to compare current and future concentrations of key air pollutants with the objectives detailed in regulations as part of the National Air Quality Strategy. This report comprises Glasgow City Council's Updating and Screening Assessment as part of Round 4 of review and assessment. This Updating and Screening Assessment has looked in detail at the new monitoring data available since the last round of review and assessment as well as considering the impact from various potential sources of air pollution.

Previous rounds of review and assessment have shown the potential for exceedences of the 2010 objective for PM_{10} at various locations throughout the city. Glasgow City council undertook to carry out additional monitoring of PM_{10} levels at various locations and as such commissioned three new FDMS TEOM monitors. These units are located at Abercromby St, Broomhill and Nithsdale Rd. Predictions based on the results from these units indicate that the 2010 objective level will not be met at these locations. Therefore Glasgow City Council proposes to move forward to a Detailed Assessment for PM_{10}.

Monitoring using nitrogen dioxide diffusion tubes show that there continues to be the potential for exceedences of the NO_2 objective around the Bridge St / Norfolk St area. Although monitoring at nearby residential streets gives results within the National Air Quality objectives, the presence of suitable receptors around this junction gives cause for concern. Therefore Glasgow City Council proposes to move forward to a Detailed Assessment for NO_2 at this location.

Monitoring results show that there continues to be the potential for exceedences of the NO_2 objective around Finnieston St. At present this diffusion tube is located on a lamp post about 5 metres away from the closest relevant exposure. Glasgow City Council proposes to relocate this tube to better reflect public exposure and to undertake additional monitoring around the junction.

Table of contents

Introduction

1.1 Description of Local Authority Area

Glasgow City Council, serving a population of around 580,000, is Scotland's largest local authority. As the largest city in Scotland, Glasgow is a centre for business, manufacturing and retail. As such, the city attracts a large daily influx of people and traffic from the surrounding areas.

The city of Glasgow lies at the western end of the Clyde Valley which takes its name from the river which runs through the city.

Glasgow in many ways typifies the modern developed city where road traffic tends to be the major air quality concern, superseding a long industrial heritage.

1.2 Purpose of Report

This report fulfils the requirements of the Local Air Quality Management process as set out in Part IV of the Environment Act (1995), the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 and the relevant Policy and Technical Guidance documents. The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where exceedences are considered likely, the local authority must then declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives.

1.3 Air Quality Objectives

The air quality objectives applicable to LAQM in Scotland are set out in the Air Quality (Scotland) Regulations 2000 (Scottish SI 2000 No 97), the Air Quality (Scotland) (Amendment) Regulations 2002 (Scottish SI 2002 No 297), and are shown in Table 1.1. This table shows the objectives in units of micrograms per cubic metre $\mu g/m^3$ (milligrammes per cubic metre, mg/m^3 for carbon monoxide) with the number of exceedences in each year that are permitted (where applicable).

Table 1.1 Air Quality Objectives included in Regulations for the purpose of Local Air Quality Management in Scotland.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene			
	16.25 $\mu g/m^3$	Running annual mean	31.12.2003
	3.25 $\mu g/m^3$	Running annual mean	31.12.2010
1,3-Butadiene	2.25 $\mu g/m^3$	Running annual mean	31.12.2003
Carbon monoxide	10.0 mg/m^3	Running 8-hour mean	31.12.2003
Lead	0.5 $\mu g/m^3$	Annual mean	31.12.2004
	0.25 $\mu g/m^3$	Annual mean	31.12.2008
Nitrogen dioxide	200 $\mu g/m^3$ not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 $\mu g/m^3$	Annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)	50 $\mu g/m^3$, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 $\mu g/m^3$	Annual mean	31.12.2004
	50 $\mu g/m^3$, not to be exceeded more than 7 times a year	24-hour mean	31.12.2010
	18 $\mu g/m^3$	Annual mean	31.12.2010
Sulphur dioxide	350 $\mu g/m^3$, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 $\mu g/m^3$, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 $\mu g/m^3$, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

1.4 Summary of Previous Review and Assessments

The Environment Act 1995 requires that local authorities review the air quality within their boundaries. Where the review concludes that air quality objectives will not be met within the statutory timeframe then the local authority is required to designate an Air Quality Management Area (AQMA). The local authority is then required to produce an Air Quality Action Plan (AQAP) to demonstrate how the authority intends to work towards meeting the air quality objectives within its AQMA.

Glasgow's first AQMA was declared in 2002 for NO_2 within the City Centre area. Since that time further assessments have concluded that the boundary of the original AQMA required to be increased and that new AQMAs were required for both Parkhead Cross and for the Byres Rd / Dumbarton Rd area.

Table 1.2 below shows a summary of the previous rounds of review and assessment and a brief description of the outcomes from each.

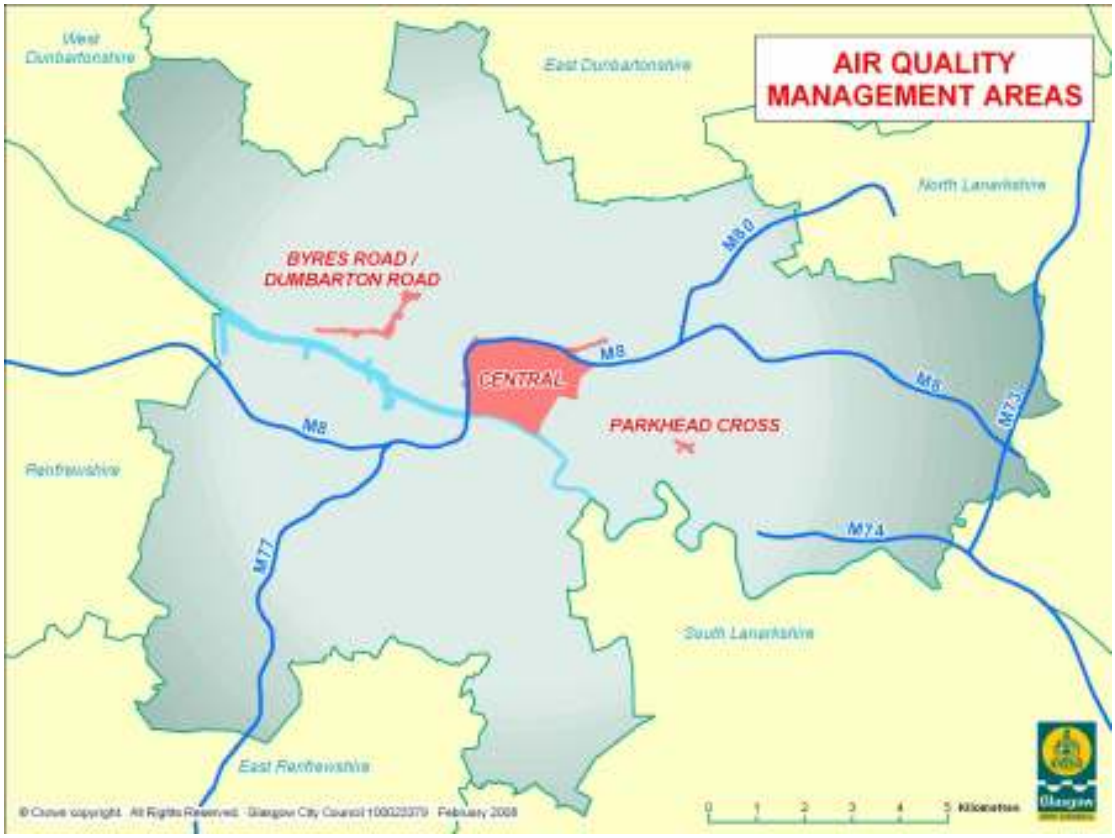
Table 1.2 Summary of Previous Rounds of Review and Assessment

Report	Date Produced	Outcome
Stage I	1998	Proceed to Stage II for CO. Proceed to Stage III for NO_2 and PM_{10}
Stage II	2000	Concluded that levels of CO and SO_2 will meet objectives.
Stage III	2001	Recommended an AQMA be declared for the city centre for NO_2
USA	2003	Proceed to DA for NO_2, SO_2 and PM_{10}
Stage IV	2004	Confirmed city centre AQMA declaration for NO_2
Detailed Assessment	2005	Recommended AQMA's be declared for NO_2 at Parkhead Cross and Dumbarton Rd / Byres Rd. Extension of city centre AQMA to Royston Rd and recommended declaration of the city centre as an AQMA for PM_{10}
Progress Report	2005	Reported on continued monitoring and recommended new monitoring at appropriate locations
USA	2006	Proceed to DA for NO_2 in a variety of areas. Recommended new monitoring of PM_{10} at various locations
Detailed Assessment	2007	Recommended additional NO_2 monitoring at locations of concern.
Further Assessment	2008	Confirmed ongoing exceedences of the objectives in the declared AQMA's
Progress report	2008	Confirmed ongoing exceedences of the objectives in the declared AQMA's and predicted likely exceedences of PM_{10} objectives for 2010.

1.4.1 Air Quality Management Areas in Glasgow

Glasgow City Council has declared three Air Quality Management Areas across the city. The areas are shown in Figure 1.1

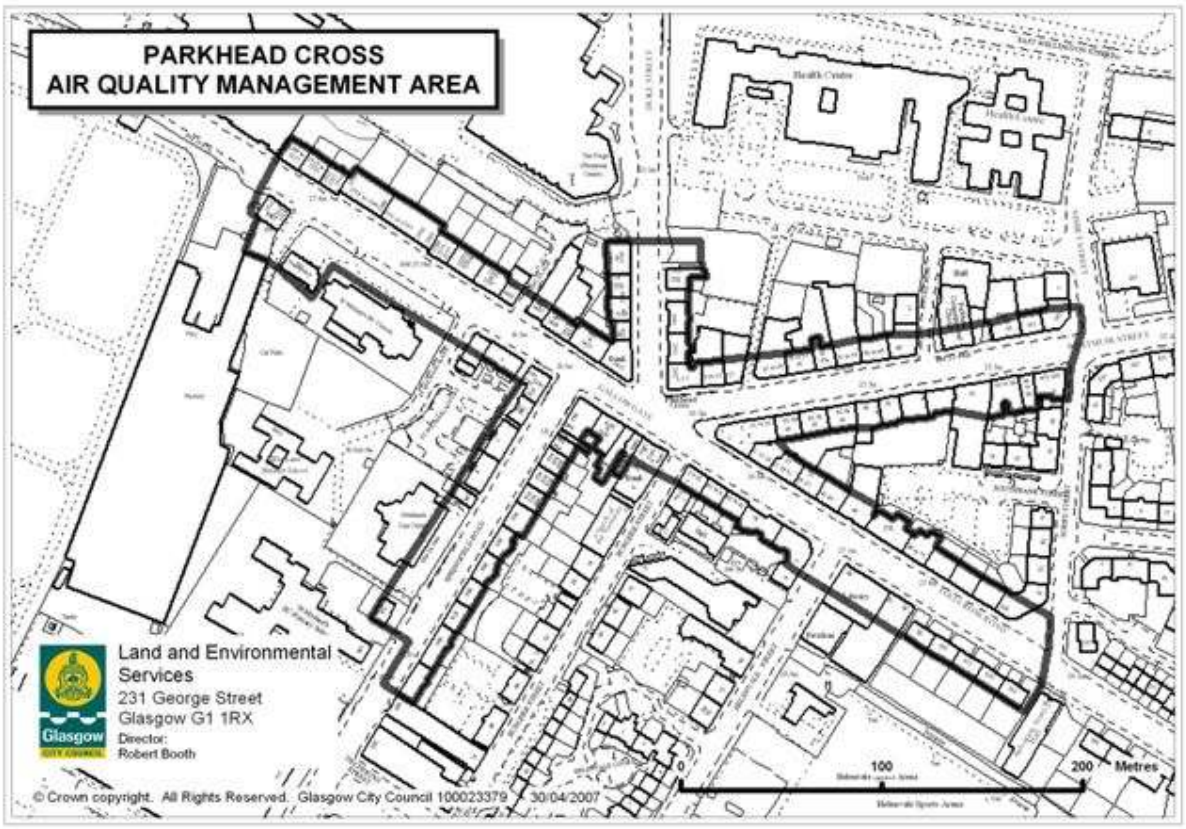
Fig 1.1 The City of Glasgow's Current Boundaries including AQMAs



1.4.1.1 Parkhead Cross

Parkhead Cross is formed by the convergence of five roads in Glasgow's east end. The roads are Westmuir Street, Tollcross road, Springfield Road, Duke Street and Gallowgate. The area is a mixture of commercial and residential properties within mostly tenement properties.

Fig 1.2 Parkhead Cross Air Quality Management Area

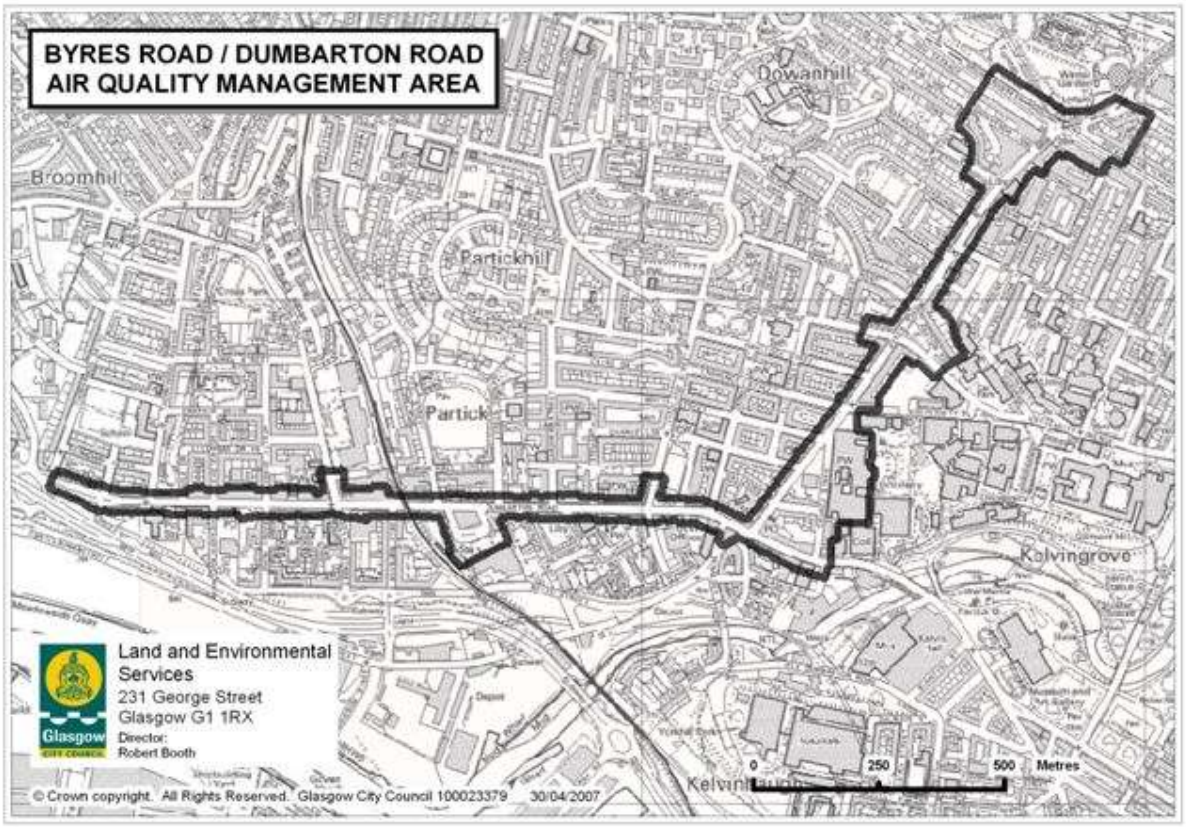


The detailed street listing for this AQMA can be found in the 1st July 2007 order.

1.4.1.2 Byres Road and Dumbarton Road

Byres Road and Dumbarton Road are at the heart of Glasgow's west end and comprise a mixture of residential and commercial properties within mostly tenement type properties. The Area covers from the junction of Byres Road and Great Western Road south to Dumbarton Road and west along Dumbarton Road as far as Thornwood Drive roundabout.

Fig 1.3 Byres Rd and Dumbarton Rd Air Quality Management Area



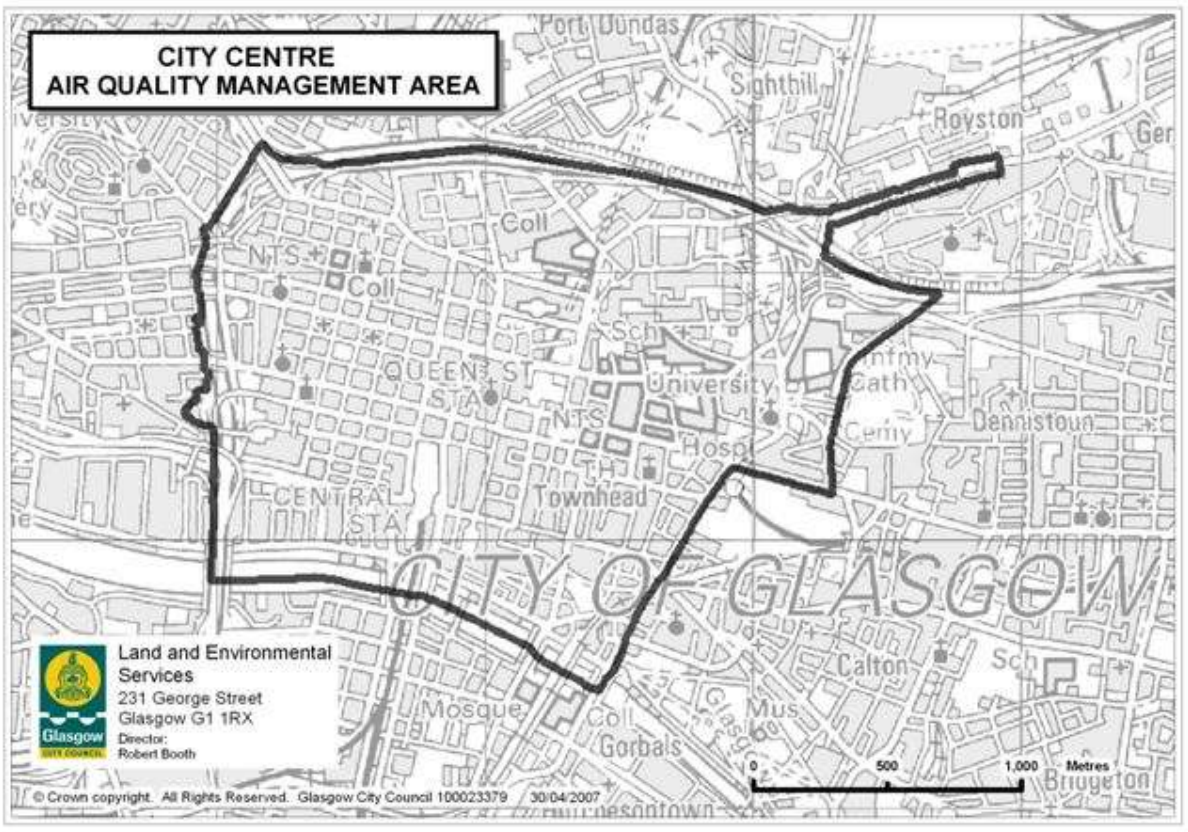
The detailed street listing for this AQMA can be found in the 1st July 2007 order.

1.4.1.3 City Centre Air Quality Management Area

The city centre area has been extensively developed with a large number of multi-storey properties for both commercial and residential use.

The city centre AQMA is loosely bound by the M8 motorway to the west and north (with slight protrusions at North Street and Royston Road), by High Street and Saltmarket to the east and by the river Clyde to the south.

Fig 1.4 City Centre Air Quality Management Area



1 New Monitoring Data

2.1 Summary of Monitoring Undertaken

2.1.1 Automatic Monitoring Sites

Glasgow City Council operates an extensive monitoring network across the city to measure ambient levels of air pollutants.

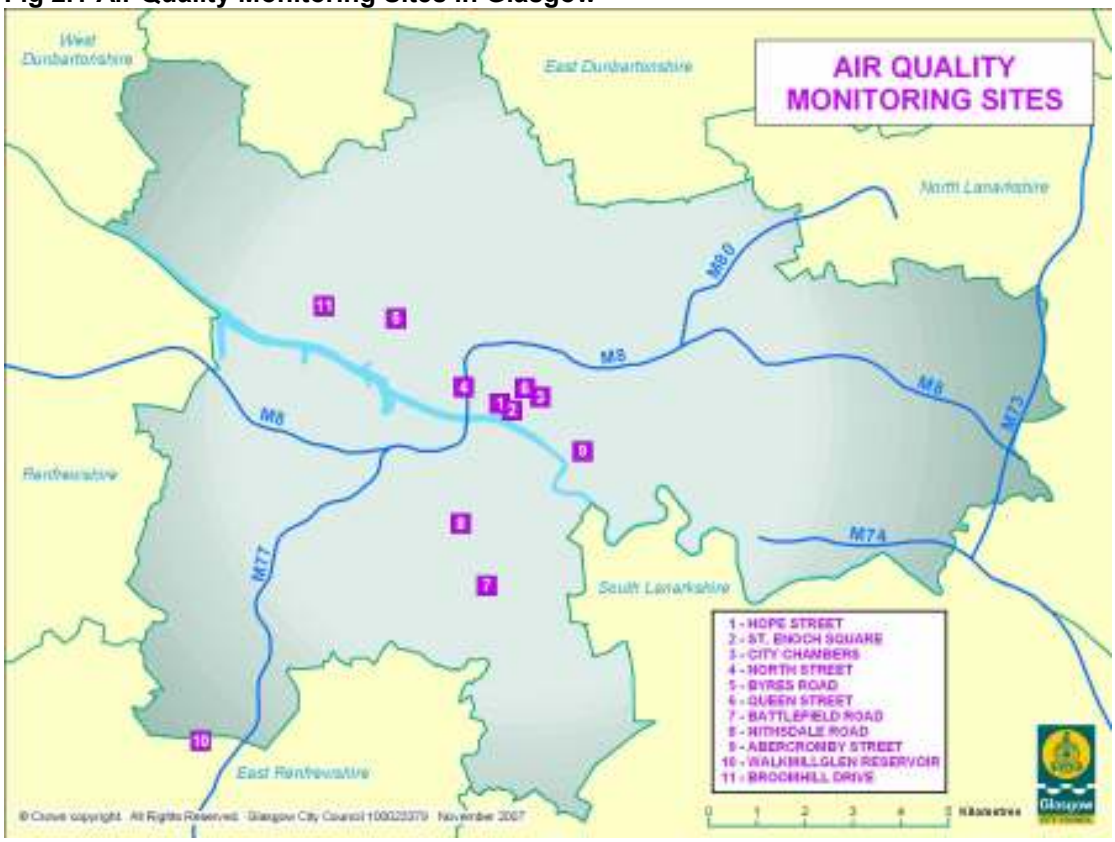
Automated monitoring equipment is located at eleven sites with three of the units (Glasgow Kerbside, Glasgow Centre and the City Chambers) forming part of the Department for Environment, Food and Rural Affairs (DEFRA) Automated Urban and Rural Network (AURN).

Equipment located at the sites measure a variety of air pollutants including NO_2, carbon monoxide, sulphur dioxide and PM_{10}. Hydrocarbons including benzene and 1,3-butadiene are monitored at the Glasgow Kerbside site. Instruments at these sites are calibrated every two weeks by the Local Site Operators and audits are carried out every six months by AEA Technology. All of the automatic air quality data we gather is independently ratified by AEA Technology and made available for viewing by the public at the Scottish Government funded air quality website at: http://www.scottishairquality.co.uk

Table 2.1 Details of Automatic Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Glasgow Kerbside	Kerbside	X 258708 Y 665200	NO_2 PM_{10} Hydrocarbon	Y	Y	1m	Y
Glasgow Centre	Urban Centre	X 258902 Y 665028	NO_2 PM_{10} CO O_3 SO_2	Y	N (>10m)	>10m	N
Glasgow Chambers	Urban Background	X 259528 Y 665308	NO_2	Y	Y	3m	N
Glasgow Anderston	Urban Background	X 257925 Y 665487	NO_2 PM_{10} CO SO_2	Y	Y	N/A	N
Glasgow Byres Rd	Roadside	X 256526 Y 666933	NO_2 PM_{10} CO	Y	Y	3m	Y
Glasgow Battlefield Rd	Roadside	X 258427 Y 661385	NO_2 PM_{10}	N	Y	3m	Y
Glasgow Abercromby St	Roadside	X 260420 Y 664175	PM_{10}	N	Y	3m	Y
Glasgow Broomhill	Roadside	X 255030 Y 667195	PM_{10}	N	Y	3m	Y
Glasgow Nithsdale Rd	Roadside	X 257883 Y 662673	PM_{10}	N	Y	3m	Y
Glasgow Waulkmillglen Reserviour	Rural	X 252520 Y 658095	NO_2 PM_{10} O_3	N	N	N/A	N

Fig 2.1 Air Quality Monitoring Sites in Glasgow



The automatic monitoring sites located at Nithsdale Road, Abercromby Street and Broomhill Drive were first installed in late 2007 and therefore only data from 2008 has been included in this report. These sites all contain FDMS TEOM analysers for monitoring PM_{10} concentrations.

2.1.2 Volatile Correction Model

The UK objective levels for PM_{10} are based on gravimetric measurements where a sample is collected on a filter and subsequently weighed. This has a number of disadvantages, in that only 24-hour concentrations are measured, no real time reporting can be undertaken and the operation is labour intensive. Historically, local authorities have measured PM_{10} levels through use of the Tapered Element Oscillating Microbalance (TEOM). A correction factor of 1.3 has been applied to this data in order to generate a gravimetric equivalent result.

However, the outcome of equivalence studies mean that TEOM analysers cannot strictly be used to measure PM_{10} concentrations for comparison with the air quality objectives.

Studies commissioned by Defra have resulted in King's College London devising the Volatile Correction Model, which can result in the calculated concentrations being considered as equivalent to the objectives. The model uses the Filter Dynamics Measurement System (FDMS) purge measurement as an indicator of the volatile component of PM_{10}.

As such, the TEOM measurements for 2008 at Glasgow Kerbside, Centre, Anderston, Byres Rd, Battlefield and Waulkmillglen have been corrected using the Volatile Correction Model. This model used temperature and pressure measurements recorded at a weather station operated by Glasgow City Council located in the Dalmarnock area of Glasgow. Purge measurements from the FDMS TEOMs located at Glasgow Broomhill and Nithsdale Rd were also used for the correction. Purge measurements from the Abercromby Street FDMS TEOM were not included due to results which displayed excessive noise in the data with a significant number of large positive values.

2.1.3 Non-Automatic Monitoring

Glasgow City Council also operate a non-automatic monitoring network of diffusion tubes which measure NO_2 levels at almost 100 sites around the city. NO_2 diffusion tubes represent a simple, effective and low cost method of monitoring ambient concentrations of nitrogen dioxide in a large number of locations. However, NO_2 concentration data provided by diffusion tubes is limited to fairly long-term exposure. Tubes are generally exposed for periods of a month, annual mean concentrations determined and compared with the annual mean objective. Furthermore, the accuracy of diffusion tubes can vary depending on the preparation methodology, handling procedures and the identity of the analysing laboratory.

To correct for this possible bias in tube data, results are corrected using information gained from co-location studies. Triplicate tubes are co-located with the automatic NO_2 analysers at Glasgow Centre, Glasgow Kerbside, Glasgow City Chambers, Glasgow Anderston and Byres Road. Concentrations detected by these tubes were compared against those recorded through chemiluminescent detection over the same sampling period and a bias-correction factor determined using the guidance outlined in LAQM.TG(09). For 2008 annual means a bias correction factor of 0.87 was used. Diffusion tubes utilised by Glasgow City Council are prepared and analysed by Glasgow City Council's Scientific Services. This laboratory participates in both the WASP scheme and the field intercomparison exercise managed by AEA. The laboratory also follows the procedures set out in the Harmonisation Practical Guidance.

In addition to these monitoring methods Glasgow City Council also operated benzene diffusion tubes at four sites across the city and lead levels are monitored by filter analysis at a further two locations. All analysis is conducted by Glasgow City Council Scientific Services Laboratory.

Table 2.2a Details of Non- Automatic NO_2 Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Hope St	Kerbside	258708 665200	NO_2	Y	N (5M)	<1m	Y
George Square	Urban Background	259296 665389	NO_2	Y	N(30m)	30m	N
Union St	Roadside	258829 665201	NO_2	Y	Y	3m	Y
Bath St	Roadside	258215 665864	NO_2	Y	N (3m)	3m	Y
Glassford St	Roadside	259355 665254	NO_2	Y	Y	3m	Y
Briggait	Kerbside	259458 664701	NO_2	Y	N	<1m	Y
Castle St	Roadside	260068 665589	NO_2	Y	Y	3m	N
Hope St 2	Roadside	258733 665363	NO_2	Y	Y	3m	Y
Hope St 3	Kerbside	258857 665913	NO_2	Y	N (5m)	1m	N
Montrose St	Roadside	259548 665283	NO_2	Y	Y	3m	Y
Cochrane St	Roadside	259430 665316	NO_2	Y	Y	3m	Y
Renfield St	Roadside	258898 665644	NO_2	Y	Y	3m	Y
George St	Kerbside	259551 665380	NO_2	Y	N (3m)	1m	Y
North St	Roadside	257883 665650	NO_2	Y	N (15m)	3m	N
Hope St 1	Roadside	258730 665322	NO_2	Y	Y	3m	Y
Gordon St	Roadside	258766 665347	NO_2	Y	N (5m)	3m	N
Heilan'man's Umbrella North	Roadside	258770 665117	NO_2	Y	Y	3m	Y
Heilan'man's Umbrella South	Roadside	258769 665106	NO_2	Y	Y	3m	Y
Saltmarket	Roadside	259545 664739	NO_2	Y	Y	3m	Y
High St	Roadside	259732 664991	NO_2	Y	Y	3m	Y
Dobbies Loan	Urban Background	259414 666194	NO_2	Y	Y	3m	N

Table 2.2b Details of Non- Automatic NO_2 Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Cathedral Bridge	Roadside	259136 665661	NO_2	Y	N (10m)	3m	N
Dundasvale St	Urban Background	258820 666305	NO_2	Y	Y	15m	N
Royston Rd	Roadside	260435 666265	NO_2	Y	N (5m)	3m	N
St Mungo Avenue	Urban Background	259389 665867	NO_2	Y	Y	5m	N
Brown St	Roadside	258300 665062	NO_2	Y	Y	3m	N
McLeod St 1	Urban Background	260077 665481	NO_2	Y	Y	8m	N
McLeod St 2	Urban Backround	260077 665481	NO_2	Y	Y	8m	N
Sauchiehall St	Urban Background	258639 665852	NO_2	Y	N (10m)	N/A	N
Kennedy Path	Urban Background	259726 665980	NO_2	Y	Y	10m	N
Byres Rd	Roadside	256526 666933	NO_2	Y	N (20m)	4m	Y
Dumbarton Rd	Roadside	256209 666525	NO_2	Y	N (3m)	3m	Y
Lawrence St	Roadside	256295 666816	NO_2	Y	N (5m)	2m	N
Cooperswell St	Roadside	256154 666478	NO_2	Y	Y	4m	Y
Westmuir St	Roadside	262589 664139	NO_2	Y	Y	3m	Y
Mosside Rd	Roadside	257235 662064	NO_2	N	N (3m)	3m	Y
Bridge St	Roadside	258702 664480	NO_2	Y	N (3m)	3m	Y
Finnieston St	Roadside	257235 665108	NO_2	N	N(5m)	3m	Y
Hillcrest Rd 1	Roadside	256485 663205	NO_2	N	N (5m)	3m	N
Hillcrest Rd 2	Roadside	256485 663205	NO_2	N	N (5m)	3m	N
St Andrews Dr	Urban Background	256230 662587	NO_2	N	Y	N/A	N

Table 2.2c Details of Non- Automatic NO_2 Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Haggs Rd	Roadside	256295 661792	NO_2	N	Y	3m	Y
Pollokshaws Rd	Roadside	255864 661180	NO_2	N	Y	5m	N
Queen Margaret Dr	Roadside	257440 668016	NO_2	N	N (20m)	3m	Y
Napiershall St	Roadside	257793 666794	NO_2	N	Y	4m	Y
Queen Margaret Dr 2	Roadside	257216 667639	NO_2	N	Y	3m	Y
Queen Margaret Dr 3	Roadside	256941 667363	NO_2	N	Y	3m	N
Oxford St	Roadside	258731 664590	NO_2	N	Y	3m	N
Anniesland Cross	Roadside	254613 668885	NO_2	N	Y	15m	N
Balshagray Ave	Roadside	254497 667298	NO_2	N	Y	10m	N
Dougrie Rd	Roadside	259586 658996	NO_2	N	N (20m)	3m	Y
Main St (Bridgeton)	Roadside	260654 663429	NO_2	N	Y	5m	Y
Aikenhead Rd	Roadside	259229 662581	NO_2	N	Y	6m	Y
Langside Primary School	Roadside	257135 661622	NO_2	N	N (5m)	3m	N
Thornwood Dr	Roadside	254904 666856	NO_2	N	Y	3m	N
Springburn Rd	Roadside	269540 669268	NO_2	N	Y	6m	Y
Paisley Rd West	Roadside	255705 664325	NO_2	N	Y	3m	Y
Sutherland Avenue	Urban Background	256343 663153	NO_2	N	N (10m)	5m	N
Belmont St	Roadside	257533 667418	NO_2	N	N (5m)	3m	Y
Mallaig Pl	Urban background	253984 665299	NO_2	N	N (20m)	6m	N
Govanhill St	Roadside	258545 665299	NO_2	N	N (3m)	3m	N
Westercraigs	Urban Background	260943 665225	NO_2	N	Y	15m	N

Table 2.2d Details of Non- Automatic NO_2 Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Inveresk Lane	Urban Background	264162 664854	NO_2	N	Y	20m	N
Kippen St	Urban Background	259727 668476	NO_2	N	N (5m)	3m	N
Sacone SW	Urban background	263920 664570	NO_2	N	Y	20m	N
Castlemilk	Urban Background	260156 659189	NO_2	N	N (10m)	30m	N
Invergarrie Rd	Urban Background	253824 658589	NO_2	N	N (5m)	3m	N
Easterhouse	Roadside	267005 666215	NO_2	N	Y	5m	N
Dunn St	Urban Background	261288 663931	NO_2	N	Y	5m	N
Glasgow Harbour	Urban Background	254475 666544	NO_2	N	Y	30m	N
Mavisbank Gardens	Roadside	257118 664914	NO_2	N	Y	3m	N

Table 2.3 Details of Non- Automatic Benzene Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Heilanmans Umbrella North	Roadside	258770 665117	Benzene	Y	Y	3m	Y
Hope Street	Kerbside	258708 665200	Benzene	Y	N (3m)	<1m	Y
Ochiltree Avenue	Roadside	254839 669295	Benzene	N	N (3m)	5m	Y
Pollokshaws Road	Roadside	255869 661185	Benzene	N	N (3m)	3m	Y

Table 2.4 Details of Non- Automatic Lead Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Chambers	Urban Background	259528 665308	Lead	Y	Y	3m	Y
Pattersons	Urban Background	267663 663336	Lead	N	Y	N/A	N

2.2 Comparison of Monitoring Results with AQ Objectives

2.2.1 Nitrogen Dioxide

Automatic Monitoring Data

Nitrogen dioxide is monitored using automatic analysers at seven locations; the three AUN sites and Glasgow Anderson, Byres Road, Battlefield and Waulkmillglen reservoir. Table 2.5 shows the measured annual mean at the all seven sites over the last three years.

Table 2.5 Results of Automatic Monitoring for Nitrogen Dioxide: Comparison with Annual Mean Objective

Location	Within AQMA?	Proportion of year with valid data 2008 %	Annual mean concentrations ($\mu g/m^3$)		
			2006	2007	2008
Glasgow Kerbside	Y	95	68	70	82
Glasgow Centre	Y	86	31	31	35
Glasgow Chambers	Y	97	47	47	48
Glasgow Anderston	Y	79	34	33	32
Glasgow Byres Rd	Y	99	41	40	43
Glasgow Battlefield Rd	N	94	38	34	32
Glasgow Waulkmillglen Reserviour	N	77	10	9	12

Figure 2.2 shows that the Kerbside, Chambers and Byres Road sites are recording concentrations of nitrogen dioxide which are continually breaching the annual mean objective.

Fig 2.2 Annual Mean NO_2 Levels 2006 – 2008 from Automatic Monitoring

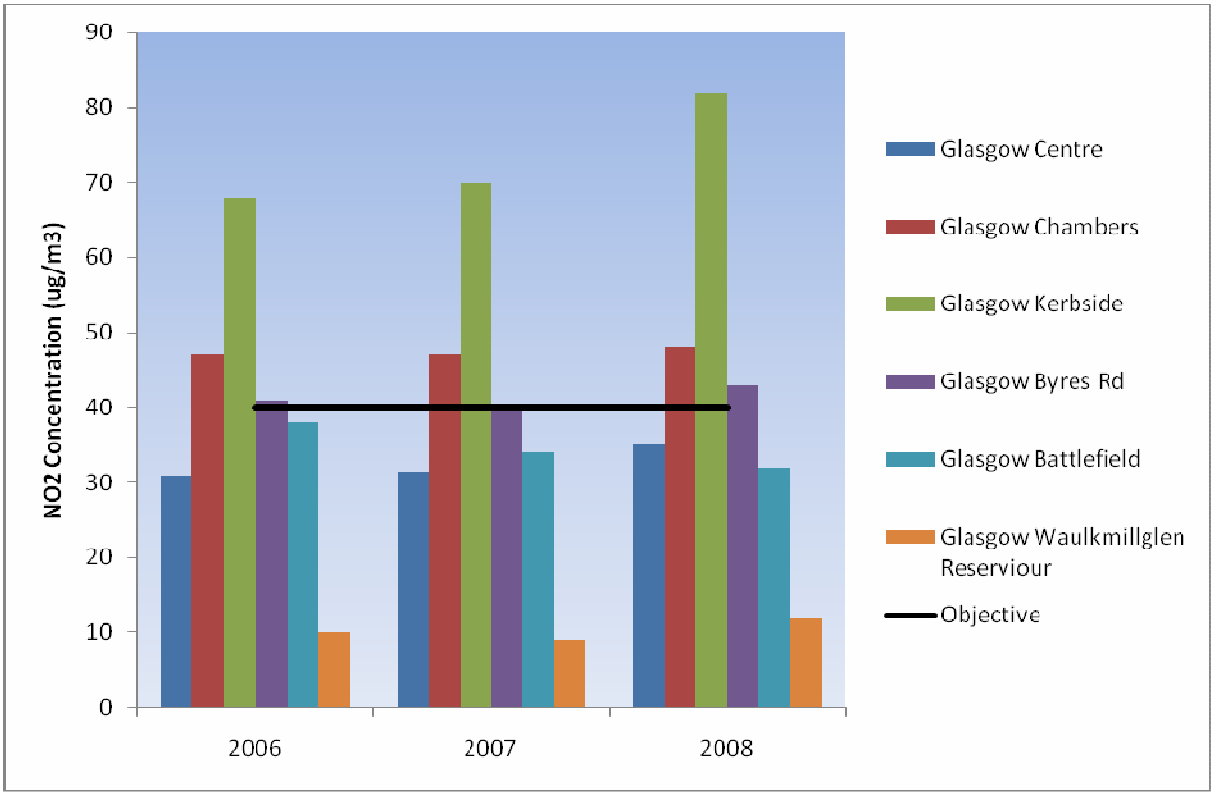


Table 2.6 shows the number of exceedences of the 200µg/m^3 hourly objective. As can be seen, Glasgow Kerbside is the only site breaching the permitted 18 exceedences of this objective per year.

Table 2.6 Results of Automatic Monitoring for Nitrogen Dioxide: Comparison with 1-hour Mean Objective

Location	Within AQMA?	Data Capture 2008 %	Number of Exceedences of hourly mean (200 µg/m^3) *If the period of valid data is less than 90% of a full year, include the 99.8th %ile of hourly means in brackets.*		
			2006	2007	2008 *
Glasgow Kerbside	Y	95	3	21	72
Glasgow Centre	Y	86	2	0	0 (175)
Glasgow Chambers	Y	97	0	2	0
Glasgow Anderston	Y	79	0	0	1 (137)
Glasgow Byres Rd	Y	99	0	6	6
Glasgow Battlefield Rd	N	94	19	0	0
Glasgow Waulkmillglen Reserviour	N	77	0	0	0 (87)

Diffusion Tube Monitoring Data

Tables 2.7a – 2.7d show the annual mean NO_2 concentrations measured using diffusion tubes. All values have been corrected for bias using the factor appropriate for the year represented (2006 = 0.82, 2007 = 0.92, 2008 = 0.87).

Table 2.7a Results of Nitrogen Dioxide Diffusion Tubes within City Centre AQMA

Location	Annual mean concentrations ($\mu g/m^3$) Adjusted for bias		
	2006	2007	2008
Hope St	69	77	83
George Square	45	53	47
Union St	63	74	66
Bath St	47	40	60
Glassford St	55	63	67
Briggait	38	49	40
Castle St	37	42	40
Hope St 2	77	82	
Hope St 3	56	64	62
Montrose St	38	45	41
Cochrane St	43	42	
Renfield St	60	74	66
George St	51	35	57
North St	58	59	44
Hope St 1	83	90	82
Gordon St	75	74	57
Heilan'man's Umbrella North	75	92	91
Heilan'man's Umbrella South	86	91	91
Saltmarket	41	46	47
High St	53	59	58
Dobbies Loan	29	35	31
Cathedral Bridge	59	56	59
Dundasvale St	31	36	35
Royston Rd	44	46	49
St Mungo Avenue	36	46	35
Brown St	31	38	40
McLeod St 1	34	42	39
McLeod St 2	35	41	38
Sauchiehall St	46	42	51
Kennedy Path	28	35	36

Table 2.7b Results of Nitrogen Dioxide Diffusion Tubes within the Byres Rd & Dumbarton Rd AQMA

Location	Annual mean concentrations ($\mu g/m^3$) Adjusted for bias		
	2006	2007	2008
Byres Rd	52	55	57
Dumbarton Rd	39	41	38
Lawrence St	39	30	33
Cooperswell St	34	30	33

Figure 2.3 below shows that the diffusion tube at Byres Road continually breaches the annual mean objective for NO_2. However, the other diffusion tubes within this AQMA are showing levels of NO_2 within the objective.

Fig 2.3 Annual Mean NO_2 Levels 2006 – 2008 Within Byres Rd & Dumbarton Rd AQMA

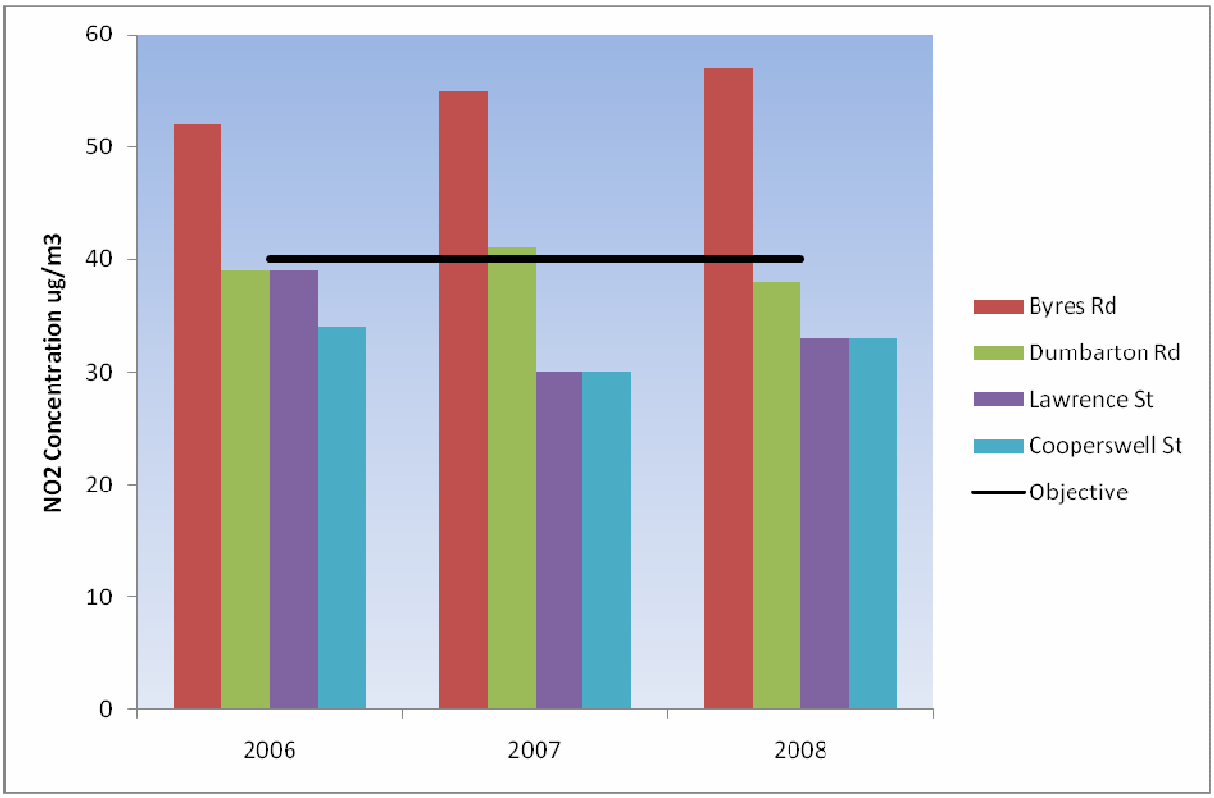


Table 2.7c Results of Nitrogen Dioxide Diffusion Tubes Within the Parkhead Cross AQMA

Location	Annual mean concentrations ($\mu g/m^3$) Adjusted for bias		
	2006	2007	2008
Westmuir St	58	54	49

The Westmuir Street diffusion tube within this AQMA continually breaches the objective level for NO_2. However, a regular decline in annual mean NO_2 can be observed in Figure 2.4

Fig 2.4 Annual Mean NO_2 Levels 2006 – 2008 Within Byres Rd & Dumbarton Rd AQMA

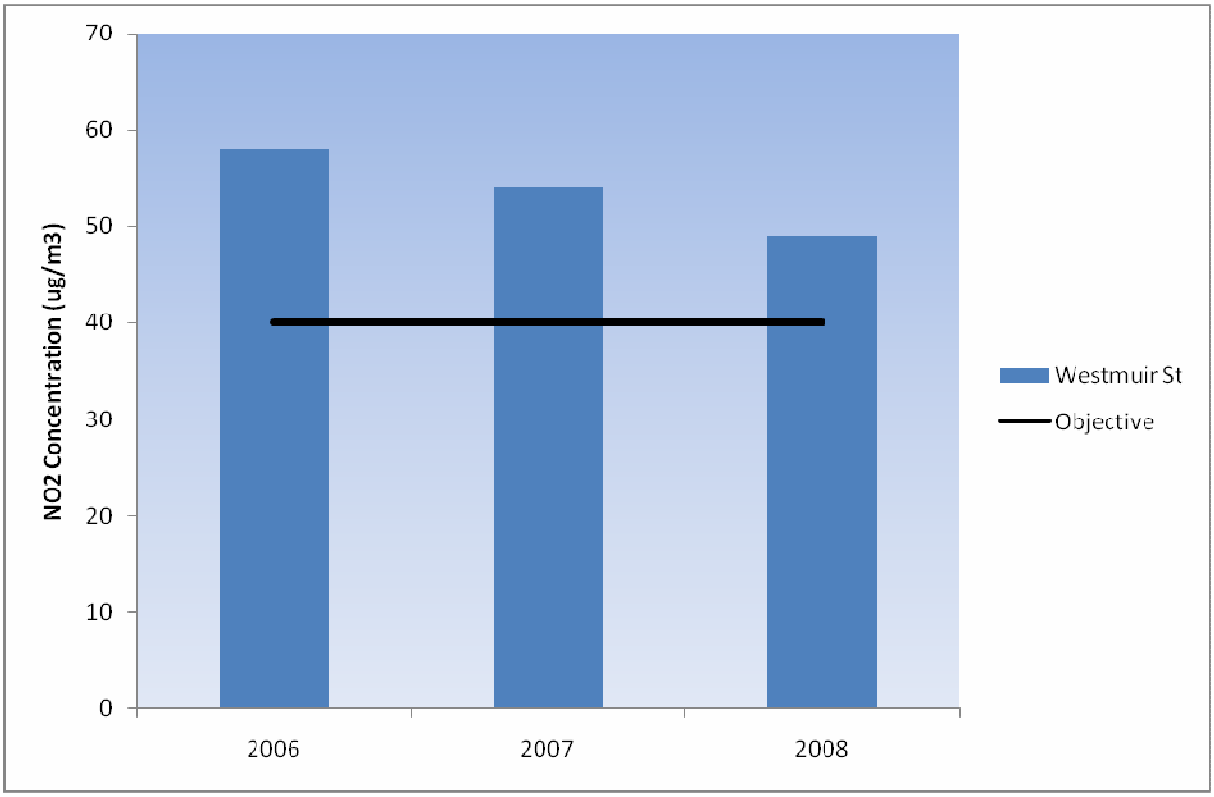


Table 2.7d Results of Nitrogen Dioxide Diffusion Tubes outwith the existing AQMAs

Location	Annual mean concentrations (μg/m^3) Adjusted for bias		
	2006	2007	2008
Mosside Rd	29	38	35
Bridge St / Norfolk St	54	49	50
Finnieston St	37	44	48
Hillcrest Rd 1	21	26	22
Hillcrest Rd 2	20	26	25
St Andrews Dr	20	26	22
Haggs Rd	32	35	36
Pollokshaws Rd	24	28	27
Queen Margaret Dr	29	35	32
Napiershall St	35	38	37
Queen Margaret Dr 2	35	33	42
Queen Margaret Dr 3	39	45	39
Oxford St	30	36	32
Anniesland Cross	33	45	39
Balshagray Ave	27	33	30
Dougrie Rd	19	26	23
Main St (Bridgeton)	25	29	25
Aikenhead Rd	25	26	29
Langside Primary School	21	29	22
Thornwood Dr	22	29	25
Springburn Rd	30	33	30
Paisley Rd West	33	36	37
Sutherland Avenue	18	20	21
Belmont St	22	26	26
Mallaig Pl	22	24	29
Govanhill St	32	32	30
Westercraigs	24	26	27
Inveresk Lane	21	23	20
Kippen St	25	22	21
Sacone SW	23	26	21
Castlemilk	19	19	19
Invergarrie Rd	16	22	16
Easterhouse	20	22	21
Dunn St	23	31	26
Glasgow Harbour	33	30	27
Mavisbank Gardens	27	37	26

2.2.2 PM_{10}

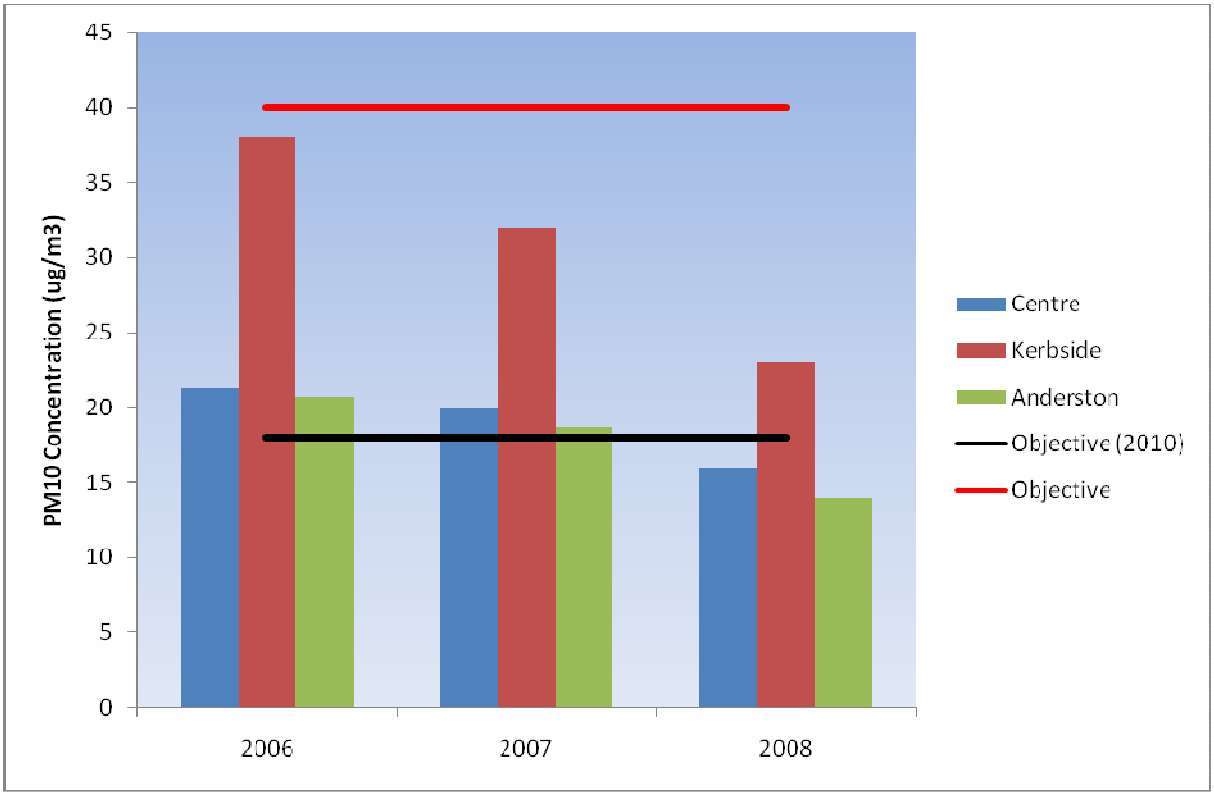
Levels of PM_{10} recorded through automatic analysers within Glasgow are summarised in Table 2.8a. Glasgow meets the current 40µg/m^3 National Air Quality Strategy objective for annual mean PM_{10}, however in 2010 the objective is lowered to 18µg/m^3.

Table 2.8a Results of PM_{10} Automatic Monitoring: Comparison with Annual Mean Objective

Location	Within AQMA?	Data Capture 2008 %	Annual mean concentrations (µg/m^3)			
			2006	2007	2008	2010 +
Glasgow Kerbside	Y	98	38	32	23	22.0
Glasgow Centre	Y	94	21	20	16	15.7
Glasgow Anderston	Y	79	16	19	14	13.0
Glasgow Byres Rd	Y	99	27	25	18	16.4
Glasgow Battlefield Rd	N	86	23	23	15	14.7
Glasgow Abercromby St	N	94	-	-	19	18.6
Glasgow Broomhill	N	94	-	-	19	18.0
Glasgow Nithsdale Rd	N	94	-	-	21	20.4
Glasgow Waulkmillglen	N	81	15	15	11	11.0

+ Predicted from 2008 data using the methodology in Box 2.1 of LAQM.TG(09).

Fig 2.6 Annual Mean PM_{10} Levels 2006 – 2008 Within City Centre AQMA



As shown above, the current PM_{10} levels at several sites within Glasgow are above the objective level required by 2010. Future PM_{10} levels expected at these sites have been calculated in accordance with LAQM.TG(09) and show that this objective level is unlikely to be met at a number of locations throughout the city.

Table 2.8b Results of PM_{10} Automatic Monitoring: Comparison with 24-hour Mean Objective

Location	Within AQMA?	Data Capture 2008 %	Number of Exceedences of 24 hour mean (50 µg/m^3) *If data capture < 90%, include the 98.1th %ile of hourly means in brackets.*			
			2006	2007	2008	2010 +
Glasgow Kerbside	Y	98	70	41	10	6
Glasgow Centre	Y	94	2	4	0	0
Glasgow Anderston	Y	79	3	3	1(44)	0
Glasgow Byres Rd	Y	99	6	10	1	0
Glasgow Battlefield Rd	N	86	3	7	0(49)	0
Glasgow Abercromby St	N	94	-	-	9	2
Glasgow Broomhill	N	94	-	-	8	2
Glasgow Nithsdale Rd	N	94	-	-	7	5
Glasgow Waulkmillglen	N	81	1	3	0(38)	0

+ 2010 exceedences estimated from 2008 data using the methodology in LAQM.TG(09).

2.2.3 Sulphur Dioxide

Sulphur Dioxide is measured at two sites in Glasgow using automatic analysers. Table 2.9 shows the measured annual mean concentrations of SO_2 measured at the Glasgow Centre and Glasgow Anderston sites.

The air quality objectives for SO_2 are 15-minute, 1-hour and 24-hour means. There were no measured exceedences of these objectives in Glasgow.

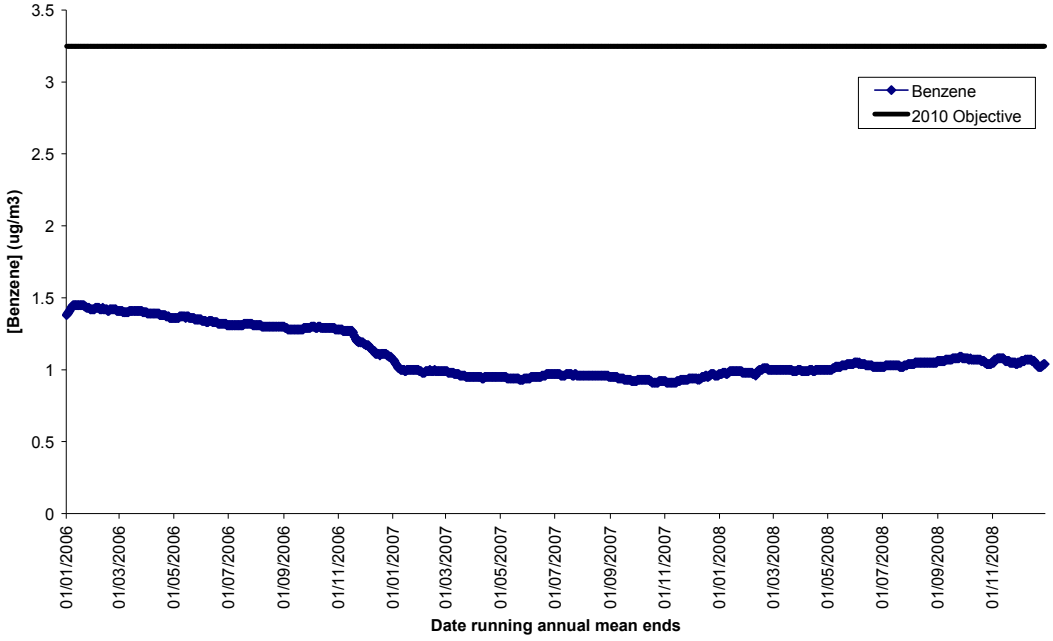
Table 2.9 Measured Annual Mean Sulphur Dioxide

Location	Measured Annual Mean (µgm^{-3})		
	2006	2007	2008
Glasgow Anderston	3.26	3.54	1.88
Glasgow Centre	1.56	2.19	1.98

2.2.4 Benzene

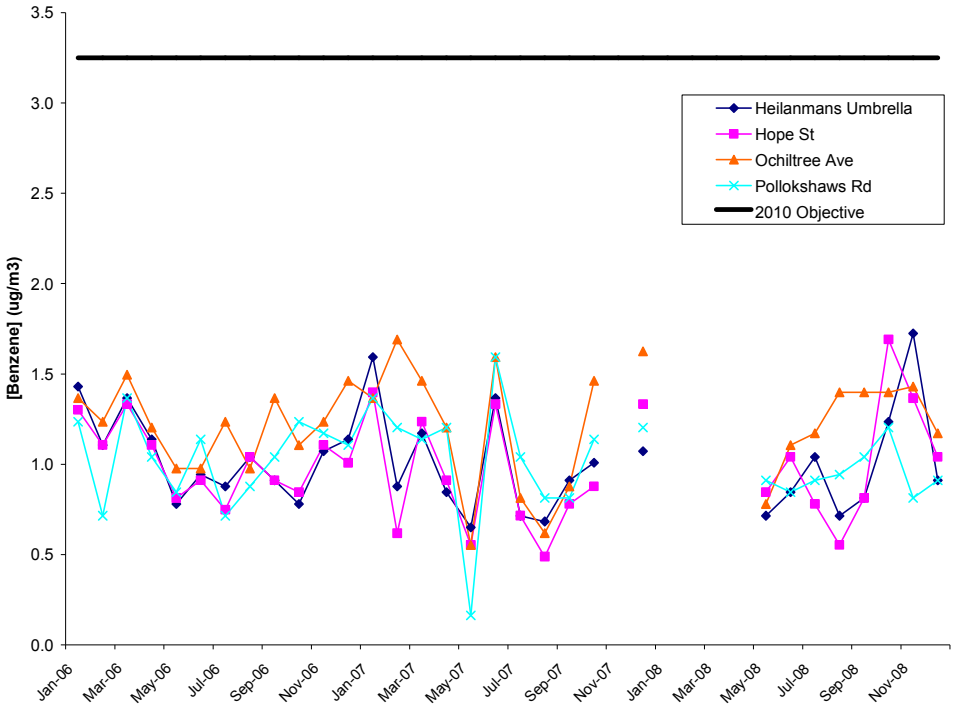
Benzene is measured at Glasgow Kerbside using an automatic analyser, the results of which are shown in Figure 2.6. As can be seen the running annual mean is well below the objective level at this location.

Fig 2.6 Running Annual Mean Benzene levels measured at Glasgow Kerbside



Benzene is also measured using diffusion tubes at four sites in Glasgow. The tubes at these sites have been in operation since early 2006 and the tubes are exposed for one month at a time and then analysed. The results can be seen in Figure 2.7.

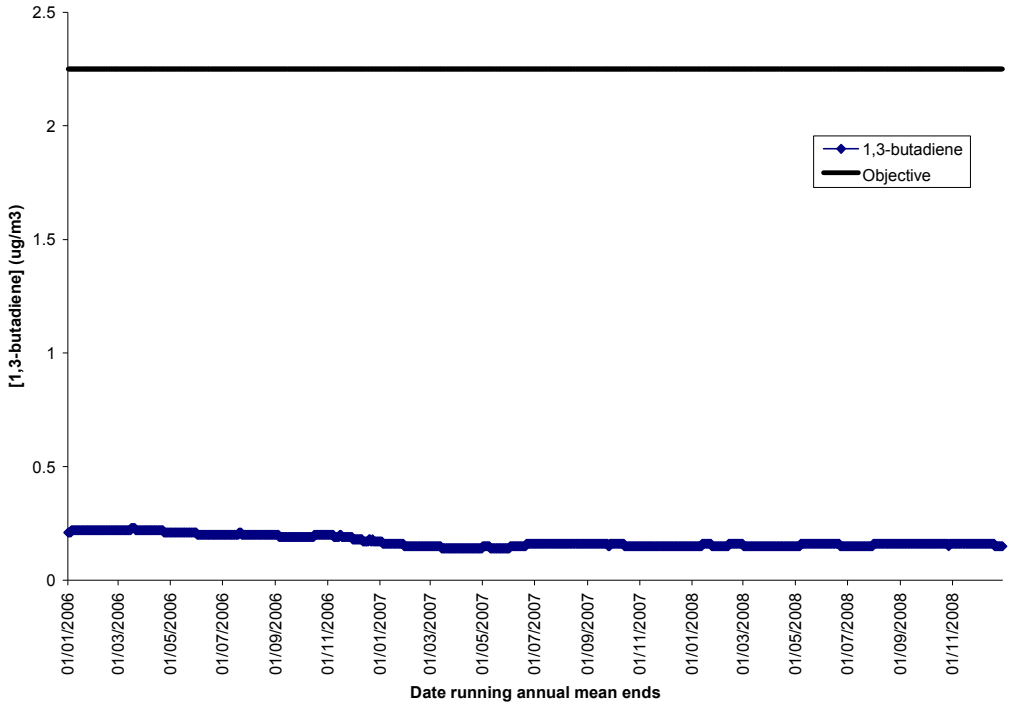
Fig 2.7 Monthly Mean Benzene levels measured by diffusion tube



2.2.5 1,3-Butadiene

1,3-Butadiene is measured at Glasgow Kerbside using the same automatic analyser which measures benzene, the results of which are shown in Figure 2.8. As can be seen the running annual mean is well below the objective level at this location.

Fig 2.8 Running Annual Mean 1,3-Butadiene levels measured at Glasgow Kerbside



2.2.6 Carbon Monoxide

Table 2.10 shows CO concentrations measured at three sites using automatic analysers. The air quality objective for Scotland for CO is a running 8-hour mean of 10.0 mg/m3. In Glasgow there have been no exceedences of this objective.

Table 2.10 Measured Annual Means and Maximum 8-hr running means for CO_2

	Data Capture 2008 %	Measured Annual Mean (mg/m3)			Maximum 8hr running mean (mg/m3)		
		2006	2007	2008	2006	2007	2008
Glasgow Centre	82.9	0.3	0.3	0.3	2.0	1.1	2.8
Glasgow Anderston	72.1	0.2	0.1	0.2	2.0	1.0	2.2
Byres Road	94.2	0.3	0.3	0.3	3.0	1.8	2.9

2.2.7 Lead

Glasgow City Council operates 2 monitoring sites for lead. One is located within the City Chambers while the other is located close to the Patterson's tip in the east end of the city. A measured concentration is pulled through a filter. Particulate matter is gathered on the filter and analysed using wet chemical techniques to determine the concentration of lead deposited.

Table 2.11 – Annual mean lead levels

	Lead Concentration (µg/m3)		
	2006	2007	2008
City Chambers	0.015	0.026	0.022
Pattersons	0.031	0.028	0.027

Annual averages recorded at both sites are significantly below the Air Quality Strategy Objective of 0.25µg/m3.

3 Road Traffic Sources

3.1 Narrow Congested Streets with Residential Properties Close to the Kerb

A location with a combination of high traffic volume and narrow streets is where exceedences of the objectives are most likely. Slow moving, stop/start driving can cause high emissions, with buildings on either side of the road reducing dispersion. Such locations should be assessed for potential exceedences of the air quality objectives.

Previous rounds of review and assessment have considered these streets in some detail. No new streets which meet the criteria have been identified.

Glasgow City Council confirms that there are no new/newly identified congested streets with a flow above 5,000 vehicles per day and residential properties close to the kerb, that have not been adequately considered in previous rounds of Review and Assessment.

3.2 Busy Streets Where People May Spend 1-hour or More Close to Traffic

There are certain locations where members of the public may be expected to spend 1-hour or more on a regular basis, such as shopping areas. These need to be assessed if they are next to a busy road where there is the potential for exceedences of the 1-hour objective for NO_2.

Glasgow has a number of locations such as these. However, the busiest streets for traffic and for shopping are currently within the existing boundary of the city centre AQMA. Therefore, these will not to be assessed further at the present time. No new streets which meet the criteria have been identified.

Glasgow City Council confirms that there are no new/newly identified busy streets where people may spend 1 hour or more close to traffic.

3.3 Roads with a High Flow of Buses and/or HGVs.

Certain streets may not have an exceptionally high traffic flow, but if there is a high proportion of buses or heavy goods vehicles (HGVs), which are large emitters of NO_x, there may still be elevated concentrations of pollution.

Outwith the existing AQMA's it is considered that there are no roads which meet the criteria laid out in LAQM.TG(09).

Glasgow City Council confirms that there are no new/newly identified roads with high flows of buses/HDVs.

3.4 Junctions and Busy Roads

Busy road junctions are areas where concentrations of NO_2 can increase due to build up of traffic. Busy junctions are those with more than 5000 vehicles per day where the annual mean PM_{10} background in 2010 is expected to be above 15µg/m^3. Alternatively it can be considered if there are more than 10,000 vehicles per day where the mean background level in 2010 is expected to be below 15µg/m^3. It is not necessary to assess those junctions that do not have relevant exposure.

It is considered that all junctions which meet the above criteria have been evaluated in previous rounds of review and assessment.

Glasgow City Council confirms that there are no new/newly identified busy junctions/busy roads.

3.5 New Roads Constructed or Proposed Since the Last Round of Review and Assessment

Previous rounds of review and assessment have considered the potential impact on air quality from two major proposed new roads. These are the M74 extension and the East End Regeneration Route. At present both of these roads are under construction. Air quality monitoring has been undertaken along both of these routes to help quantify any potential impact. Monitoring will continue after the routes are completed.

At the present time there are no new major roads proposed for within the city of Glasgow.

Glasgow City Council confirms that there are no new/proposed roads.

3.6 Roads with Significantly Changed Traffic Flows

Those roads which were previously at risk of exceeding the objectives may be subject to higher concentration of pollutants if there has been a 'large' increase in traffic flow, where 'large' is defined as,

> "*..more than 25% increase in traffic flow."*

The road network in Glasgow has not undergone any major changes that could lead to such an increase in traffic flow since the last round of review and assessment.

Glasgow City Council confirms that there are no new/newly identified roads with significantly changed traffic flows.

3.7 Bus and Coach Stations

Because of the high volume of buses and coaches using bus stations on a regular basis, there is a risk of exceedences of the hourly objective for NO_2. The main bus station in Glasgow is Buchanan Bus Station, located within the city centre AQMA.

This bus station has been extensively assessed in previous rounds of review and assessment.

Glasgow City Council confirms that there are no relevant bus stations in the Local Authority area.

4 Other Transport Sources

4.1 Airports

Aircraft are significant sources of nitrogen oxide emissions, most particularly during takeoff. It is thought that they can make a significant contribution to ground-level concentrations when they are below 200m.

Glasgow International Airport is located outwith the city boundary and falls within the jurisdiction of Renfrewshire Council. Guidance suggests to,

…establish whether there is relevant exposure within 1000m of the airport boundary…

Since the airport is more than two kilometres from the city boundary, there is no relevant exposure and so emissions from aircraft takeoff are not predicted to have any effect on air quality in Glasgow.

Glasgow City Council confirms that there are no airports in the Local Authority area.

4.2 Railways (Diesel and Steam Trains)

Diesel and coal-fired railway locomotives can potentially emit large quantities of SO_2, and if these engines are stationary while running for 15-minute periods or more, then there is a risk of exceedences of the 15-minute objective. Locations where this is likely to occur include stations, depots and junctions. For this to be an issue in terms of public exposure, there must be, according to the Technical Guidance, a potential for:

"regular *outdoor exposure of members of the public within 15m of the stationary locomotives".*

It is considered unlikely that there will be any locations where diesel trains have their engines running for extended periods *and* where there is potential exposure for the public. Even in locations like Glasgow Central and Queen Street stations, where engines may idle occasionally, the areas where the public would wait are more than 15m from the locomotive engines. In addition, the potential exists for locomotive engines running at rail depots; however, such sites are not generally accessible to the public.

4.2.1 Stationary Trains

Glasgow City Council confirms that there are no locations where diesel or steam trains are regularly stationary for periods of 15 minutes or more, with potential for relevant exposure within 15m.

4.2.2 Moving Trains

The main Glasgow to Edinburgh line has been identified as a section of track that may have a large number of movements of diesel locomotives. However, there are no areas along the route identified using the national background maps where the background annual mean NO_2 concentration is above 25 µg/m^3.

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

4.3 Ports (Shipping)

Large ships, such as cross-Channel ferries or cruise ships, often use fuel oil which has a high sulphur content, and if there is a large amount of shipping traffic in the area around a port, there will be a risk of exceedences of the 15-minute objective. However, there is currently on average three freight ships a week visiting Glasgow, with an average draft of 1500 tonnes. Consequently, it is considered unlikely that this

volume of traffic would cause any exceedences of the SO_2 objective. Therefore, *there is no requirement* to progress to a Detailed Assessment of SO_2 for this source.

Glasgow City Council confirms that there are no ports or shipping that meet the specified criteria within the Local Authority area.

5 Industrial Sources

Industrial Installations

Industrial sources can make a significant contribution in relation to the 1-hour objective. They are not as important in terms of annual mean concentrations.

No new industrial sources which could make a significant contribution to pollutant concentrations have commenced operation in Glasgow since the last round of review and assessment.

5.1 New or Proposed Installations for which an Air Quality Assessment has been Carried Out

Glasgow City Council confirms that there are no new or proposed industrial installations for which planning approval has been granted within its area or nearby in a neighbouring authority.

5.1.1 Existing Installations where Emissions have Increased Substantially or New Relevant Exposure has been Introduced

Existing industrial installations have been considered extensively in previous rounds of review and assessment. At present there are no existing installations with substantially increased emissions since prior assessment.

Glasgow City Council confirms that there are no industrial installations with substantially increased emissions or new relevant exposure in their vicinity within its area or nearby in a neighbouring authority.

5.1.3 New or Significantly Changed Installations with No Previous Air Quality Assessment

Glasgow City Council confirms that there are no new or proposed industrial installations for which planning approval has been granted within its area or nearby in a neighbouring authority.

5.2 Major Fuel (Petrol) Storage Depots

There are no major fuel (petrol) storage depots within the Local Authority area.

5.3 Petrol Stations

Petrol stations that are to be considered for benzene emissions are defined in the guidance as,

"..all petrol stations with an annual throughput of more than 2000m^3 of petrol (2 million litres) per annum and with a busy road nearby."

A busy road is identified as,

"*..one with more than 30,000 vehicles per day."*

In Glasgow, there are no locations with a busy road, a sufficiently large petrol station and relevant exposure in the immediate vicinity. Two of the benzene diffusion tubes are located close to petrol stations to confirm this assertion. These are the Polokshaws Rd and the Ochiltree Avenue tubes. Results from these tubes are considerably and consistently below the objective level for benzene.

Glasgow City Council confirms that there are no petrol stations meeting the specified criteria**.**

5.4 Poultry Farms

Glasgow City Council confirms that there are no poultry farms meeting the specified criteria.

6 Commercial and Domestic Sources

6.1 Biomass Combustion – Individual Installations

Biomass burning can lead to an increase in PM_{10} emissions, due to the nature of combustion. NO_2 levels can also be higher than in conventional gas installations. Rising prices for conventional fuels and pressure to reduce carbon emissions has seen the popularity of biomass as a fuel source grow.

At present Glasgow has no major biomass combustion plants. There have been early stage proposals, including the potential for a biomass central heat and power plant for the 2014 Commonwealth Games.

Glasgow City Council confirms that there are no biomass combustion plant in the Local Authority area.

6.2 Biomass Combustion – Combined Impacts

Glasgow City Council confirms that there are no significant areas with large numbers of small biomass combustion plant in the Local Authority area.

6.3 Domestic Solid-Fuel Burning

In areas where domestic solid fuel is still in widespread use, there can be a problem with PM_{10} concentrations. The growth in popularity of biomass in domestic situations, particularly the use of wood burning stoves could lead to potential problems with PM_{10}. At present within Glasgow, there is no area of 500 x 500m with sufficient numbers of small solid fuel burners to present a significant impact on PM_{10} levels.

Glasgow City Council confirms that there are no areas of significant domestic fuel use in the Local Authority area.

7 Fugitive or Uncontrolled Sources

Fugitive emissions from a variety of sources can give rise to elevated PM_{10} concentrations. Fugitive sources, i.e. dust has the potential to be a problem in the achievement of the PM_{10} objectives, especially in Scotland where the objective level for 2010 is lower than in the rest of the UK. It is thought that dust emissions contain around 20% PM_{10}.

The guidance on dealing with these sources is to identify potential sources, and then determine whether there are dust concerns at the facility. This assessment should be based on dust complaints about the facility, air quality assessments already carried out or a visual inspection indicating significant dust.

The only potential sources which Glasgow contains within its boundaries are landfill sites, of which there are several. These have been considered in previous rounds of review and assessment where it was concluded that they would not have a significant impact on PM_{10} concentrations.

Glasgow City Council confirms that there are no potential sources of fugitive particulate matter emissions in the Local Authority area.

8 Conclusions and Proposed Actions

8.1 Conclusions from New Monitoring Data

Automatic analyser and diffusion tube monitoring of NO_2 within this Updating and Screening Assessment indicates that concentrations of NO_2 are likely to continue to exceed the National Air Quality Objectives at several locations within the existing Air Quality Management Areas. The diffusion tube results also show that there continues to be the potential for exceedences of the NO_2 objective around the Bridge St / Norfolk St area and at Finnieston St. Monitoring at residential streets close to Bridge St / Norfolk St produce results consistently below the objective level.

Previous rounds of review and assessment have shown the potential for exceedences of the 2010 objective for PM_{10} at various locations throughout the city. Glasgow City council undertook to carry out additional monitoring of PM_{10} levels at various locations and as such commissioned three new FDMS TEOM monitors. These units are located at Abercromby St, Broomhill and Nithsdale Rd. Predictions based on the results from these units indicate that the 2010 objective level will not be met at these locations.

Monitoring results for carbon monoxide, benzene, 1,3-butadiene and lead continue to show that in Glasgow, levels of these pollutants are well below the National Air Quality Objectives.

8.2 Conclusions from Assessment of Sources

Road, transport, industrial and domestic sources of air pollution were considered as part of the Updating and Screening Assessment. It was shown that there are no new developments or changes to existing developments likely to lead to significant contributions to air pollution levels.

8.3 Proposed Actions

Monitoring results have shown that it is Glasgow is unlikely to meet the 2010 objective for PM_{10} at a number of locations. Although there is a declining trend in recorded PM_{10} levels, a trend which has been further enhanced by the Volatile Correction Model for non-FDMS TEOMs, this is unlikely to lead to compliance with the objectives within the timescale. Therefore Glasgow City Council proposes to move forward to a Detailed Assessment for PM_{10}.

Monitoring results show that there continues to be the potential for exceedences of the NO_2 objective around the Finnieston St. At present this diffusion tube is located on a lamp post about 5metres away from the closest relevant exposure. Glasgow City Council proposes to relocate this tube to better reflect public exposure and to undertake additional monitoring around the junction. It should be noted that the area has seen significant development over the last few years and the presence of roadworks has disrupted traffic flow. The additional monitoring data will be looked at in more detail in further rounds of review and assessment.

The diffusion tube results also show that there continues to be the potential for exceedences of the NO_2 objective around the Bridge St / Norfolk St area. Although monitoring at nearby residential streets gives results within the National Air Quality objectives, the presence of suitable receptors around this junction gives cause for concern. Therefore Glasgow City Council proposes to move forward to a Detailed Assessment for NO_2 at this location.

9 References

- Department of the Environment, Food and Rural Affairs (2000). Part IV The Environment Act 1995, Local Air Quality Management, Technical Guidance, LAQM.TG(09);

- Glasgow City Council (1998). Local Air Quality Management, Review and Assessment of Air Quality in Glasgow Stage 1;

- Glasgow City Council (2000). Local Air Quality Management, Review and Assessment of Air Quality in Glasgow Stage 2;

- Glasgow City Council (2001). Local Air Quality Management, Review and Assessment of Air Quality in Glasgow Stage 3;

- Glasgow City Council (2003). Local Air Quality Management, Review and Assessment of Air Quality in Glasgow Stage 4;

- Glasgow City Council (2003). Local Air Quality Management, Updating and Screening Assessment;

- Glasgow City Council (2004). Local Air Quality Plan;

- Glasgow City Council (2005). Local Air Quality Management, Detailed Assessment;

- Glasgow City Council (2005). Local Air Quality Management, Progress Report;

- Glasgow City Council (2007). Local Air Quality Management, Detailed Assessment;

- Glasgow City Council (2008). Local Air Quality Management, Further Assessment;

- Glasgow City Council (2008). Local Air Quality Management, Progress Report;

- The Scottish Executive (2002). Air Quality (Scotland) Amended Regulations