Local Air Quality Management

Update and Screening Assessment 2003

Environmental Protection Services

Glasgow City Council

EXECUTIVE SUMMARY

The United Kingdom Air Quality Strategy details eight key air pollutants. These are benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, particles, sulphur dioxide and ozone. Air quality standards and objectives for compliance have been enacted through the Air Quality Regulations 2000 and the Amended regulations 2002.

Under the Environment Act 1995, local authorities must undertake a review and assessment of air quality in their areas with regard to the objectives. This procedure should be undertaken in a phased manner with the results of each stage indicating whether it is necessary to proceed to the next.

Should it appear at the conclusion of the review and assessment process that one or more of the objectives will not be complied with, the local authority must declare an Air Quality Management Area for the relevant pollutants and draw up an Action Plan detailing the action to be taken to reduce pollutant levels to below the standard in that area.

Glasgow City Council completed its Stage One Review and Assessment in 1999, one conclusion of which was the requirement of a Stage Two investigation for carbon monoxide. Furthermore, following comments received from the Scottish Executive regarding sulphur dioxide, a Stage Two assessment was also been undertaken for this pollutant.

Stage Two focused on these two pollutants and considered data of concentrations of both at representative locations across the City and modelling using appropriate screening methodology. Stage Two was completed in 2000 and concluded that both carbon monoxide and sulphur dioxide would achieve compliance with the relevant objectives by 2003 and 2005 respectively, and therefore would require no further assessment.

Stage Three of Review and Assessment was completed by Glasgow City Council in 2001 and consisted of a detailed assessment of NO_2 and PM_{10}, the two pollutants considered to be of greatest concern in Glasgow. Results of monitoring and modelling of NO_2 predicted exceedences of both the annual mean and hourly objectives at locations within Glasgow City centre, but no exceedences outwith the City centre. In contrast, results of monitoring and modelling of PM_{10} indicated that no exceedences of the 24-hour and annual mean objectives were recorded or predicted in any part of Glasgow.

As a result of these findings, Stage Three of Glasgow City Council's Review and Assessment concluded that many parts of the City centre would be subject to exceedances of the NO_2 objectives and must be contained within an Air Quality Management Area (AQMA). This AQMA was subsequently declared for the whole of the City centre.

This report forms the first step of the next round of Review and Assessment process for Glasgow City Council by undertaking an Updating and Screening Assessment using the checklist approach for each pollutant as described within Technical Guidance LAQM.TG(03).

This report concludes that no exceedences of the National Air Quality Strategy objectives are predicted for carbon monoxide, benzene, 1,3-butadiene and lead and consequently, that there is no requirement to proceed to a detailed assessment for these pollutants. In contrast, exceedances of the relevant Air Quality objectives were predicted for NO_2, SO_2 and PM_{10}. It was therefore concluded that a detailed assessment of each is required in the following areas:

NO_2

- Monitoring locations outside the AQMA where exceedences of the air quality objectives have been recorded.
- Junctions – where DMRB has indicated potential exceedences of the air quality objectives.
- Busy streets - where DMRB has indicated potential exceedences of the air quality objectives.
- New roads proposed – M74.

SO_2

- Monitoring locations outside/ within the AQMA where exceedences of the air quality objectives have been recorded.

PM_{10}

- Monitoring locations City-wide where exceedences of the 2010 air quality objective are expected.
- Busy roads and junctions – where DMRB has indicated potential exceedances.
- New roads proposed – M74.
- Existing industrial sites that may result in breaches of the 2010 objectives.

The Detailed Assessments of pollutants identified as requiring further research are due to be completed by the end of April 2004.

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APPENDICES

1. INTRODUCTION

One of the major environmental and public health concerns of recent years has been that of air pollution. In particular, concern has been expressed over the levels of air pollution from industry and road transport experienced in urbanised areas and large towns and cities.

This debate has taken place on a global scale but is relevant here in Glasgow, the largest city in Scotland.

One of the responses to the concerns has been the publication in 1997 by the United Kingdom Government of its National Air Quality Strategy.

The Strategy set target concentrations for eight air pollutants and seeks to bring the levels of these pollutants throughout the United Kingdom to within the targets by the end of 2005. This date has subsequently been brought forward to 2004 or 2003 for some of the pollutants. In addition, more stringent future objectives have been set for certain pollutants.

The eight pollutants are: nitrogen dioxide, sulphur dioxide, carbon monoxide, particulates, lead, benzene, 1,3-butadiene and ozone.

The main players in achieving this are the local authorities. They must undertake a review of seven of the air pollutants in their area and assess whether the target levels set will be achieved in their area by the specified objective date. Ozone is to be dealt with at a national level.

Local authorities will have to take appropriate action should their assessment indicate that levels of a pollutant would not achieve the objective set.

Following an appraisal of the first round of Review and Assessment by the Department of Environment, Food and Rural Affairs together with the devolved administrations, it has been recommended that the current round of Review and Assessment be carried out in two steps, these being:

a) **Updating and Screening Assessment** to identify factors that have changed since the round one of review and assessment and potentially require further assessment.

b) **Detailed Assessment** of pollutants and/ or locations, which have been, identified as requiring further research.

This report constitutes the Updating and Screening Assessment using the checklist approach for each pollutant as described within Technical Guidance LAQM.TG(03).

2. LEGISLATIVE FRAMEWORK

In response to continuing concerns regarding air pollution and the effect on health, a number of policies have been adopted by the European Union and United Kingdom government in recent years.

In 1989 the Air Quality Standards Regulations implemented EC Directives in the United Kingdom which set air quality limit values for nitrogen dioxide, lead, sulphur dioxide and suspended particulates. This was the first United Kingdom legislation to lay down mandatory air quality standards.

In 1990 the United Kingdom government then introduced the Environmental Protection Act. This gave local authorities new powers to control air pollution from industrial processes, with operators required to obtain authorisations from their local authority. In Scotland in 1996 these powers passed to the Scottish Environment Protection Agency (SEPA).

In 1995 the Environment Act was introduced. This set targets for future air pollutant levels and remains the primary enactment pertaining to air quality for local authorities in Scotland.

It led to the publication of the United Kingdom National Air Quality Strategy in 1997, as well as associated Regulations and Guidance Notes. This document was reviewed and a revamped Air Quality Strategy for England, Scotland, Wales and Northern Ireland, along with new draft Regulations and Guidance Notes, was published in early 2000. Amended regulations ('the Regulations') for Air Quality in England, Scotland and Wales were published in 2002.

2.1 Environment Act 1995

This is the enabling legislation for local air quality management in the United Kingdom. Air quality is covered in Part IV of the Act.

Section 82 instructs local authorities to conduct an air quality review within the authority's area. In addition, an assessment must be made of whether air quality standards and objectives are being achieved, or are likely to be achieved within a specified period.

If it appears that any air quality standard and objective is not being achieved, or is not likely to be achieved within the specified period, the local authority shall by order designate that part of its area affected as an Air Quality Management Area. These orders are made under Section 83 and may, following a subsequent air quality review of the affected part, be varied or revoked.

Section 84 of the Act places duties upon local authorities that designate Air Quality Management Areas to assess the quality of the air within the designated area. Local authorities must then prepare a written plan (an Action Plan) in pursuit of the achievement of the air quality standards and objectives in the designated area. They must also state the time period in which the measures proposed in the Plan may be implemented.

The Environment Act 1995, under Section 87, makes provision for the drawing up of Regulations relating to matters of local air quality management. From this came the

Air Quality Regulations 1997. These have now been superseded by the Air Quality (Scotland) Regulations 2000. The Regulations list the air pollutants of concern (benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, particulates, sulphur dioxide, and ozone) and the respective objectives to be achieved. The complete objectives are detailed later in this Chapter. The relevant time periods for Part IV of the Environment Act 1995 are also specified in the Regulations. All local authority assessments of air quality objectives must consider the level of each air pollutant as it would be at the end of the specified period and all Action Plans must seek to bring air pollutant levels to within the limits set in the Regulations by the same date.

Ozone is not to be dealt with on a local level, due to its ability to transmigrate local authority and national boundaries. Instead action to reduce and control ozone concentrations will require to be taken on a national and international basis.

Section 88 of the Act allows the relevant Secretary of State to issue guidance to local authorities with respect to any of the powers or duties conferred to local authorities in Part IV of the Environment Act. Local authorities must have regard to this guidance when carrying out any of their functions by virtue of Part IV.
With regard to carrying out a review and assessment of air quality in their area, local authorities are guided by the document *'Local Air Quality Management: Technical Guidance LAQM.TG(03)'* issued by the Department for Environment, Food and Rural Affairs (Defra), the Scottish Executive and the Welsh Assembly Government under section 88(1) of the Environment Act 1995 ('the Act') .

2.2 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland Standards and Objectives

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland assesses individual air pollutants and categorises eight of current concern.

These are: benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, particles, sulphur dioxide and ozone. All of these air pollutants are known to adversely affect human health at sufficiently high concentrations. All are relatively widespread throughout the United Kingdom. Moreover, a reasonable amount is known about their ambient levels across the United Kingdom and about the major sources of each pollutant. Standards for each air pollutant and fixed objectives for the achievement of each of the standards are set by the Air Quality Strategy. However, following the latest evidence of the impacts of these pollutants on human health and developments within Europe, the objectives for a number of these pollutants have been revised, with tighter objectives being introduced including separate objectives for Scotland. The standards and objectives set for each pollutant are included in their respective chapters in the following report.

In order that the information of standards and objectives can be accurately used as part of an air quality review and assessment, a number of points have to be considered.

Firstly, it is observed that the time period for each of the standards varies according to the pollutant. This is done in order to reflect the health effect of the pollutant. For example, a sufficiently high concentration of SO_2 could potentially impact on a person's health within a short time period (minutes). For benzene, however, the time

required for a health effect to occur would be much longer (years). Therefore, the respective objectives are of appropriate periods of exposure to represent this.

Secondly, is the issue of the allowance of exceedences of a given standard. This approach is applied to those pollutants that have shorter averaging times and allows these standards to be exceeded at times when it would not be appropriate to try to prevent breaches. This would include those occasions when complete compliance would require disproportionately expensive abatement measures. Or it may arise during specific social or cultural occasions, such as Bonfire Night, which would be impractical to control. Or it could be due to uncontrollable natural sources or adverse weather conditions.

This means, for instance, that for SO_2, 35 of the highest 15-minute values in any single year can be above 266 $\mu g/m^3$.

3. THE CITY OF GLASGOW

3.1 Topography

Glasgow, latitude 55^0 52' North, longitude 4^0 15' West, lies at the western end of Scotland's Midland Valley. This valley is a major geological feature some 50 miles wide and 120 miles long, stretching from the Firth of Clyde to the Firths of Forth and Tay, and separating the Highlands from the Southern Uplands. Glasgow's location can be seen on the Map presented in Appendix I.

Glasgow's position has been described as lying in a vast horseshoe-shaped howe or open space, hemmed in on the north, west and south by the plateaux of the Campsie, Kilpatrick, Beith and Renfrewshire Hills. The River Clyde flows through this howe, the only major Scottish river to flow west into the Atlantic Ocean.

From the earliest recorded history of the howe, Glasgow is believed to be the furthest point upriver at which the river could be forded and the lowest point downriver at which it could be bridged.

The material left behind in the valley by retreating glaciers at the end of the last ice age is the ground surface on which the city is built. The disappearance of the glaciers left a prominent feature of the city's landscape in the form of drumlins. These are smooth elongated low hills, often with steep sides, characteristically formed from deposits of till or boulder clay underlying an icesheet. There are 180 drumlins in Glasgow the presence of which is reflected in the suffix 'hill' which appears in many Glasgow place names. Most of Glasgow's drumlins lie to the west of the City centre and the most prominent include Garngad Hill (252ft), Partick Hill (179ft), Garnethill (176ft), Hillhead (157ft), Woodlands Hill (153ft) and Blythswood Hill (135ft). One singularity of the City's layout is the imposition of a strict gridiron configuration over the top of these eminencies.

3.2 Meteorology

The Glasgow area is sheltered from the coldest easterly and northerly winds of winter so that, under the benign influence of the sea surface temperatures adjacent to the western seaboard, winters in Glasgow are rarely more severe than in locations much further south, in England.

For the remainder of the year, however, when characteristics such as latitude and solar radiation become more powerful factors than air mass, the temperatures are reduced compared to areas further south.

The mean annual temperature of the City is around 9^0C with a mean maximum of around 12^0C and mean minimum of around 5^0C. The diurnal range of temperature is normally a good deal larger in summer than winter, varying from less than 2^0C in January to an average of about 6^0C in July.

Ground frost can occur at any time of the year, although it is rare in July. Glasgow has about 60 air frosts per year on average, which are essentially confined to the October-April period.

Frost hollow effects can contrast markedly between urban built up areas and surrounding rural locations. Artificially high temperatures may be found on cold nights in built up areas such as Glasgow, termed as 'urban heat islands'. On still anticyclonic nights the overall urban-rural temperature difference can exceed 8^0C in and around Glasgow. This is fairly large compared to that reported for other cities but may be explained by the topographic situation of Glasgow and the compact development of the City.

Glasgow experiences around 1200 mm of rainfall per annum with the first half of the calendar year generally drier than the last six months. On moving immediately to the north of Glasgow, on upland locales, annual values increase rapidly. Maximum daily falls of rain in the vicinity of Glasgow are generally around 50 mm. A particular feature of precipitation in the Glasgow area is the combination of heavy rainfall with high wind speed. The worst wind direction for such 'driving rain' in Glasgow is from a south-westerly direction and the City suffers from this phenomenon more than any other comparably sized settlement in the United Kingdom.

Local topography exerts a significant control on both the wind speed and direction. At an open level site in Glasgow wind velocity is often comparable to cities in locations much further south, such as Birmingham and London. Westerly gales, however, especially in winter, do occur and Glasgow is subjected to around 5 days per annum of gales.

Snowfall is mainly confined to January and February but can fall on low ground in the Glasgow area as late as May or as early as October. On average, there are some 25 days per year with snow or sleet falling around Glasgow with probably less than half of that number of days with snow lying at 0900 hours.

Glasgow experiences a fairly modest 1400 hours of sunshine per annum. This is influenced by surrounding high ground and a tendency for convective cloud to form inland during the afternoons. During May, however, sunshine levels compare favourably with those of the south coast of England.

The Glasgow basin can occasionally experience sea fogs which are either carried inland from the Firth of Clyde with light winds in the summer or, in the case of the east coast haar, are advected right through the Midland valley. More usually, local radiation fogs naturally result from the drainage of cold air into the Clyde valley from the surrounding hills on calm, cold winter nights. This process has been on occasion compounded by smoke particles trapped by temperature inversion near to ground level, leading to episodes of atmospheric pollution. In the more polluted past this lead to the mean annual duration of bright sunshine in Springburn in the north-east of Glasgow being 8.3% lower than that at Glasgow Airport only 10 km to the west.

3.3 Land Use

Until the middle of the 19th century the land mass occupied by the City of Glasgow was relatively small and generally focused around the fordable section of the River Clyde and the historical settlement around the City's pre-Reformation Cathedral.

During the 20th century, however, the area occupied by the City has expanded considerably with a burgeoning population attracted by industry and economic benefits.

This comprises around 17,730 hectares (68 square miles). Of this 22% is countryside or green belt land and 10% is classed as vacant land.

3.4 Population

Glasgow lies at the heart of Scotland's only conurbation. The population rose from the early to mid 19th century level of around 200,000 to its peak in 1939 at over 1,100,000. The latest figures available for Glasgow's population show that it was at 616,430 in 1996.

During the decade to 1996, Glasgow's population is estimated to have declined by around 53,000. The annual rate of population decline has fallen from around 6,000 in 1985-86 to 2,000 in 1995-96. The City's population is expected to continue to decline, albeit at a reduced rate. The projected figure for 2005 is 588,417. Despite this population decline, the number of households is expected to continue to increase.

3.5 Industry and Economy

Glasgow's economy has experienced significant change over the last 10 years. The traditional base of mercantile, engineering, and marine activities have remained, although declined. Other production industries have modernised around new technologies and City centre services have increased in importance. Service industries now account for 83% of the workforce with manufacturing employing 11% and other production and construction providing 6%.

Despite these changes in work activity Glasgow still produces around 18% of Scotland's gross domestic product and remains the third largest manufacturing hub in the United Kingdom (behind Birmingham and Leeds) outwith London.

Glasgow is the principal business focus in Scotland and one of the largest office centres in the United Kingdom.

The City is the largest shopping nucleus in Scotland and the second in the United Kingdom after London. It draws trade from the whole of the west of Scotland and beyond.

The City also attracts large numbers of visitors through its tourist attractions, including museums and galleries. Visits are also generated through the three universities, colleges, sports and leisure facilities, and conference and business venues.

4 Update and Screening Assessment of Carbon Monoxide

4.1 Introduction

Concentrations of carbon monoxide (CO) were last considered in Glasgow in the Stage II report of the last Review and Assessment process. At this time, the Air Quality objective for CO was set at 11.6 mg/m^3(10ppm) as a running 8 hour mean. This objective was to be achieved by 31st December 2003. Stage II concluded that Glasgow would comply with the air quality objective for carbon monoxide.

The air quality objective for CO has since been tightened to 10 mg/m^3 (8.6ppm) as a running 8 hour mean to bring the standard into line with European Union standard. The objective has still to be met by 31st December 2003.

The steps that will be followed in this assessment are those that are outlined in the guidance note *Review and Assessment: Technical Guidance LAQM.TG (03).* There are two steps, the first being the analysis of all available monitoring data and the second is a screening process around the busiest roads.

4.2 Sources of carbon monoxide

The main source of CO in the UK is road traffic. The National Atmospheric Emissions Inventory (NAEI) estimates that for Glasgow, 90% of CO emissions in 2000 came from road traffic, with another 8% from other transport sources (air, rail, shipping). Only 2% of total CO emissions come from a non-transport related source. In Glasgow City centre, it would be expected that road traffic would contribute an even higher proportion of total CO emissions. This is illustrated in Figure 4.1.

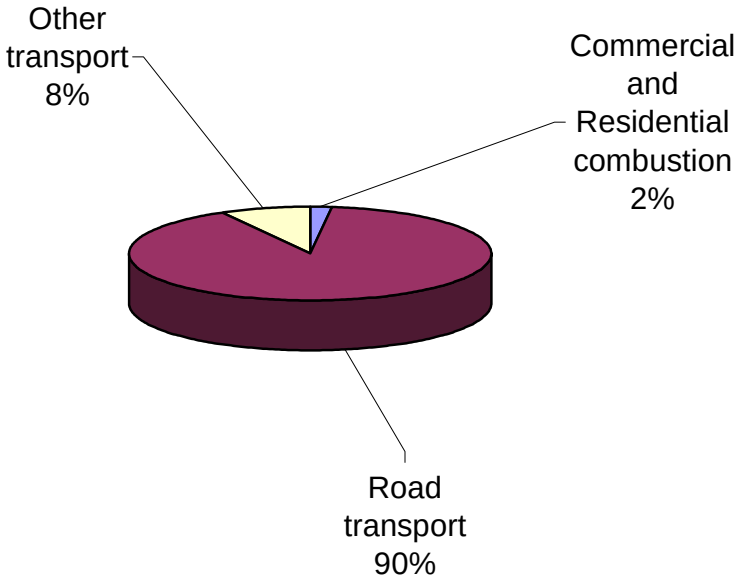


Figure 4.1 – Sources of CO in Glasgow, 2000 (NAEI)

CO emissions from traffic are increased when a vehicle's engine is cold or badly tuned, or when it is idling or the vehicle is moving slowly. Concentrations are highest close to busy roads in cities, especially during peak periods when traffic is slow moving.

Improvements in engine design and increased use of catalytic converters have contributed to large reductions in CO emissions. Nationally, projections have indicated that road transport emissions will decrease by 42% between 2000 and 2005. However, this will be partly offset by expected increases in traffic volume.

4.3 Monitoring methodology

4.3.1 Monitoring equipment and locations

Glasgow has several automatic units that measure ambient CO concentrations. Three of these samplers are part of the UK-wide Automatic Urban and Rural Network (AURN). These are;

GLASGOW CITY CHAMBERS
The site is located on the 2nd floor of Glasgow City Chambers in Cochrane Street (259527 665297) and samples air from a height of approximately 8 metres. Cochrane Street is a street canyon, and the site is classified as urban background.

GLASGOW CENTRE
This site is in St Enoch Square, an open, pedestrianised area in the centre of Glasgow (258943 665027). It is around 20m from Argyle Street which has a traffic flow of approximately 20,000 vehicles per day. The site is classed as an urban centre site.

GLASGOW KERBSIDE
Positioned at the southern end of Hope Street next to Central Station (258696 665166) close to the junction with Argyle Street in a street canyon. It is a kerbside site with its inlet less than 1m from the road. Traffic flow here is more than 25,000 vehicles per day.

Glasgow City Council independently operates another three air quality monitoring units which measure CO. These are described below.

GROUNDHOG
This unit has monitored since 1999 in various locations across Glasgow. It has suffered numerous communication problems, resulting in an extremely poor data capture rate. For this reason, it will only be possible to use sets of data from two sites. The first is Byres Road, a busy thoroughfare in the west end of the City. Monitoring was carried out for a continuous 6 month period in 1999. The second site with usable data is St Patrick's Primary School, Anderston. While the Groundhog has been sited here since May 2001, data capture from 2002 is less than 50% with large gaps throughout the year. However, seven continuous months of data available in 2001 can be used.

ROLLALONG

The Rollalong has been located at Townhead, adjacent to the M8 motorway since May 2001. Previously, the Groundhog was at this site, so by using both sets of data, there are two years available.

BACKGROUND
A third mobile unit has recently gone into operation at Waulkmillglen reservoir which is just outside the south-west boundary of Glasgow. This monitors background concentrations, but has only been in operation for a short time period, and so data from this will not be used.

These sites, except the background site, are highlighted in Figure 4.2.

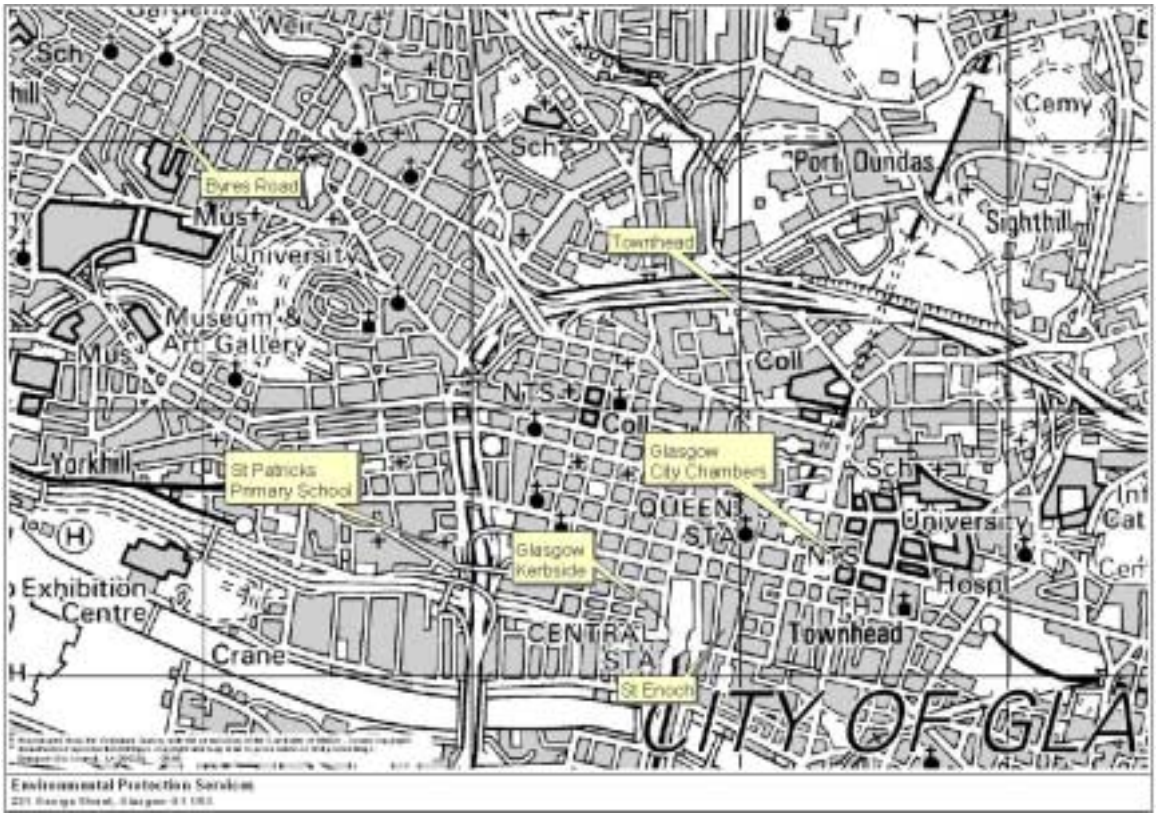


Figure 4.2 – CO monitoring site locations

4.3.2 Public exposure

When assessing concentrations of pollutants, published guidance states that the only sites that should be considered are those which represent relevant exposure against the objective. In the case of CO, the objective is an 8-hour mean. Locations where this should be considered include all background and roadside locations up to the building façade of properties such as residencies, schools, hospitals and other buildings where the public may visit or remain for long periods.

The objective would not apply at building facades of offices or other places of work where members of the public do not have regular access or at kerbside locations where public exposure will be short.

4.4 Update and Screening of CO

Update and screening of CO will have two steps, which considers different CO sources, locations or data sets. The headings of the steps are listed below, and each one is then addressed in turn.

- Monitoring data
- Very busy roads and junctions

4.4.1 Monitoring data

Figure 4.3 displays the maximum running 8-hour mean CO concentrations measured at Glasgow's three AURN sites. The assessment of CO in Stage II included years up to, and including, 1998, so results are presented from 1999 onwards. Data capture rates at all three AURN sites has been excellent and at all times being greater than 95%.

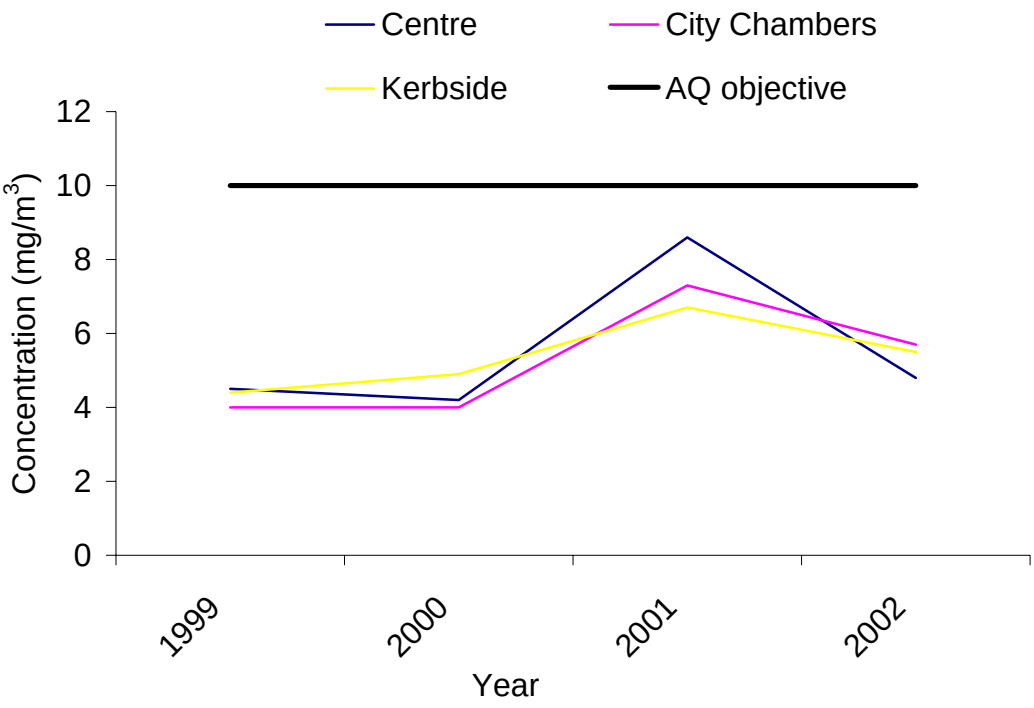


Figure 4.3 – Maximum 8 hour means at AURN sites

Monitoring from AURN sites has shown that there were no exceedences of the CO objective at any AURN site in Glasgow. The three AURN sites give a good indication of typical CO levels expected across the City, as they range from an urban background site, giving typical exposure levels, to the kerbside site, which would be expected to show the 'worst-case' results due to its proximity to traffic.

Highest CO concentrations were observed in 2001 at all three sites, with Glasgow Centre and Glasgow City Chambers experiencing greater maximum levels than Glasgow Kerbside. This occurred during a pollution episode in December, when meteorological conditions caused pollutants to accumulate and concentrations to increase considerably. Nevertheless, even during this period, CO concentrations were still below the air quality objective at all sites.

While there is insufficient data from the mobile units to make an accurate assessment against the objective, the data that is available from Byres Road and St Patrick's Primary is given in Table 4.1.

Site	Dates	Maximum 8 hour mean (mg/m^3)	Data capture (%)
Byres Road	Jan – Jun 2000	5.3	85.8
St Patrick's	May – Dec 2001	3.8	74.4

Table 4.1 – Maximum 8 hour means at mobile sites

In both cases, data capture is too low to demonstrate compliance with the objective. However, considering the maximum 8 hour mean that has been recorded at either site is well below the objective, and that no exceedences are noted at the AURN sites, it is very unlikely that there would have been any other exceedences at other times of the year.

4.4.2 Very busy roads and junctions in built-up areas

As road traffic is responsible for the majority of CO in Glasgow, any possible exceedences would be most likely to occur close to very busy roads or junctions. These locations are described in the guidance note as,

"..'very busy' roads and junctions in areas where the 2003 background is expected to be above 1 mg/m^3".

'Very busy' roads are defined as,

- *"Single carriageway roads with daily average traffic flows which exceed 80,000 vehicles per day"*
- *"Dual carriageway (2 or 3-lane) roads with daily average traffic flows which exceed 120,000 vehicles per day."*
- *"Motorways with daily average traffic flows which exceed 140,000 vehicles per day"*

Estimated annual mean background concentrations of CO for 2001 are provided on the air quality website (www.airquality.co.uk/archive/laqm/tools/). In Glasgow, the highest background CO concentration in the City is 0.488mg/m^3 and this is expected to decrease further by 2003. While some roads may meet the criteria in terms of

traffic flow, as the background concentration is so low, it is not necessary to carry out screening at any roads or junctions, and it can be assumed that there are no potential exceedences of the CO objective.

4.5 Conclusions

Monitoring of CO has taken place across Glasgow City centre and concentrations were compared against the air quality objective, which is a maximum 8-hour running mean of 10mg/m^3. Results showed that there were no exceedences of this objective at any site where sufficient data was available. These sites are representative of concentrations across Glasgow, so it is not likely that there were any exceedences at other locations.

Screening was undertaken at busy roads and junctions, to identify potential exceedences of the CO objective. No locations in Glasgow fulfilled the criteria for a busy road or junction, in addition to background concentrations being significant. Therefore, no exceedences of the CO objective are expected at heavily trafficked sites in Glasgow.

As a result of monitoring and screening procedures, *there will be no requirement* for Glasgow City Council to progress to a Detailed Assessment for carbon monoxide.

5 Update and Screening Assessment of Benzene

5.1 Introduction

Concentrations of benzene in ambient air were last considered in Glasgow during Stage I of the previous Review and Assessment process. At this time, the air quality objective for benzene was set at 16.25µg/m^3 as a running annual mean to be achieved by 31st December 2003. Stage I concluded that Glasgow would comply with the air quality objective for benzene.

The air quality objective for benzene has since been tightened and is now a running annual mean of 3.25µg/m^3 to be met by 31st December 2010.

5.2 Sources of benzene

The main sources of benzene in the UK are petrol engine vehicles, petrol refining and the emissions from petrol station forecourts without vapour recovery systems. The National Atmospheric Emissions Inventory (NAEI) estimates that for Glasgow, 67% of benzene emissions in 2000 came from road traffic. In Glasgow City centre, road traffic would contribute an even higher proportion of total benzene emissions. Other sources in Glasgow include residential, commercial and industrial combustion, and other forms of transport (air, rail, shipping). This is illustrated in Figure 5.1.

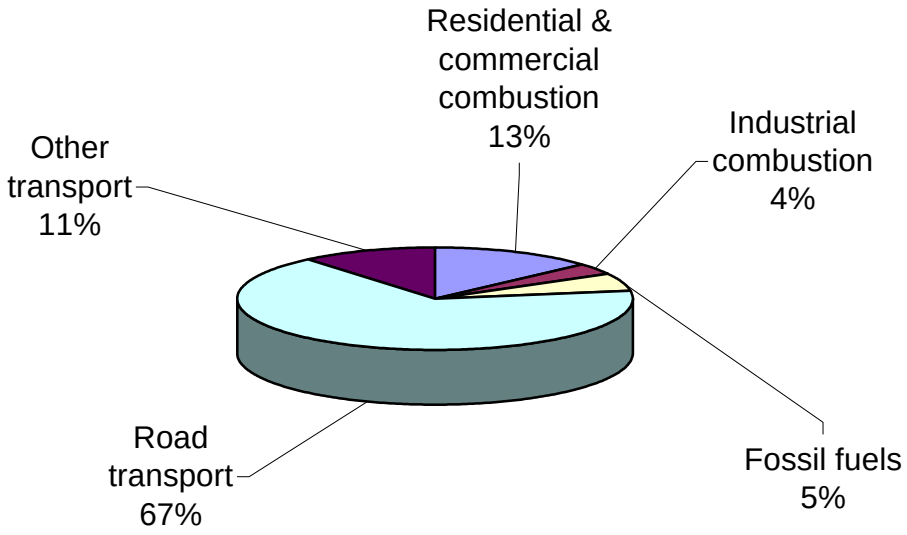


Figure 5.1 – Sources of benzene in Glasgow, 2000 (NAEI)

Since Glasgow's Stage I report, EU legislation has been introduced which reduces the maximum benzene content of petrol from 5% to 1%. This took effect in January 2000. Additional measures are further expected to reduce emissions from cars and light-duty vehicles. However, these reductions could be offset by the increase in traffic volume on the roads.

During the Stage I report for benzene, no major industrial processes were identified as a significant emitter of benzene. There have been no new industrial processes, or changes to existing processes, that would have lead to an increase in benzene emissions in Glasgow since then.

It has recently been recognised that there is a potential for high benzene emissions around petrol stations. This can be caused by either petrol vapours being displaced when filling underground storage tanks or by petrol vapour being displaced from vehicle petrol tanks during refuelling.

5.3 Monitoring methodology

5.3.1 Monitoring equipment and locations

Monitoring of benzene is carried out using passive diffusion tubes. These tubes contain a Chromosorb absorbent, on which ambient benzene accumulates before being analysed. Tubes are exposed for periods of two weeks.

Prior to 1999, benzene monitoring in Glasgow was patchy, taking place at several locations for short time periods. This does not compare well to the air quality objective, which requires an annual mean to be considered.

Since 1999, monitoring of benzene has taken place at three locations in the City centre, and has continued uninterrupted, to the present. Two of the monitoring sites are on opposite sides of Argyle Street under the Heilanman's Umbrella, the railway bridge that carries rail traffic over the river Clyde and into Central Station. The third site is on the enclosed roadway under the Buchanan Galleries, on Cathedral Street. These sites are highlighted in Figure 5.2.

There has recently been installed an automatic hydrocarbon site at Hope Street (Glasgow Kerbside AURN). However, there has been insufficient data obtained from this site as yet and, therefore, results from this site will be included in future reports on benzene.

5.3.2 Public exposure

When assessing concentrations of pollutants, published guidance states that the only sites that should be considered are those that represent relevant exposure against the objective.

In the case of benzene, the standard is a running annual mean. Sites that should be considered are all background and roadside locations up to the building façade of properties such as residencies, schools, hospitals and other buildings where the public may visit or remain for long periods. The objective would not apply at building facades of offices or other places of work where members of the public do not have regular access or at kerbside locations where public exposure is likely to be short.

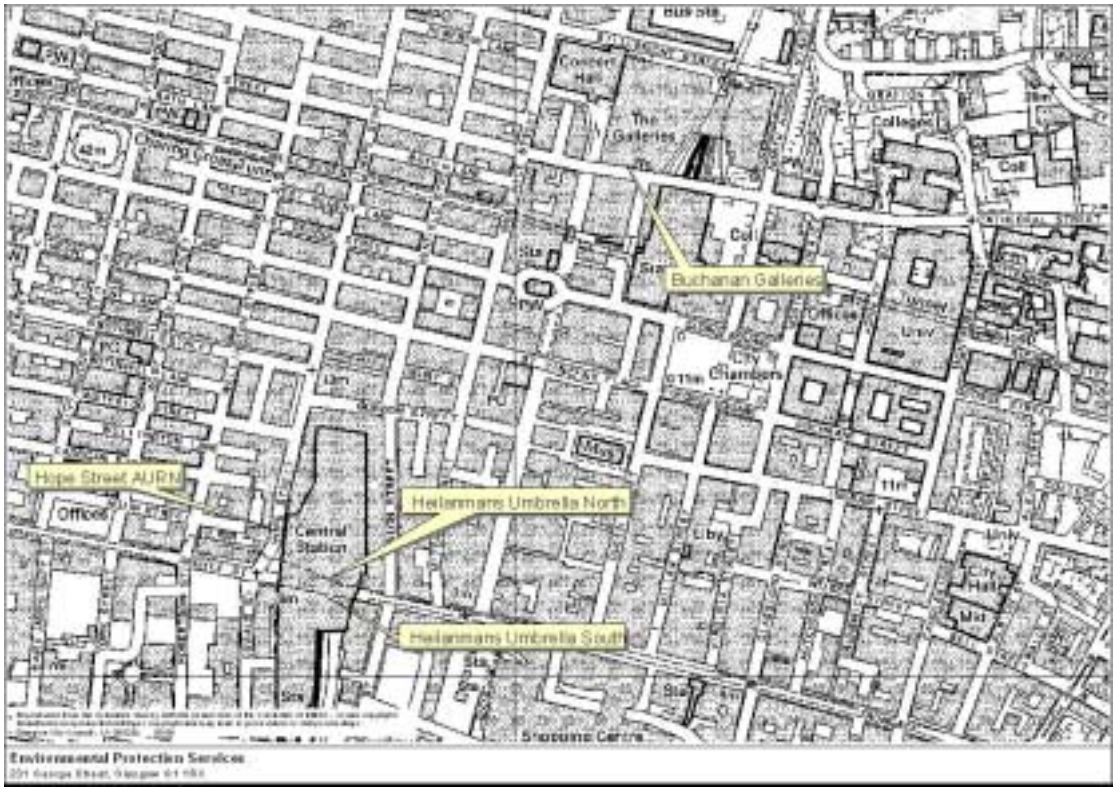


Figure 5.2 – Locations of benzene diffusion tubes

5.4 Update and Screening of benzene

The Update and Screening Assessment for benzene will consider benzene sources, locations and data separately, in the form of a checklist. The headings of these are listed below, and each will be addressed in turn.

- Monitoring data
- Very busy roads and junctions in built-up areas
- Industrial sources
- Petrol stations
- Major fuel storage depots (petroleum only)

5.4.1 Monitoring data

Figure 5.3 presents the running annual means measured using diffusion tubes since 1999 at the three sites described above.

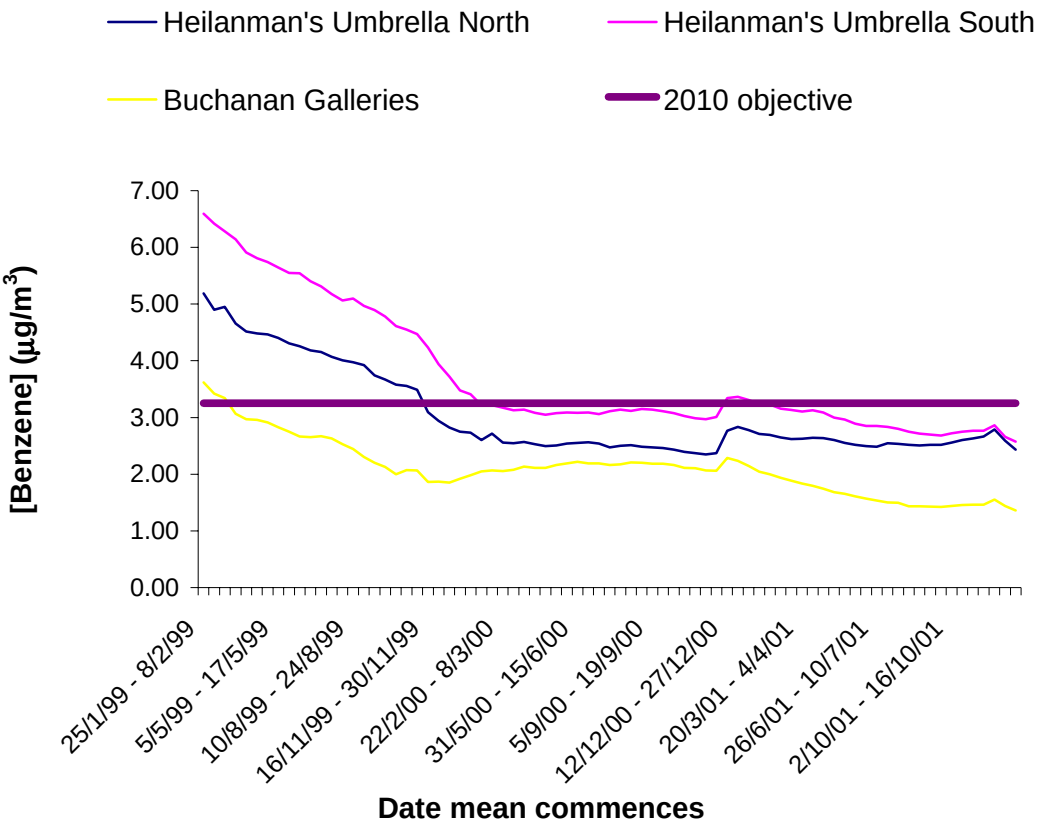


Figure 5.3 – Benzene diffusion tubes running annual means, 99-02

From the graph, concentrations of benzene have been steadily falling since 1999. The largest decline in benzene concentration occurred around 2000, which coincides with the reduction of benzene content in fuel as discussed above. Concentrations have continued to decrease since 2000, although not at the same rate.

It is clear that there have been no exceedences of the 2003 running annual mean objective of 16.25µg/m^3 from the diffusion tube data. Exceedences of the 2010 objective did occur regularly before 2000, but since then, exceedences have been very rare. Heilanman's Umbrella South (HUS) has generally measured slightly higher concentrations than the other sites, tending to be just under the 2010 objective. At one point around the beginning of 2001, all three sites experienced a rise in ambient benzene, with the Heilanman's Umbrella South site exceeding the concentration stated in the air quality objective. Nonetheless, since this time concentrations have fallen further, to the point where both Heilanman's Umbrella sites are very similar.

The diffusion tubes are all kerbside sites and are situated underneath a canopy. For this reason, dispersion will be very low and measured benzene concentrations will be higher than normally expected. Therefore, these diffusion tube sites represent the 'worst case' benzene concentrations in ambient air. Since these sites are no longer failing the 2010 objective, it is extremely unlikely that there would be any other sites that might fail the objective.

5.4.2 Very busy roads and junctions in built-up areas

There are suggestions that there could be a few locations, close to busy roads, where background concentrations are high and these locations may be at risk of exceeding the objective and must be considered. The locations are described in the guidance as,

".. 'very busy' roads and junctions in areas where the 2010 background is expected to be above 2μg/m^3"

'Very busy' roads are defined as,

- *"Single carriageway roads with daily average traffic flows which exceed 80,000 vehicles per day"*
- *"Dual carriageway (2 or 3-lane) roads with daily average traffic flows which exceed 120,000 vehicles per day."*
- *"Motorways with daily average traffic flows which exceed 140,000 vehicles per day"*

While in Glasgow there may be roads which fulfil the above criteria, background concentrations are not expected to be above 2μg/m^3 by 2010. Estimated annual mean background concentrations of benzene in 2001 are provided on the air quality website (www.airquality.co.uk/archive/laqm/tools/). In Glasgow, the highest background benzene concentration is 1.03μg/m^3 in 2001. Since benzene concentrations are expected to decline by 2010, background concentrations at this time will be well below 2μg/m^3.

For this reason, it will not be necessary to assess benzene concentrations near busy roads and junctions.

5.4.3 Industrial sources

Since Glasgow has no major industrial emitters of benzene, there is no need to make an assessment of industrial sources.

5.4.4 Petrol stations

Petrol stations which 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, it is not believed that there is any location with a busy road, a sufficiently large petrol station and relevant exposure in the immediate vicinity. For this reason *there will be no requirement* to make a Detailed Assessment of benzene around petrol stations.

5.4.5 Major fuel storage depots

As Glasgow has no major fuel storage depots within its boundaries, or within the surrounding areas, *there will be no requirement* to make a Detailed Assessment for benzene at these locations.

5.5 Conclusions

Monitoring of benzene has taken place across Glasgow City centre and concentrations have been compared against the air quality objective, which is a running annual mean of 3.25μg/m^3. Results showed that while exceedences did occur in 1999, levels of benzene have been steadily declining since 2000 coinciding with the reduction of benzene content in petrol. There have been no exceedences of the objective at any monitoring location since 2000.

As the monitoring locations are representative of the worst benzene concentrations in Glasgow due to their location under bridges, it is not likely that there are any other exceedences at other locations in Glasgow.

Screening was carried out at busy roads and junctions, to identify potential exceedences of the benzene objective. However, with the low background concentrations of benzene in Glasgow, it is not considered likely that there would be any exceedences.

There are no significant industrial sources or petroleum storage depots in Glasgow that could contribute to elevated benzene concentrations.

There are no locations with a large petrol station close to a 'busy' road and with relevant public exposure that could result in elevated benzene concentrations.

As a result of monitoring and screening procedures, *there will be no requirement* for Glasgow City Council to progress to a Detailed Assessment for benzene.

6 Update and Screening Assessment of 1,3-butadiene

6.1 Introduction

Concentrations of 1,3-butadiene in ambient air were last considered in Glasgow during Stage I of the Review and Assessment process. At this time, the Air Quality objective for 1,3-butadiene was set at 2.25 μg/m^3 as a running annual mean to be achieved by 31st December 2003. Stage I concluded that Glasgow would comply with the air quality objective for 1,3-butadiene.

There have been no alterations to the air quality objective for 1,3-butadiene since the last round of review and assessment.

6.2 Sources of 1,3-butadiene

The main source of 1,3-butadiene in the UK is emissions from road traffic. In Glasgow, 96% of emissions are from road transport with 4% of emissions from other forms of transport. 1,3-butadiene is also an important industrial chemical in certain industrial processes, mainly the manufacture of synthetic rubber for tyres, and is used in bulk in these procedures. However, there are no industrial sources like this in or around Glasgow. Figure 6.1 shows a breakdown of 1,3-butadiene sources, as given by the National Atmospheric Emissions Inventory (NAEI), in 2000.

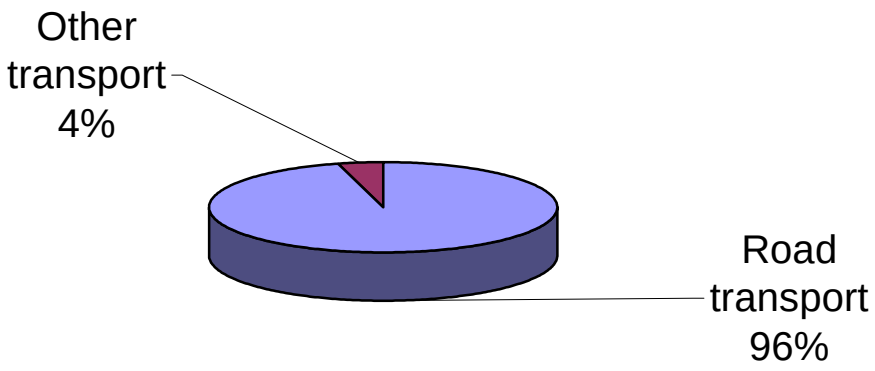


Figure 6.1 – Sources of 1,3-butadiene in Glasgow, 2000 (NAEI)

Reductions in 1,3-butadiene content of petrol and the increasing number of vehicles equipped with three way catalysts have resulted in greatly decreasing concentrations of 1,3-butadiene. Recently agreed further reductions in emissions and improvements to fuel quality are expected to further decrease ambient levels in future years.

6.3 Monitoring methodology

6.3.1 Monitoring equipment and locations

There has been no monitoring of 1,3-butadiene carried out in Glasgow over the past few years. However, an automatic monitor has now been installed in Glasgow, and commenced monitoring on August 1, 2002. The site is known as Glasgow Kerbside and is described below.

GLASGOW KERBSIDE
Positioned at the southern end of Hope Street next to Central Station (258696 665166) close to the junction with Argyle Street in a street canyon. It is a kerbside site with its inlet less than 1 m from the road. Traffic flow here is more than 25,000 vehicles per day.

However, since the majority of the data is still unratified, and since there is not enough data available to make an assessment against the objective time period of an annual mean, this data cannot be used in this Update and Screening Assessment.

The only automatic site in Scotland, which has monitored 1,3-butadiene over the past few years, is sited in Edinburgh. Data from this site can be examined to give an indication of what concentrations of 1,3-butadiene might be expected in an urban environment.

6.3.2 Public exposure

When assessing concentrations of pollutants, published guidance states that the only sites that should be considered are those which represent relevant exposure against the objective.

In the case of 1,3-butadiene, the standard is a running annual mean. Sites which should be considered are all background and roadside locations up to the building façade of properties such as residencies, schools, hospitals and other buildings where the public may visit or remain for long periods. The objective would not apply at building facades of offices or other places of work where members of the public do not have regular access or at kerbside locations where public exposure is likely to be short.

6.4 Update and Screening of 1,3-butadiene

Update and screening of 1,3-butadiene has three steps, which consider different sources, locations or data sets. The headings of the steps are listed below, and each one is then addressed in turn.

- Monitoring data
- New industrial sources
- Existing industrial sources with significantly increased emissions

6.4.1 Monitoring data

As mentioned above, there is no monitoring data available in Glasgow for 1,3-butadiene. However, it will be possible to make a crude estimate of concentrations using levels of 1,3-butadiene and benzene in Edinburgh. Figure 6.2 shows annual means of both these pollutants between 1999 and 2002.

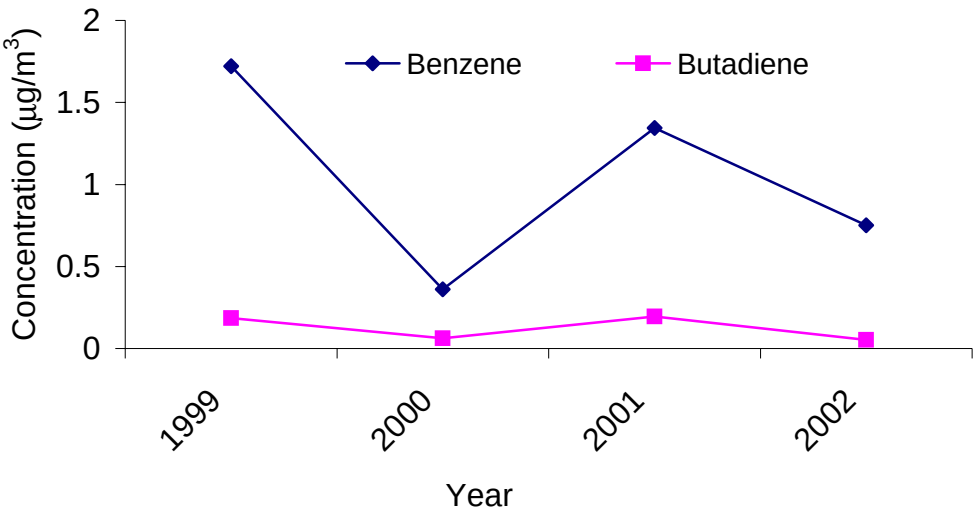


Figure 6.2 – 1,3-butadiene and benzene annual means in Edinburgh

The main source of both of these pollutants in an urban atmosphere with no significant industrial processes nearby (as in Edinburgh and Glasgow) is road traffic. Concentrations of benzene are between six to fourteen times greater than 1,3-butadiene in Edinburgh. This is extended to Glasgow data in Tables 6.1 to 6.3 below. Benzene concentrations are taken to be six times greater than 1,3-butadiene concentrations, to give an indication of a 'worst case' scenario.

Year	Benzene concentration (µg/m^3)	1,3-butadiene concentration (µg/m^3)
1999	5.2	0.9
2000	2.9	0.5
2001	2.9	0.5
2002	2.3	0.4

Table 6.1 – Heilanman's Umbrella North

Year	Benzene concentration (µg/m^3)	1,3-butadiene concentration (µg/m^3)
1999	6.5	1.1
2000	3.5	0.6
2001	3.4	0.6
2002	2.5	0.4

Table 6.2 – Heilanman's Umbrella South

Year	Benzene concentration ($\mu g/m^3$)	Estimated 1,3-butadiene concentration ($\mu g/m^3$)
1999	3.6	0.6
2000	1.9	0.3
2001	2.2	0.4
2002	1.3	0.2

Table 6.3 – Buchanan Galleries

This method of estimation suggests that concentrations of 1,3-butadiene are safely below the air quality objective. The locations mentioned above are representative of high benzene concentrations due to poor dispersion under a canopy. It is not likely that any other locations would have higher 1,3-butadiene concentrations.

Therefore, *there is no requirement* to proceed to a Detailed Assessment at these locations.

6.4.2 New industrial sources/ Existing industrial sources with significantly increased emissions

There are no new or existing industrial sources in Glasgow that are high emitters of 1,3-butadiene. As such, *there is no requirement* to proceed to a detailed assessment for 1,3-butadiene.

6.5 Conclusions

No monitoring data for 1,3-butadiene has been available in Glasgow to make an assessment against the air quality objective. However, by utilising data from an automatic monitoring site in Edinburgh, plus the close correlation between ambient benzene and 1,3-butadiene concentrations, it is extremely unlikely that any exceedences of the 1,3-butadiene objective has occurred in Glasgow.

There are no industrial sources in Glasgow that could make a large contribution to ambient 1,3-butadiene concentrations.

There will be no requirement for Glasgow City Council to progress to a Detailed Assessment for 1,3-butadiene.

7. Update and Screening Assessment of Lead

7.1 Introduction

Lead is a heavy metal, exposure to which is recognised to have potentially serious deleterious effects on human health. Lead may enter the body via ingestion or through inhalation of lead-containing particles, after which it accumulates in various body tissues, such as bone, muscle and blood. The toxic effects of lead on humans vary depending upon the extent of exposure. Effects of lead poisoning can include anaemia, osteoporosis, reproductive disorders and severe damage to the kidneys, liver and central nervous system. Furthermore, the effect of prolonged exposure to low levels of lead on the central nervous system and in particular, on the developing brain and nerves of children has received greatest attention, as this is believed to reduce the average intelligence quotient (IQ) of the exposed population. For these reasons the assessment of the atmospheric concentrations of lead is included in the National Air Quality Strategy.

Concentrations of lead in ambient air were last considered in Glasgow during Stage I of the Review and Assessment process. At this time, the Air Quality objective for lead was set at 0.5 $\mu g/m^3$ as an annual mean to be achieved by 31st December 2004. Stage I of Review and Assessment of Air Quality in Glasgow (1998) concluded that Glasgow would comply with the National Air Quality Strategy objective for lead. The air quality objective for lead has since been tightened to an annual mean of 0.25 $\mu g/m^3$ to be met by 31st December 2008.

7.2 Sources of lead

Lead is a naturally occurring element, found in the form of minerals in the earth's crust, and released by a variety of biogeochemical processes. However, anthropogenic activities represent the major sources of atmospheric lead. These include processes such as ore mining and smelting, the manufacture, utilisation and disposal of lead-containing products, and the combustion of fossil fuels. In recent decades road traffic emissions have been considered as a primary source of atmospheric lead due to the utilisation of tetraethyl lead as a petrol additive.
At the time of the last Review and Assessment of Air Quality in Glasgow, the main source of lead in air was road traffic, although this had been steadily falling since the introduction of unleaded petrol in the mid 1980's and the total ban on the sale of leaded petrol across the EU on the 1st January 2000. Emissions of lead are now largely restricted to certain industrial activities.

7.3 Monitoring methodology

7.3.1 Monitoring equipment and locations

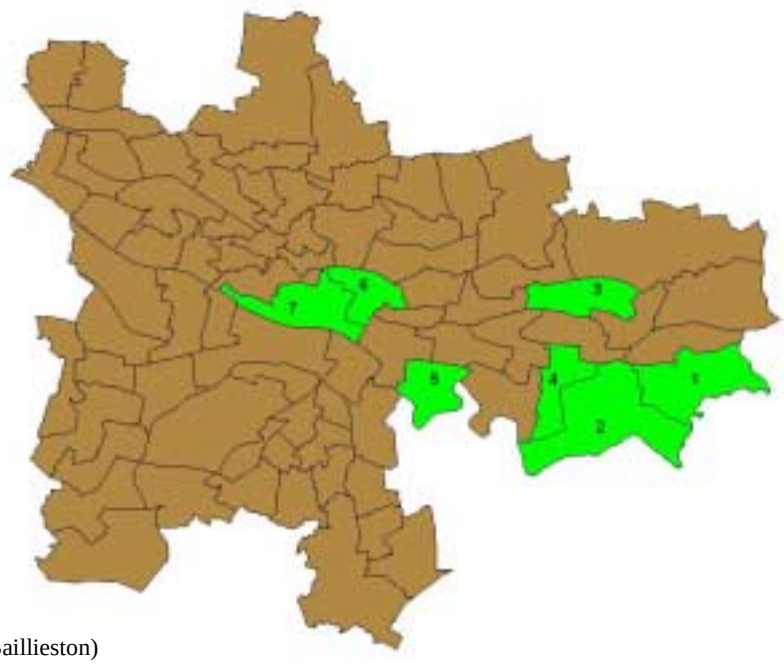
Monitoring of atmospheric lead concentrations in Glasgow has been carried out at nine locations across Glasgow since 1997. These sites are listed in Table 7.1 and the approximate locations of each are presented in Figure 7.1.

Table 7.1 Locations of atmospheric lead monitoring sites in Glasgow

Monitoring Site Name	Grid Reference
Baillieston* (1)	2679 6642
Carmyle (2)	2653 6622
Fastnet St. (3)	2645 6659
Shettleston (4)	2632 6644
Dalmarnock (5)	2612 6627
St- Anne's Primary School (5)	2613 6644
Montrose St.(6)	2595 6653
Glasgow Cross (6)	2597 6649
Charing Cross (7)	

The ST-Anne's site is part of the UK National network.

Since Stage I of the Review and Assessment of Air Quality in Glasgow (1998), several changes in the location of lead monitoring sites have occurred. The monitoring of lead at Charing Cross and Shettleston was discontinued in 2000 and 2002 respectively. In contrast, new monitoring sites have been introduced at Fastnet Street (Queenslie) and Baillieston in 2002. However, the monitoring site at *Baillieston has only been in operation since December 2002 and as such the results are not included in this report.



1 Ward 47 (Baillieston)
2 Ward 46 (Mount Vernon) Carmyle
3 Ward 40 (Queenslie) Fastnet Street
4 Ward 43 (Shettleston)
5 Ward 35 (Bridgeton/Dalmarnock) Dalmarnock & St Annes primary school
6 Ward 27 (Merchant City) City Chambers & Glasgow Cross
7. Ward 17 (Anderston) Charing Cross

Figure 7.1 – Metal monitoring locations

A standard protocol was used to determine atmospheric lead concentrations. Air is sampled by drawing air through a cellulose filter at a rate of 5 L $min^{-1}$for periods of 7 days, and lead concentrations determined by atomic absorption spectroscopy.

7.3.2 Public exposure

When assessing atmospheric concentrations of pollutants the technical guidance is clear that the only sites that should be considered are those relevant to the averaging period of the objective. For the annual objective for lead this includes locations where members of the public might be regularly exposed such as building facades of residential properties, schools, hospitals, libraries and other buildings where members of the public may be present for prolonged periods of time. The objective does not apply at locations where members of the public have restricted access and at kerbsides, where exposure is likely to be short-term.

7.4 Update and Screening of lead

The update and screening of lead has three steps that consider different sources, locations and data sets. The headings of the steps are listed below and each one is then addressed in turn.

- Monitoring data outside an AQMA
- New industrial sources
- Industrial sources with substantially increased emissions

7.4.1 Monitoring data outside an AQMA

As there has been no AQMA declared for lead, the results from the eight valid monitoring locations listed in Table 7.1 will be considered in this report. Table 7.2 presents results of annual atmospheric lead concentrations detected at all eight monitoring locations utilised in Glasgow from 1997 to 2002.

Table 4.2 Annual mean concentrations of lead (μg/ m^3) detected at monitoring locations across Glasgow from 1997 to 2002.

Location	Year					
	1997	**1998**	**1999**	**2000**	**2001**	**2002**
City Chambers	0.045	0.026	0.023	0.041	0.023	0.031
Glasgow Cross	0.039	0.025	0.019	0.024	0.041	0.033
Carmyle	0.027	0.009	0.043	0.015	0.013	0.026
Dalmarnock	0.029	0.012	0.014	0.041	0.026	0.026
Shettleston	0.060	0.039	0.027	0.031	0.043	-
Charing Cross	0.044	0.030	0.020	-	-	-
Fastnet Street	-	-	-	-	-	0.027
ST. Anne's Primary	0.044	0.029	0.020	0.017	0.025	0.015

N.B. Data presented in units of μg/ m^3.

The data presented in Table 7.2 indicates that there have been no exceedences of the 2004 air quality objective for lead (annual mean 0.5 μg/ m^3) at any of Glasgow's monitoring locations since Stage I of Review and Assessment of Air Quality in Glasgow (1998). All mean annual atmospheric concentrations of lead detected in Glasgow were approximately an order of magnitude lower than the 0.5 μg/ m^3 standard for lead, and in addition were considerably lower than the annual mean of 0.25 μg/m^3 that is to be met by 31st December 2008. Therefore, *there is no requirement* to proceed to a detailed assessment of lead.

7.4.2 New industrial sources/ Existing industrial sources with substantially increased emissions

Since the last round of review and assessment, no new industrial sources in Glasgow that are high emitters of lead have commenced operation.

At Stage I of Review and Assessment of Air Quality in Glasgow (1998), only one industrial source: Alpha Fry Metals Ltd. (1650 London Road, Glasgow) was identified as a potentially high emitter of lead into air. This site has since ceased operation (December 1999) and is thus no longer a potential source of atmospheric lead. There are therefore no existing sources with substantially increased emissions defined in the Technical Guidance (LAQM.TG(03)) as:

"A 'substantial' increase can be taken to be one greater than 30%"

Consequently, there is no requirement to proceed to a Detailed Assessment of any industrial sources.

7.5 Conclusions

Results of monitoring for lead in Glasgow, has demonstrated no exceedances of the air quality objective (annual mean: 0.5 μg/ m^3) since the last round of review and assessment (1998). This data combined with that compiled in Stage I of Review and Assessment of Air Quality in Glasgow (1998), has indicated that there have been no recorded exceedances of the 0.5 μg/ m^3 air quality objective in Glasgow since 1978. Furthermore, all detected atmospheric concentrations of lead in Glasgow were safely below the annual mean of 0.25 μg/m^3 to be met by 31st December 2008.

Taking into consideration the aforementioned information and the absence of significant industrial sources of lead in Glasgow, it is considered extremely unlikely that the annual lead objectives for 2004 and 2008 will be exceeded. Consequently, it is considered that there will be no requirement for Glasgow City Council to progress to a Detailed Assessment for lead at this time.

8 Update and Screening Assessment of Nitrogen Dioxide

8.1 Introduction

Concentrations of nitrogen dioxide (NO_2) in ambient air were last considered in Glasgow during Stage III of the Review and Assessment process. At this time, the air quality objectives for NO_2 were set at 40 µg/m^3 as an annual mean and 200µg/m^3 as an hourly mean, with 18 exceedences allowed. Both these objectives are to be achieved by 31st December 2005. Stage III concluded that exceedences of both air quality objectives were expected to occur in Glasgow before and after 2005. These exceedences occur at several locations in the city centre, and resulted in the declaration of an Air Quality Management Area (AQMA). This encompasses the entire City centre, and is shown in Figure 8.1.

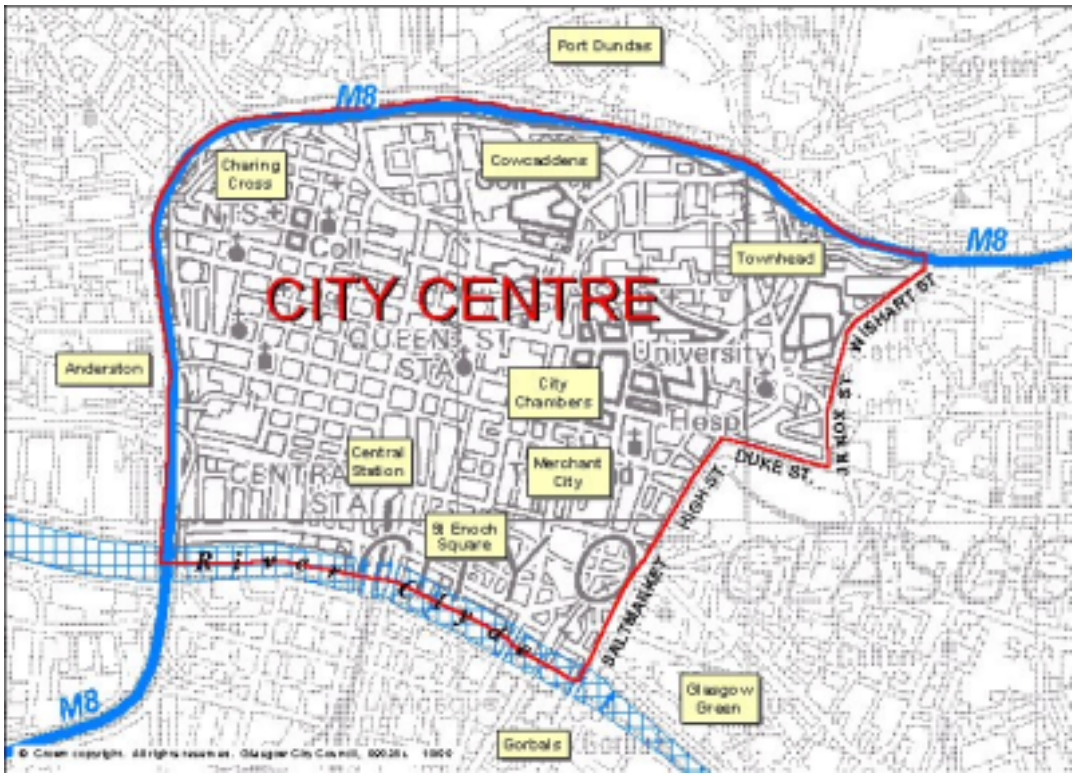


Figure 8.1 – AQMA for NO_2

8.2 Sources of nitrogen dioxide

All combustion processes produce emissions of oxides of nitrogen, NO_X, which consist of nitrogen dioxide and nitric oxide (NO). Emissions of NO_x from combustion are mainly in the form of NO at first, which is then converted to NO_2 through chemical reactions in air, primarily reacting with ozone.

The principle source of NO_X is road transport, with other sources including industrial, commercial and residential combustion. In urban areas, road transport is by far the most significant source of NO_X. The National Atmospheric Emissions Inventory

(NAEI) estimated that 78% of NO_X emissions in Glasgow in 2000 came from road sources.

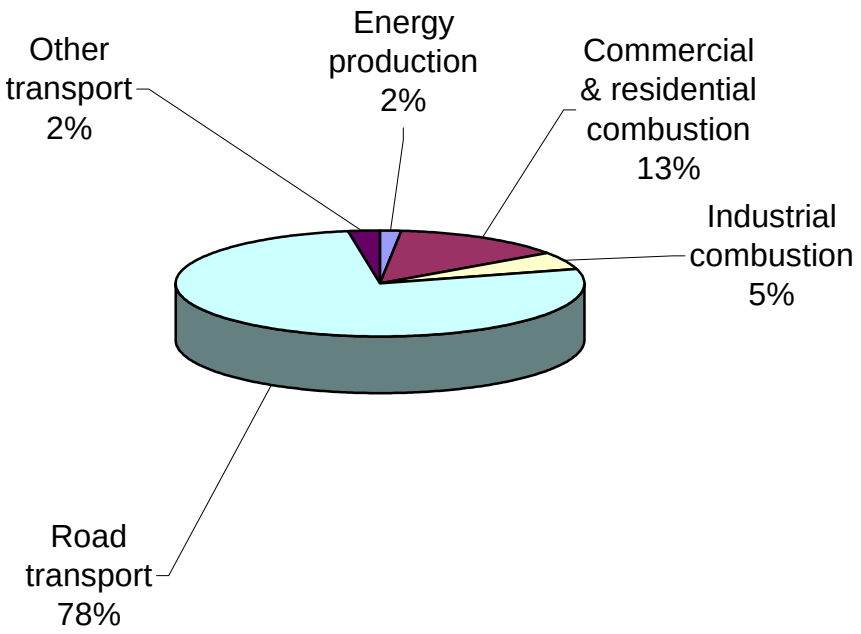


Figure 8.2 – Sources of NO_X in Glasgow, 2000 (NAEI)

NO_X emissions from road transport have been declining due to various policy measures and this is expected to continue. Urban NO_X emissions from traffic are expected to fall by about 20% between 2000 and 2005, and by 46% between 2000 and 2010. However, this will be partly offset by increases in traffic volume.

There are a few industrial processes in Glasgow that have the potential to emit significant quantities of NO_X. These are identified in Table 8.1 below.

Name	Process	Location
A Cohen	Non-ferrous metals	254298, 664460
Sacones	Incineration	263821, 664591
Allied Distillers	Combustion	259832, 663996

Table 8.1 – Industrial processes with high potential NO_2 emissions

These processes were all considered during Stage III, which concluded that these processes were unlikely to result in exceedences of the air quality objectives for NO_2. No new industrial processes, which have a high potential for NO_2 emissions, have commenced operation in Glasgow since Stage III.

8.3 Monitoring methodology

8.3.1 Monitoring equipment and locations

Monitoring of NO_2 is carried out across the City in different ways. Automatic monitoring using chemiluminescent samplers takes place at six locations across the City, although they are concentrated in or just outside the City centre AQMA. Use of this instrument is recommended in the guidance note, *Review and Assessment: Technical Guidance LAQM.TG (03).*

There is also a large NO_2 diffusion tube network in operation across Glasgow with tubes located both within and outwith the AQMA.

Three of the six automatic monitors are part of the national Automatic Urban and Rural Network (AURN) run by the Scottish Executive and the Department for the Environment, Food and Rural Affairs (DEFRA). These are:

GLASGOW CITY CHAMBERS
The site is located on the 2nd floor of Glasgow City Chambers in Cochrane Street (259527 665297) and samples air from a height of approximately 8 metres. Cochrane Street is a street canyon, and the site is classified as urban background.

GLASGOW CENTRE
This site is in St Enoch Square, an open, pedestrianised area in the centre of Glasgow (258943 665027). It is around 20m from Argyle Street which has a traffic flow of approximately 20,000 vehicles per day. The site is classed as an urban centre site.

GLASGOW KERBSIDE
Positioned at the southern end of Hope Street next to Central Station (258696 665166) close to the junction with Argyle Street in a street canyon. It is a kerbside site with its inlet less than 1m from the road. Traffic flow here is more than 25,000 vehicles per day.

Glasgow City Council independently operates another three air quality monitoring units which measure NO_2. These are described below.

GROUNDHOG
This unit has monitored since 1999 in various locations across the city. It has suffered numerous communication problems, resulting in an extremely poor data capture rate. However it is possible to make an estimation of the annual mean from short collection periods by applying adjustment factors to the available data. The method used to do this is detailed in the guidance note, *Review and Assessment: Technical Guidance LAQM.TG (03).* The adjustment factor is calculated by analysing patterns in pollutant concentrations at sites which do have complete data.

The dates and locations of Groundhog data which will be included in this report are given in Table 8.2.

Groundhog monitoring locations		
Dates	**Location**	Grid reference
Jan – Jun 2000	*Byres Road*	256553, 665487
Jan – Apr 2001	*Office World, Townhead*	259805, 666233
May – Dec 2001	*St Patrick's Primary School, Anderston*	257925, 665487

Table 8.2 – Groundhog monitoring locations

ROLLALONG

The Rollalong has been located at Office World, Townhead (259805, 666233) since May 2001. Since the Groundhog was located as this site before this, combining both data sets gives two years worth of data.

BACKGROUND

A third mobile unit has recently gone into operation at Waulkmillglen reservoir (252520, 658095), which is just outside the south-east boundary of Glasgow. This monitors background concentrations, but has only been in operation for a short time period, and so data from this will not be used at this stage. This data will be available for use in future assessments.

Figure 8.3 shows the locations all automatic monitoring sites for NO_2, except the background site.

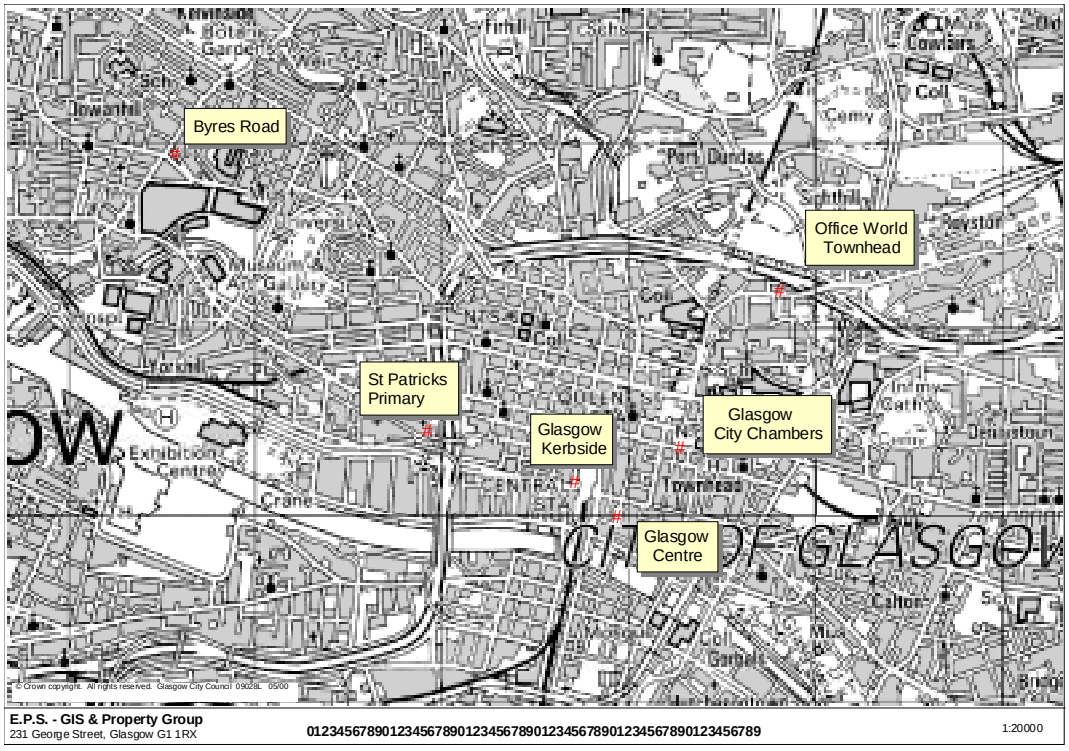


Figure 8.3 – Automatic monitoring site locations

8.3.2 Public exposure

When assessing concentrations of pollutants, the guidance is clear that the only sites that should be considered are those which represent relevant exposure against the objective.

For the annual mean objective this means considering all background and roadside locations up to the building façade of properties such as residencies, schools, hospitals and other buildings where the public may visit or remain for long periods. The objective would not apply at building facades of offices or other places of work where members of the public do not have regular access or at kerbside locations where public exposure is likely to be short.

The hourly NO_2 objective is applicable at any outdoor location where the public might reasonably be expected to have access and will include all background, roadside and kerbside sites.

8.3.3 Projected NO_2 concentrations

Monitored NO_2 can be used to estimate annual mean concentrations in 2005, the year that objectives are to be met. This is done by applying correction factors which take into account expected changes in emissions from road traffic. For this reason, these factors can only be used for areas where traffic is the main source of NO_2. The correction factors are given in Table 8.3.

Year	Correction Factor Background sites	Correction Factor Roadside sites
1999	1.066	1.075
2000	1.025	1.033
2001	1.000	1.000
2002	0.973	0.969
2003	0.948	0.941
2004	0.927	0.915
2005	0.908	0.892

Table 8.3 – Correction factors to predict 2005 NO_2 annual means

8.4 Update and Screening of NO_2

The Update and Screening Assessment of NO_2 will consider the individual sources, locations and data separately, in the form of a checklist. For NO_2 there are 13 steps, which are listed below and then addressed in the following section in turn.

- Monitoring data outside an AQMA
- Monitoring data within an AQMA
- Narrow congested streets with residential properties close to the kerb
- Junctions

- Busy streets where people may spend 1-hour or more close to traffic
- Roads with high flow of buses and/or HGVs
- New roads constructed or proposed since first round of review and assessment
- Roads close to the objectives during the first round of review and assessment
- Roads with significantly changed traffic flows
- Bus stations
- New industrial sources
- Industrial sources with substantially increased emissions
- Aircraft

8.4.1 Monitoring data outside an AQMA

The Groundhog provides the only automatic monitoring of NO_2 carried out outside the AQMA. Monitoring took place at two sites, at Byres Road and at St Patrick's Primary School. The results from the monitoring periods are presented in Tables 8.4 and 8.5.

As discussed earlier, where monitoring did not take place over a full 12-month period, an estimation of the annual mean has been made. In cases where data capture is less than 90%, the 99.8th percentile of hourly means is used. Any breaches of the objectives are highlighted red.

Year	Data capture over period (%)	Measured mean over period ($\mu g/m^3$)	Estimated annual NO_2 mean ($\mu g/m^3$)	Maximum hour ($\mu g/m^3$)	99.8th percentile of hourly means ($\mu g/m^3$)
Jan – June 2000	93.7	55	53	373	173

Table 8.4 - Byres Road monitoring results

Year	Data capture over period (%)	Measured mean over period ($\mu g/m^3$)	Estimated annual NO_2 mean ($\mu g/m^3$)	Maximum hour ($\mu g/m^3$)	99.8th percentile of hourly means ($\mu g/m^3$)
May – Dec 2001	78.8	26	31	206	141

Table 8.5 - St Patrick's Primary School monitoring results

Applying correction factors as described in 8.3.3 to the measured annual means allows an estimation of annual means in 2005 to be made. These are presented in Table 8.6.

Site	Year of monitoring	Measured mean ($\mu g/m^3$)	Estimated 2005 mean ($\mu g/m^3$)
Byres Road	2000	53	49
St Patrick's Primary School	2001	31	28

Table 8.6 – Estimated 2005 NO_2 annual means

In addition to the automated monitoring of NO_2 by the Groundhog, an extensive network of some 40 NO_2 diffusion tubes has also been utilised to monitor NO_2 at sites outside the AQMA. These tubes are located at:

Sutherland Avenue (UK)	Hillcrest Road (UK)	Broomhill Road
Sutherland Avenue 1 (Albert Drive)	Hillcrest Road	Dumbarton Road
Mosspark Boulevard	Dumbreck Road	Craigton road
Kinning Park (Stanley Street)	St Andrews Drive	Haggs Road
Pollokshaws Road	Thornliebank Road	Ascaig Crescent
Invergarry Road	Kippen Street	Dunn Street
Byres Road	Belmont Street	Mallaig Place
Castlemilk Sports Centre.	Govanhill Street	Drumhead Road
Caledonia Road	Westercraigs `	Westmuir Street
Queen Margaret Drive	Inveresk Lane	Royston Road
Easterhouse Sports Centre	Maxwellton Road	Mosside Road
North Street	Finnieston Street	Bridge/ Norfolk Street
Aikenhead Road	Balshagray Avenue	Celtic Park 1
Celtic Park 2		

According to the guidance note, Review and Assessment: Technical Guidance LAQM.TG (03), laboratory bias for NO_2 diffusion tubes must be determined and allowed for. To this end sets of triplicate diffusion tubes have been collocated with chemiluminscence monitors at the AURN sites. Bias correction has been undertaken for diffusion tubes within Glasgow City in accordance with the guidance. However, due to insufficient collocation data and changes in the analytical procedure used to prepare diffusion tubes, only the results obtained for 2002 have been adjusted for bias. Annual means of NO_2 detected at diffusion tube sites outside the City centre from 1997 to 2002 are provided together with projected annual means for 2005 in Tables 8.7 to 8.10. In these tables tube locations subdivided into type, i.e. kerbside, roadside, urban background or suburban according to Table A1.4 in Review and Assessment: Technical Guidance LAQM.TG (03). Projections of annual means for 2005 are based on years 2000, 2001 and 2002 and any breaches of the objectives are highlighted red.

Location	Grid ref.	Annual Mean NO_2 (µg/ m^3)						Projected 2005 annual mean (µg/ m^3)		
Year/ Base Year		'97	'98	'99	'00	'01	'02	'00	'01	'02
Mosspark Boulevard	255392 663286	38	33	26	24	27	39	20	24	36
Thornliebank Road	255193 659969	28	26	22	18	22	25	16	20	23
Mosside Road	257235 662064	31	23	18	21	28	41	18	25	38
Royston Road	260278 666186	46	31	31	36	49	43	31	44	40
Bridge St./ Norfolk St.	258702 664480	-	-	-	-	33	47	27	29	44
Aikenhead Road	259323 661763	-	-	-	-	27	39	-	24	36
Balshagray Avenue	254566 667431	-	-	-	-	39	36	-	27	33
North Street	257971 665654	-	-	-	-	46	52	-	41	48
Dumbarton Road	256209 666525	-	-	-	-	-	50	-	-	46

Table 8.7 NO_2 levels detected by diffusion tube at kerbside sites out with the City centre

Location	Grid ref	Annual Mean NO_2 (µg/ m^3)						Projected 2005 annual mean (µg/ m^3)		
Year/ Base Year		'97	'98	'99	'00	'01	'02	'00	'01	'02
Hillcrest Road (UK)	256485 663205	18	18	16	19	19	22	16	17	20
Hillcrest Road	256485 663205	20	21	28	14	16	20	12	14	19
Dumbreck Road	255497 663126	25	28	20	18	25	21	16	22	19
St Andrews Drive	256214 662536	24	21	19	16	21	21	14	19	19
Haggs Road	256263 661781	29	27	26	19	25	20	16	22	19
Pollokshaws Road	255839 661189	33	31	25	20	26	28	18	23	26
Dunn Street	261328 663817	-	29	26	18	31	41	15	28	37
Byres Road	256530 666939	39	38	27	33	35	47	28	31	44
Queen Margaret Drive	257440 668016	38	24	18	22	25	41	19	22	38
Westmuir Street	262559 664181	44	43	28	24	25	38	21	22	35
Finnieston Street	257235 665108						36	-	-	33

Table 8.8 NO_2 levels detected by diffusion tube at roadside sites out with the City centre

Location	Grid ref	Annual Mean NO_2 (µg/ m^3)						Projected 2005 annual mean (µg/ m^3)		
Year/ Base Year		'97	'98	'99	'00	'01	'02	'00	'01	'02
Sutherland Ave. (UK)	256343 663153	17	16	18	13	15	18	12	14	17
Kinning Park (Stanley Street)	257335 664239	33	32	24	10	26	41	9	24	38
Ascaig Crescent	254119 662931	21	18	16	12	15	17	11	14	16
Belmont Street	257535 667378	51	21	18	24	21	25	22	19	24
Mallaig Place	253984 665299	32	18	13	17	18	24	15	16	22
Govanhill Street	258545 662882	34	19	17	21	17	27	19	15	25
Drumhead Road	263744 662327	21	12	34	26	14	20	23	13	18
Caledonia Road	259504 663055	31	18	15	19	21	23	17	19	21
Westercraigs	260943 665225	34	18	9	23	19	30	21	17	28
Inveresk Lane	264162 664854	27	17	16	19	18	20	16	16	18
Maxwellton Road	262705 666577	40	28	11	33	29	35	29	26	33
Kippen Street	259727 668476	31	20	11	16	16	18	14	15	17
Broomhill Road	254904 666873	-	-	-	-	21	32	-	19	30
Celtic Park 1	261799 663987	-	-	-	-	20	17	-	18	16
Celtic Park 2	261788 664091	-	-	-	-	25	21	-	23	20

Table 8.9 NO_2 levels detected by diffusion tube at urban background sites outwith the City centre

Location	Grid ref	Annual Mean NO_2 (µg/ m^3)						Projected 2005 annual mean (µg/ m^3)		
Year/ Base Year		'97	'98	'99	'00	'01	'02	'00	'01	'02
Invergarry Road	253837 658490	17	18	12	9	14	12	8	13	11
Easterhouse Sports Centre	266936 666148	33	19	15	19	21	23	17	19	21
Castlemilk Sports Centre	260110 659181	-	13	7	17	17	20	15	15	18
Craigton Road	254513 664510	-	-	-	-	24	33	-	22	31

Table 8.10 NO_2 levels detected by diffusion tube at suburban sites out with the City centre

Automated monitoring data from outside the current NO_2 AQMA has indicated an exceedence of the annual mean air quality objective in 2005 at Byres Road. The estimated annual mean in 2005 here is 49µg/m^3. Similarly, exceedences of the 2005 annual mean objective are projected from diffusion tube data at Royston Road, Bridge Street/ Norfolk Street, North Street, Dumbarton Road and Byres Road (Tables 8.7 and 8.8). No other exceedences of the annual mean objective are projected at other locations outside the AQMA in 2005. The 99.8th percentile of hourly means at locations outside the AQMA has not indicated any exceedences of the hourly air quality objective.

On the basis of the observed exceedances of the annual mean objective at Royston Road, Bridge Street/ Norfolk Street, North Street, Dumbarton Road and Byres Road, *there will be a need* to proceed to a detailed assessment of NO_2 at these locations, to determine whether an AQMA should be declared.

8.4.2 Monitoring data within an AQMA

Monitoring data within the AQMA is to be assessed in the same manner as data gathered outside the AQMA. The automatic network inside the AQMA is much more widespread, with four automatic monitors available. These are the three AURN stations and the Rollalong/Groundhog data at Office World, Townhead.

Figure 8.4 displays the annual means measured at the three AURN stations since they commenced operation and Figure 8.5 compares the number of hourly exceedences against the permitted amount at the AURN locations. Table 8.11 presents the combined results from the Groundhog and the Rollalong at Office World.

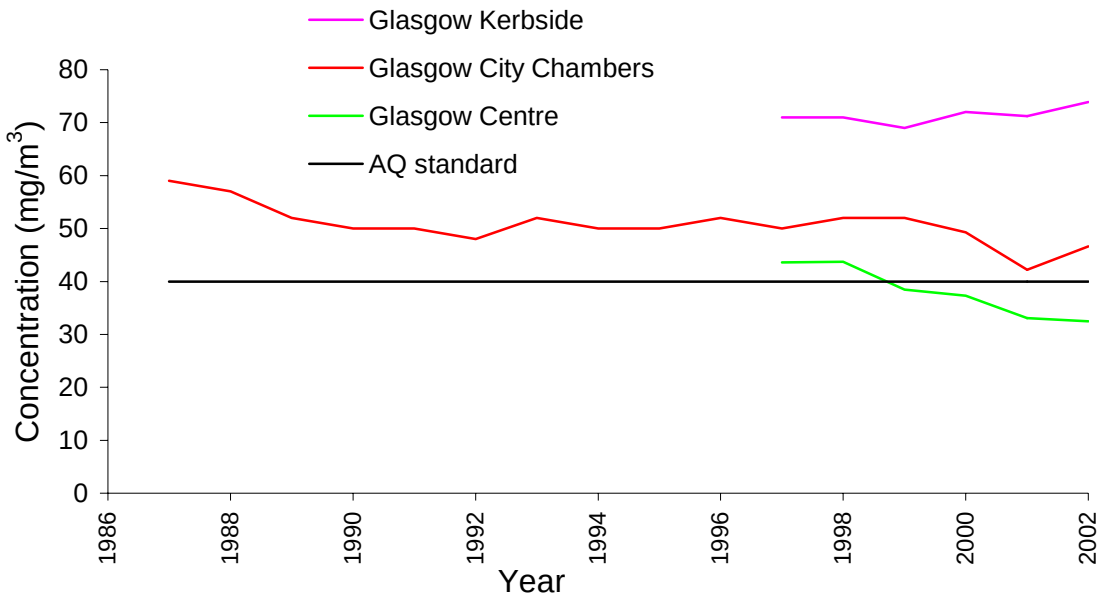


Figure 8.4 – Annual mean NO_2 concentrations at Glasgow AURN stations

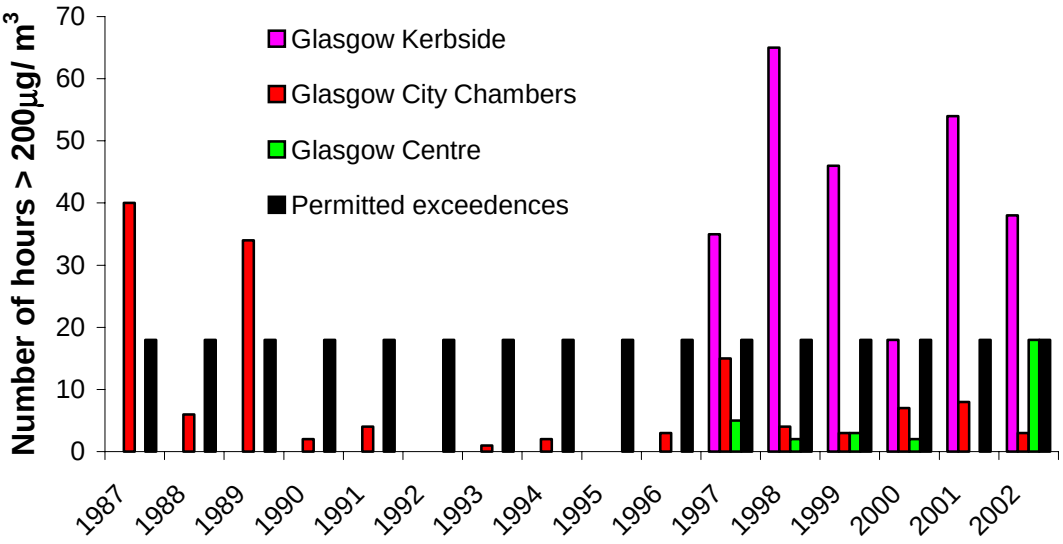


Figure 8.5 – Number of exceedences of 1 hour mean, Glasgow AURN stations

Year	Data capture (%)	Annual NO_2 mean (µg/m^3)	Maximum hour (µg/m^3)	99.8th percentile of hourly means (µg/m^3)
2001	76.7	42	335	260
2002	63.8	43	224	176

Table 8.11 – Office World monitoring results

Applying correction factors as described in 8.3.3 to the measured annual means allows an estimation of annual means in 2005 to be made. These are presented Table 8.12.

Location	Measured annual mean ($\mu g/m^3$)			Projected 2005 annual mean ($\mu g/m^3$)		
	2000	2001	2002	Base year 2000	Base year 2001	Base year 2002
Glasgow City Chambers	49	42	47	44	38	43
Glasgow Centre	37	33	32	32	30	30
Glasgow Kerbside	72	71	74	61	62	68
Office World	--	42	43	--	38	40

Table 8.12 – 2005 annual mean concentrations in AQMA

In addition to the automatic monitoring sites, Glasgow City Council also operates a system of NO_2 diffusion tube sites within the City centre. The annual mean NO_2 concentration detected from these tubes is presented below together with projected 2005 annual means at each location. As stated in Section 8.4.1, tube locations have been subdivided into type, i.e. kerbside, roadside, urban centre according to Table A1.4 in Review and Assessment: Technical Guidance LAQM.TG (03). Projections of annual means for 2005 are based on years 2000, 2001 and 2002 and any breaches of the objectives are highlighted red. Bias correction has been undertaken for diffusion tubes within Glasgow City in accordance with the guidance. However, due to insufficient collocation data and changes in the analytical procedure used to prepare diffusion tubes, only the results obtained for 2002 have been adjusted for bias.

The locations of NO_2 diffusion tubes within the City centre are:

Hope Street (UK)	Hope Street 1 (south)	Hope Street 2 (mid)
Hope Street 3 (north)	Argyle Street	Gordon Street
Glassford Street	Castle Street	George Square
Heilan'man's Umbrella north	North Hanover Street	Union Street
Heilan'man's Umbrella south	Glasgow Cross	St Vincent Street
High Street	Saltmarket	Bath Street
Buchanan Galleries north	Buchanan Galleries south	Briggait
Montrose Street	Cochrane Street 1	Cochrane Street 2
Ingram Street	Renfield Street	George Street
Broomielaw	Dobbies loan	McLeod Street (UK)
McLeod Street	Buchanan Street	

Location	Grid ref	Annual Mean NO_2 (µg/ m^3)						Projected 2005 annual mean (µg/ m^3)		
Year/ Base Year		'97	'98	'99	'00	'01	'02	'00	'01	'02
Hope Street (UK)	258730 665322	55	65	74	66	73	79	57	65	72
Argyle Street	258846 665088	54	54	46	42	35	-	36	31	-
George Square	259246 665442	52	50	36	36	40	53	31	36	49
Union Street	258833 665210	62	63	51	49	53	69	42	47	64
Glasgow Cross	259658 664868	40	42	28	24	33	42	21	29	39
Bath Street	258215 665864	26	29	42	46	34	68	40	30	63
Glassford Street	259361 665250	48	56	43	39	43	56	34	38	51
Briggait	259420 664703	35	41	30	26	29	42	23	26	39
St Vincent Street	258844 665446	62	63	48	49	47	86	43	42	79
N. Hanover Street	259375 665900	48	47	37	39	41	57	34	37	53
Castle Street	260100 665579	45	48	39	42	45	53	36	40	49
Hope Street 2 (mid)	258730 665405	62	69	63	49	48	80	42	43	74
Hope Street 3 (north)	258857 665913	44	49	42	33	43	48	29	38	44
Montrose Street	259543 665332	-	-	-	-	-	57	-	-	52
Cochrane Street (1)	259524 665294	-	-	-	-	-	43	-	-	40
Cochrane Streer (2)	259430 665316	-	-	-	-	-	46	-	-	42
Ingram Street	259524 665253	-	-	-	-	-	39	-	-	36
Renfield Street	258954 665873	-	-	-	-	-	62	-	-	57
George Street	259551 665380	-	-	-	-	-	44	-	-	40
Broomielaw	258561 664931	-	-	-	-	-	47	-	-	44

Table 8.13 NO_2 levels detected by diffusion tubes at Kerbside sites within the City centre

Location	Grid ref.	Annual Mean NO_2 (µg/ m^3)						Projected 2005 annual mean (µg/ m^3)		
Year/ Base Year		'97	'98	'99	'00	'01	'02	'00	'01	'02
Hope Street 1 (south)	258730 665322	54	59	51	45	53	80	39	47	74
Gordon Street	258766 665347	59	60	54	44	49	73	38	44	67
Heilan'man's Umbrella north	258770 665117	48	54	40	40	54	114	34	48	105
Heilan'man's Umbrella south	258769 665106	56	57	56	35	55	46	31	49	42
Saltmarket	259545 664739	-	41	33	28	31	41	25	28	38
High Street	259732 664991	-	44	37	30	34	52	26	30	47
Buchanan Galleries north	259138 665660	-	57	38	-	-	-	-	-	-
Buchanan Galleries south	259138 665641	-	52	32	39	41	74	34	37	68
Dobbies loan	259302 666289	-	-	-	-	-	39	-	-	36

Table 8.14 NO_2 levels detected by diffusion tubes at Roadside sites within the City centre

Location	Grid ref	Annual Mean NO_2 (µg/ m^3)						Projected 2005 annual mean (µg/ m^3)		
Year/ Base Year		'97	'98	'99	'00	'01	'02	'00	'01	'02
M^{c}Leod Street (UK)	260077 665481	35	36	37	27	34	34	24	31	32
M^{c}Leod Street	260077 665481	33	36	26	25	24	24	22	22	32
Buchanan Street	259024 665344	34	40	28	-	43	74	-	39	69

Table 8.15 NO_2 levels detected by diffusion tubes at urban centre sites within the City centre

The data presented in Figure 8.4 demonstrates that exceedences of the annual mean have been occurring every year at Glasgow Kerbside and Glasgow City Chambers. The last exceedence of the annual mean objective to occur at Glasgow Centre was in 1998, and concentrations have been declining steadily since. There is no need to assess Glasgow Kerbside against the annual mean, but the results are included for completeness. Furthermore, exceedences of the annual mean objective have been observed at the Office World site in 2001 and 2002 (Table 8.11). Although data capture rates are quite low for both these years, the gaps in data are spread evenly throughout the year, and it is not thought that estimating an annual mean would be any more accurate than using the data available.

Predictions for annual mean NO_2 concentrations in 2005 (Table 8.12) indicate that potential exceedences are likely to occur at Glasgow City Chambers, Glasgow Kerbside and Office World. No exceedances are expected at Glasgow Centre.

In terms of the 1 h objective, the data presented in Figure 8.4 demonstrated that the permitted number of annual exceedences (18) of the 200 $\mu g/m^3$ has been regularly exceeded at Glasgow Kerbside in recent years. In comparison, while exceedences of the 1 h objective do occur at Glasgow Centre and Glasgow City Chambers, it is unusual for the amount to approach the permitted number. In addition, the 99.8^{th} percentile of hourly means suggests a potential exceedence of the 1 h objective at Office World when the data from 2001 is used.

The data presented in Tables 8.13-8.15 list annual mean concentrations of NO_2 detected by diffusion tubes located within the AQMA for Glasgow. This data demonstrated that the annual mean for NO_2 of 40 $\mu g/m^3$ is commonly exceeded in the majority of NO_2 diffusion tubes sites located within the AQMA. Projections of NO_2 concentrations at each site by 2005 suggested that at the majority of these sites, the mean annual objective would continue to be exceeded.

As exceedences of the both the annual and 1 h air quality objectives are still regular occurrences within the AQMA, *there is no requirement* to proceed to a Detailed Assessment for this part of the City.

8.4.3 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.

The guidance note specifies those roads which should be considered in this section. It details that,

"Only include areas where the average speed is 50kph or less. Only include roads where the carriageway is less than 10m wide."

It also states that roads should be considered that,

"..have a flow greater than 10,000 vehicles per day."

There will be no roads in Glasgow which fulfil the above criteria. There are only a few roads in Glasgow which have a traffic flow of more than 10,000 vehicles per day, and these are generally found in the City centre, or on arterial routes, where the road with is much greater than 10m. For this reason, *there is no requirement* to proceed to a Detailed Assessment for NO_2 at these locations.

8.4.4 Junctions

Busy junctions are areas where high concentrations of NO_2 are likely to occur. Those junctions which were not considered fully in the last round of review and assessment should be addressed here. The assessment should be made against the predicted 2005 annual mean objectives.

Junctions which should be considered are defined in the guidance and outlined below,

"A busy junction can be taken to be one with more than 10,000 vehicles per day."
"Determine whether there is relevant exposure within 10m of the kerb"

Some of the busiest junctions in Glasgow are found within the City centre AQMA. However, as this area is under constant scrutiny, there is no need to assess these junctions. Instead, focus will be on major junctions outside the City centre.

The road network of Glasgow consists of many major arterial routes into the city centre from all directions. The busier junctions outside the AQMA have been investigated using the Design Manual for Roads and Bridges (DMRB) screening model.

This model was developed by the Highways Agency to examine the effects road developments would have on air quality. It has been adapted into a spreadsheet form for use as an air quality management tool, and is used to provide an indication of local air quality levels. It requires input information of traffic flow, speeds and proportions of vehicle types, and background concentrations of pollutants. For NO_2, the background concentrations in 2005 are used, since this is the year the objectives must be met. However, traffic flows used were from 2002, so the results may be slightly conservative, since traffic flows are expected to increase between these years. The road network and junctions investigated are listed in Table 8.16 and are shown in Appendix II. Table 8.16 shows the results obtained from the DMRB model.

Junction	**Grid reference**	**Traffic flow (AADT)**	**2005 background (µg/m^3)**	**Modelled 2005 annual mean (µg/m^3)**
Bridgeton Cross	260735, 663972	22514	35.5	40.50
Parkhead Cross	262558, 664188	19251	32.1	39.50
Battlefield	258178, 661660	21766	29.0	36.28
Victoria Infirmary	258110, 661703	21810	29.0	32.75
Shawlands Cross	257357, 662190	26916	28.3	36.64
Aikenhead Road/Calder St	259250, 662750	27240	33.0	40.14
Crow Road @ Jordanhill	254605, 667670	40549	28.7	36.08

Table 8.16 – Results from DMRB screening model at junctions

Results have indicated exceedences of the NO_2 annual mean at Bridgeton Cross and at the junction of Aikenhead Road and Calder Street. At all other sites, the estimated annual mean was below the standard of 40µg/m^3, although Parkhead Cross, Battlefield, Shawlands Cross and Crow Road are between 36 and 40µg/m^3.

It is recommended that a Detailed Assessment for NO_2 is carried out at Bridgeton Cross and Aikenhead Road / Calder Street. It is also recommended that a Detailed Assessment be carried out at Parkhead Cross, since it is only 0.5µg/m^3 under the objective, and the DMRB tool is not completely accurate.

8.4.5 Busy streets where people may spend 1-hour or more close to traffic

There are certain street locations where members of the public may be expected to spend 1-hour or more on a regular basis. If these locations are next to a busy street, there is the potential for exceedences of the 1-hour objective. Glasgow has several locations such as this, commonly a busy shopping street. The busiest streets for traffic and for shopping are found within the boundary of the AQMA, and as such will not need to be screened, since these locations are already being addressed. However, there may be streets outside the AQMA which could be a problem. The criteria for streets with potential exceedence is detailed in the guidance, and outlined below,

"Identify all busy streets where members of the public may be exposed within 5m of the kerb for 1-hour or more."

"A busy street can be taken to be one with more than 10,000 vehicles per day."

Those streets to be considered are listed in Table 8.17 and are shown in Appendix III. As discussed in 8.4.4, the DMRB model was used to screen busy streets for high pollutant concentrations.
The results are given in Table 8.17.

Street	Grid reference	Traffic flow (AADT)	2005 background (µg/m^3)	Modelled 2005 annual mean (µg/m^3)
Victoria Park Drive South @ Whiteinch	254390, 666967	21163	29.7	33.77
Dumbarton Road @ Partick	255710, 666578	15654	34.2	40.41
Great Western Road @ Kelvinbridge	257285, 667090	24673	36.9	44.73
Shieldhall Road @ Cardonald	254100, 664985	21415	29.3	35.51
Paisley Rd West @ Cessnock	256210, 664455	17701	32.4	39.87
Maryhill Road @ Kelvindale Road	256920, 668713	20078	30.1	37.26

Table 8.17 – Results from DMRB screening model at busy streets

Results from the DMRB screening model have indicated exceedences of the NO_2 annual mean at Dumbarton Road at Partick and Great Western Road at Kelvinbridge. Annual means estimated at Paisley Road West and Maryhill Road were between 36 and 40µg/m^3.

It is recommended that a Detailed Assessment be carried out at Dumbarton Road and Great Western Road. Additionally, a Detailed Assessment should be carried out at Paisley Road West, as this site was only just below the objective. The DMRB run did not include emissions from the M8, which is close to Paisley Road West, and would have an influence of pollutant concentrations.

8.4.6 Roads with 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 good vehicles (HGVs), which are large emitters of NO_X, there may still be elevated concentrations of pollution. Again, criteria is set out in the guidance and described below,

"Identify all roads with an unusually high proportion of heavy duty vehicles. An unusually high proportion can be taken to be greater than 25%."
"Determine whether there is relevant exposure within 10m of the kerb."
"There would be no need to look for relevant exposure if the flow is less than 2,500 HDV vehicles per day."

As above, there is no need to investigate locations within the AQMA, as it is already known that the air quality objectives are exceeded at these locations. Outwith the AQMA, it is considered that there are no roads which meet the above criteria. Consequently, it is considered that *there is no requirement* to proceed to a Detailed Assessment for these locations.

8.4.7 New roads constructed or proposed since first round of review and assessment

The existing M74 terminates at Fullarton Road in the south east of Glasgow, with a 'missing link' between here and the Kingston Bridge. Work is currently still in development, however, it is planned to complete the 5 mile link from the Fullarton Road Junction to the M8 just west of the Kingston Bridge, and have this section of road open to traffic by 2008. Obviously, such a major road may have implications for local air quality. A map of the proposed route is presented in Appendix IV.

It is recognised that such a development may have implications for local air quality and consequently, Environmental Resources Management have conducted an air quality assessment on the M74 extension on behalf of the Scottish Executive. This report concluded that although a long term overall improvement in air quality is predicted with some 96 % of residential properties in the wider study area expected to experience a reduction in NO_2; detailed modelling identified some increases in NO_2 concentrations close to the road corridor which could potentially result in exceedences of the air quality objectives. Consequently, it is considered that *there is a requirement* to proceed to a Detailed Assessment for these locations.

8.4.8 Roads close to the objective during the first round of review and assessment

Since the emission factors for road traffic were updated in 2002, there may be locations which were addressed in the first road of review and assessment and were close to the objective that must be investigated again. "Close" to the objective is defined in the guidance as,

"..any roads where annual mean concentrations in 2005 were predicted to be above 36μg/m^3 but below 40μg/m^3.."

This only applies against the annual mean objective in 2005 where AQMAs were not declared.

Analysis of predictions of 2005 annual means made in the Stage III report shows that there are no locations outwith the declared AQMA expected to be between 36 and 40μg/m^3 in 2005. Therefore, it is considered that *there is no requirement* to proceed to a Detailed Assessment at these locations.

8.4.9 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 since Stage III (2001) which could lead to such a significant increase in traffic flow.

Consequently, it is considered that *there is no requirement* to proceed to a Detailed Assessment at these locations.

8.4.10 Bus 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. The main bus station in Glasgow is Buchanan Bus Station, located within the AQMA. The guidance advises to,

"Determine whether there is relevant exposure within 10 m of the bus station (20 m in major conurbations."

An assessment should be made against the 1-hour objective. However, it is unlikely that members of the public would be within 10m of Buchanan Bus Station. It is more probable that the public would merely pass by the bus station, but would have no reason to stay for long periods. As a result, it is considered that *there is no requirement* to proceed to a Detailed Assessment at this location.

8.4.11 New industrial sources

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 NO_2 concentrations have commenced operation in Glasgow since the last round of review and assessment. As a result, it is considered that *there is no requirement* to proceed to a Detailed Assessment for this source.

8.4.12 Industrial sources with substantially increased emissions

Existing industrial sources that were considered in Stage III could cause exceedences of the 1 h objective if emissions have increased substantially, defined as,

"A substantial increase can be taken to be one greater than 30%."

Emissions from existing industrial sources in Glasgow have not increased significantly since the last round of review and assessment. Therefore, it is considered that *there is no requirement* to proceed to a Detailed Assessment for these sources.

8.4.13 Aircraft

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, so emissions from aircraft takeoff will not have any effect on air quality in Glasgow. For this reason, it is considered that *there is no requirement* to proceed to a Detailed Assessment for this source.

8.5 Conclusions

The Update and Screening Assessment of NO_2 has concluded that a Detailed Assessment will be required in the following areas;

- Monitoring locations outside the AQMA where exceedences of the air quality objectives have been recorded
- Junctions – where DMRB has indicated potential exceedences of the air quality objectives
- Busy streets - where DMRB has indicated potential exceedences of the air quality objectives
- New roads proposed – M74

9 Update and Screening Assessment of Sulphur Dioxide

9.1 Introduction

There are three air quality objectives for sulphur dioxide (SO_2), a 15-minute mean, an hourly mean and a 24-hour mean. These objectives are outlined in Table 9.1 below.

Averaging period	Air Quality objective ($\mu g/m^3$)	Number of permitted exceedences	Compliance date
15 minutes	266	35	31 Dec 2005
1 hour	350	24	31 Dec 2004
24 hour	125	3	31 Dec 2004

Table 9.1 – SO_2 air quality objectives

Concentrations of SO_2 in ambient air were last considered in Glasgow during Stage II of the Review and Assessment process. This report concluded that there would be no exceedences of any of the air quality objectives for SO_2. There have been no changes in the air quality objectives for SO_2 since Stage II.

9.2 Sources of sulphur dioxide

Across the UK as a whole, power stations are the most significant sources of SO_2, accounting for 71% of total emissions, with other industrial combustion sources another major source. Nationally, domestic sources and road transport account for only 4% and 1% respectively.
The National Atmospheric Emissions Inventory (NAEI) for Glasgow paints a very different picture, as domestic and commercial combustion accounts for almost 2/3 of total SO_2 emissions with road transport the next most important sources. Figure 9.1 illustrates SO_2 in Glasgow for 2000, the most recent data available.

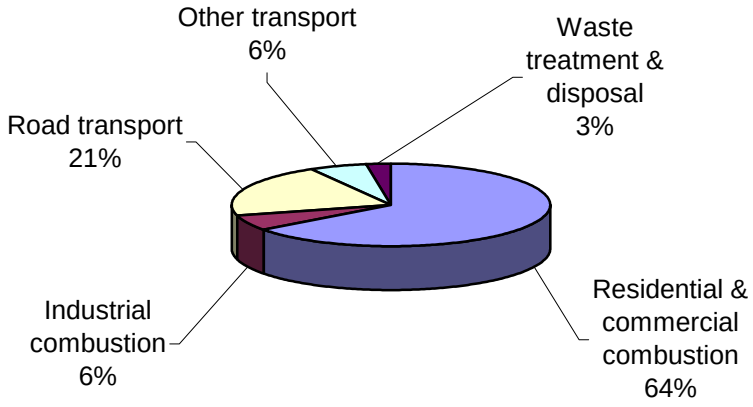


Figure 9.1 – Sources of sulphur dioxide in Glasgow, 2000 (NAEI)

Residential and commercial combustion sources that are likely to be significant will include small (>5MW) combustion plants and boilers from places including schools,

hospitals and universities. These sources may lead to exceedences of the objectives in the immediate area, principally the 15-minute objective.

There are three Part A sources in Glasgow which have the potential to contribute significantly to SO_2 concentrations, again most notably in the local area. These are listed in Table 9.2.

Name	Grid reference	Process
James Reid	263096, 664469	Non-ferrous metals
A Cohen	254298, 664460	Non-ferrous metals
Allied Distillers	259832, 663996	Combustion

Table 9.2 – Significant industrial sources of SO_2

These sources were considered in Stage II, and a report prepared by BP Energy which investigated emissions at Allied Distillers, concluded that there would not be exceedences of any air quality objectives in the vicinity of any of these sites.

While road transport accounts for a large amount of total SO_2 emissions in Glasgow, it is not considered likely that it will result in exceedences of any air quality standards.

9.3 Monitoring methodology

9.3.1 Monitoring equipment and locations

In the past, SO_2 was primarily generated by the burning of coal, which was extremely widespread, and often lead to episodes of high pollution. For this reason, Glasgow operated an extensive SO_2 monitoring network dating back to the 1950's, at one time running more than 40 sites. There are currently six sites operated in the national network, and these are listed in Table 9.3 together with numbers corresponding to their locations as presented in Figure 9.2. In addition a Council run monitoring site is located at Carmyle.

Site Name	**Grid Reference**
Baillieston (1)	2679 6642
Carmyle (2)	2653 6622
Dalmarnock (3)	2612 6627
Springburn (4)	2611 6678
Montrose Street (5).	2595 6653
Kelvinhall Art Galleries (6)	2568 6663
Cardonald (7)	2533 6641

Table 9.3 Locations of SO_2 bubbler in Glasgow

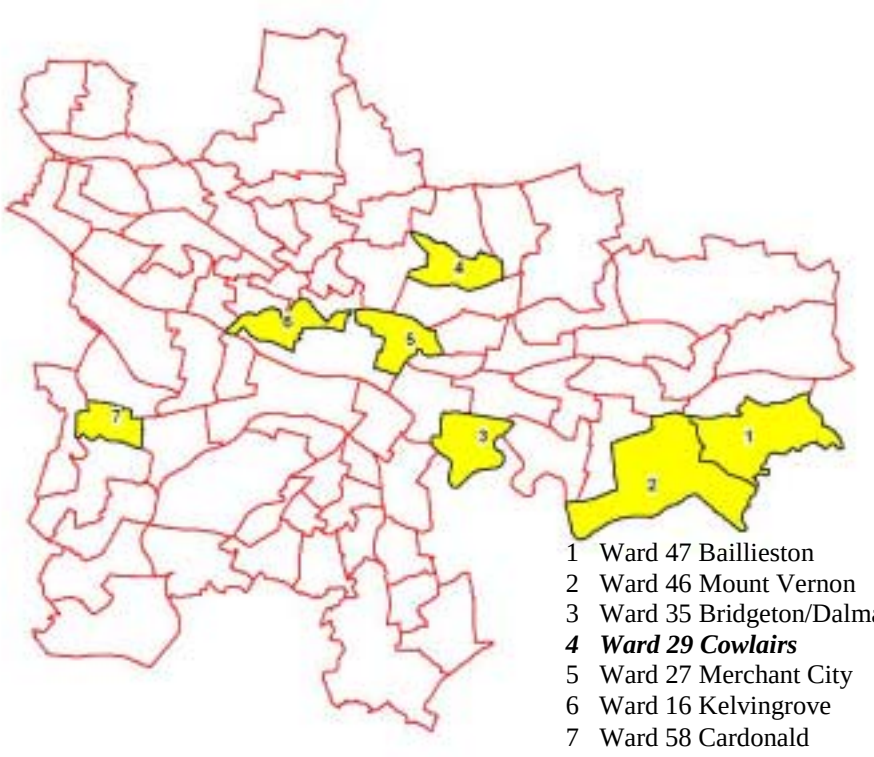


Figure 9.2 – 8 port bubbler site locations

At these sites, atmospheric SO_2 is sampled by bubbling ambient air through a solution of hydrogen peroxide over a 24-hour period. The solution is analysed by net acidity titration, and a daily concentration of SO_2 is derived. However, analysis by acidity titration increases the uncertainty in the results, and a correction factor must be applied when making comparisons against objectives which relate to peak SO_2 concentrations. This method is described in the guidance note, and is set at 1.25.

Since the bubbler technique is only able to supply SO_2 concentrations over a 24-hour period, empirical relationships are required for allow comparisons with the 15 minute and 1 hour objectives. These relationships are given below.

$$99.9^{th} \text{ percentile of 15 minute mean} = 1.8962 * \text{maximum daily mean}$$
$$99.7^{th} \text{ percentile of 1 hour mean} = 1.3691 * \text{maximum daily mean}$$

However, due to the uncertainty of these relationships, the LAQM.TG(03) Technical Guidance states that:

"It may be assumed that the 15-minute mean objective is unlikely to be exceeded if the maximum daily mean concentration is less than 80 $\mu g/ m^3$, and the 1-hour objective is unlikely to be exceeded if the maximum daily mean concentration is less than 200 $\mu g/ m^3$"

There are also two sites where SO_2 is monitored using automatic, real-time samplers. This method is more accurate than the bubbler technique, and also has the advantage of being able to make direct comparisons against all three air quality objectives. A description of both sites follows below, and their locations are also highlighted in Figure 9.3.

GLASGOW CENTRE

This site is in St Enoch Square, an open, pedestrianised area in the centre of Glasgow (258943 665027). It is around 20m from Argyle Street which has a traffic flow of approximately 20,000 vehicles per day and is classed as an urban centre site.

GROUNDHOG

This unit has monitored since 1999 in various locations across the city. It has suffered numerous communication problems, resulting in an extremely poor data capture rate. For this reason, it will only be possible to use sets of data from two sites. The first is Byres Road, a busy thoroughfare in the west end of the city. Monitoring was carried out for a continuous 6 month period in 1999. The second site with usable data is St Patrick's Primary School, Anderston. While the Groundhog has been sited here since May 2001, data capture from 2002 is less than 50% with large gaps throughout the year. However, seven continuous months of data available in 2001 can be used.

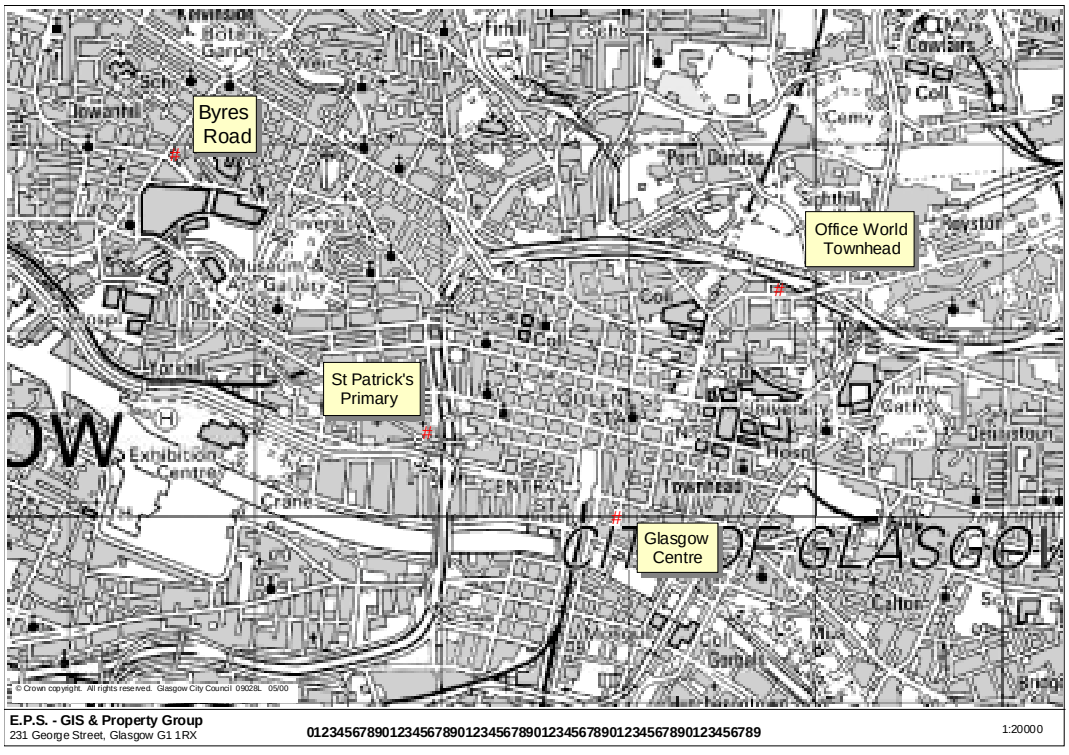


Figure 9.3 – Automatic monitoring site locations

9.3.2 Public exposure

When assessing concentrations of pollutants, the guidance is clear that the only sites that should be considered are those that represent relevant exposure against the objective.

For the annual mean objective this means considering all background and roadside locations up to the building façade of properties such as residencies, schools, hospitals and other buildings where the public may visit or remain for long periods. The objective would not apply at building facades of offices or other places of work where members of the public do not have regular access or at kerbside locations where public exposure is likely to be short.

The hourly SO_2 objective is applicable at any outdoor location where the public might reasonably be expected to have access and will include all background, roadside and kerbside sites. The 15-minute objective is applicable at all locations where members of the public may be exposed for a period of 15-minutes or longer.

9.4 Update and Screening of SO_2

There are 8 stages that are required to be carried out for the Update and Screening Assessment of SO_2. These headings are listed below, and each will then be addressed in turn.

- Monitoring data outside an AQMA
- Monitoring data within an AQMA
- New industrial sources
- Industrial sources with substantially increased emissions
- Areas of domestic coal burning
- Small boilers (>5 $MW_{(thermal)}$) burning coal or oil
- Shipping
- Railway locomotives

9.4.1 Monitoring data outside/ within an AQMA

Since there is no AQMA declared for SO_2 in Glasgow, both these sections will be addressed together. In relation to the AQMA which has declared for NO_2, the Glasgow Centre automatic monitoring site and Montrose Street bubbler are inside the AQMA, the rest are outside the AQMA. The graphs below compare maximum 15 minute, 1 hour and 24 hour SO_2 concentrations against their respective air quality objective. For bubbler data, the correction factor has been applied to the 24-hour mean, and the empirical relationships used to estimate the 15 minute and 1 hour percentiles as discussed above. Data from the two automatic sites is presented first, followed by 8-port bubbler results. Note that for the Groundhog results, where data capture is less than 90%, the relevant percentiles are considered rather than number of exceedences.

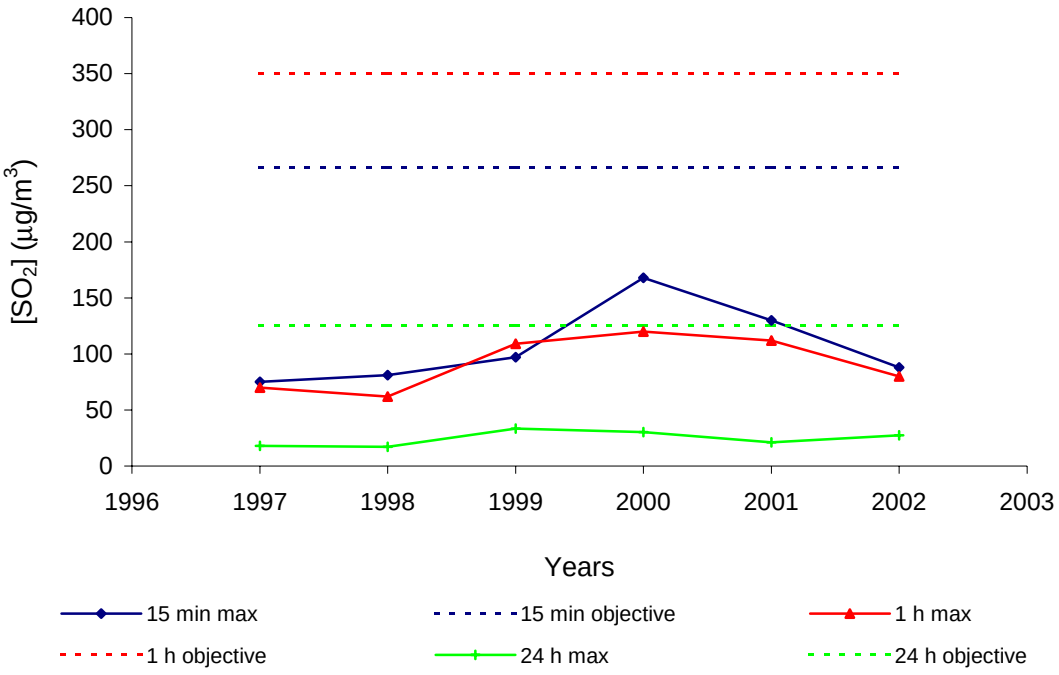


Figure 9.4 Glasgow Centre AURN maximum SO_2 concentrations

	Byres Road Jan – Jun 2000			**St Patrick's May – Dec 2001**		
	Data capture (%)	*Percentile/ Number of exceedences*	*AQ objective ($\mu g/m^3$)*	*Data capture (%)*	*Percentile*	*AQ objective ($\mu g/m^3$)*
15 min	97.4	0 exceedences	266	71.5	99.9^{th} = 83.8µg/m^3	266
1 hour	72.5	99.7^{th} = 37.6µg/m^3	350	73.2	99.7^{th} = 53.2µg/m^3	350
24 hour	81.4	99^{th} = 14.4µg/m^3	125	72.7	99^{th} = 18.1µg/m^3	125

Table 9.4 – Groundhog maximum SO_2 concentrations

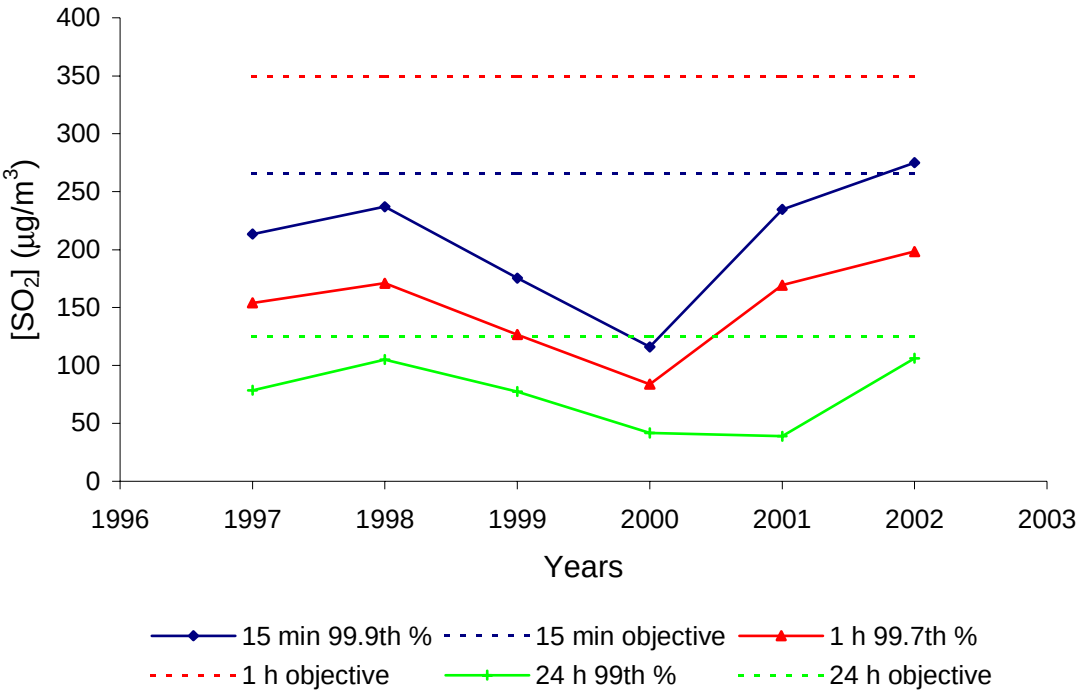


Figure 9.5 – Baillieston SO_2 concentrations (8 port bubbler)

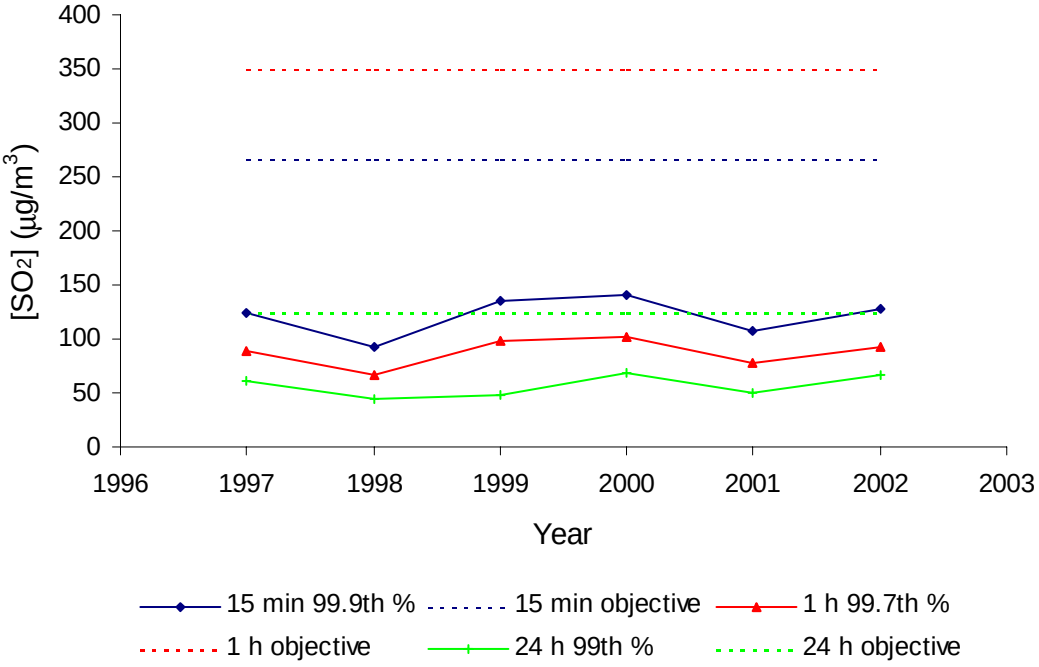


Figure 9.6 Carmyle SO_2 concentrations (8 port bubbler)

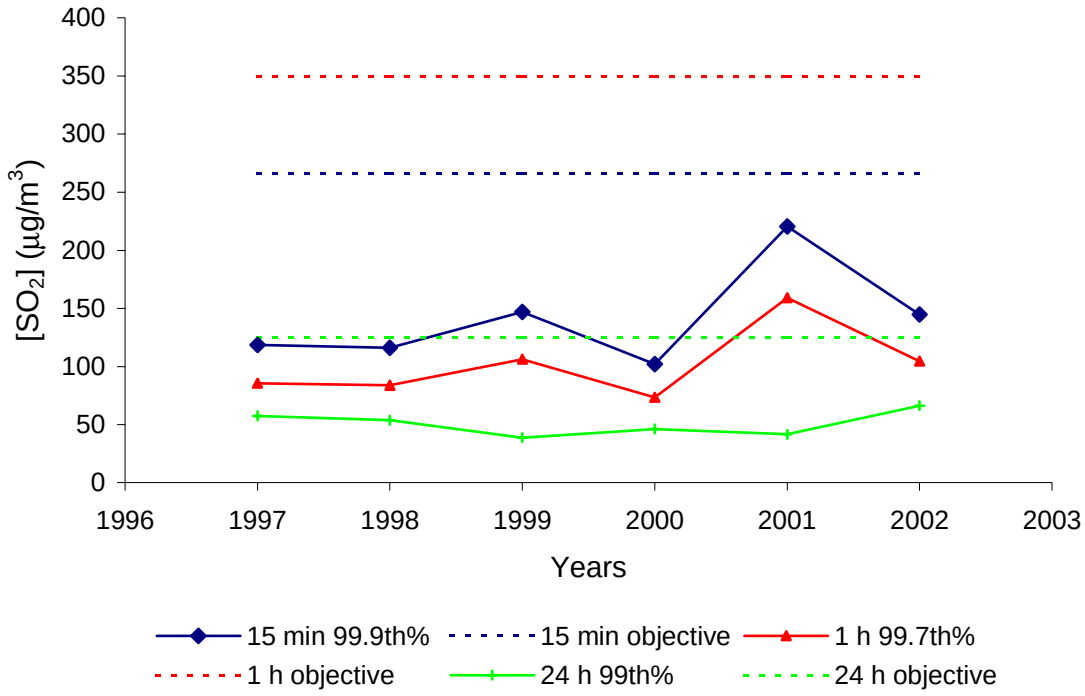


Figure9.7 Dalmarnock SO_2 concentrations (8 port bubbler)

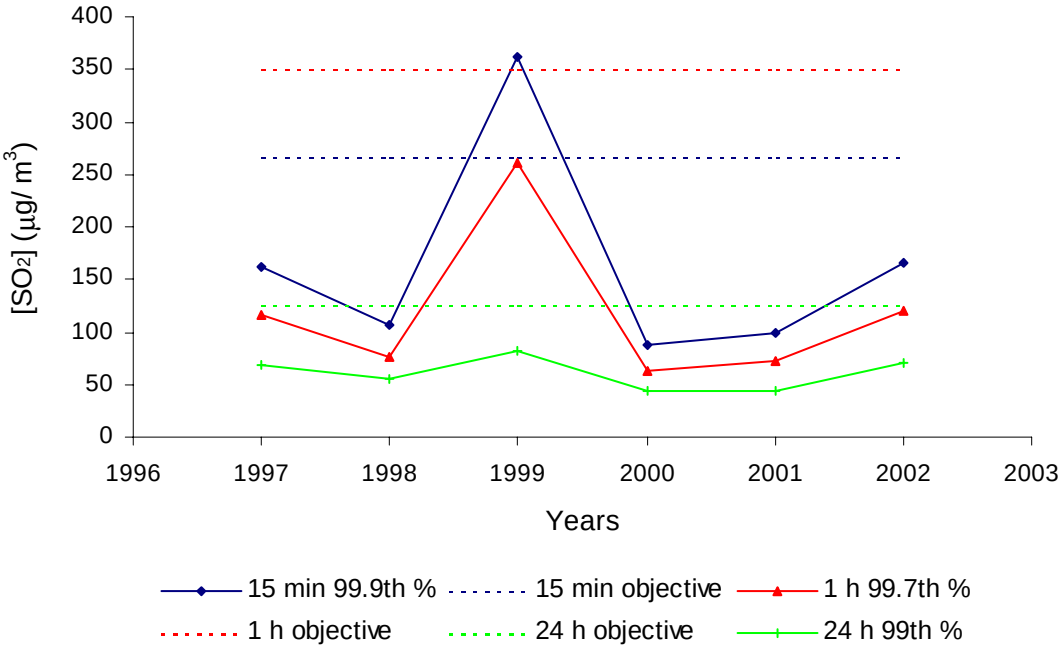


Figure 9.8 Springburn SO_2 concentrations (8 port bubbler)

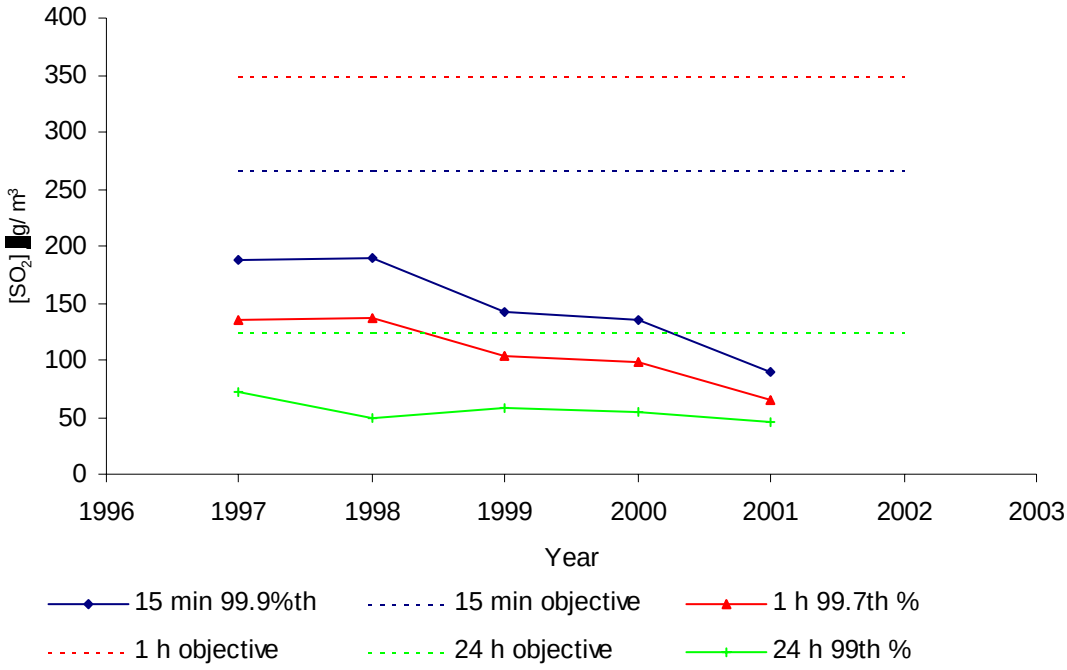


Figure 9.9 Montrose Street SO_2 concentrations (8 port bubbler)

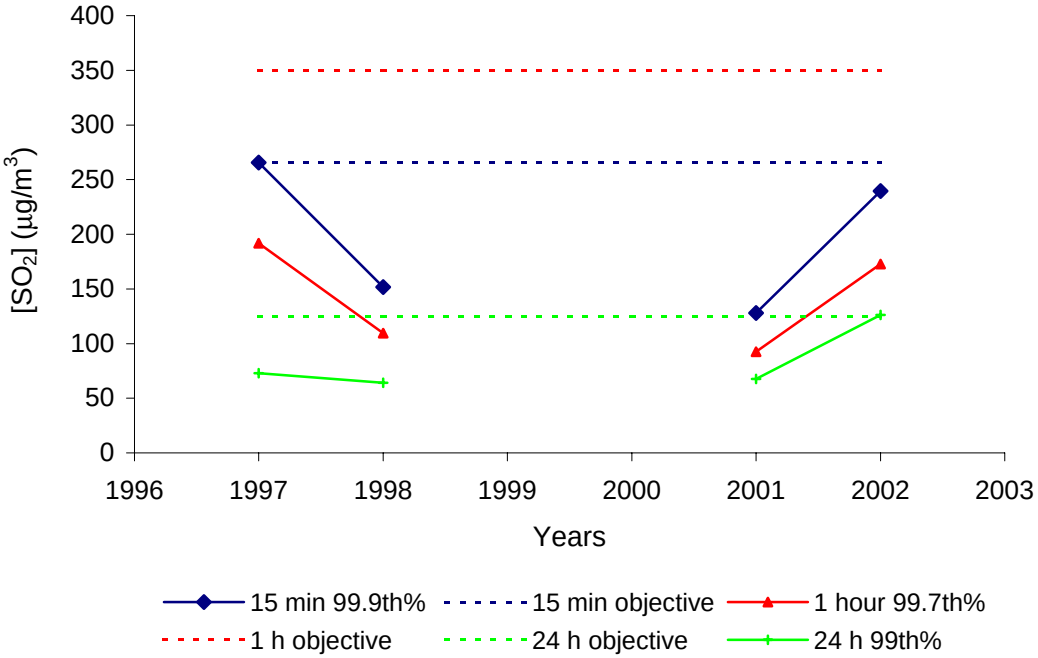


Figure 9.10 Kelvingrove Art Galleries SO_2 concentrations (8 port bubbler)

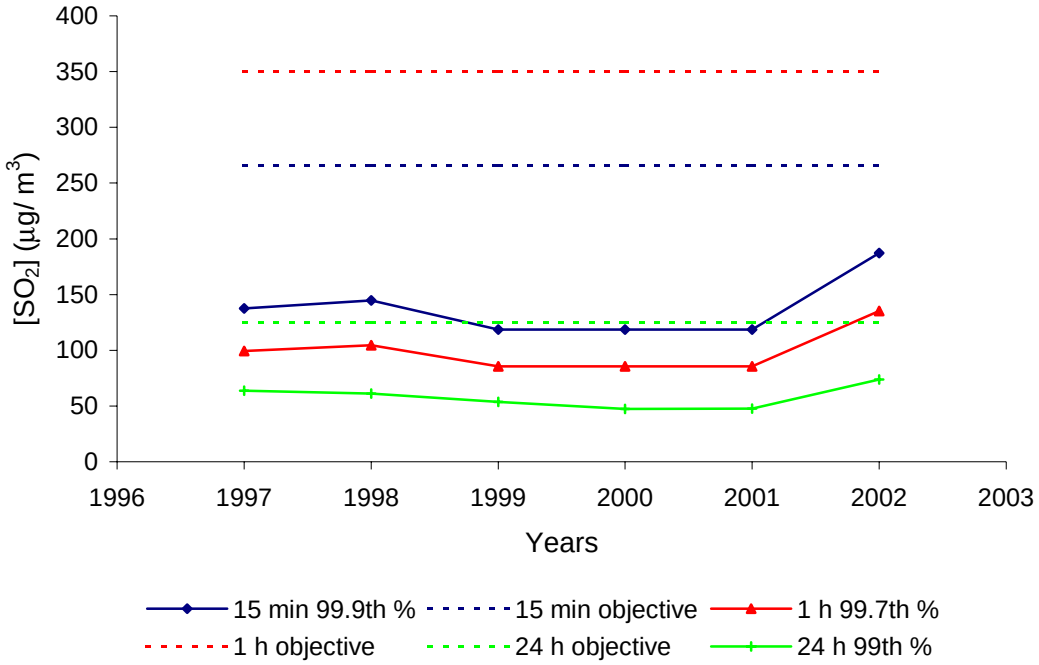


Figure 9.11 Cardonald SO_2 concentrations (8 port bubbler)

	Baillieston	Carmyle	Dalmarnock	Springburn	Montrose St.	Kelvinhall Art Galleries	Cardonald
Year							
1997	113	65	63	85	79	140	73
1998	125	49	61	56	80	80	76
1999	93	71	78	191	75	N.A.	63
2000	61	74	54	58	71	N.A.	63
2001	124	56	116	53	47	68	63
2002	145	68	76	88	-	126	99

Table 9.5 Maximum daily mean [SO_2](µg/m^3) determined by 8-port bubblers

The results of automatic SO_2 monitoring from Glasgow Centre (Fig. 9.4) and the Groundhog (Table 9.4) demonstrated that no exceedences of the 15-min, 1-hour or 24-hour objectives were recorded at either location. In comparison, results of SO_2 concentrations at various locations determined using 8 port bubblers (Figures 9.5-9.11) demonstrated 2 exceedences of the 15-min air quality objective. These exceedances were of the 99.9th percentile of the 15-min objective and were observed at Springburn in 1999 (Fig. 9.8) and Baillieston in 2002 (Fig. 9.5).
However, as the data from the 8 port bubblers was not a direct measurement of SO_2 concentration but instead relied upon approximations (see Section 9.3.1), the Technical Guidance takes account of the uncertainty of these relationships stating that;

"…it may be assumed that the 15-minute mean objective is unlikely to be exceeded if the maximum daily mean concentration is less than 80 µg/m^3, and the 1-hour mean objective is unlikely to be exceeded if the maximum daily mean concentration is less than 200 µg/m^3."

The inclusion of maximum daily mean SO_2 concentrations from all 8-port bubbler locations (Table 9.5) demonstrates that daily means equal to or in excess of 80 $\mu g/m^3$ have been observed at Baillieston, Dalmarnock, Springburn, Kelvinhall Art Galleries, Montrose Street and Cardonald, indicating the potential exceedence of the 15-min mean objective. However, no exceedences of the 1-hour objected are foreseen.

Consequently, it is considered that it will be *necessary to proceed* to a Detailed Assessment of SO_2.

9.4.2 New industrial sources

Since the last round of Review and Assessment, there have been no new industrial sources which have the potential to emit large amounts of SO_2 into ambient air. There is therefore no requirement to make an assessment of SO_2 against this topic.

9.4.3 Industrial sources with substantially increased emissions

There are several sources in Glasgow which are relatively significant emitters of SO_2. However, these were considered fully both in Stage II and, in some cases, independent assessments, which concluded that exceedences of the air quality objectives were not likely to be caused by these sources. Since the emissions from these locations have not increased significantly in the last few years, there is no need for any further assessment.

9.4.4 Areas of domestic coal burning

There are no areas of Glasgow where 'significant' domestic coal burning takes place, when according to Technical Guidance (LAQM.TG(03), 'significant' is taken to mean:

"any area of about 500 x 500 m where there may be more than 100 houses burning solid fuel as their primary source of heating".

It is therefore considered that *there will be no requirement to progress to a Detailed Assessment* of SO_2 regarding domestic coal burning.

9.4.5 Small boilers > 5 $MW_{(thermal)}$

There is the risk of exceedences of the 15-minute objective around large (>5 MW) boiler plants, as these can produce high short-term concentrations in the local area. Although such boilers are unlikely to lead to exceedences of the 15-minute objective individually, especially with regulations, which limit the sulphur content of fuel oil to 1% coming into effect from January 2003, there may potentially be a problem in an area with multiple sources.

There are not believed to be any such processes within Glasgow City boundaries which emit sufficient quantities of SO_2 or which may act in combination with other sources to lead to an exceedence of the SO_2 objective.

9.4.6 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 no longer a great deal of movement of heavy ships such as these in Glasgow, and there is no requirement to consider these as a potential source.

9.4.7 Railway locomotives

Diesel and coal-fired railway locomotives will 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 Technical Guidance (LAQM.TG(03)), a potential for:

"regular outdoor exposure of members of the public within 15 m 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 15 m away from the locomotive engines. In addition, the potential exists for locomotive engine running at rail depots, however, such sites are not generally accessible to the public.

It is thus considered that *there will be no requirement* to proceed to a Detailed Assessment at these locations.

9.5 Conclusions

Monitoring of SO_2 using automatic and passive samplers has indicated two direct exceedences of the 15-min air quality objective (99.9^{th} percentile), whilst examination of the maximum daily mean SO_2 concentrations from 8-port bubbler locations demonstrated the potential for exceedences of the 15-min objective at other sites. No exceedences of the 1-hour or 24-hour objectives were noted at any site.

As a consequence the Update and Screening of SO_2 has concluded that a Detailed Assessment will be required in the following area:

- Monitoring locations outside/ within the AQMA where exceedances of the air quality objectives have been recorded

10 Update and Screening Assessment of PM_{10}

10.1 Introduction

Concentrations of fine particles (PM_{10}) were last considered in Glasgow during Stage III of the Review and Assessment process. It was considered that there would be no exceedences of the air quality objectives for PM_{10} at any locations across the City.

At this time, the air quality objectives were an annual mean of 40μg/m^3, and a 24-hour mean of 50μg/m^3 not to be exceeded on more than 35 occasions per year. Both these objectives are to be achieved by 31st December 2005. However, since Stage III, the Scottish Executive has tightened these objectives considerably. The new objectives and targets dates for compliance are given in Table 10.1.

Averaging period	Air Quality objective (μg/m^3)	Number of permitted exceedences	Compliance date
24 hour mean	50	7	31 Dec 2010
Annual mean	18	na	31 Dec 2010

Table 10.1 – PM_{10} air quality objectives

10.2 Sources of PM_{10}

There are several different sources which contribute to PM_{10} concentrations in the UK. These can be split into three distinct categories.

- *Primary particles* are those which are produced directly through combustion. Sources include road transport, power generation and industrial processes.
- *Secondary particles* are formed through chemical reaction in the atmosphere. These mainly comprise sulphates and nitrates and can travel considerably distances from their source.
- *Coarse particles* have a variety of sources and include resuspended dust from road traffic, construction works and sea salt.

In Glasgow, the main source of PM_{10} emissions is road traffic, with the National Atmospheric Emissions Inventory (NAEI) estimating that this source accounts for just over half of all emissions. Other sources include residential and commercial combustion, industrial combustion and other industrial processes. Figure 10.1 gives a breakdown of emissions from within the Glasgow boundary.

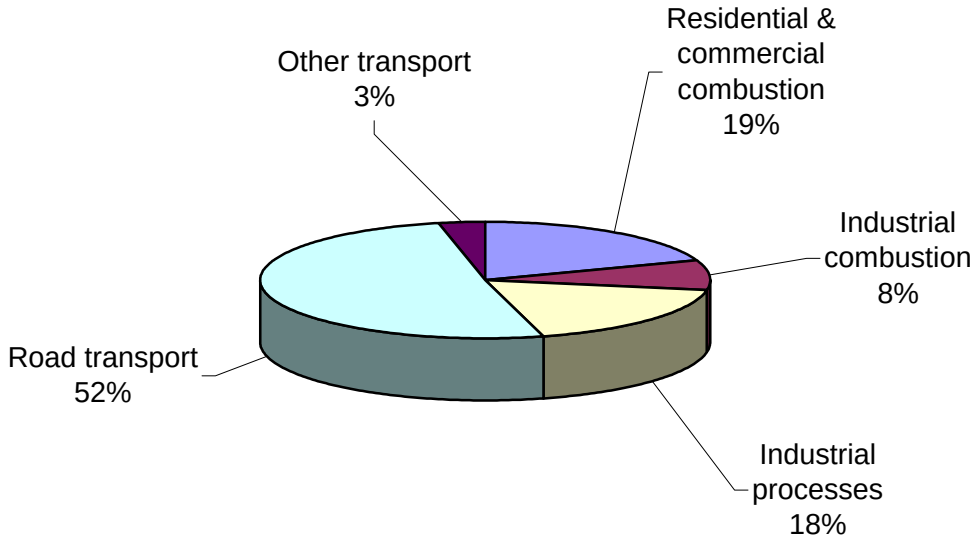


Figure 10.1 – Sources of PM_{10} in Glasgow, 2000 (NAEI)

However, a significant contribution to PM_{10} levels in Glasgow will come from sources outwith the City boundary. Long distance transport from regional sources, and sources in Europe, make up a large portion of background concentrations, which are outside of the control of local authorities.

Background concentrations of PM_{10} are available on the national air quality website (http://www.airquality.co.uk/archive/laqm/tools.php?tool=background). Some typical background concentrations are given in Table 10.2.

Grid reference		**Location**	**Background PM_{10} 2001 ($\mu g/m^3$)**
Easting	**Northing**		
258890	665540	City Centre	20.3
259360	669520	North	17.5
257600	660560	South	18.0
264360	664041	East	18.7
252200	669640	West	17.0

Table 10.2 –Background PM_{10} concentrations

Reductions in emissions of the three types of particles will be controlled independently from each other. Primary particles will be governed by legislation on such areas as vehicle emission standards and combustion processes, secondary particles will largely be governed by controls on power generation, SO_2 and NO_X emissions from industry and transport, while coarse particles are uncontrolled, and would not be expected to decline.

There are likely to be areas where road traffic sources are particularly significant. These would be locations including the City centre, where volume of traffic is

extremely high, the motorways which run through the city, and congested arterial routes and junctions.

There are several industrial sites which are potentially large emitters of PM_{10}, these are identified in Table 10.3 below.

Name	Process	Location
A Cohen	Non-ferrous metals	254298, 664460
United Distillers	Grain drying	259155, 666710
Allied Distillers	Combustion	259832, 663996

Table 10.3 – Industrial sources of PM_{10}

These processes were addresses during Stage III, and the conclusion reached was that they would not result in any exceedences of the air quality objectives for PM_{10}. However, due to the new objectives to be met in Scotland, these locations may have to be considered once again.

10.3 Monitoring methodology

10.3.1 Monitoring equipment and locations

Monitoring of PM_{10} can only be carried out using continuous automatic samplers. In Glasgow, there are currently five sites which measure PM_{10} using Tapered Element Oscillating Microbalance (TEOM) analysers. However, results from these instruments are not directly comparable to the air quality standards, which are based on measurements made with gravimetric samplers. Measurements from TEOM samplers are found to underestimate gravimetric samplers by between 15-30% and so a correction factor must be applied to TEOM results. The guidance advice on what this factor should be is,

"Measurements of PM_{10} concentrations carried out using a TEOM or β-attenuation instrument, operated with a heated manifold, should be adjusted by multiplying the data by 1.3 to estimate gravimetric equivalent concentrations."

This factor of 1.3 has been applied to all monitored PM_{10} data in Glasgow.

Two of the five automatic monitors are part of the national Automatic Urban and Rural Network (AURN) run by the Scottish Executive and the Department for the Environment, Food and Rural Affairs (DEFRA). These are,

GLASGOW CENTRE
This site is in St Enoch Square, an open, pedestrianised area in the centre of Glasgow (258943 665027). It is around 20m from Argyle Street which has a traffic flow of approximately 20,000 vehicles per day. The site is classed as an urban centre site.

GLASGOW KERBSIDE
Positioned at the southern end of Hope Street next to Central Station (258696 665166) close to the junction with Argyle Street in a street canyon. It is a kerbside site with its inlet less than 1m from the road. Traffic flow here is more than 25,000 vehicles per day.

Glasgow City Council independently operates another three air quality monitoring units which measure PM_{10}. These are described below.

GROUNDHOG
This unit has monitored since 1999 in various locations across the city. It has suffered numerous communication problems, resulting in an extremely poor data capture rate. However it is possible to make an estimation of the annual mean from short collection periods by applying adjustment factors to the available data. The method used to do this is detailed in the guidance note, *Review and Assessment: Technical Guidance LAQM.TG (03).* The adjustment factor is calculated by analysing patterns in pollutant concentrations at sites which do have complete data.

The dates and locations of Groundhog data which will be included in this report are given in Table 10.4.

Groundhog monitoring locations		
Dates	**Location**	Grid reference
Jan – Jun 2000	*Byres Road*	256553, 665487
Jan – Apr 2001	*Office World, Townhead*	259805, 666233
May – Dec 2001	*St Patrick's Primary School, Anderston*	257925, 665487

Table 10.4 – Groundhog monitoring locations

ROLLALONG
The Rollalong has been located at Office World, Townhead (259805, 666233) since May 2001. Since the Groundhog was located as this site before this, combining both data sets gives two years worth of data.

BACKGROUND
A third mobile unit has recently gone into operation at Waulkmillglen reservoir (252520, 658095), which is just outside the south-east boundary of Glasgow. This monitors background concentrations, but has only been in operation for a short time period, and so data from this will not be used. This data will be available to use in future assessments.

Figure 10.2 shows the locations of the automatic monitoring sites for PM_{10} except the background site.

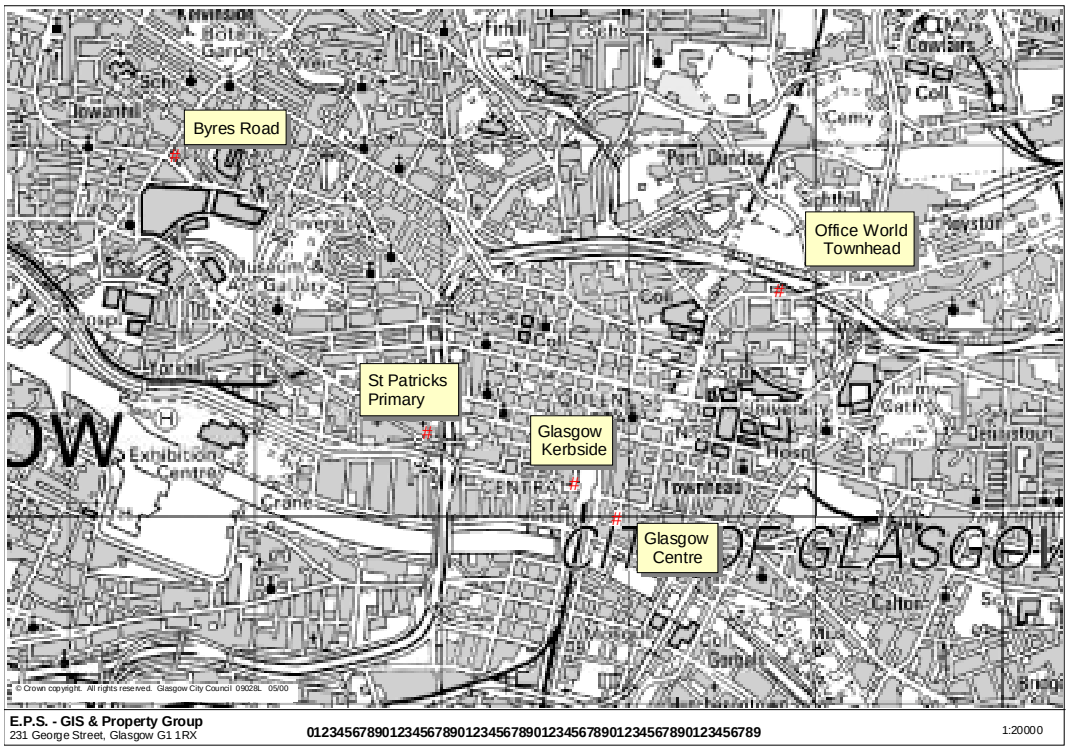


Figure 10.2 – Location of PM_{10} monitoring sites

10.3.2 Public exposure

When assessing concentrations of pollutants, the guidance is clear that the only sites that should be considered are those which represent relevant exposure against the objective.

For the annual mean objective this means considering all background and roadside locations up to the building façade of properties such as residencies, schools, hospitals and other buildings where the public may visit or remain for long periods. The objective would not apply at building facades of offices or other places of work where members of the public do not have regular access or at kerbside locations where public exposure is likely to be short. The 24-hour PM_{10} objective will apply at all locations the annual mean objective applies, and also gardens of residential properties. It should not apply at kerbside sites or any other locations where public exposure would be expected to be short term.

For the automatic monitoring sites in use in Glasgow, this means that Glasgow Centre will be compared to both the annual and 24-hour objectives. Glasgow Kerbside does not represent a location with relevant exposure for either objective, although the results will still be presented for completeness.

Groundhog data from Byres Road and St Patrick's Primary School will also be compared to both annual and 24-hour objectives. While the Office World site is not itself positioned in an area where public exposure is likely, it will still be compared to both objectives since it is probable that there will be other locations with similar PM_{10} concentrations and relevant exposure.

10.3.3 Projected PM_{10} concentrations

It is possible to make projections of PM_{10} concentrations using monitored data, to estimate whether the objectives will be breached in 2004 and 2010. However, making predictions of changing particle concentrations over time is complex, due to the different types of particles, primary, secondary and coarse, being governed by different sources, as discussed in Section 10.2.

In order to estimate total PM_{10} levels in the future the three particle components must be considered individually. Estimates of the changes in primary and secondary particle concentrations can be made, and the coarse component added to this. An example of this method, estimating total PM_{10} concentrations in 2004, is given below,

- PM_{10} annual mean measured by TEOM for 1999, **$[C_{T99}]$**
- Gravimetric annual mean, **$[C_{G99}] = 1.3 \times [C_{T99}]$**
- Obtain local secondary particle component for 2001 using maps provided on air quality website, **$[C_{sec01}]$**
- Calculate local secondary component in 1999, **$[C_{sec99}]$**, using correction factors provided
- Estimate local primary component in 1999 by subtracting the secondary and coarse (assumed to be 10.5μg/m^3) components from the measured PM_{10} concentration, **$[C_{prim99}] = [C_{g99}] - [C_{sec99}] - 10.5$**
- Use correction factors to estimate local primary component in year of interest, e.g. 2004, **$[C_{prim04}]$**
- Use correction factors to estimate local secondary component in year of interest, e.g. 2004, **$[C_{sec04}]$**
- Calculate the total estimated PM_{10} in 2004 by adding all the components together, **$[C_{g04}] = [C_{prim04}] + [C_{sec04}] + 10.5$**

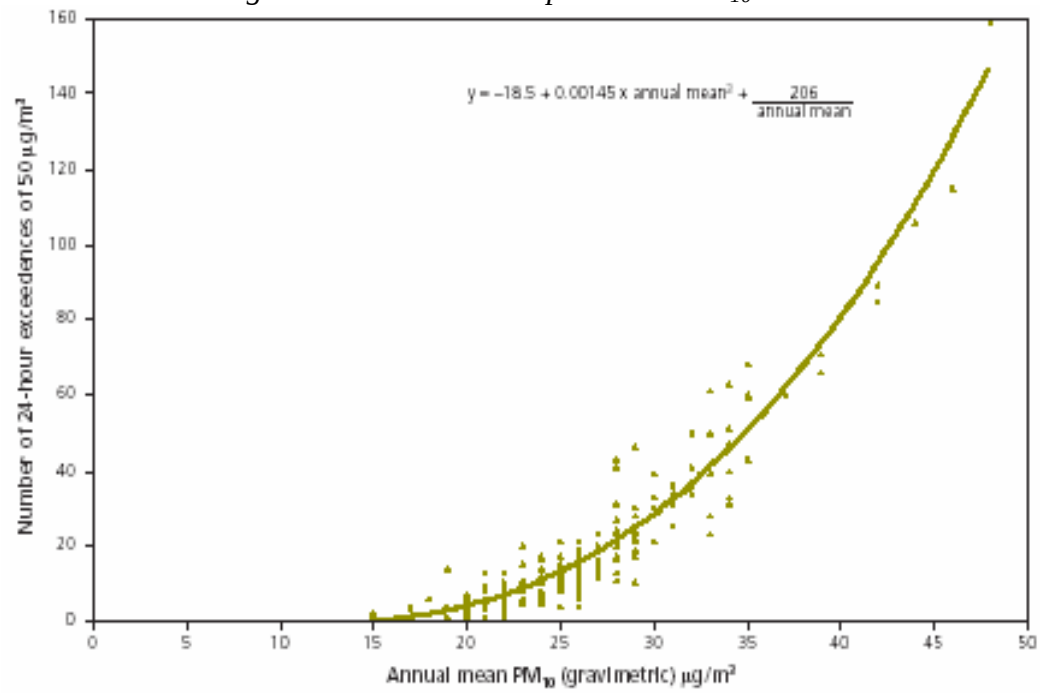
The correction factors used are given in Table 10.5.

Year	Correction factor	
	Secondary PM_{10}	**Primary PM_{10}**
1996	1.571	1.367
1997	1.340	1.289
1998	1.062	1.207
1999	0.972	1.158
2000	0.891	1.025
2001	1.000	1.000
2002	0.977	0.977
2003	0.955	0.954
2004	0.932	0.930
2005	0.909	0.907
2006	0.886	0.890
2007	0.864	0.870
2008	0.841	0.850
2009	0.818	0.832
2010	0.795	0.815

Table 10.5 – Correction factors to predict 2005 PM_{10} annual means

While it is not possible to estimate the number of exceedences of the PM_{10} 24-hour objective in the same manner as above, there is a relationship between the annual mean concentration and the number of exceedences of the 24-hour objective. This relationship was established by examination of results from AURN sites between 1997 and 2001, and is shown in Figure 10.3.

Figure 10.3 – Relationship between PM_{10} annual and 24-hour means



(Taken from Review and Assessment: Technical Guidance LAQM.TG (03))

10.4 Update and Screening of PM_{10}

The Update and Screening Assessment of PM_{10} will consider the individual sources, locations and data separately, in the form of a checklist. For PM_{10} there are 12 steps, which are listed below and then addressed in the following section in turn.

- Monitoring data outside an AQMA
- Monitoring data within an AQMA
- Busy roads and junctions
- Roads with high flow of buses and/or HGVs
- New roads constructed or proposed since first round of review and assessment
- Roads close to the objective during the first round of review and assessment
- Roads with significantly changed traffic flows
- New industrial sources
- Industrial sources with substantially increased emissions
- Areas with domestic solid fuel burning
- Quarries, landfill sites, opencast coal, handling of dusty cargoes at ports etc
- Aircraft

10.4.1 Monitoring data outside/within an AQMA

As there has been no AQMA declared for PM_{10}, all monitoring locations will be considered together. The majority of the sites are within the boundaries of the City centre. The exceptions to this are the two Groundhog monitoring locations, at Byres Road in the west of the city, and at St Patrick's Primary School, just to the west of the M8 motorway at Anderston. While there is no relevant exposure at Glasgow Kerbside, this site is also included for completeness.
Tables 10.6 to 10.10 present monitoring results from all automatic sites in Glasgow.

As discussed in 10.3.1, where monitoring did not take place over a full 12 month period, an estimation of the annual mean has been made. In cases where data capture is less than 90%, the 90th percentile of 24-hour means is used for comparison against the 2004 standard, and the 98th percentile for the 2010 standard.

Any breaches of the 2004 objectives are highlighted red, while breaches of the 2010 objectives are highlighted purple.

Year	Data capture (%)	Annual mean PM_{10} (µg/m^3)	Maximum 24-hour mean (µg/m^3)	No. of days >50µg/m^3
1997	72	40	125	80
1998	97	35	147	68
1999	97	27	105	44
2000	97	27	75	23
2001	98	31	147	36
2002	96	30	132	42

Table 10.6 - Results of monitoring for PM_{10} at Glasgow Kerbside

Year	Data capture (%)	Annual mean PM_{10} (µg/m^3)	Maximum 24-hour mean (µg/m^3)	No. of days >50µg/m^3
1997	95	27	113	19
1998	98	26	70	11
1999	98	23	87	9
2000	97	28	111	27
2001	99	22	130	12
2002	97	20	114	8

Table 10.7 - Results of monitoring for PM_{10} at Glasgow Centre

		Annual PM_{10}	Maximum 24-hour	90th percentile of 24-hour	98th percentile of 24-hour

Year	Data capture (%)	mean ($\mu g/m^3$)	mean ($\mu g/m^3$)	means ($\mu g/m^3$)	means ($\mu g/m^3$)
2001	77	25	102	26	41
2002	64	26	81	26	35

Table 10.8 - Results of monitoring for PM_{10} at Office World, Townhead

Year	Data capture (%)	Annual PM_{10} mean ($\mu g/m^3$)	Maximum 24-hour mean ($\mu g/m^3$)	90th percentile of 24-hour means ($\mu g/m^3$)	98th percentile of 24-hour means ($\mu g/m^3$)
Jan - June 2000	87	20.5	38	26	35

Table 10.9 - Byres Road monitoring results

Year	Data capture (%)	Annual PM_{10} mean ($\mu g/m^3$)	Maximum 24-hour mean ($\mu g/m^3$)	90th percentile of 24-hour means ($\mu g/m^3$)	98th percentile of 24-hour means ($\mu g/m^3$)
Jan - June 2000	87	22.4	105	19	47

Table 10.10 - St Patrick's Primary School monitoring results

Applying correction factors as described in 10.3.3 to the measured annual means allows an estimation of annual means in 2004 and 2010 to be made. These are presented in Table 10.11.

	Estimated 2004 PM_{10} annual mean concentration ($\mu g/m^3$)	Estimated 2010 PM_{10} annual mean concentration ($\mu g/m^3$)

Location	Base year 2000	Base year 2001	Base year 2002	Base year 2000	Base year 2001	Base year 2002
Glasgow Centre	27	22	20	25	20	19
Glasgow Kerbside	26	29	29	24	27	27
Office World	--	24	25	--	22	23
Byres Road	20	--	--	19	--	--
St Patrick's Primary School	--	22	--	--	20	--

Table 10.11 – Estimated PM_{10} annual mean concentrations

The relationship between the annual mean and the number of exceedences of the 24-hour mean described in 10.3.3 is used to estimate number of exceedences in 2004 and 2010. These estimations are given in Table 10.12.

Location	Predicted number of exceedences of 24hr objective in 2004 (µg/m^3)			Predicted number of exceedences of 24hr objective in 2010 (µg/m^3)		
	Base year 2000	Base year 2001	Base year 2002	Base year 2000	Base year 2001	Base year 2002
Glasgow Centre	17	5	3	11	3	1
Glasgow Kerbside	14	25	24	9	17	16
Office World	--	9	12	--	6	8
Byres Road	3	--	--	2	--	--
St Patrick's Primary School	--	5	--	--	3	--

Table 10.12 – Estimated number of exceedences of PM_{10} 24-hour standard

Monitoring data has indicated that there are no exceedences of the 2004 air quality objectives expected. The estimated annual means in 2004 are expected to be well below the objective, even at Glasgow Kerbside, where highest concentrations are expected. The number of exceedences of the 24-hour objective in 2004 is also expected to be safely below the permitted amount at all locations.

However, results show that there are exceedences of the 2010 air quality objectives across the City. Indications are that the 2010 objective will not be met at any locations where monitoring has taken place. There are two instances where the

number of exceedences of the 24-hour objective will be more than the permitted amount. These were Glasgow Centre using monitored data from 2000, and Office World using data from 2002.

Due to anticipated exceedences of the 2010 PM_{10} annual mean objective in Glasgow, and two cases regarding the 24-hour mean objective, it is considered that *there will be a requirement* to proceed to a Detailed Assessment for PM_{10}.

10.4.2 Busy roads and junctions

It is possible that high concentrations of PM_{10} are present at busy roads and junctions, and such locations should be investigated for exceedences. These should be assessed against the 2010 objectives.

The guidance advises that 'busy' roads and junctions should be inspected, where 'busy is defined as,

"Roads and/or junctions with more than 5,000 vehicles per day (AADT), where the background in 2010 is expected to be above 15$\mu g/m^3$."

"Roads and/or junctions with more than 10,000 vehicles per day (AADT), where the background in 2010 is expected to be below 15$\mu g/m^3$."

Some of the busiest roads and junctions in Glasgow are found within the City centre area. However, as discussed in 10.4.1, the City centre is known to have a problem with PM_{10}, and a Detailed Assessment will be carried out here. Instead, focus in this section is on major roads and junctions outside the City centre.

The road network of Glasgow consists of many major arterial routes into the city centre from all directions. The busier roads and junctions have been investigated using the Design Manual for Roads and Bridges (DMRB) screening model.

This model was developed by the Highways Agency to examine the effects road developments would have on air quality. It has been adapted into a spreadsheet form for use as an air quality management tool, and is used to provide an indication of local air quality levels. It requires input information of traffic flow, speeds and proportions of vehicle types, and background concentrations of pollutants.

For PM_{10}, the background concentrations in 2010 are used, since this is the year the objectives must be met. However, traffic flows used were from 2002, so the results may be slightly conservative, since traffic flows are expected to increase between these years. The road network and junctions that will be investigated are shown in Appendices II and III.

Table 10.13 shows the results obtained from the DMRB model for PM_{10}.

Junction	Grid reference	Traffic flow (AADT)	2010 background ($\mu g/m^3$)	Modelled 2010 annual mean ($\mu g/m^3$)

Bridgeton Cross	260735, 663972	22514	17.7	19.61
Parkhead Cross	262558, 664188	19251	16.9	19.82
Battlefield	258178, 661660	21766	16.3	19.02
Victoria Infirmary	258110, 661703	21810	16.3	17.54
Shawlands Cross	257357, 662190	26919	15.8	18.57
Aikenhead Rd / Calder St	259250, 662750	27240	17.0	19.32
Crow Road @ Jordanhill	254605, 667670	40549	16.1	18.80
Victoria Park Drive South @ Whiteinch	254390, 666967	21163	16.4	17.79
Dumbarton Road @ Partick	255710, 666578	15654	16.9	19.33
Great Western Road @ Kelvinbridge	257285, 667090	24673	17.5	20.76
Shieldhall Road @ Cardonald	254100, 664985	21415	16.2	18.44
Paisley Rd West @ Cessnock	256210, 664455	17701	16.4	19.36
Maryhill Road @ Kelvindale Road	256920, 668713	20078	16.2	18.95

Table 10.13 – Roads and junctions screened using DMRB

Results have indicated exceedences of the 2010 PM_{10} annual mean objective of 18µg/m^3 at several locations across the city, which are those highlighted purple. It will be required to proceed to a Detailed Assessment at all these locations. Since background PM_{10} concentrations are still expected to be high in 2010, it is possible that there will be other locations in the city which also have the potential for breaching the annual mean objective in 2010.

10.4.3 Roads with high flow of buses and/or HGVs

At locations where there is a particularly high proportion of heavy goods vehicles and buses, which are large emitters of PM_{10}, there is a possibility of elevated PM_{10} concentrations. These locations should be considered individually, with the following criteria set out in the guidance. The guidance notes that,

"If the flow of HDVs is below 2000 vehicles per day then you do not need to proceed further."

Traffic flow data shows that the stretch of road with the highest number of heavy vehicles is part of the M8, with an average of 1845 heavy vehicles per day. The highest non-motorway heavy vehicle flow is just over 500 vehicles per day.

Since relevant flow is so low, it is considered that *there is no requirement* for a Detailed Assessment at this type of location.

10.4.4 New roads constructed or proposed since last round of Review and Assessment

The existing M74 terminates at Fullarton Road in the south east of Glasgow, with a 'missing link' between this location and the Kingston Bridge. Work is currently still in development, however, it is planned to complete the 5 mile link from the Fullarton Road Junction to the M8 just west of the Kingston Bridge, and have this section of road open to traffic by 2008. A map of the proposed route is presented in Appendix IV.

It is recognised that such a development may have implications for local air quality and consequently, Environmental Resources Management have conducted an air quality assessment on the M74 extension on behalf of the Scottish Executive. This report concluded that although a long term overall improvement in air quality is predicted with some 56 % of residential properties in the wider study area expected to experience a reduction in particulate matter (PM_{10}); detailed modelling identified some increases in PM_{10} concentrations close to the road corridor which could potentially result in exceedences of the air quality objectives. Consequently, it is considered that *there is a requirement* to proceed to a Detailed Assessment for these locations.

10.4.5 Roads close to the objectives during the first round of Review and Assessment

There were several roads considered in Stage III as potential exceedences of the PM_{10} objectives. They were modelled using the model, ADMS Urban (Atmospheric Dispersion Modelling System). At the time, these roads were below the 2004 objectives, but when compared against the 2010 standards, they all fail against the annual mean objective. There was one exceedence of the 24-hour objective, at Renfield Street where the 90.4th percentile was estimated at 53.5μg/m^3. Several other streets in the City centre fell within a range of 45-50μg/m^3. The roads assessed in this manner in Stage III are listed in Tables 10.14 and 10.15, split into those within the City centre, and those outside the City centre.

	Predicted PM_{10} annual	**Predicted 90.4th percentile 24-**

Road	mean ($\mu g/m^3$)	hour mean ($\mu g/m^3$)
Union Street	24.2	46.1
M8 Townhead	25.0	47.5
Cathedral Street	22.7	43.1
M8 Charing Cross	24.2	46.1
Argyle Street	22.7	43.1
Renfield Street	28.1	53.5

Table 10.14 – Modelled PM_{10} concentrations in City centre

Road	Receptor	Predicted PM_{10} annual mean ($\mu g/m^3$)	Predicted 90.4th percentile 24-hour mean ($\mu g/m^3$)
M77/M8 Junctions	Scotland Street West	21.9	41.6
Balshagray Avenue	Balshagray Drive	21.5	40.9
Parkhead Cross	Gallowgate	21.5	40.9
Finnieston Bridge	Lancefield Quay	22.5	42.7
M8 Braehead	Shieldhall Road	21.2	40.2
Byres Road	Byres Road	21.0	40.0

Table 10.15 – Modelled PM_{10} concentrations outside City centre

Results from this monitoring indicate that the problem with the 2010 annual mean objective is widespread across the City. Results from the City centre streets suggest that there may be exceedences in many parts of the City centre.

The results also indicate that there may be exceedences in several areas outside the City centre. Several of these sites including Byres Road and Parkhead Cross, have been considered in previous sections in this report, which concluded that a detailed assessment was required at these locations. This is likely to be the case for all these locations.

Due to the expected exceedences of the 2010 air quality objective at locations both within and outside the City centre, it is considered that *there will be a requirement* to carry out a Detailed Assessment at these locations.

10.4.6 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, which is defined by,

"A 'large' increase can be taken to be greater than 25% in AADT traffic flow."

The road network in Glasgow has not undergone any major changes since Stage III (2001) which could lead to such a significant increase in traffic flow.

Consequently, it is considered that *there is no requirement* to proceed to a Detailed Assessment at these locations.

10.4.7 New industrial sources /Industrial sources with substantially increased emissions

Industrial sources do not make a significant contribution to annual mean concentrations, but they can be important in terms of the 24-hour objective, particularly in the area surrounding the source. Since Stage III, there have been no new industrial sources, and no existing sources have substantially increased their emissions, defined in the guidance as,

"A 'substantial' increase can be taken to be one greater than 30%."

On this basis, there would be no requirement to proceed to a Detailed Assessment for any industrial sources. However, the original assessments were made against the 2004 objectives. When compared against the new objectives introduced in Scotland for 2010, it is likely that exceedences will occur. The original assessments were mainly based on modelling work carried out by Glasgow City Council using ADMS Urban. Additional modelling was carried out at one site, Cohens, by SEPA using ADMS 3. A separate report prepared by BP Energy for Allied Distillers using ADMS 3 was also used. Table 10.16, 10.17 and 10.18 show the results from previous modelling studies.

Location	Year	Pollutant	Air Quality criteria	Process emissions ($\mu g/m^3$)	Background PM_{10} ($\mu g/m^3$)	Total PM_{10} ($\mu g/m^3$)**	Distance from stack (m)

A Cohen & Co.	1997	PM_{10}	24 hour mean*	40.7	42.96	117.6	280
		PM_{10}	annual mean	14.7	24	38.7	280
	1998	PM_{10}	24 hour mean*	43.2	42.96	120.1	280
		PM_{10}	annual mean	15.7	24	39.7	280
	1999	PM_{10}	24 hour mean*	43.8	41.2	117.5	280
		PM_{10}	annual mean	15.1	23	38.1	280
United Distillers	1997	PM_{10}	24 hour mean*	1.4	26	48	98
		PM_{10}	annual mean	0.4	26	26.4	115
	1998	PM_{10}	24 hour mean*	1.2	26	48	113
		PM_{10}	annual mean	0.35	26	26.35	124
	1999	PM_{10}	24 hour mean*	1.59	25	46	97
		PM_{10}	annual mean	0.54	25	25.54	129
Tarmac	1997	PM_{10}	24 hour mean*	5.92	24	49	220
		PM_{10}	annual mean	1.67	24	25.67	155
	1998	PM_{10}	24 hour mean*	4.76	24	48	155
		PM_{10}	annual mean	1.68	24	25.68	153
	1999	PM_{10}	24 hour mean*	6.48	20	42	165
		PM_{10}	annual mean	2.36	20	22.36	160

***to 90.4th percentile** ** 24 hour mean totals derived from PM_{10} (background) x 1.79 + process emission**

Table 10.16 – Modelling carried out by Glasgow City Council using ADMS Urban

Location	Year	Pollutant	Air Quality criteria	Process emissions ($\mu g/m^3$)	Background PM_{10} ($\mu g/m^3$)	Total PM_{10} ($\mu g/m^3$)**	Distance from stack (m)
A Cohen & Co.	1999	PM_{10}	24 hour mean*	13.48	41.2	54.65	280
		PM_{10}	annual mean	8.03	23	26.03	280

***to 90.4th percentile** ** 24 hour mean totals derived from PM_{10} (background) x 1.79 + process emission**

Table 10.17 – Modelling carried out at Cohen by SEPA using ADMS 3

Location	Year	Pollutant	Air Quality criteria	Process emissions ($\mu g/m^3$)	Background PM_{10} ($\mu g/m^3$)	Total PM_{10} ($\mu g/m^3$)	Distance from stack (m)
Allied Distillers	1998	PM_{10}	24 hour mean*	0.29	20	20.29	--
		PM_{10}	annual mean	0.09	20	20.09	--

***to 90.4th percentile**

Table 10.18 – Modelling carried out at Allied Distillers by BP Energy using ADMS 3

If these modelling results were compared against the 2010 objectives, exceedences of the annual mean occur at every location. However, since the background concentration in most of these cases is above the annual mean objective of 18$\mu g/m^3$, it is not surprising that exceedences occur.

These results are not directly comparable against the 2010 24-hour mean objective, since the 90.4th percentile was calculated which corresponds to the 35 exceedences permitted under the 2004 standards. For comparison to the 2010 objectives, the 98th percentile would have to be calculated.

Because of the introduction of extremely stringent air quality objectives in 2010, *it is recommended that a Detailed Assessment be carried out* at existing industrial sources in Glasgow against these new objectives. Projections can be made of concentrations in 2010 incorporating the expected fall in background concentrations in that time, and alterations to the processes which may reduce their emissions. Glasgow City Council can carry out further modelling studies using ADMS Urban to this effect.

10.4.8 Areas of domestic solid fuel burning

In areas where domestic solid fuel is still in widespread use, there can be a problem with PM_{10} concentrations. However, it is thought that for a potential problem to exist, there should be more than 50 houses burning solid fuel as their primary heating source in a 500 x 500m area.

There are no such areas in Glasgow where solid fuel burning takes place, and as such, it is considered that *there is no requirement* to proceed to a Detailed Assessment for these locations.

10.4.9 Quarries/landfill sites/opencast coal/handling of dusty cargoes at ports e.t.c.

There are several other sources which may be significant for PM_{10}, mainly through fugitive sources, ie dust. It is thought that dust emissions contain around 20% PM_{10}.

The guidance advice 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, or a visual inspection indicating significant dust.

The only source which Glasgow contains within its boundaries are landfill sites, of which there are several. The only site that the Council has received complaints about is Paterson's Tip, in the east of the City. There have been no other complaints received regarding dust, nor is dust considered an issue, at any other site.

The complaints regarding Paterson's have also not concerned dust, but mainly smell. There is a working group concerned with Paterson's, of which Glasgow City Council is an active participant, to address all issues surrounding Paterson's, so there is no need for any separate investigation.

Therefore, it is considered that *there is no requirement* to proceed to a Detailed Assessment for these sources.

10.4.10 Aircraft

While aircraft are not considered significant sources of PM_{10} emissions, they may make a contribution close to the source.

Glasgow International Airport is located outwith the city boundary, so emissions from aircraft will not have any effect on air quality in Glasgow. For this reason, it is considered that *there is no requirement* to proceed to a Detailed Assessment for this source.

10.5 Conclusions

The Update and Screening Assessment of PM_{10} has concluded that a detailed assessment will be required in the following areas:

- Monitoring locations City-wide where exceedences of the 2010 air quality objective are expected.
- Busy roads and junctions – where DMRB has indicated potential exceedences.
- New roads proposed – M74.
- Existing industrial sites which may result in breaches of the 2010 objectives.

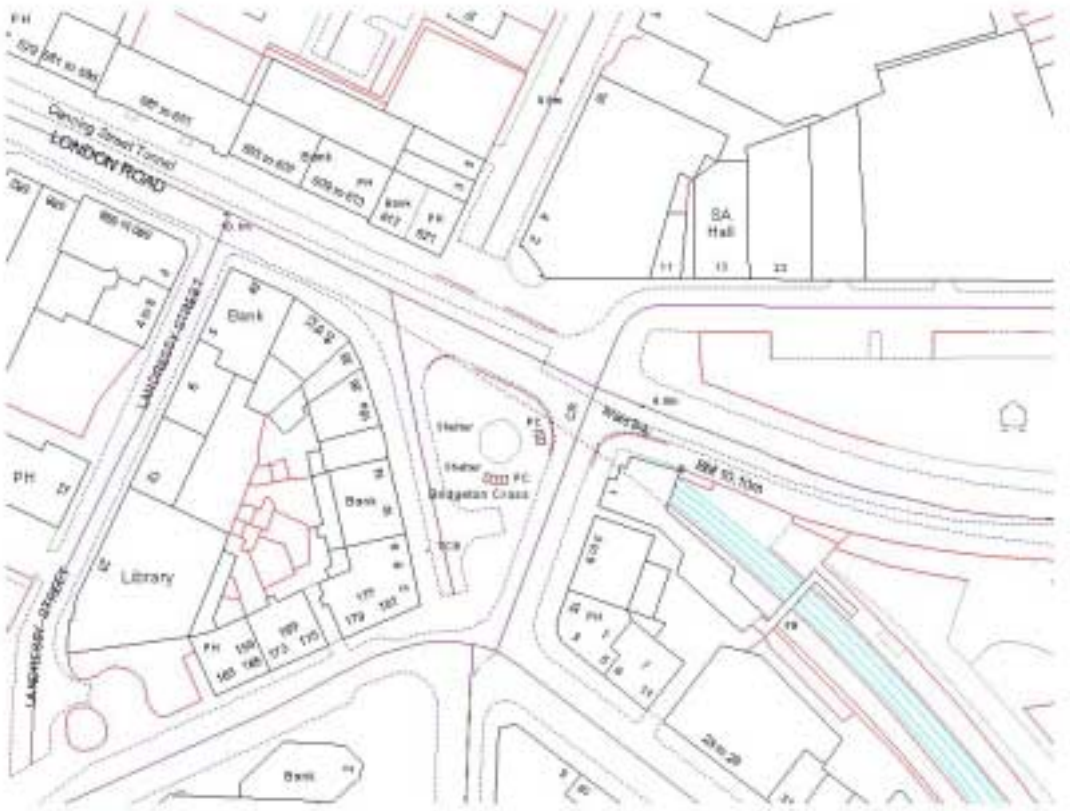
APPENDICES

Appendix I

Glasgow's Location in Scotland

Appendix II

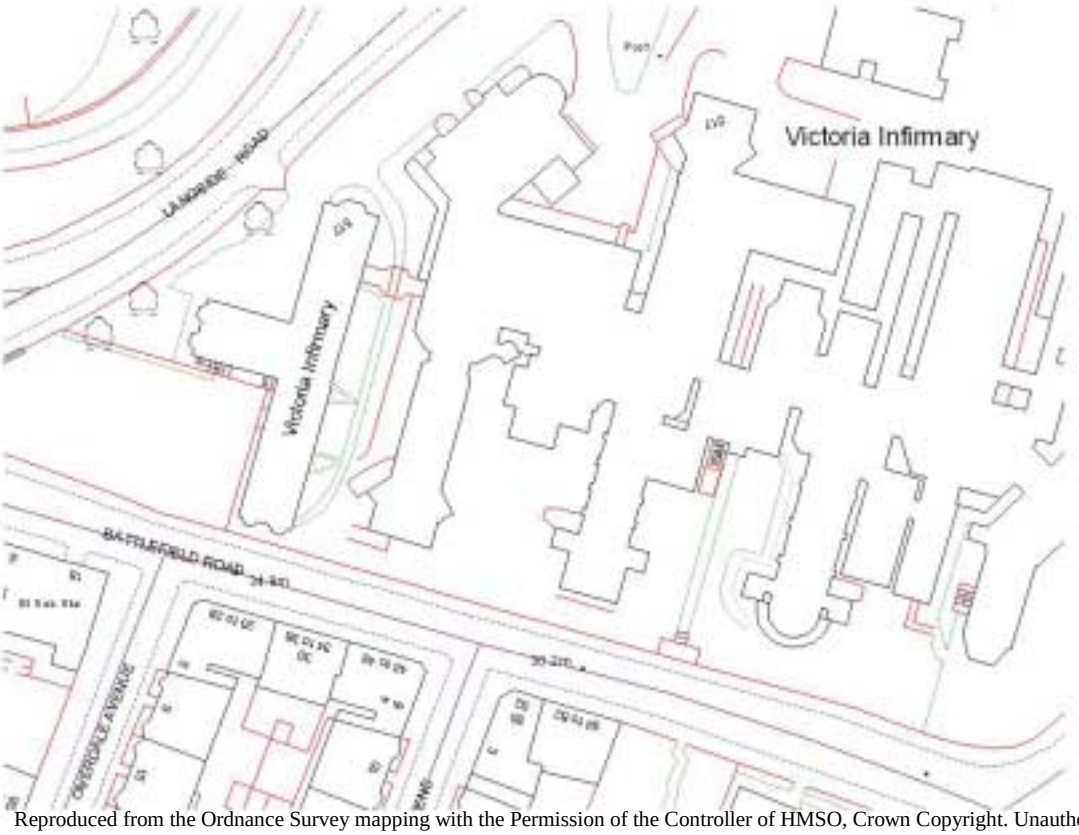
(a) Bridgeton Cross



(b) Parkhead Cross

(c) Battlefield

(d) Victoria Infirmary



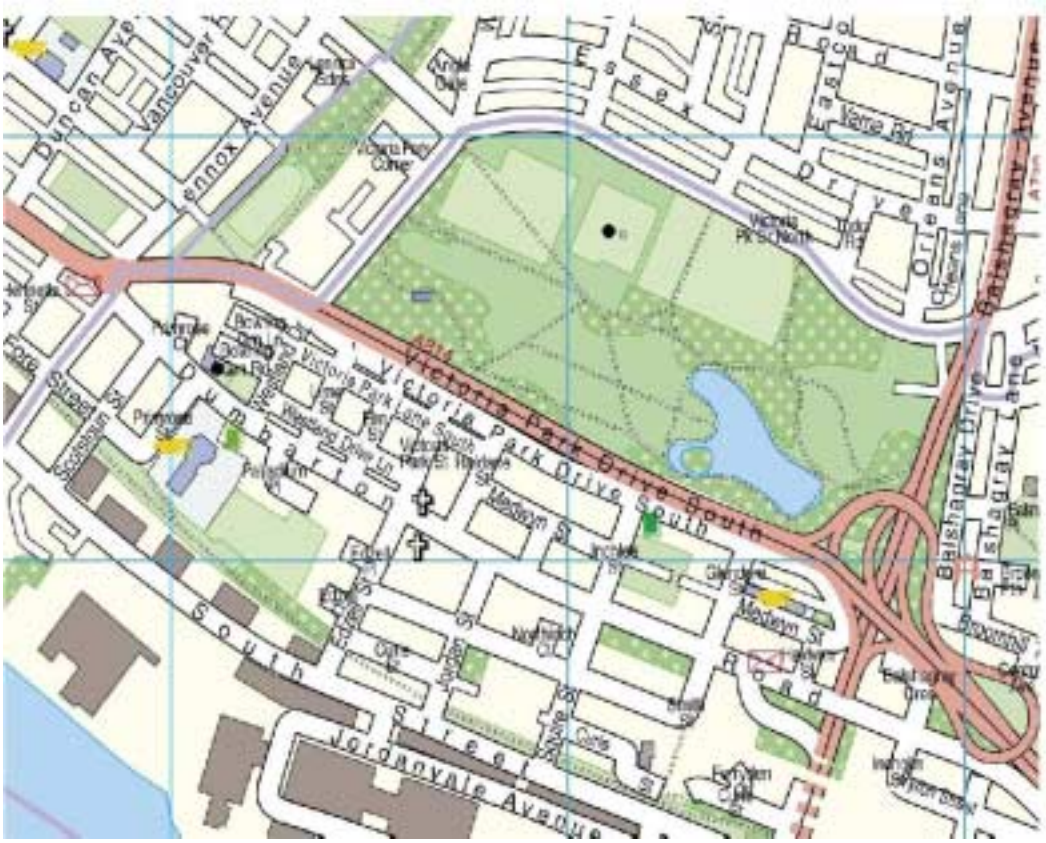
(e) Shawlands Cross

(f) Aitkenhead Road/ Calder Street

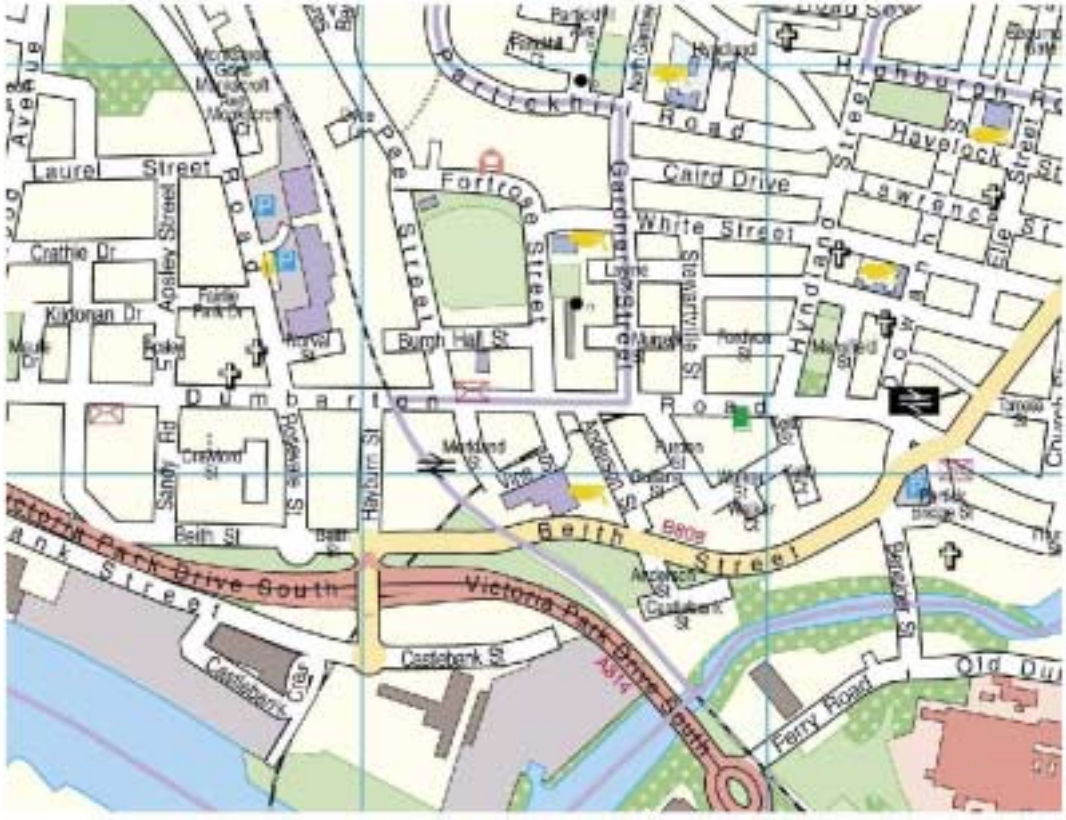
(g) Crow Road at Jordanhill

Appendix III

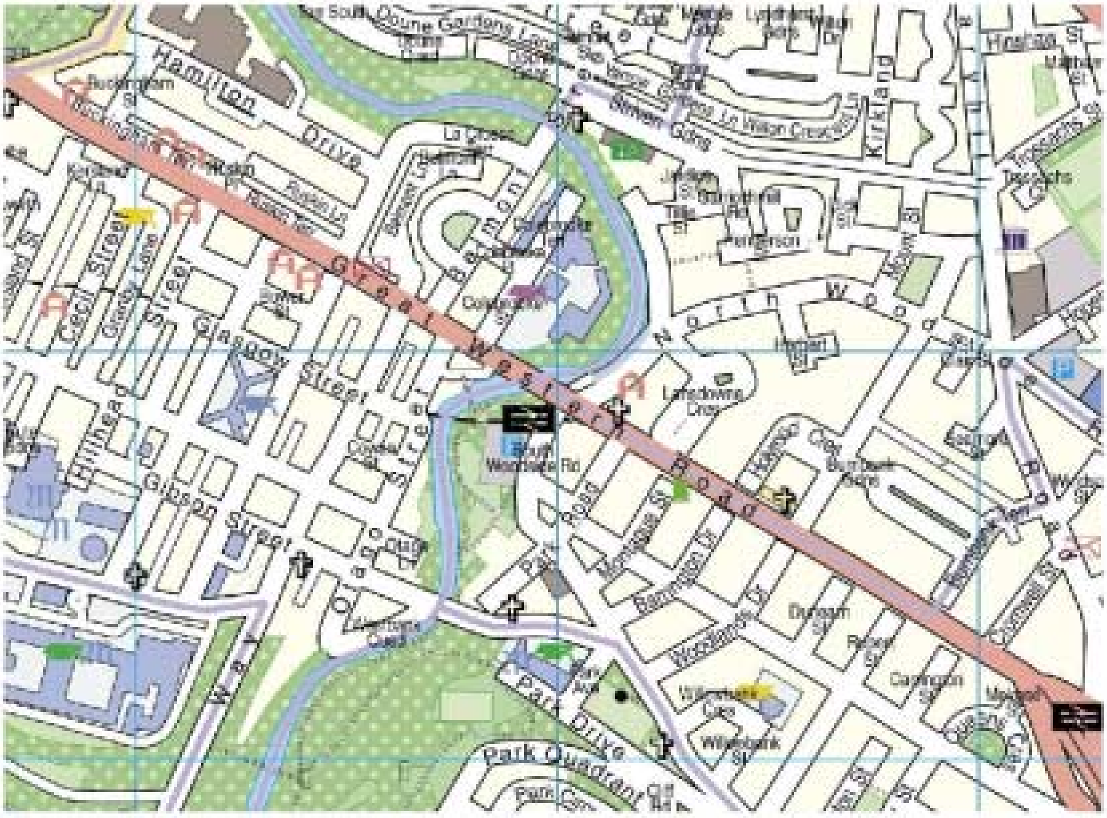
(a) Victoria Park Drive South



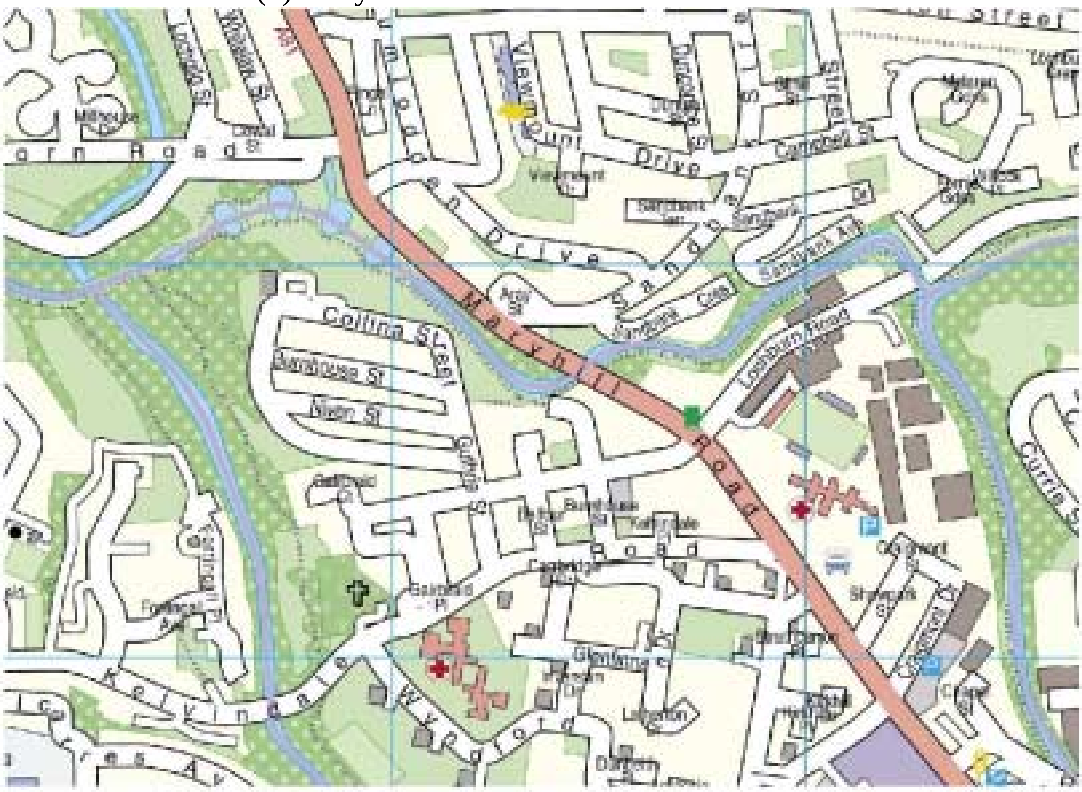
(b) Dumbarton Road



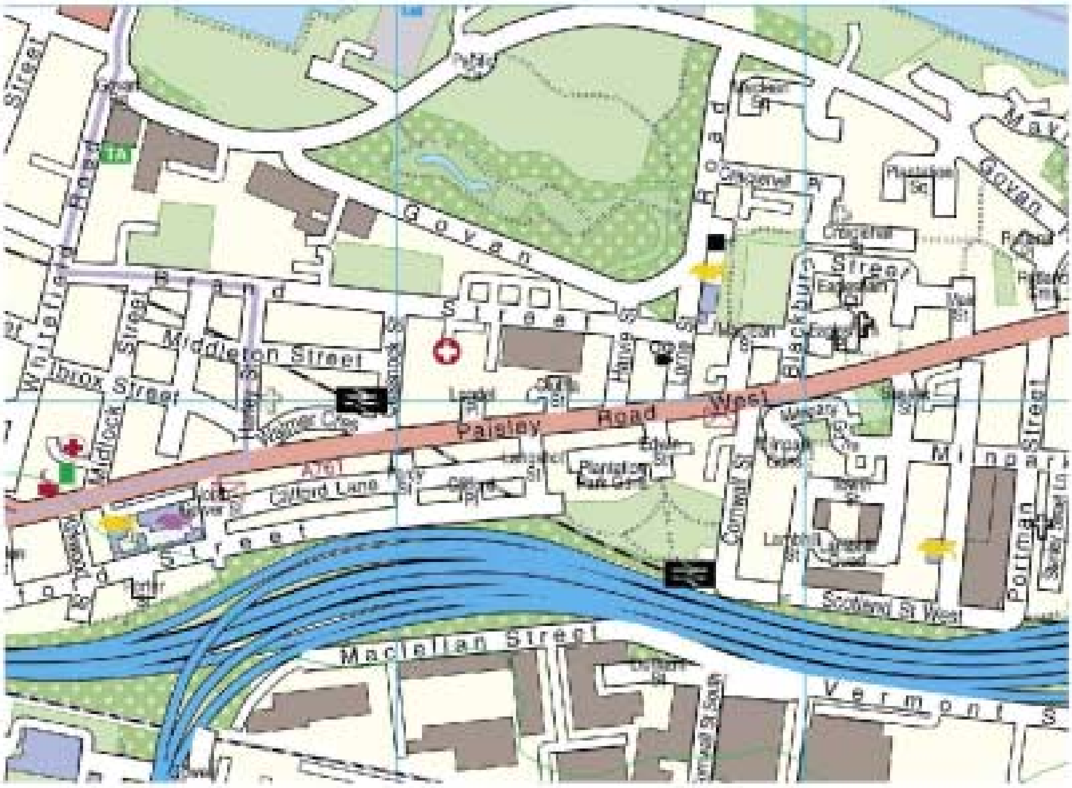
(c) Great Western Road



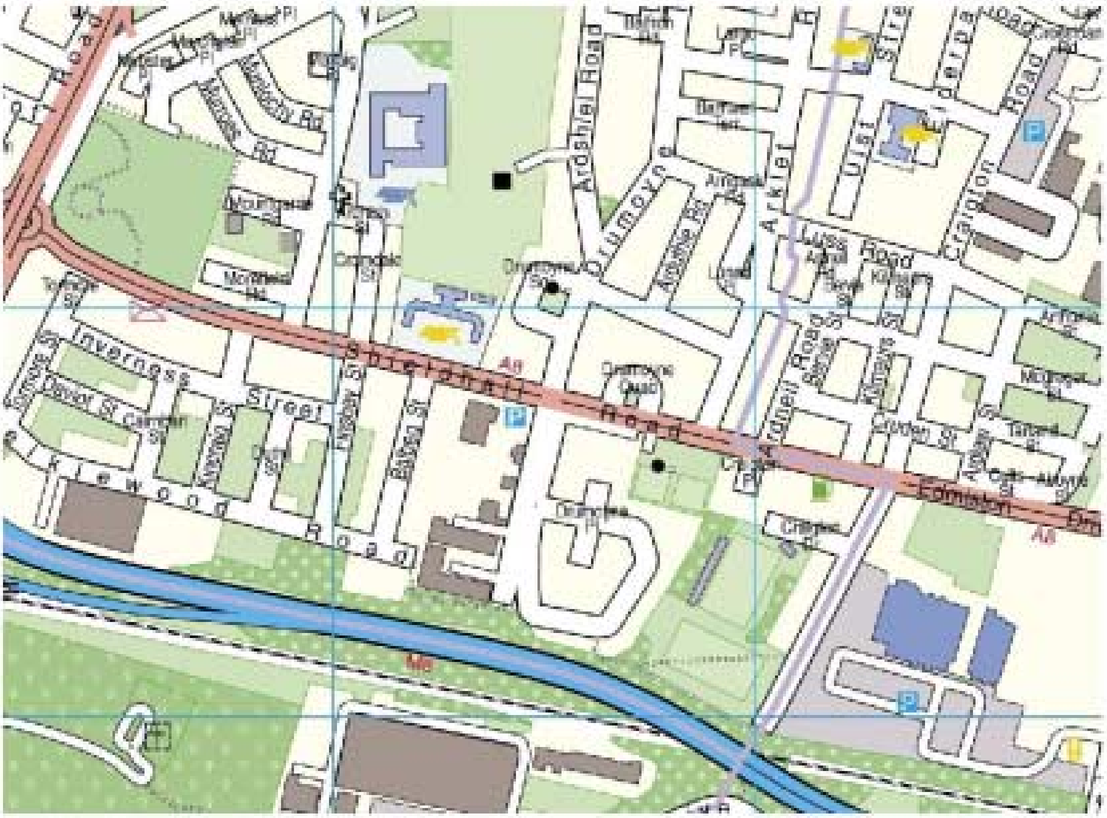
(d) Maryhill Road and Kelvindale Road



(e) Paisley Road West @ Cessnock



(f) Shieldhall Road



Appendix IV
Aerial view of Proposed M74 route