NORTH AYRSHIRE
COUNCIL

Detailed Assessment of Nitrogen Dioxide Concentrations in High Street, Irvine for

North Ayrshire Council

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

September 2013

TSI Scotland

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Cover Photo: High Street, Irvine (taken by TSI Scotland Ltd)

Executive Summary

The Environment Act 1995 makes a requirement for Local Authorities to review and assess air quality in their areas. The Air Quality Regulations 1997 provided National Air Quality objectives for 7 key pollutants and local authorities must assess whether these objectives are liable to be met. If any area is identified where air quality objectives are not met, the Local Authority must declare an Air Quality Management Area (AQMA).

In North Ayrshire Council, there is a small section of the High Street in Irvine which has recorded annual mean concentrations of Nitrogen Dioxide (NO_2) exceeding or very close to the air quality standard concentration of 40µg/m^3 during the past 10 years. The number of diffusion tube sites located in the High Street has increased from 6 in 2000, to 14 in 2008 and reduced back to 7 in 2012 as the area of potential exceedence of the limit has become well defined and low concentrations were consistently recorded for some locations.

The potential area of exceedence is now well defined to cover approximately 10m in length at the façade of the buildings that line the south side of the High Street between numbers 73 and 79. Adjacent tubes within 10m in the same street consistently record concentrations below the air quality limit. The hotspot area is adjacent to bus stops which effectively act as a bus terminus for Irvine. There are residential properties above the shops along this section and so there is the potential for public exposure to concentrations above the air quality limit.

In the Updating and Screening Assessment (USA) written in 2012, there were 2 out of 11 diffusion tube sites in the High Street where the annual mean concentration exceeded 40µg/m^3.

During 2012 the same sites recorded annual mean concentrations of 59µg/m^3 and 46µg/m^3, the latter being measured at the building façade. The concentration at all other sites in the High Street was between 32-34µg/m^3.

The automatic roadside monitoring (ROMON) unit is also located on the same side of the street, but a bit further south. The NO_2 annual mean concentration measured at this location from 2009-2012 was between 26-34µg/m^3, confirming that compliance with the objective for NO_2 elsewhere in the High Street was being achieved.

After submission of the 2012 USA report, consultation with SEPA, Scottish Government and other consultees concluded that a Detailed Assessment was required to present a clear picture of the historical air quality in this hotspot area and provide, with a degree of certainty, the likely area and magnitude of exceedence and the risk of public exposure.

This report was prepared in accordance with the Local Air Quality Management, Technical Guidance LAQM, TG(09) and examines in detail the air quality monitoring carried out in High Street, Irvine. It explores correlations with bus movements and other activities and illustrates the potential area of exceedence of the limit.

The results of the monitoring undertaken historically and most recently in 2012 conclude that the annual mean air quality limit of 40µg/m^3 has been exceeded within a 10m section of the High Street in Irvine.

The public exposure to the area of exceedence is limited to occupants of residential properties above the shops at numbers 73, 75 and 79a-c. The precise number of occupants in each flat is unknown and some have been unoccupied for extended periods over the last two years. However, if it assumed that there are two occupants per flat, the estimated public exposure is 10 people. It is possible that the air quality at the façade of the upper storey windows will be better than that at first floor level but there are no monitoring data to substantiate this. Therefore, all properties must be considered to be within a potential area of exceedence of the air quality limit.

The Detailed Assessment has considered a number of influences on the local air quality including traffic flow patterns, street topography, prevailing winds and planned developments.

Changes to the street topography and bus stop relocation have been financially approved and are expected to significantly improve local air quality. These are planned for 2014. The Council will maintain the diffusion tube monitoring in the current “hotspot” for a period of 6 months after the bus stop relocation in order to report on the degree of change in NO_2 concentration achieved by the measure. Additional diffusion tube monitoring will be introduced next to the relocated bus stops in the north section of the High Street for the same period. It is anticipated that the diffusion tube monitoring can then be reviewed and reduced in the High Street area in the future once improved air quality is evident.

Due to the existing small localised area and potential number of people exposed to an exceedence of the annual mean NO_2 limit, the Council wish to implement the bus stop relocation project and report on its success or otherwise in improving local air quality before taking the decision on whether or not to declare an AQMA.

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1 Introduction

1.1 Description of Detailed Assessment Area

The area of assessment is a section of High Street, Irvine which is approximately 95m long and 25 metres wide. Irvine town centre is the administrative hub of the district and the absence of an official bus station has resulted in heavy use of the High Street by public transport. Currently around 60 buses per hour travel along the High Street which runs through the middle of the town. This is the main area of concern for Local Air Quality in North Ayrshire. Traffic restrictions have been in force here for some time preventing private vehicles entering the area during office hours so the primary source of pollution is public transport. A map of the assessment area is shown in Figure 1.

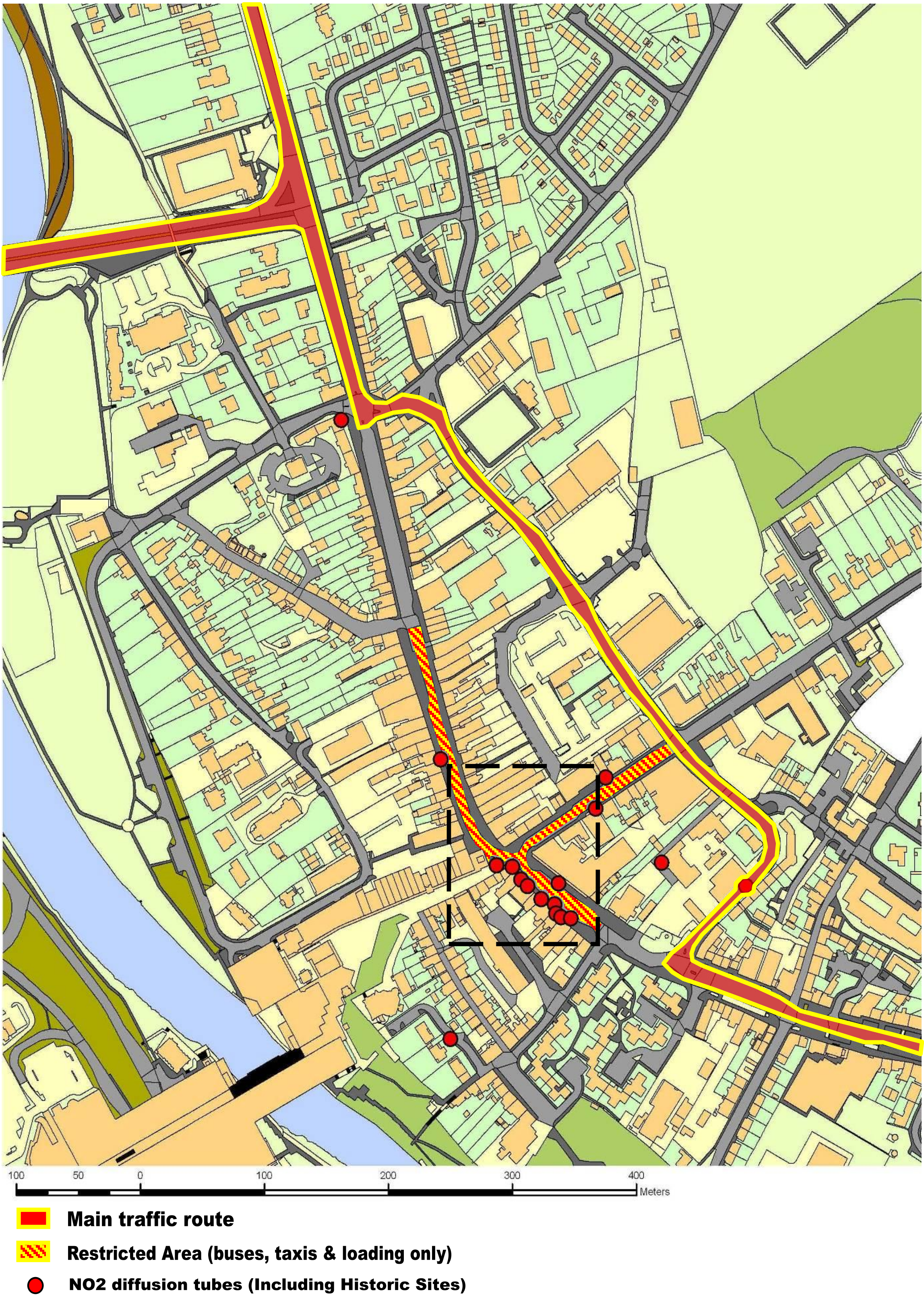
1.2 Purpose of Report

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

The objective of this Detailed Assessment is to identify the potential magnitude and extent of exceedence of the annual mean objective for NO_2 and to determine with a degree of certainty the risk of public exposure within the exceedence area.

The report considers the historical monitoring data available for the area and looks at timetabled and actual bus movements taken from a site survey in November 2012.

Figure 1 Detailed Assessment Study Area and Historical and Current Diffusion Tube Locations



1.3 Air Quality Objectives for NO_2

The air quality objectives applicable to LAQM in Scotland are set out in the Air Quality (Scotland) Regulations 2000 (Scottish SI 2000 No 97) and the Air Quality (Scotland) (Amendment) Regulations 2002 (Scottish SI 2002 No 297). Those applicable to NO_2 and are shown in Table 1.1. This table shows the objectives in units of microgrammes per cubic metre µg/m^3 with the number of exceedences in each year that are permitted.

Table 1-1 NO_2 Air Quality Objectives included in Regulations for the purpose of LAQM in Scotland

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Nitrogen dioxide	**200 µg/m^3** not to be exceeded more than **18 times** a year	**1-hour mean**	31.12.2005
	40 µg/m^3	**Annual mean**	31.12.2005

1.4 Summary of NO_2 Concentrations in High Street Irvine during Previous Review and Assessments

Table 1-2 Summary of NO_2 Concentrations in the High Street, Irvine during previous Review and Assessments

Report	Summary
2003 Updating and Screening Assessment	The annual mean NO_2 concentration at 79 High Street, was marginally in excess of the annual mean objective in 2002. When the "future year correction factors" were applied, as allowed in the guidance, all Annual Mean levels projected for 2005 met the Air Quality Objective. Passive monitoring by diffusion tubes continued in the High Street to assess the effect of a traffic management scheme to limit the types of vehicles using this section of road.
2004 Progress Report	The annual mean NO_2 concentration at 79 High Street, was 49.6µg/m^3. It was predicted that it would continue to exceed the national air quality standard at the end of 2005. Passive sampling continued in the area and it was decided to locate the TEOM particulate monitor in the area from May 2005 for twelve months.
2005 Progress Report	The annual mean NO_2 concentration at 79 High Street, was 45.6µg/m^3. The measured annual mean concentrations at other locations within the High Street ranged from 27.8-37µg/m^3. At that time, the area of exceedence was not an area of relevant public exposure as the flats above the shop units were unoccupied. Consequently, a detailed assessment for nitrogen dioxide was not necessary.
2006 Updating and Screening Assessment Report	The annual mean NO_2 concentration did not exceed the limit at any site across North Ayrshire during 2005. The annual mean NO_2 concentration was between 23.3-31.2µg/m^3 in the High Street.
2007 Progress Report	During 2006, the annual mean concentration of NO_2 at two sites, 75 and 79 High Street was 43µg/m^3, with the remaining sites in the vicinity between 31-37µg/m^3. On the advice of the Scottish Government and the Scottish Environment Protection Agency (SEPA), it was decided to carry out a Detailed Assessment for NO_2 for this area.
2008 Progress Report & Detailed Assessment	During 2007, the annual mean concentration of NO_2 was 44µg/m^3 at 79 High Street and 48µg/m^3 at 75 High Street with the remaining sites in the vicinity between 29-38µg/m^3. Triplicate tubes were introduced at the site of the automatic monitor to allow a local co-location study to be done.

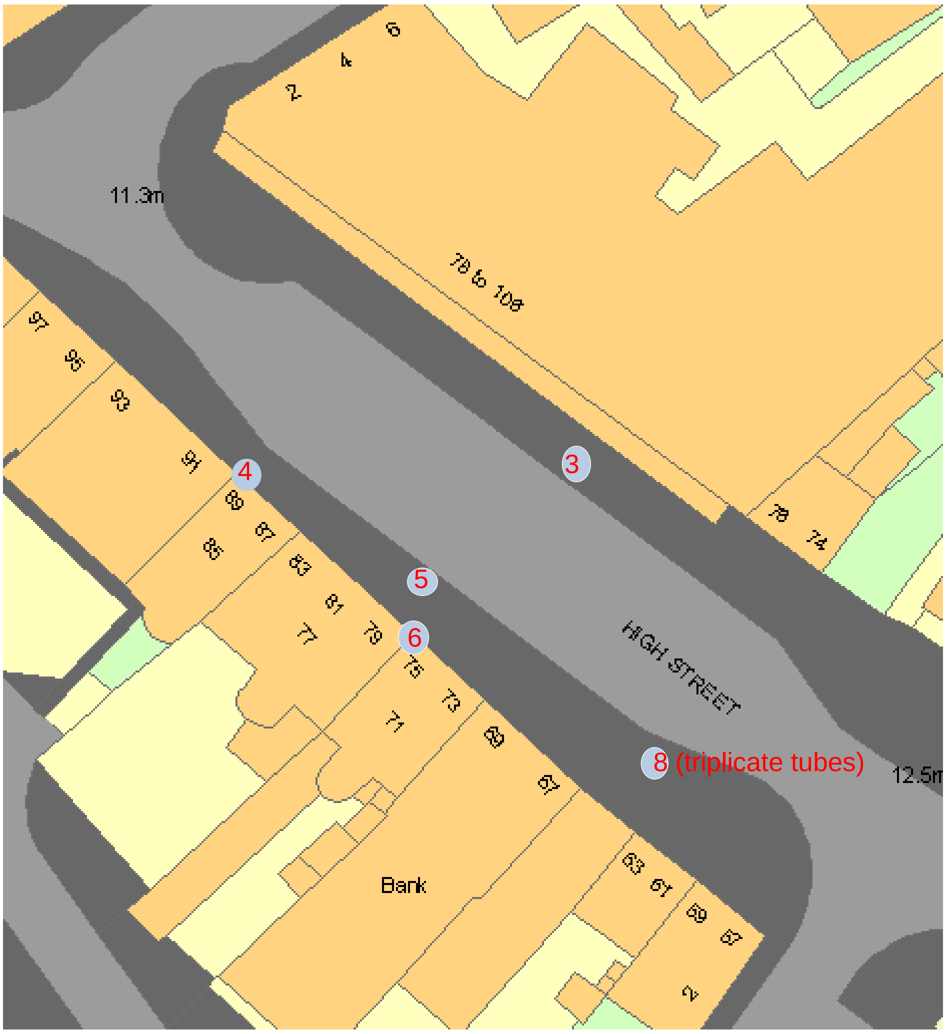
2009 Air Quality Updating and Screening Assessment	A total of 12 diffusion tubes were located in the High Street during 2008 in order to obtain a more detailed understanding of the potential area of exceedence of the air quality limit. Some tubes were located at first storey level in order to determine how concentration changed with height above ground at the façade of the building. There was one exceedence of 44.6µg/m^3 at 75 High Street (High) while all other sites remained below the 40µg/m^3 limit ranging from 28-39µg/m^3. An NO_2 analyzer was installed into the automatic monitoring site (ROMON) located in High Street Irvine to provide more detailed information on the pattern of NO_2 concentrations and to check against the 1-hour objective concentration of 200µg/m^3. It also enabled the co-location study for the accuracy of the diffusion tubes to be undertaken.
2010 Progress Report	A total of 12 diffusion tubes were located in the High Street during 2009 in order to continue the detailed understanding of the potential area of exceedence of the air quality limit. All sites remained below the 40µg/m^3 limit ranging from 27-37µg/m^3.
2011 Progress Report & Detailed Assessment	Three tubes located in the High Street exceeded the limit. They were located at 79 High Street (50µg/m^3) and 71 High Street (High (41µg/m^3) and Low (44µg/m^3)), adjacent to the major bus stops in the town. This time the lower tube had a higher concentration whereas in 2008 it was the higher tube at this location that had the higher concentration. The next nearest tubes are about 10m away and had NO_2 annual mean concentrations of 31µg/m^3 and 33µg/m^3. All the remaining tubes in the same vicinity ranged between 25µg/m^3 and 32µg/m^3 confirming that the majority of the street used by the buses complies with the air quality objective and the exceedences are concentrated in a very localised spot.
2012 **Updating & Screening Assessment**	The number of diffusion tubes in the High Street was decreased for the 2011 monitoring as several sites had demonstrated compliance with the limit consistently year on year. Tubes were maintained at the "hotspot" location and 10 metres either side of that, including the ROMON automatic monitoring site to maintain the local co-location study to be done and a local bias correction factor for the diffusion tubes to be calculated. During 2011, the annual mean concentration of NO_2 was 54µg/m^3 at 79 High Street and 46µg/m^3 at 75 High Street with the remaining sites in the vicinity between 29-38µg/m^3.
2012 **Detailed Assessment**	During 2012, the annual mean concentration of NO_2 was 59µg/m^3 at 79 High Street and 46µg/m^3 at 75 High Street with the remaining sites in the vicinity between 31-34µg/m^3.

2 Historical Monitoring of NO_2 in High Street, Irvine

2.1 Diffusion Tube Sites

The number of diffusion tubes sites located in the High Street has increased from 6 in 2000, to 14 in 2008 and reduced back to 7 in 2012 as the area of potential exceedence of the annual mean air quality standard of 40µg/m^3 has become well defined and low concentrations were consistently recorded for some locations. The historical and present locations of diffusion tubes shown are shown in Figure 1. The current High Street sites are listed in Table 2-1 below and shown in detail in Figure 2.

Figure 2 Current Monitoring Sites in the High Street



2.2 Diffusion Tube Concentrations

The results for each tube located in the High Street for the period 2000 – 2012 are summarised in Table 2-2 and displayed graphically in the chart in Figure 3 below.

It can be seen that the historical exceedences and concentrations approaching the limit are clustered around the diffusion tubes located at numbers 75 and 79 High Street. The location of these sites is shown visually in the photograph in Figure 4.

Table 2-1 Current Location of Diffusion Tubes in the High Street, Irvine

Site ID	Location	Site Type	Easting	Northing	Data Capture 2012 (Months)
3	147 High Street, Irvine	K	232077	638990	11
4	85 High St, Irvine	K	232158	638882	11
5	79 High St, Irvine	K	232160	638885	11
6	75 High St, Irvine HIGH	K	232170	638871	11
7*	71 High St, Irvine	K	232174	638868	4
8	65a High Street, Irvine, (ROMON)	K	232182	638867	11
9	65 High Street, Irvine, (ROMON)	K	232182	638867	11
10	63 High Street, Irvine, (ROMON)	K	232182	638867	11

*Tube was subject to damage and is also outside area of potential public exposure. Has been allocated to a site in Ardrossan

All tubes for July 2012 were void due to a problem with the analysis at the Gradko laboratory.

Table 2-2 Historical NO_2 Concentrations in the High Street, Irvine (2001-2012)

ID	Location	Annual Mean Concentration (µg/m³)											
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007 Bias 0.83**	**2008 Bias 0.87**	**2009 Bias 0.96**	**2010 Bias 0.93**	**2011 Bias 0.79**	**2012 Bias 0.91**
3	147 High Street, Irvine	19.1	30.2	31.5	27.8	23.3	31	29	34	29	26	30	31
	97 High Street	21.9	32.7	37.1	33.3	26.9	38	32	28	28	30	-	-
	97 High Street HIGH	-	-	-	-	-	-	-	39.4	29	29	-	-
	91 High Street LOW	-	-	-	-	-	-	-	34.1	32	33	-	-
4	85 High St, Irvine	-	-	-	-	-	-	-	34	27	31	34	34
5	79 High St, Irvine	30.7	**40.8**	**49.6**	**45.6**	31.2	**43**	**44**	39	37	**50**	**54**	**59**
	75 High Street LOW	25.8	36.2	**41.9**	36.3	30.5	**43**	**48**	37	35	**44**	-	-
6	75 High St, Irvine HIGH	-	-	-	-	-	-	-	**44.6**	37	**41**	**46**	**46**
7*	71 High St, Irvine	-	-	-	-	-	-	-	35	29	33	34	**42***
8	65a High Street, Irvine, (ROMON)	8.5	30.9	33.1	37	28.9	37	35	31	27	32	30	32
9	65 High Street, Irvine, (ROMON)	-	-	-	-	-	-	34	30	29	31	31	32
10	63 High Street, Irvine, (ROMON)	-	-	-	-	-	-	38	29	30	31	31	33

Figure 3 Historical Annual Mean NO_2 Concentrations in the High Street, Irvine 2001-2012

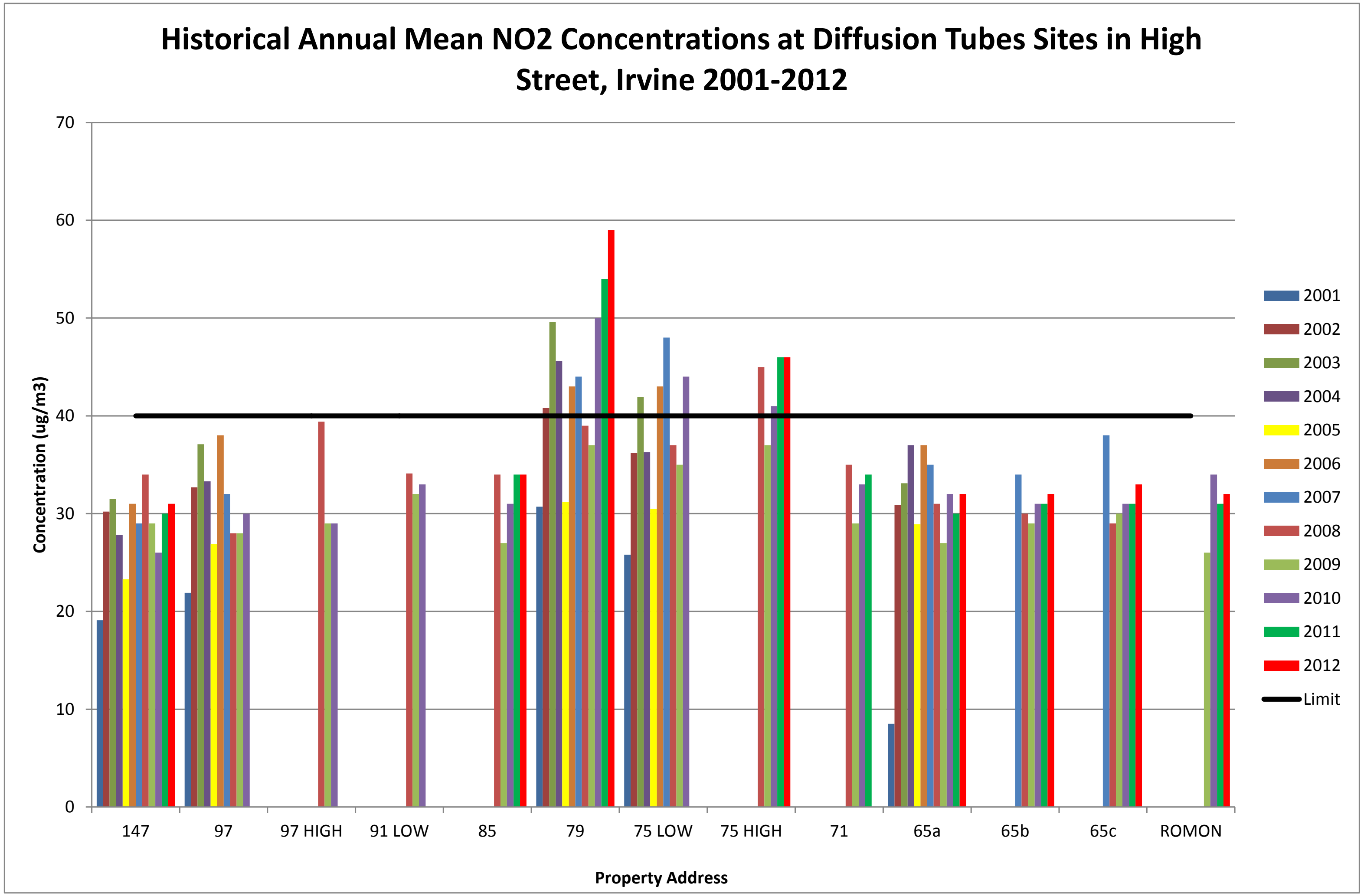


Figure 4 Diffusion Tube Locations at 79 and 75 High Street

Site 5 – On Lamppost opposite 79 High Street

Site 6 – On building facade above shop at 75 High Street

2.3 Automatic Monitoring Site

The fixed ROMON unit containing the NO_2 analyser and Beta Attenuation Monitor for PM_{10} has been operational since early 2009 and is the site being used for the co-location tubes. The unit is permanently located in the High Street and is shown on a map in Figure 2 and the photograph in Figure 5.

There have been operational problems with data collection ever since the unit was commissioned with gaps in data being sent via the modem. Funding was granted for 2012 to allow the purchase of a web logger which has improved data capture. Combined with other maintenance work on the monitoring equipment this has resulted in good data capture and reliable data collection in the latter half of 2012.

Calibration checks are conducted every 2 weeks on site by Local Authority Officers and collected data is forwarded to AEA Technologies who validate it. The unit is calibrated by AEA Technologies every 6 months. AEA were consulted to obtain the ratified annual mean NO_2 concentration at the site for 2012 and it was confirmed that is was 32µg/m^3. The full AEA reports for 2012 are included in the Progress Report for 2013.

This site is located approximately 20m from the diffusion tube at 75 High Street.

Table 2-3 Details of Automatic Monitoring Sites

Site Name	Site Type	OS Grid Ref		Pollutants Monitored	Monitoring Technique	In AQMA?	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to kerb of nearest road (N/A if not applicable)	Does this location represent worst-case exposure?
		X	Y						
ROMON	Kerbside	232188	638861	NO_2, PM_{10}	NOx & BAM	No	Y 20m	2.5m	Y

Figure 5 Automatic Monitoring Site (ROMON)

2.4 Automatic Monitoring Site Concentrations

The annual mean concentration recorded at this site has consistently been below the air quality limit of 40µg/m^3 and has ranged from 31-34µg/m^3 since 2009. The figures are summarised in Table 2-4. There was only one exceedence of the hourly mean objective of 200µg/m^3 which occurred in 2010.

The first official co-location study for North Ayrshire Council commenced at this site in 2009 and has been continued for each report since then. The three NO_2 diffusion tubes are located ~20cm away from the ROMON sampling inlet.

The corresponding data for 2012 was entered in the "Checking Precision and Accuracy of Triplicate Tubes" spreadsheet provided by AEA Energy & Environment and resulted in a local bias correction factor of 0.91 for 2012. This is shown in Appendix 1. The same study for 2011 gave a local bias correction factor of 0.79.

Table 2-4 Results of Automatic Monitoring of Nitrogen Dioxide: Comparison with Annual Mean Objective

Site ID	Site Type	Within AQMA?	Valid Data Capture for period of monitoring %	Valid Data Capture 2012 %	Annual Mean Concentration μg/m^3			
					2009	2010	2011	2012
ROMON	Kerbside	N	89.0	89.0	**26**	**34**	**31**	**32**

Table 2-5 Results of Automatic Monitoring for Nitrogen Dioxide: Comparison with 1-hour mean Objective

Site ID	Site Type	Within AQMA?	Valid Data Capture for period of monitoring %	Valid Data Capture 2012 %	Number of Exceedences of Hourly Mean (200 μg/m^3)			
					2009	2010	2011	2012
ROMON	Kerbside	N	89.0	89.0	**0**	**1**	**0**	**0**

3 Site Visit November 2012

Personnel from TSI Scotland Ltd made a site visit to the High Street on Thursday 22nd November 2012. The main objectives of the visit were to:

- monitor traffic flow in the High Street, paying particular attention to bus movements;
- record examples of bus engine idling times at the two stops adjacent to 75-79 High Street;
- measure road and pavement widths;
- establish the potential number of sensitive receptors where there is exceedence of the annual mean NO_2 limit; and
- take photographs and video footage in situ.

3.1 Traffic Flow

Irvine town centre is the administrative hub of the district and the absence of an official bus station has resulted in heavy use of the High Street by public transport. It was reported in the 2012 Updating and Screening Assessment that 60 buses per hour travel along High Street and the current timetables for the services using this route would agree. Not all services stop at the 2 bus stops under close scrutiny however, but their movements as users of the High Street are recorded.

A traffic count survey was undertaken between 1030 and 1230 on 22nd November 2012 in order to check the actual number of traffic movements per hour as well as gather information on when clusters of vehicles arrive at the bus stops simultaneously causing congestion, prolonged emissions and delayed departure.

The results of the traffic count survey are summarised in Table 3-1 and shown in Figure 6.

Table 3-1 Vehicle Movements in High Street During Site Survey 22nd Nov 2012

Vehicle Type	Number
HGV	11
Buses	56
Mini Bus/Van	11
Car	29
TOTAL	**107**
% Buses	**52%**

The number of buses actually stopping at either of the two bus stops between 1030 and 1130 on the south side of the High Street was 23.

The survey data were examined to see if any correlation could be found between traffic numbers and measured NO_2 concentrations at the automatic site. It can be seen in Figure 6 that there does not appear to be a direct correlation between total traffic and NO_2 or total buses and NO_2 concentrations.

The monitored NO_2concentrations for the week beginning 19th November were extracted from the data logger to examine if there were any patterns to the measured concentrations throughout the whole day.

Measurements are recorded every 15 minutes. The graph in Figure 7 below shows the (unratified) data for the period 7am -7pm for each day from 19th – 25th November 2012, illustrating the variable nature of the measurements throughout the day. There are generally two periods of peak concentrations between 0900-1100 and again between 1630-1830 however timetabled bus numbers remain almost constant at approximately 60 per hour throughout the day. Other vehicle movements were only recorded between 1030-1230 on one day so the daily pattern of other vehicles is not known. The traffic is limited to taxis, commercial delivery vehicles and buses in the High Street. There are likely to be peaks in business hours traffic in the High Street which may account for the peaks in concentration at these times.

Figure 6 Vehicle Movements and Corresponding NO_2 Concentrations During Site Survey 22nd November 2012

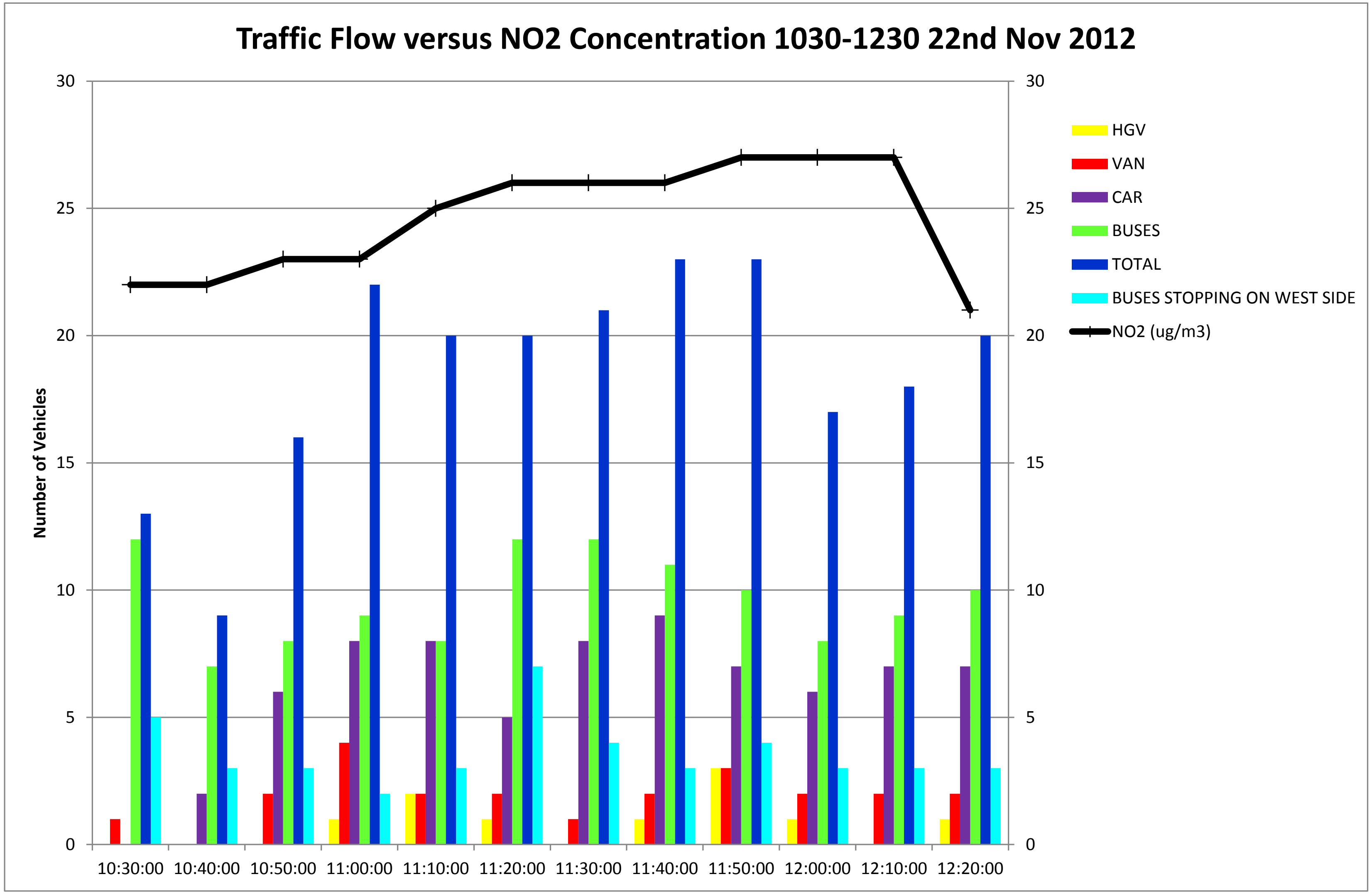
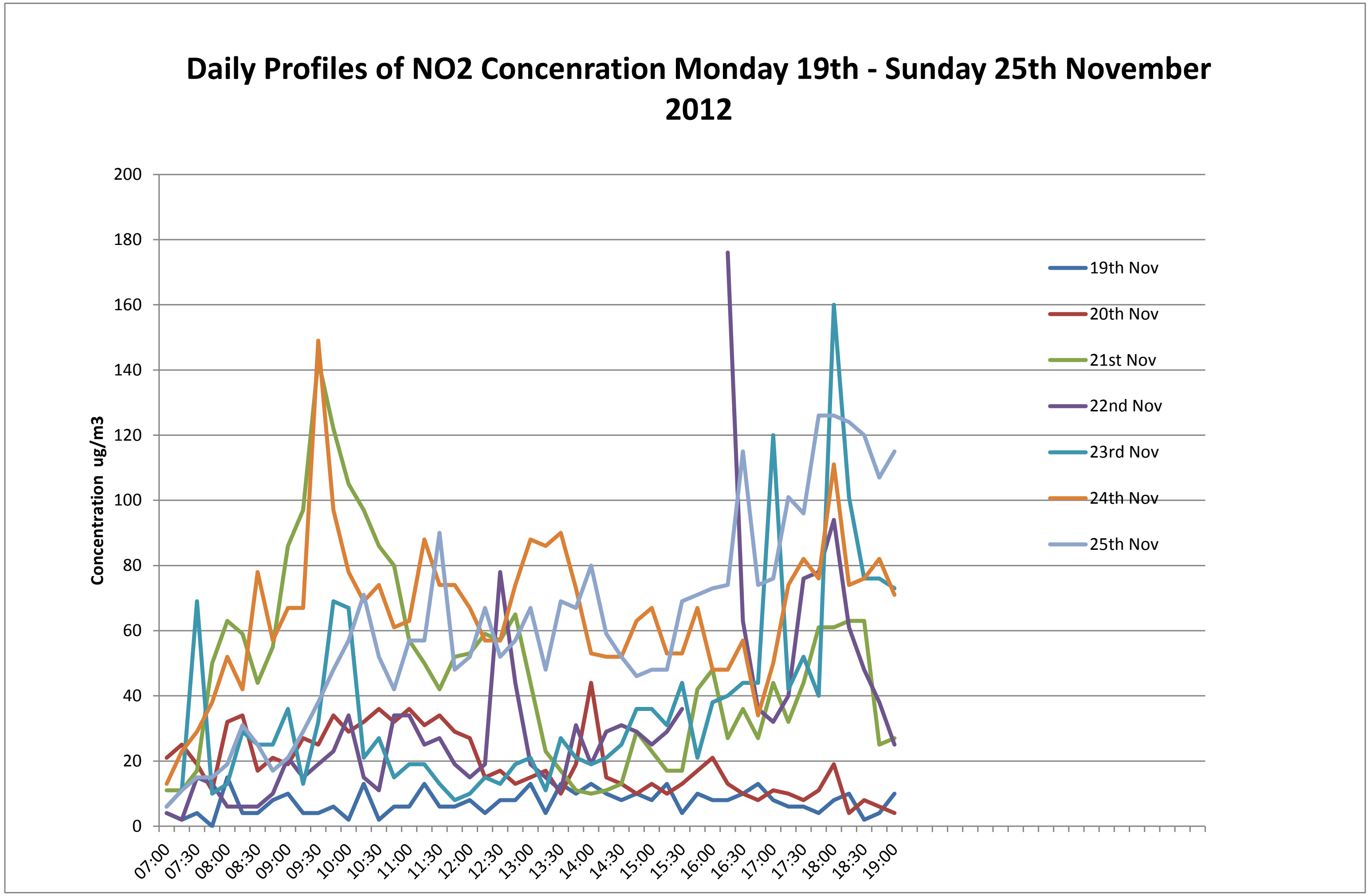


Figure 7 Daily NO_2 Concentrations from 0700-1900 on 19th-25th November 2012



3.2 Bus Emissions

It can be seen from the site survey that approximately 50% of the vehicles using the High Street are buses with almost half of the total buses actually stopping at the two bus stops on South High Street. The significant majority (>90%) of buses using the High Street are Stagecoach buses. During the preparation of the 2012 Detailed Assessment and Upgrading and Screening Assessment, various meetings with North Ayrshire Transportation, Stagecoach and Strathclyde Partnership for Transport (SPT) confirmed the following:

- **All Stagecoach fleet buses are Euro 4 or 5 classification**. During the site survey, the majority of buses were observed to be of Euro V classification. Older vehicles were only observed on bus routes that visited the High Street less frequently during the day.
- **All of the Stagecoach fleet buses run on B5 fuel (5% Biodiesel) with all of the Irvine fleet running on B30 (30% Biodiesel)**
- **All Stagecoach fleet buses are now fitted with auto shut off systems which turn off the engines after 3 minutes of idling.** During the survey, the duration of engine idling depended on the time taken for passengers to embark and disembark at the bus stop and whether or not the bus was waiting for a timetabled departure. For the service 11, one of the most frequent services throughout the day, the idling time was approaching 3 minutes on several occasions.

While these measures would suggest that the best practicable means are being adopted by Stagecoach in an effort to minimise bus emissions, it was observed that there are also times when there can be up to 4 buses lined up at the two stops simultaneously with boarding times approaching greater than 2 minutes.

There is also a traffic light junction where the High Street meets Bank Street. It was observed on many occasions during the survey that although ready to leave the bus stops on the south side of the High Street, the buses are often prevented from doing so due to other traffic stopped in the main carriageway by the red light. This results in idling engines near to the receptors for longer periods than if the buses were able to drive off freely from the stops. On other occasions the buses are able to leave the stops after short periods but are often immediately stopped by the traffic lights so engine idling occurs again.

It may be possible that it is this cumulative effect of idling engines that is resulting in the higher concentrations at the diffusion tubes in this hotspot area.

A recent study by Transport and Travel Research Ltd (TTR) for Passenger Transport Executive Group (PTEG) (Ref.1) has been undertaken to examine bus emissions versus engine running times and the impact of reducing idling times on reducing emissions. The findings are discussed in more detail in Section 3.2.2.

3.2.1 Engine Idling Times

Idling vehicles are using fuel for little benefit, and when this is combusted it releases varying quantities of air pollutants, for example Particular Matter (PM) and Oxides of Nitrogen (NOx), and CO2 which is a green-house gas (GHG). Buses that are stationary yet idling are estimated to produce emissions that account for between 5-25% of total PM emissions and 15-25% of total NOx emissions for each route.

Emissions from idling vehicles occur at:

- Bus stops.
- Termini at either end of the routes.
- Junctions/traffic signals along the network.

The south side of the High Street in Irvine has all these factors since the bus stops here effectively act as a Terminus for the town.

While the Stagecoach fleet are all fitted with automatic shut-off systems after 3 minutes, there can be up to 25 buses per hour idling for periods approaching 3 minutes at the two bus stops in the south of the High Street. On some occasions the idling time is prolonged due to the time taken to embark and disembark the bus, but in some instances it is because the bus stop is effectively acting as a terminus and the bus is required to wait until its timetabled departure slot. It is on these occasions that there is most potential to immediately switch off the engines. The largest emissions savings are realised by immediate switch off of engines when the bus comes to a halt and there is no hard evidence to prove that turning off the engine will either damage modern engines or cause reliability issues.

The TTR study examined the idling emissions reductions achievable with engine shut-off times of 5, 10 and 30 seconds. It was recognised that there are few situations when the idling time would be 5 seconds and a shut-off instruction after 5 seconds would introduce significant inconvenience for drivers. However, most idling times were observed between 10-30 seconds. A shut-off after 10 seconds was shown to result in a 13-17% reduction in the total idling emissions and a 30 second shut-off time still resulted in between 0.7% and 9.1% reduction in total idling emissions. The study discusses different methods of administering such shut-off schemes and includes simple measures such as signage at the stops to more sophisticated in-cabin systems where the driver receives an alert after a specified time period to shut-off the engine.

In the case of the Irvine bus fleet, where idling can approach 3 minutes, significant emissions reductions could be achieved with a 30 second shut-off period when the bus stop is acting as a terminus without undue inconvenience to the drivers. However, this will do little to prevent extended engine idling periods due to the traffic lights at the junction.

3.3 Current Street Topography

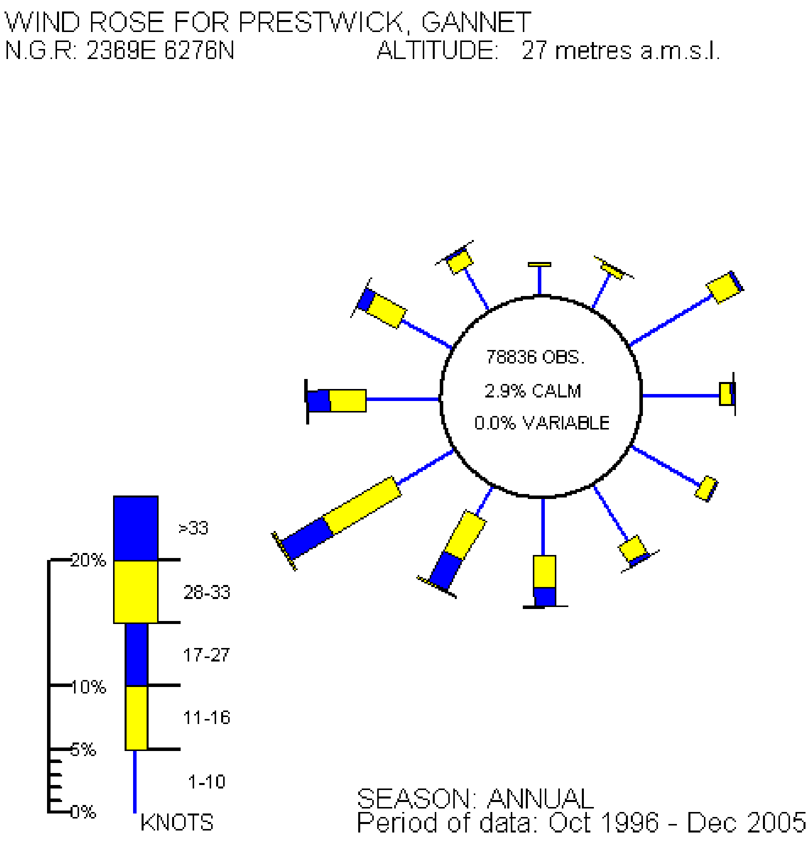
The street width from building to building is approximately 21-25m along the assessment area with buildings of approximately 14m high on the south side of the street and approximately 9m high on the north side of the street. This can be seen in the photograph in Figure 8.

Figure 8 Street Layout and Topography

3.3.1 Canyon Effects and Prevailing Wind

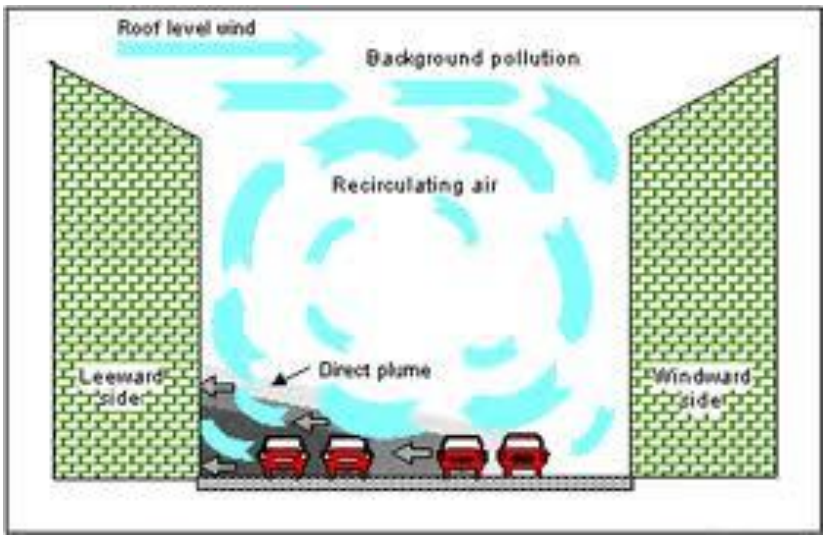
Figure 1 shows that the assessment area of High Street, Irvine runs in a south-east to north-west direction and the wind rose in Figure 9 shows that the prevailing wind for North Ayrshire, taken from Prestwick Airport is south-westerly. This results in wind flow perpendicular to the angle of the street for a significant proportion of the time. While the street topography as described in 3.3 above would not normally describe a deep canyon, the aspect ratio of height (H) over width (W) of approximately 0.5 in some sections could describe an "avenue canyon".

Figure 9 Prevailing Wind Direction for Irvine



The diagram in Figure 10 illustrates the build-up of air pollution on the leeward side of a street canyon when there is a perpendicular wind direction. This situation is similar to that in the High Street in that the majority of idling buses are on the leeward side of the street.

Figure 10 Street Canyon Effect on Pollutant Dispersion



Diffusion tubes on the windward side of the street have consistently recorded annual mean concentrations of NO_2 significantly lower than the 40µg/m^3 limit while those on the leeward side have exceeded or have been close to exceeding it at two monitoring sites. This may be an indication of the existence of the street canyon effect.

Observations on-site have noted that this effect may be exacerbated with vehicles being unable to pass through the area unhindered due to the traffic light junction. In particular, double decker buses may be causing a micro canyon effect concentrating contaminant levels further. This can be seen in the photograph in Figure 11.

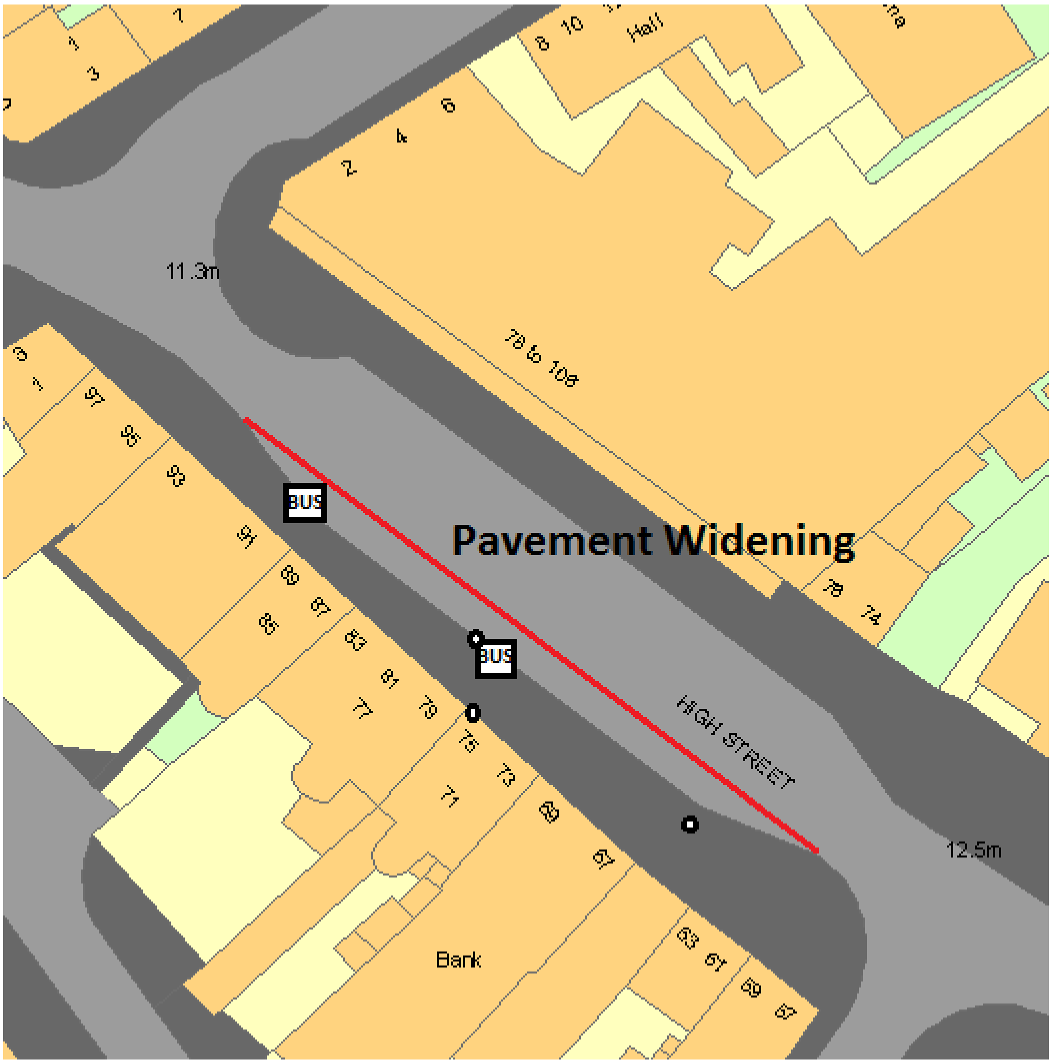
Figure 11 Stationary Queuing Traffic at Traffic Lights

3.4 Planned Developments in the High Street

3.4.1 Pavement Widening

A programme to upgrade several street areas in Irvine Town Centre commenced in 2012 in the nearby Bridgegate. The upgrade plans for the High Street include a number of measures including street furniture, but the most significant in terms of having the potential to influence air quality is the widening of the pavement adjacent to the two bus stops in the "hot spot" area on the south side of the High Street as illustrated in Figure 11.

Figure 12 Planned Pavement Alterations (High St, Irvine)



It is anticipated this will have a significant impact on reducing the NO_2 levels at the building façades in the hotspot area by allowing better dilution and dispersal of pollutants.

The drop-off with distance calculator (Ref.2) was used to predict reductions based on 2012 measured concentrations and the results are summarised in Table 3-2.

Table 3-2 Drop-off with Distance for NO_2 Tube Exceedences

Location	Distance from Kerb		Annual Mean NO_2		Predicted NO_2 at Sensitive Receptor
	Site	Receptor	Background	Site	
79 High Street, Irvine *(Actual)*	1.25m	5.2m	6 ug/m^3	59 ug/m^3	41.3 ug/m^3
NEW widened pavement (predicted)	*1.25m*	*8.2m*	*6* ug/m^3	*59* ug/m^3	*38* ug/m^3
75 High Street, Irvine *(Actual)*	5.7m	5.7m	6 ug/m^3	46 ug/m^3	46 ug/m^3
NEW widened pavement (predicted)	*5.7m*	*8.8m*	*6* ug/m^3	*46* ug/m^3	*40.6* ug/m^3

Based on the 2012 results, the annual mean concentration is predicted to exceed 40µg/m^3 at the façade of the buildings at 75-79 High Street. With the widened pavement, an exceedence is still predicted at the façade of 75 High Street. The Drop-Off with Distance Calculator does not account for any street canyon effects, and greater dispersion may be achieved due to the movement of buses further from the leeward side of the street.

There is no precise start date for this development, however the Development Planning Services (Roads) Department confirmed that the budget has been approved for the current financial year and it is likely that the work will commence in 2014.

3.4.2 Relocation of Bus Stops

While the pavement widening may improve dispersion of pollutants in the High Street, it is considered that a more effective means of improving air quality in the "hotspot" area is to remove the bus stops on the south side of the High Street and relocate them to new areas in the pedestrianized north of the High Street, beyond the traffic light junction with Bank Street. The area is shown in Figure 12.

The relocation of the two stops to the north part of the High Street is a practicable, affordable option for reducing the pollution generated close to sensitive receptors in Irvine town centre and has a number of advantages over the current siting:

- The north section of the High Street has less traffic and more restrictions to other vehicles than the south section. Permit holder delivery vehicles are only permitted between 4.30pm and 10.30am. This reduces the potential for idling buses due to congestion;
- The street geometry and lower building heights along its length mean that the potential for street canyon effects is significantly lower allowing freer dispersal of any released pollutants from traffic. The buildings next to the proposed locations are typically 2 and 2.5 storeys compared with 3.5 storeys in the current location. The pavement width of approximately 4.2m allows significant drop off of concentration with distance from kerbside to building façade;
- The proposed new bus stop locations are adjacent to properties with minimal or non-residential use;
- The diffusion tube site located near the existing bus stop northbound outside 147-149 High Street has recorded an annual mean of between 26-31µg/m^3 since 2007;
- There are no traffic lights; and
- Residence time at bus stops is reduced due to free flowing traffic.

The relocation project is approved and planned for 2014.


(North) High Street, Irvine
10
RESTRICTED ZONE
Except buses
Bus Stop
10
RESTRICTED ZONE

3.4.3 Other Development Plans that May Influence Air Quality

Planning permission has been granted for a Leisure Centre development at the site adjacent to the Town Hall near the entrance to the south part of the High Street. However there is no dedicated parking available at this time and it is unknown how this will affect local air quality. These matters have been raised with the design team and are being given careful consideration. There may also be the opportunity to change several bus routes through the town due to this development. Ground preparation works commenced in August 2013.

3.5 Public Exposure

Local Air Quality Management Technical Guidance LAQM.TG(09) (Ref.3) specifies that in a Detailed Assessment, local authorities are required to estimate the number of people exposed to pollutant concentrations above the objectives, and the maximum pollutant concentration at a relevant receptor location.

The regulations make it clear that likely exceedences of the air quality objectives should be assessed in relation to “the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present”.

For this assessment it is the annual mean concentration of NO_2 that is exceeded or close to exceeding the limit around a particular “hotspot” area on South High Street, Irvine. It is therefore important to consider residential properties within this area. The buildings on this side of the street are mainly shops and other commercial premises at street level with offices above. The only residential properties are flats at numbers 71, 73 and 79a-c. The precise number of occupants in each flat is unknown and some have been unoccupied for extended periods over the last two years. However, if it is assumed that there are two occupants per flat, the estimated public exposure is 10 people. The residential properties are on two storeys above the shops with a couple of smaller attic properties. It is possible that the air quality at the façade of the upper storey windows will be better than that at first floor level but there are no monitoring data to substantiate this. Therefore, all properties must be considered to be within a potential area of exceedence of the air quality limit. The residential properties are shown in the photograph in Figure 13.

Figure 13 Area of Public Exposure

4 Conclusions and Recommendations

The results of the monitoring undertaken historically and most recently in 2012 conclude that the annual mean air quality limit of 40μg/m^3 has been exceeded within a 10m section of the High Street in Irvine.

The potential public exposure to the area of exceedence is limited to occupants of residential properties above the shops at numbers 73, 75 and 79a-c. The precise number of occupants in each flat is unknown and some have been unoccupied for extended periods over the last two years. However, if it is assumed that there are two occupants per flat, the estimated public exposure is 10 people. It is possible that the air quality at the façade of the upper storey windows will be better than that at first floor level but there are no monitoring data to substantiate this. Therefore, all properties must be considered to be within a potential area of exceedence of the air quality limit.

The Detailed Assessment has considered a number of influences on the local air quality including traffic flow patterns, street topography, prevailing winds and planned developments.

The approved changes to the street topography which are expected to significantly improve local air quality are planned for 2014. The council will maintain the diffusion tube monitoring in the current “hotspot” for a period of 6 months after the bus stop relocation in order to report on the degree of change in NO_2 concentration achieved by the measure. Additional diffusion tube monitoring will be introduced next to the relocated bus stops for the same period. It is anticipated that the diffusion tube monitoring can then be reviewed and reduced in the High Street area in the future once improved air quality is evident.

Due to the existing small localised area and potential number of people exposed to an exceedence of the annual mean NO_2 limit, the Council wish to implement the bus stop relocation project and report on its success or otherwise in improving local air quality before taking the decision on whether or not to declare an AQMA.

5 References

1. Bus Idling and Emissions, A Report for Passenger Transport Executive Group by TTR Ltd, September 2010
2. www.laqm.defra.gov.uk/tools-monitoring-data/no2-falloff.html – Distance from Roads Calculator
3. Local Air Quality Management, Technical Guidance LAQM.TG (09), February 2009.

Appendices

Appendix 1: QA:QC Data

Factor from Local Co-location Studies (if available)

The automatic monitoring station (ROMON) has been operational since early 2009 and is the site being used for 3 co-location tubes. The unit is permanently located here and allows for full “calendar year” data to be collected.

The ROMON has fortnightly checks carried out in accordance with the prescribed methodology as issued by AEA Technologies. The unit is audited every 6 months by AEA Technologies and is serviced every 6 months under contract to another company.

Corresponding data was entered in the “Checking Precision and Accuracy of Triplicate Tubes” spreadsheet provided by AEA Energy & Environment .The resulting Bias factor for 2012 data is **0.91**.

Diffusion Tube Bias Adjustment Factors

Diffusion tubes (20% TEA/Water) used in the sampling period for 2012 were supplied and analysed by

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

UKAS TESTING 2187

It was not possible to calculate the diffusion tube bias adjustment factors for tubes provided by Gradko Environmental for 2012 as the data have not been collated and published by NPL.

QA/QC of automatic monitoring

The automatic monitoring station (ROMON – NOx) has an onsite calibration check conducted every 2 weeks by Local Authority Officers. All checks are carried out in accordance with procedures laid out by AEA Technologies and calibration check sheets are forwarded to them after each visit. The site is visited by AEA engineers every 6 months to carry out calibration tests and the unit is serviced twice yearly.

QA/QC of diffusion tube monitoring

The Workplace Analysis Scheme for Proficiency (WASP) for the diffusion tube provider is not yet available for 2012. However, the results for 2010-2011 are shown below:

: Tube Precision & WASP Results

Table 1: Laboratory summary performance for WASP NO_2 PT rounds 108 - 115

The following table lists those UK laboratories undertaking LAQM activities that have participated in recent HSL WASP NO_2 PT rounds and the percentage (%) of results submitted which were subsequently determined to be **satisfactory** based upon a z-score of < ± 2 as defined above.

WASP Round	WASP R108	WASP R109	WASP R110	WASP R111	WASP R112	WASP R113	WASP R114	WASP R115
Round conducted in the period	Jan – March 2010	April – June 2010	June – August 2010	Oct – Dec 2010	Jan -March 2011	April - June 2011	July - Sept 2011	October - December 2011
Aberdeen Public Analysts	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Bristol City Council	75 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Cardiff Scientific Services	100 %	50 %	100 %	75 %	100 %	100 %	100 %	75 %
Edinburgh City Council	100 %	100 %	75 %	100 %	100 %	100 %	100 %	0 %
Environmental Services Group, Didcot (formerly Bureau Veritas Laboratories, Glasgow and Harwell Scientifics) [1] [2]	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Exova (formerly Clyde Analytical)	100 %	50 %	50 %	100 %	100 %	100 %	0 %	75 %
Glasgow Scientific Services	50 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Gradko International [2]	100 %	87.5 %	100 %	100 %	100 %	100 %	100 %	37.5 %
Kent Scientific Services	100 %	100 %	100 %	100 %	50 %	100 %	100 %	75 %
Kirklees MBC	100 %	100 %	100 %	0 %	100 %	0 %	0 %	50 %
Lambeth Scientific Services	50 %	100 %	100 %	100 %	50 %	25 %	100 %	25 %
Lancashire County Analysts [3]	100 %	75 %	50 %	100 %	75 %	-	-	-
Milton Keynes Council	100 %	25 %	50 %	100 %	100 %	75 %	100 %	100 %
Northampton Borough Council	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Somerset Council [4]	-	-	-	-	-	-	-	100 %
South Yorkshire Council Laboratory [5]	25 %	-	-	-	-	-	-	-
South Yorkshire Air Quality Samplers [6]	-	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Staffordshire County Council	100 %	100 %	50 %	100 %	100 %	100 %	100 %	100 %
Tayside (formerly Dundee CC)	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Walsall MBC [7]	-	100 %	100 %	100 %	-	-	-	-
West Yorkshire Analytical Services	100 %	100 %	100 %	100 %	75 %	75 %	100 %	100 %

[1] Bureau Veritas laboratory and Harwell Scientific now part of ESG Group.
[2] Participant subscribes to two sets of test samples (2 x 4 test samples) in each WASP PT round.
[3] No longer involved in NO_2 diffusion tube measurements from R113.
[4] New participant from R115.
[5] No longer involved in NO_2 diffusion tube measurements from R109.
[6] New participant from R109.
[7] Results for WASP R107, R108 and R112 not submitted. No longer involved in NO_2 diffusion tube measurements from R113.

WASP Summary – R108-R115 5

Adjustment of SINGLE Tubes

AEA Energy & Environment
From the AEA group

Adjusted measurement (95% confidence interval)
with all the data
11 periods used in this calcuations

Bias Factor A 0.91 (0.83 - 1.02)
Bias B 9% (-2% - 21%)

Tube Precision: 5 Automatic DC: 92%

Diffusion Tube Measurements																		
Site Name/ID	Periods													Raw Mean	Valid periods			
	1	2	3	4	5	6	7	8	9	10	11	12	13					
1. 35 East Road Irvine	35.0	33.8	37.4	28.9	20.3	23.1		26.7	21.9	36.1	28.9	32.0		29.5	11	Adjusted with 95% CI	27	(24 - 30)
2. 18 Bank St, Irvine (Pitchers)	39.0	36.7	43.3	24.3	23.2	21.9		28.7	19.7	30.6	36.8	35.6		30.9	11	Adjusted with 95% CI	28	(26 - 32)
3. 147 High Street, Irvine	35.4	38.0	40.7	29.6	23.4	26.2		30.3	23.4	51.5	39.7	34.4		33.9	11	Adjusted with 95% CI	31	(28 - 35)
4. 85 High St, Irvine	38.7	43.0	40.7	36.0	25.3	28.6		41.2	25.7	44.2	50.7	33.9		37.1	11	Adjusted with 95% CI	34	(31 - 38)
5. 79 High St, Irvine	68.1	73.4	81.3	77.7	41.5	57.7		66.3	54.6	77.7	65.5	51.7		65.0	11	Adjusted with 95% CI	59	(54 - 66)
6. 75 High St, Irvine (HIGH)	58.3	59.7	61.7	56.4	38.8	36.2		45.1	42.2	61.6	50.8	51.2		51.1	11	Adjusted with 95% CI	46	(42 - 52)
7. 71 High St, Irvine	46.2	48.0	47.0	42.0										45.8	4	Adjusted with 95% CI	42	(38 - 47)
8. 65a High Street, Irvine	47.1	41.1	38.3	32.5	27.6	29.3		30.6	30.3	42.7	33.3	31.3		34.9	11	Adjusted with 95% CI	32	(29 - 36)
9. 65 High Street, Irvine	46.9	35.8	36.2	40.4	29.1	26.7		31.4	29.6	40.6	37.2	35.6		35.4	11	Adjusted with 95% CI	32	(29 - 36)
10. 63 High Street, Irvine	43.7	41.8	41.1	40.5	26.7	30.6		30.7	30.4	42.1	35.4	32.3		35.9	11	Adjusted with 95% CI	33	(30 - 37)
11. 34 Kirkgate Irvine	20.1	19.3	18.9	12.2	10.3	9.3		11.0	8.8	20.0	15.5	23.4		15.4	11	Adjusted with 95% CI	14	(13 - 16)
12. 25 Main Rd, Springside	28.3	27.3	25.0	20.7	13.0	15.8		15.7	11.3	24.5	20.1	24.6		20.6	11	Adjusted with 95% CI	19	(17 - 21)
13. Auchengate (Bridge)	16.7	18.4	18.9	12.1	9.1	11.2		11.3	7.6	16.0	15.0	18.3		14.0	11	Adjusted with 95% CI	13	(12 - 14)
14. Dalry Rd , Kilwinning	37.3	39.4	35.1	19.9	16.2	21.4		21.4	14.6	29.1	57.3	28.0		29.1	11	Adjusted with 95% CI	26	(24 - 30)
15. Vernon St, Saltcoats	29.4	30.4	36.1	23.8	20.1	25.8		28.6	19.1	32.1	26.6	28.2		27.3	11	Adjusted with 95% CI	25	(23 - 28)
16. 12 Garnock St, Dalry	24.0	19.3	15.2	12.0	11.4	10.9		9.0	7.7	18.1	14.8	23.9		15.1	11	Adjusted with 95% CI	14	(13 - 15)
17. 67 New St, Dalry	51.0	53.9	47.3	41.7	27.3	32.7		32.1	27.6	43.8	36.9	39.5		39.4	11	Adjusted with 95% CI	36	(33 - 40)
18. 45 New St Dalry	52.0	61.1	67.7	41.1	30.7	39.4		49.1	35.2	54.5	56.7	46.7		48.6	11	Adjusted with 95% CI	44	(40 - 50)
19. 2 Townhead, St, Dalry	44.0	42.1	45.2	33.6	26.2	31.1		37.9	24.4	43.7	38.4	29.5		36.0	11	Adjusted with 95% CI	33	(30 - 37)
20. Highfield Hamlet , Dalry	26.7	24.0	25.0	17.9	17.1	23.6		20.8	17.4	25.9	23.4	30.7		22.9	11	Adjusted with 95% CI	21	(19 - 23)
21. 85 Main Street , Largs	21.1	29.3	31.8	38.0	21.8	25.6		22.3	19.6	32.5	24.8	26.1		26.6	11	Adjusted with 95% CI	24	(22 - 27)
22. Hunterston Road	8.9	9.1	8.2	5.4		9.6		6.0	5.2	9.4	6.8	10.2		7.9	10	Adjusted with 95% CI	7	(7 - 8)
7a Princes St/Glasgow St					20.8	21.1		21.1	15.5	28.8	21.7	27.0		22.3	7	Adjusted with 95% CI	20	(18 - 23)

The bias adjustment factor used in these calculations include all the data and no screening of data due to poor precision has been applied.

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm -3	Tube 2 µgm -3	Tube 3 µgm -3	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	04/01/2012	01/02/2012	47.1	46.9	43.7	46	1.9	4	4.8	34	94	Good	Good
2	01/02/2012	29/02/2012	41.1	35.8	41.8	40	3.3	8	8.1	33	93	Good	Good
3	29/02/2012	28/03/2012	38.3	36.2	41.1	39	2.5	6	6.2	34	92	Good	Good
4	28/03/2012	25/04/2012	32.5	40.4	40.5	38	4.6	12	11.4	29	89	Good	Good
5	25/04/2012	30/05/2012	27.6	29.1	26.7	28	1.2	4	3.0	29	90	Good	Good
6	30/05/2012	27/06/2012	29.3	26.7	30.6	29	2.0	7	4.9	25	93	Good	Good
7	27/06/2012	01/08/2012											
8	01/08/2012	29/08/2012	30.6	31.4	30.7	31	0.5	1	1.1	27	92	Good	Good
9	29/08/2012	27/09/2012	30.3	29.6	30.4	30	0.4	1	1.1	28	94	Good	Good
10	27/09/2012	01/11/2012	42.7	40.6	42.1	42	1.1	3	2.8	36	92	Good	Good
11	01/11/2012	28/11/2012	33.3	37.2	35.4	35	1.9	5	4.8	40	91	Good	Good
12	28/11/2012	07/01/2012	31.3	35.6	32.3	33	2.3	7	5.6	41	90	Good	Good
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Good Overall DC

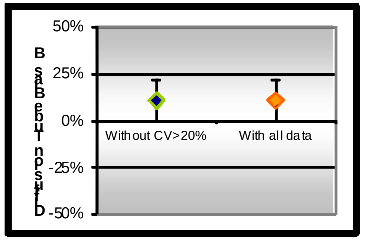
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:

Precision 11 out of 11 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 11 periods of data
Bias factor A 0.91 (0.83 - 1.02)
Bias B 9% (-2% - 21%)
Diffusion Tubes Mean: 35 µgm-3
Mean CV (Precision): 5
Automatic Mean: 32 µgm-3
Data Capture for periods used: 92%
Adjusted Tubes Mean: 32 (29 - 36) µgm-3

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 11 periods of data
Bias factor A 0.91 (0.83 - 1.02)
Bias B 9% (-2% - 21%)
Diffusion Tubes Mean: 35 µgm-3
Mean CV (Precision): 5
Automatic Mean: 32 µgm-3
Data Capture for periods used: 92%
Adjusted Tubes Mean: 32 (29 - 36) µgm-3



Jaume Targa, for AEA
Version 04 - February 2011

If you have any enquiries about this spreadsheet please contact the LAQM Helpdesk at: LAQMHelpdesk@uk.bureauveritas.com

Appendix 2: Drop-Off With Distance Calculations

79 High Street – Façade Concentration

This calculator allows you to predict the annual mean NO_2 concentration for a location ("receptor") that is close to a monitoring site, but nearer or further the kerb than the monito
The next sheet shows your results on a graph.

Air Quality CONSULTANTS

Enter data into the yellow cells

Step 1	**How far from the KERB was your measurement made (in metres)?**	(Note 1)	**1.25**	metres
Step 2	**How far from the KERB is your receptor (in metres)?**	(Note 1)	**5.2**	metres
Step 3	**What is the local annual mean background NO_2 concentration (in µg/m^3)?**	(Note 2)	**6**	µg/m^3
Step 4	**What is your measured annual mean NO_2 concentration (in µg/m^3)?**	(Note 2)	**59**	µg/m^3
Result	**The predicted annual mean NO_2 concentration (in µg/m^3) at your receptor**	(Note 3)	**43.1**	µg/m^3

Note 1: In some cases the term "kerb" may be taken to be the edge of the trafficked road - see the FAQ at http://laqm2.defra.gov.uk/FAQs/Monitoring/Location/index.htm for further details. Distances should be measured horizontally from the kerb and assume

Note 2: The measurement and the background must be for the same year. The background concentration could come from the national maps published at www.airquality.co.uk, or alternatively from a nearby monitor in a background location.

Note 3: The calculator follows the procedure set out in Box 2.3 of LAQM TG(09). The results will have a greater uncertainty than the measured data. More confidence can be placed in results where the distance between the monitor and the receptor is small

Issue 4: 25/01/11. Created by Dr Ben Marner; Approved by Prof Duncan Laxen. Contact: benmarner@aqconsultants.co.uk

79 High Street – Façade Concentration with Pavement Widening

This calculator allows you to predict the annual mean NO_2 concentration for a location ("receptor") that is close to a monitoring site, but nearer or further the kerb than the monitor. The next sheet shows your results on a graph.

Air Quality CONSULTANTS

Enter data into the yellow cells

Step 1	**How far from the KERB was your measurement made (in metres)?**	(Note 1)	**1.25**	metres
Step 2	**How far from the KERB is your receptor (in metres)?**	(Note 1)	**8.2**	metres
Step 3	**What is the local annual mean background NO_2 concentration (in $\mu g/m^3$)?**	(Note 2)	**6**	$\mu g/m^3$
Step 4	**What is your measured annual mean NO_2 concentration (in $\mu g/m^3$)?**	(Note 2)	**59**	$\mu g/m^3$
Result	**The predicted annual mean NO_2 concentration (in $\mu g/m^3$) at your receptor**	(Note 3)	**38.0**	$\mu g/m^3$

Note 1: In some cases the term "kerb" may be taken to be the edge of the trafficked road - see the FAQ at http://laqm2.defra.gov.uk/FAQs/Monitoring/Location/index.htm for further details. Distances should be measured horizontally from the kerb and assumes that the monitor and receptor have similar elevations. Each distance should be greater than 0.1m and less than 50m (In practice, using a value of 0.1m when the monitor is closer to the kerb than this is likely to be reasonable). The receptor is the location for which you wish to make your prediction. The monitor can either be closer to the kerb than the receptor, or further from the kerb than the receptor. The closer the monitor and the receptor are to each other, the more reliable the prediction will be. When your receptor is further from the kerb than your monitor, it is recommended that the receptor and monitor should be within 20m of each other. When your receptor is closer to the kerb than your monitor, it is recommended that the receptor and monitor should be within 10m of each other.

Note 2: The measurement and the background must be for the same year. The background concentration could come from the national maps published at www.airquality.co.uk, or alternatively from a nearby monitor in a background location.

Note 3: The calculator follows the procedure set out in Box 2.3 of LAQM TG(09). The results will have a greater uncertainty than the measured data. More confidence can be placed in results where the distance between the monitor and the receptor is small than where it is large.

Issue 4: 25/01/11. Created by Dr Ben Marner; Approved by Prof Duncan Laxen. Contact: benmarner@aqconsultants.co.uk

75 High Street – Pavement Widening

This calculator allows you to predict the annual mean NO_2 concentration for a location ("receptor") that is close to a monitoring site, but nearer or further the kerb than the monitor. The next sheet shows your results on a graph.

Air Quality CONSULTANTS

Enter data into the yellow cells

Step 1	**How far from the KERB was your measurement made (in metres)?**	(Note 1)	**5.25**	metres
Step 2	**How far from the KERB is your receptor (in metres)?**	(Note 1)	**8.25**	metres
Step 3	**What is the local annual mean background NO_2 concentration (in $\mu g/m^3$)?**	(Note 2)	**6**	$\mu g/m^3$
Step 4	**What is your measured annual mean NO_2 concentration (in $\mu g/m^3$)?**	(Note 2)	**46**	$\mu g/m^3$
Result	**The predicted annual mean NO_2 concentration (in $\mu g/m^3$) at your receptor**	(Note 3)	**40.5**	$\mu g/m^3$

Note 1: In some cases the term "kerb" may be taken to be the edge of the trafficked road - see the FAQ at http://laqm2.defra.gov.uk/FAQs/Monitoring/Location/index.htm for further details. Distances should be measured horizontally from the kerb and assumes that the monitor and receptor have similar elevations. Each distance should be greater than 0.1m and less than 50m (In practice, using a value of 0.1m when the monitor is closer to the kerb than this is likely to be reasonable). The receptor is the location for which you wish to make your prediction. The monitor can either be closer to the kerb than the receptor, or further from the kerb than the receptor. The closer the monitor and the receptor are to each other, the more reliable the prediction will be. When your receptor is further from the kerb than your monitor, it is recommended that the receptor and monitor should be within 20m of each other. When your receptor is closer to the kerb than your monitor, it is recommended that the receptor and monitor should be within 10m of each other.

Note 2: The measurement and the background must be for the same year. The background concentration could come from the national maps published at www.airquality.co.uk, or alternatively from a nearby monitor in a background location.

Note 3: The calculator follows the procedure set out in Box 2.3 of LAQM TG(09). The results will have a greater uncertainty than the measured data. More confidence can be placed in results where the distance between the monitor and the receptor is small than where it is large.

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