



2012 Air Quality Updating and Screening Assessment for *Dundee City Council*

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

Date (Oct, 2012)

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Report Reference number	
Date	Oct 2012

Executive Summary

This document is the 2012 Updating and Screening Assessment (USA) of air quality in the Dundee City Council area. Part IV of the Environment Act 1995 places a statutory duty on local authorities to review and assess the air quality within their area and take account of Government Guidance when undertaking such work.

The USA provides an update with respect to air quality issues within the City and has included consideration of new monitoring data (2011) and emissions sources, in addition to any significant changes to existing emission sources identified in the previous rounds. The USA considers the seven priority health based air quality objectives as laid down in Regulations and assesses the likelihood that the air quality objectives will be met. If the air quality objectives are unlikely to be met, a Detailed Assessment (DA) will be required.

Having considered and assessed (as necessary) each emission source, it is concluded that the air quality objectives for benzene, 1, 3-butadiene, carbon monoxide, lead, and sulphur dioxide will be met. The whole of Dundee is an Air Quality Management Area (AQMA) for nitrogen dioxide (NO₂) and particulate matter (PM₁₀) due to exceedences of the annual mean air quality objectives for these pollutants. The 2011 monitoring data confirm the continuing need for the AQMA and the subsequent Air Quality Action Plan (AQAP). Concentrations of these pollutants are above the objective and have increased in many areas of the city since the AQMA was declared. The greatest increases in pollutant concentrations have been recorded along the city centre bus corridor, the north-west arterial route and associated access roads, major junctions on the Kingsway and at Stannergate Roundabout.

The USA 2012 identifies the need to amend the existing AQMA order to include the hourly objective for nitrogen dioxide. The need to amend the order to include the daily objective for PM₁₀ will be kept under review.

The USA 2012 did not identify the need to proceed to a detailed assessment for any pollutant. Proposed actions arising from the USA 2012 are as follows:

- Take forward the amendment of the current AQMA order to include the hourly objective for nitrogen dioxide (NO₂);
- Review the need to amend the AQMA order to include the daily mean objective for particulate matter (PM₁₀) as more data becomes available;
- Review the results of additional monitoring installed at Kingsway–Myrekirk and Stannergate roundabouts as information becomes available;
- Review the nitrogen dioxide diffusion tube monitoring network in light of trends in monitoring results and new exposure;
- Further investigate sources of biomass/solid fuel combustion in the local authority area to enable appropriate screening and report findings in subsequent LAQM reports as information becomes available, and
- Undertake the 2013 Progress Report.

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GLOSSARY OF ACRONYMS AND DEFINITIONS

AADT	Annual Average Daily Traffic Flow
ADMS	An atmospheric air pollution dispersion model
AEA	AEA Energy & Environment
annualise	the means of estimating an annual mean from a shorter study period mean by comparison with full datasets from background AURN sites
AQ Archive	UK Air Quality Archive
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network (Defra funded air quality monitoring network)
CHP	Combined Heat and Power
CO	Carbon Monoxide
Defra	Department for Environment, Food and Rural Affairs
DERL	Dundee Energy Recycling Ltd
DMRB	Design Manual for Roads and Bridges
EC	European Community
EHTS	Environmental Health and Trading Standards Department
EPA	The Environmental Protection Act 1990
EPAQS	Expert Panel on Air Quality Standards
EU	European Union
GF	Ground floor
GIS	Geographical Information System
HDV	Heavy goods vehicles and buses
HGV	Heavy Goods Vehicle
IPC	Integrated Pollution Control
kerbside	0 to 1 metre from the kerb
LAQM.TG(03)	Local Air Quality Management: Technical Guidance (2003)
LAQM.TG(09)	Local Air Quality Management: Technical Guidance (2009)
Limit Value	An EU definition for a mandatory air quality standard of a pollutant listed in the air quality directives
MW	Mega Watts
mg/kg	Milligrams per Kilogram
mg/m ³	Milligrams per cubic metre
NAEI	National Atmospheric Emission Inventory
NAQS	National Air Quality Standard
NO	Nitric Oxide
NO ₂	Nitrogen Dioxide
NO _x	Oxides of nitrogen
ng/m ³	Nanograms per cubic metre
NRTF	National Road Traffic Forecast
Osiris	the brand name given by Turnkey Instruments Ltd. to their particle measuring nephelometer
P&T	Planning and Transportation
PM _{2.5}	Particulate Matter less than 2.5µm aerodynamic diameter
PM ₁₀	Particulate Matter less than 10µm aerodynamic diameter
Pb	Lead
percentile	The percentage of results below a given value
ppb	Parts per billion
ppm	Parts per million

receptor	In this study, the relevant location where air quality is assessed or predicted (for example, houses, hospitals and schools)
roadside	1 to 5 m from the kerb
SCA	Smoke Control Area
SED	Solvent Emissions Directive
SEPA	Scottish Environment Protection Agency
SO ₂	Sulphur Dioxide
Street Canyon	A relatively narrow street with buildings on both sides, where the height of the buildings is generally greater than the width of the road
TEA	Triethanolamine
TEOM	Tapered Element Oscillating Microbalance
UKAS	United Kingdom Accreditation Service
USA	Updating and Screening Assessment
µg/m ³	Micrograms per cubic metre
VOC	Volatile Organic Compound
vpd	Vehicles per day
WASP	Workplace Analysis Scheme for Proficiency

1 Introduction

1.1 Description of Local Authority Area

Dundee City is located on the north bank of the river Tay in the Tay valley. The Dundee City Council area covers 63 square kilometres (24 square miles) and is geographically the smallest local authority area in Scotland. It is bordered by Perth and Kinross Council to the west and by Angus Council to the north and east. The former Tayside Regional Council area previously covered all three councils and Dundee continues to serve as the regional centre for this area and north-east Fife, with an estimated catchment population of some 400,000 people.

Dundee is the fourth largest city in Scotland and the most recent estimate of Dundee's population is 144,290 (National Registers of Scotland (NRS) 2010 Mid Year Population Estimate). This equates to a population density of 2412 people per square kilometre.

Dundee is served by an airport which has daily flights to London City. Dundee also has a modern deep-water port and large harbour area. The port area has been a major industrial and commercial source of employment and wealth creation for Dundee and the Central Waterfront project is one of the key priorities in terms of re-connecting the city and its people with the river.

The City is almost entirely urban and suburban in character and is a hub for many routes. It is connected to Fife by the Tay road and rail bridges. The A92 crosses the Tay and emerges in the centre of Dundee. There is an inner ring road, the Marketgait, and five arterial routes - Broughty Ferry Road, Arbroath Road, Riverside Drive, Lochee Road and Forfar Road. There is an outer-ring road, the Kingsway, which consists of the A90(T), the main route from Edinburgh/Perth to Aberdeen, and the A972(T), the route to Arbroath. There are a significant number of busy road junctions across the City. A large proportion of roads in the City have a gradient due to a central topographical feature, The Law, the plug of an extinct volcano (height 174 metres above sea level). The main sources of pollution in the area are from the road traffic emissions from these routes, with additional emissions from industrial sources, most of which are located around the periphery of the city and in the port area.

In common with many Scottish cities the architecture consists of a significant number of 4 or 5-storey tenemental properties creating numerous street canyons. In the commercial centres, a common feature of these tenemental properties is that commercial premises are located on the ground floor with residential premises on the floors above. The main shopping area in the city is pedestrianised.

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 Updating and Screening Assessment is to identify any matters that have changed which may lead to risk of an air quality objective being exceeded. A checklist approach and screening tools are used to identify significant new sources or changes and whether there is a need for a Detailed Assessment. The USA report should provide an update of any outstanding information requested previously in Review and Assessment reports.

1.3 Air Quality Objectives

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

Table 1.1 Air Quality Objectives included in Regulations for the purpose of LAQM in Scotland

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

1.4 Summary of Previous Review and Assessments

As established by the Environment Act 1995 Part IV, all local authorities in the UK are under a statutory duty to undertake an air quality assessment within their area and determine whether they are likely to meet the air quality objectives for a number of pollutants. The process of review and assessment of air quality undertaken by local authorities is set out under the Local Air Quality Management (LAQM) regime and involves a phased three yearly assessment of local air quality. Where the results of the review and assessment process highlight that problems in the attainment of health-based objectives for air quality will arise, the authority is required to declare an Air Quality Management Area (AQMA) – a geographic area defined by high levels of pollution and exceedences of health-based standards.

The LAQM regime was first set down in the 1997 National Air Quality Strategy (NAQS) and introduced the idea of local authority 'Review and Assessment'. The Government and Devolved Administrations subsequently published policy and technical guidance related to the review and assessment processes in 1998. This guidance has since been reviewed and the latest documents include Policy Guidance (LAQM.PGS (09)) and Technical Guidance (LAQM.TG (09)). The guidance lays down a progressive, but continuous, framework for the local authorities to carry out their statutory duties to monitor, assess and review air quality in their area and produce action plans to meet the air quality objectives.

A summary of the conclusions of previous rounds of review and assessment are presented in **Table 1.2** below. A map of the boundary of the Air Quality Management Area for nitrogen dioxide (NO₂) and particulate matter (PM₁₀) is shown in **Figure 1.1** below.

Table 1.2 Summaries of Review and Assessment Reports

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Stage 1 (1998)	The principle conclusion of Dundee City Council's Stage 1 report was that it was necessary to proceed to the next stage of assessment for all seven of the key LAQM pollutants (nitrogen dioxide (NO ₂), particulate matter (PM ₁₀), lead, carbon monoxide (CO), benzene, 1,3-butadiene and sulphur dioxide(SO ₂)). The chief reasons for this conclusion were a lack of available information relating to potentially significant traffic and industrial pollution sources within the city.
Stage 2 (2000)	Additional monitoring was carried out and additional information was obtained concerning industrial and traffic sources. Screening assessments incorporating this new information were carried out in accordance with national guidance and concluded that the National Air Quality Standards and Objectives (NAQS) would be achieved in Dundee.

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Updating and Screening Assessment (2003)	<p>The imposition of stricter pollutant thresholds, changes in the technical guidance and methodologies for assessment led to an investigation of new areas. This review concluded that the NAQS for carbon monoxide, benzene, 1,3-butadiene and lead would be achieved. It was also concluded that a detailed assessment would be required as a result of potential exceedences of the NAQS for NO₂ and PM₁₀ at busy roads and junctions and to investigate the likelihood of exceedences of the NAQS for sulphur dioxide at new residential premises introduced close to an industrial source.</p>
Detailed Assessment (2005)	<p>The detailed assessment of NO₂ and PM₁₀ from traffic sources identified exceedences of the NAQS annual mean standard for NO₂ at relevant receptors in the city centre and along the north-west arterial route.</p> <ul style="list-style-type: none"> • NO₂ - the detailed assessment established the need for Dundee City Council to declare an Air Quality Management Area (AQMA), carry out a further assessment of NO₂ and develop an Action Plan to try and reduce pollution levels in exceedence areas. • PM₁₀ -there was insufficient confidence in the modelled results for 2010 and it was concluded that additional monitoring and modelling would be required to determine whether an AQMA was also required for PM₁₀. • SO₂ -the detailed assessment concluded that the NAQS would be achieved at new residential developments introduced close to an industrial source and that an AQMA was not required for this pollutant.
Progress Report (2005)	<p>2004 monitoring data and new local developments with the potential to affect air quality were assessed in accordance with statutory guidance and the conclusions reached were:</p> <ul style="list-style-type: none"> • Benzene - no AQMA required for Benzene, as a result monitoring was discontinued. • NO₂ - identified additional areas of exceedence of the NO₂ annual mean at relevant receptors on the north-west arterial route. 22 exceedences of the hourly mean NAQS for NO₂ were recorded at the Lochee Road monitoring site. 18 of the 22 occurred during water main rehabilitation works which caused traffic congestion in the vicinity of the monitor. The results were not thought to be representative of the ambient conditions in the area and no AQMA was considered necessary at that time. • PM₁₀ - the results for 2004 indicated that the 2004 and 2010 NAQS for PM₁₀ would be achieved at the Broughty Ferry Road and background monitoring sites. Exceedences of the 2010 annual mean and daily mean NAQS were recorded at the Union Street monitoring location. These were investigated and it was considered that low data capture, local demolition works and the temporary re-routing of buses along Union St during the construction of a bus-interchange in Whitehall St has contributed to these exceedences and the monitored concentrations did not represent the normal ambient concentrations. • SO₂ - monitoring indicated that no AQMA was required.

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Updating and Screening Assessment (2006)	<p>The Updating and Screening Assessment (USA) 2006 marked the beginning of the third round of review and assessment and required the re-examination all of the seven LAQM pollutants. 2005 data and any significant changes in pollutant sources and public exposure to pollutants were examined in accordance with statutory guidance. The conclusions reached were:</p> <ul style="list-style-type: none"> • that the NAQS for CO, benzene, 1,3-butadiene, lead and SO₂ would be achieved and hence no detailed assessment would be needed. • NO₂ - the report confirmed the need for the AQMA for NO₂ (which was declared for the whole city in July 2006) and identified an additional exceedence area in the city centre, one of the main bus corridors (Meadowside). • PM₁₀ - the report concluded that the only monitored PM₁₀ concentrations predicted to breach the annual mean NAQS for 2010 was the monitoring location in Union Street this was investigated and it was determined that major construction projects in the vicinity might have had an influence on the levels recorded and these may not be truly represent ambient concentrations at this location.
Progress Report (2007)	<p>2006 monitoring data and new local developments with the potential to affect air quality were assessed in accordance with statutory guidance and the conclusions reached were:</p> <ul style="list-style-type: none"> • NO₂ - analysis of the 2006 data re-confirmed the need for the AQMA and the development of an Action Plan. Two new areas of potential exceedence of the annual mean NAQS were identified on the north-east arterial route. (Kingsway/Forfar Road and Albert Street/Arbroath Road). • PM₁₀ - Dundee City Council operate a local Partisol/TEOM co-location study which allows a local gravimetric correction factor to be calculated. This was used to correct TEOM and Osiris data in the monitoring network. Using this factor, exceedences of the 2010 PM₁₀ NAQS were predicted at the following monitoring locations in the city centre and the north-west arterial route: <ul style="list-style-type: none"> • Victoria Road / Hilltown Junction, Seagate, Logie Street, and Lochee Road. • The Union Street site was also very close to exceeding the annual mean for 2010 and remains an area of concern due to increasing PM₁₀ at this city centre location. There were also potential exceedences of the daily mean NAQS predicted at the Osiris monitoring locations. The 2006 PM₁₀ monitoring results indicated that a detailed assessment would be required for PM₁₀. • SO₂ - the monitoring results for 2006 indicate that all NAQS objectives were met at the monitoring locations in Dundee. Exceedences of the 15min mean NAQS occurred at the Broughty Ferry Road site, these were well below the 35 exceedences allowed and were thought to have been caused by certain shipping movements and activities. A detailed assessment of this pollutant was not required, but monitoring data would be kept under review.

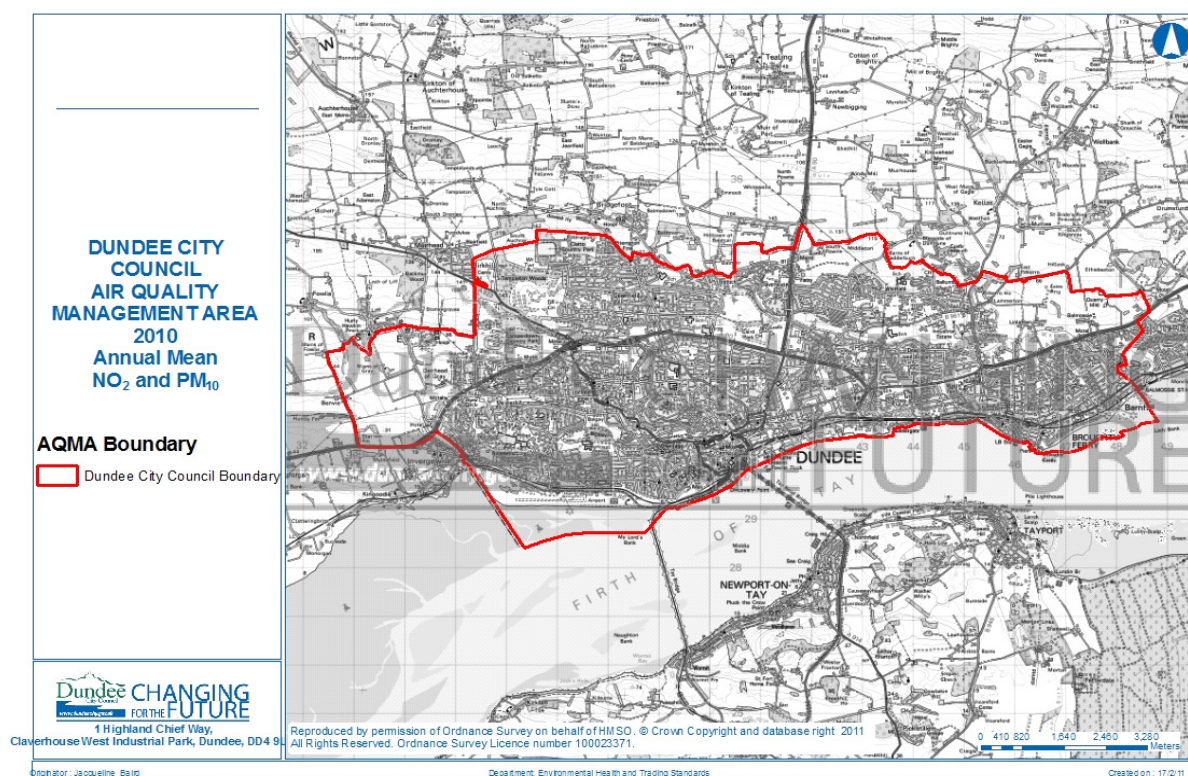
REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
Further Assessment of Nitrogen Dioxide and Detailed Assessment of Particulate Matter PM ₁₀ (2009)(FA/DA)	<p>The FA/DA combined the detailed assessment of PM₁₀ with a further assessment of both NO₂ and PM₁₀. It examined the 2007 monitoring data and established the main sources of pollution in the exceedance areas and the reduction in pollutant levels necessary to meet the NAQS. The report confirmed the need for the existing AQMA for NO₂ and concluded that an AQMA should be declared for PM₁₀. The report also estimated that 4,600 people were living in areas at risk of exceeding the NAQS for NO₂ and PM₁₀ and concluded that significant reductions in pollutant concentrations are required to meet the annual mean NAQS for both pollutants. The results of the source apportionment exercise are summarised below:</p> <ul style="list-style-type: none"> • Source apportionment of NO_x, indicates road traffic emissions of NO_x are the main contribution to total NO_x concentrations, as they account for 74 - 91% of the total NO_x concentrations at receptors. Heavy-duty vehicles (HDVs) contribute around 38 - 77% to the total NO_x concentrations at receptors and exceed the LDV contributions. HDV contributions are disproportionately high given their proportion within the vehicle fleet in the AQMA. • Source apportionment of PM₁₀, indicates background sources of PM₁₀ (e.g. sea salt) make a significant contribution to total PM₁₀ concentrations, as they account for 28-59% of the total PM₁₀ concentrations at receptors, with the majority of this being made up of secondary particulates, residual and salt contributions. Road traffic contributes 41% to 72% of the total PM₁₀ concentration at receptors. Light duty vehicles (LDVs) contribute around 7 – 24 and heavy-duty vehicles (HDVs) contribute around 11-36% to the total PM₁₀ concentrations at receptors. Brake and tyre wear contribute around 13-29% to the total PM₁₀ concentrations at receptors. HDV contributions are disproportionately high given their proportion within the vehicle fleet in the AQMA. On Commercial Street and Seagate, where there are significant bus movements, the HDV contribution exceeds the LDV contribution. <p>(HDV - is a collective term for heavy goods vehicles (HGV) and buses)</p>
Updating and Screening Assessment 2009 (2010)	<p>The Updating and Screening Assessment (USA) 2009 marked the beginning of the fourth round of review and assessment and required the re-examination all of the seven LAQM pollutants. This was carried out in accordance with revised statutory guidance and examined 2008 data and any significant changes in pollutant sources and public exposure to pollutants. The conclusions reached were:</p> <ul style="list-style-type: none"> • that the NAQS for CO, benzene, 1,3-butadiene, lead and SO₂ would be achieved and hence no detailed assessment would be needed. <p>NO₂ - the report re-confirmed the need for the AQMA for NO₂ (which was declared for the whole city in July 2006) and identified an additional potential annual mean exceedance area in Strathmore Avenue. Diffusion tube monitoring also indicated potential exceedances of the hourly mean NAQS in the vicinity of Victoria Road / Meadowside junction and informed the need for automatic monitoring to investigate whether an additional AQMA is required for hourly mean NAQS for NO₂. Monitoring programmed to begin in 2011.</p>

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
	<ul style="list-style-type: none"> • PM₁₀ - the report noted that monitored PM₁₀ concentrations at Lochee Road and Seagate breach the annual mean NAQS for 2010. Combined with the predicted exceedences of the 2010 PM₁₀ annual mean in the FA/DA, it was concluded that an AQMA should be declared. Consequently, the 2006 AQMA order was amended in October 2010 to include PM₁₀. • the revised statutory guidance contained a new requirement to review and assess biomass combustion sources. The review did not identify any sources within the local authority area that met the criteria for assessment. However, it was considered there was insufficient information available to adequately assess these sources. This will be reported in subsequent review and assessment reports as information becomes available.
Progress Report 2010	<p>2009 monitoring data and new local developments with the potential to affect air quality were assessed in accordance with statutory guidance and the conclusions reached were:</p> <p>SO₂ - New monitoring data for 2010 show the objectives for SO₂ are being achieved. Sulphur dioxide concentrations measured at the Broughty Ferry Road monitoring location remained low and achieved the objectives during 2009.</p> <p>PM₁₀ - PM₁₀ objectives for 2004 are being met at all monitoring locations within the city. However, there is a risk of exceedence of the 2010 PM₁₀ annual mean objective being exceeded at roadside sites. The 2010 PM₁₀ daily mean was also exceeded at the monitoring location in Seagate using the VCM corrected data, but not when the local gravimetric correction factor was applied to the data. Osiris monitoring units have a tendency to over-estimate the number of exceedences compared to TEOMs. The council intend to install a reference equivalent PM₁₀ analyser in this area, and the need for a detailed assessment or AQMA in relation to the daily mean will be kept under review. A detailed assessment undertaken in 2009 for PM₁₀, also identified a risk of exceedence of the 2010 objectives at receptors adjacent to busy roads and junctions in the city centre</p> <p>NO₂ - Exceedences of the nitrogen dioxide annual mean objective continued to occur within the existing AQMA in 2009 and, after façade projections were calculated, concentrations at fourteen sites failed to meet the annual mean standard. Uncertainties associated with the distance calculator tool used to estimate pollutant concentrations at façade suggest that Strathmore Avenue may be a new potential area of exceedence; this will be kept under review.</p>

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
	<p>With respect to the hourly NO₂ objective, none of the diffusion tube monitoring sites in the city recorded annual mean concentrations above 60µg/m³ –The diffusion tube site at the junction of Victoria Road/Hilltown measured a NO₂ concentration of 59.5µg/m³. Members of the public are not regularly present for more than 1-hour in these locations, however there are nearby ground floor residences on Meadowside. When projected to façade the concentrations calculated are below 60µg/m³. Keeping in view the uncertainties associated with façade projection methodology, the Council intend to monitor at sites of relevant exposure close to the identified locations to confirm if the hourly-mean of NO₂ is being exceeded.</p> <p>There were 23 exceedences of the hourly NO₂ objective recorded at the automatic monitoring station on Lochee Road during 2009, an examination of the distribution of these exceedences, concluded that they occurred mostly at peak times, on Mondays and Fridays, and during the winter months. Severe weather (snow and ice) during December 2009 may have contributed to some of the exceedences: the monitoring station is located on the main north-west arterial route into the city, which can become increasingly congested during adverse weather when alternative routes are difficult to for drivers to negotiate. The need for a detailed assessment of this location in relation to exceedences of the hourly NO₂ objective is to be re-assessed in the 2011 Progress Report.</p>
Progress Report 2011	<p>This Progress Report presented the 2010 NO₂, PM₁₀ and SO₂ monitoring results. Trends in pollutant concentrations were also examined within the report.</p> <p>Nitrogen dioxide (NO₂) – analysis of the 2010 data for nitrogen dioxide has reconfirmed the need for the AQMA and development of an Action Plan. One new area of potential exceedence of the annual mean has been identified at Strathmore Avenue.</p> <p>Sixty-seven exceedences of the NO₂ hourly mean were recorded at the automatic monitoring station on Lochee Road; this breaches the NAQS objective as only 18 are allowed. Analysis suggests this may have occurred as a result of traffic congestion caused by severe winter weather at the end of 2010. The need for a detailed assessment / AQMA for the hourly NO₂ will be kept under review.</p> <p>NO₂ annual mean concentrations throughout the city have increased since the AQMA was declared in 2006. The greatest increases in pollutant concentrations have been recorded along the city centre bus corridor, the north-west arterial route and associated access roads, major junctions on the Kingsway and at Stannergate Junction, on Broughty Ferry Road.</p> <p>Small Particulates (PM₁₀) - PM₁₀ objectives for 2004 are being met at all monitoring locations within the city. However, the 2010 PM₁₀ annual mean and 24 hour objective are being exceeded at roadside and kerbside Osiris sites. Osiris monitoring units are indicative only and the results should be treated with caution. In Spring 2011 the council installed reference equivalent PM₁₀ analysers in Lochee Road, Seagate and at the Victoria Rd/Meadowside junction, and the need for a detailed assessment or AQMA in relation to the daily mean will be kept under review. A detailed assessment undertaken in 2009 for PM₁₀, also identified a risk of exceedence of the 2010 objectives at receptors adjacent to busy roads and junctions in the city centre.</p>

REVIEW & ASSESSMENT REPORTS	BRIEF SUMMARY of OUTCOMES
	<p>Generally PM₁₀ concentrations between 2006 and 2009 levelled off or were decreasing slightly. However, monitoring locations on the north-west arterial route (Logie Street and Lochee Road) showed a significant increase in PM₁₀ concentrations in 2010.</p> <p>Sulphur Dioxide (SO₂) -The monitoring results for 2010 indicate that all the NAQS objectives were met at the monitoring location in Dundee. A detailed assessment is not currently required for this pollutant.</p> <p>SO₂ concentrations have declined at the Broughty Ferry Road monitoring station between 2002 and 2010; this is thought to be largely due to the introduction of low sulphur fuels at a nearby industrial process in the port. From 2002 to 2006 occasional exceedences of the 15min mean objective were recorded as a result of certain shipping activities/movements within the port.</p>

Figure 1.1 Map of AQMA Boundary



2 New Monitoring Data

2.1 Summary of Monitoring Undertaken

2.1.1 Automatic Monitoring Sites

This section provides details of the automatic monitoring carried out in 2011.

Dundee utilise several methods for monitoring particulate matter (PM₁₀) within the city. The Partisol is a reference equivalent method and is used to determine a local correction factor for the TEOMs, which were designated as non-equivalent in 2006. In addition, five sites are monitored with Osiris analysers. These are also non-equivalent but their measurements are considered indicative of particulate concentrations. Dundee commenced a yearly study in 2005 to compare the PM₁₀ data measured using an Osiris analyser with that from a TEOM. This study determined that the Osiris generally exaggerates peak values compared to the TEOM. Three Beta-Attenuation Monitors (BAM) were added to the network in 2011. These are gravimetric equivalent and have been installed in existing monitoring stations on the main bus corridor through the city centre and on the north-west arterial route.

Nitrogen dioxide chemiluminescence analysers are employed at six locations within the city including a new background monitor and roadside monitor on Meadowside. Meadowside is a street canyon on the main bus corridor with ground floor flats bordering the pavement. Diffusion tubes located in this area had previously recorded annual mean nitrogen dioxide concentrations in excess of 60µg/m³ indicating a possible exceedence of the short-term objective for this pollutant.

Sulphur dioxide is monitored using UV fluorescence at Broughty Ferry Road.

All analysers are audited twice yearly by an external consultant, AEA. The gas analysers at Union Street and Broughty Ferry Road have on-site gases traceable to the National Physical Laboratory (NPL) standards (provided under contract by AEA) and are calibrated automatically every 4 days and daily respectively. The remaining gas analysers do not have on-site gases and are manually calibrated every 3 weeks by AEA using NPL traceable gas.

Dundee City Council secured funding from the Scottish Executive to commission AEA to assist with data management and ratification procedures. Dundee joined the 'Calibration Club' run by AEA at the end of 2006. AEA have ratified all the real-time monitoring data reported from 2006 onwards (excluding the Osiris units) and have provided the Air Pollution Reports shown in **Appendix A**. TEOM PM₁₀ data presented in this report is corrected using both the local gravimetric correction factor and the VCM method (see **Appendix B**). BAM PM₁₀ data has been corrected for slope by AEA (0.83333). Data from the Osiris monitors are checked in-house and are adjusted using a local co-location factor (described in **Section 2.2.2**) and using the VCM correction model 2011 supplied by AEA.

Details of all these monitoring locations can be found in **Table 2.1** and their locations are shown in **Figure 2.1**. Siting automatic monitoring sites in urban areas is problematic and compromises mean that monitors cannot always be situated in the worst case location.

Further details and data for the monitors that are part of the 'Calibration Club' can be found at www.scottishairquality.co.uk. This website also contains on-line tools that enable analysis and review of long term datasets that uses open source software called Openair. Plots of data from 6 long-term monitoring sites using the "trend level hour tool" are shown in **Appendix J**. This tool summarises all hourly data into average hourly pollutant concentrations as a monthly diurnal plot for each month from January 2006 to December 2011. This is helpful for viewing seasonal and year to year differences in pollutant concentrations.

Figure 2.1 Map of Automatic Monitoring Sites

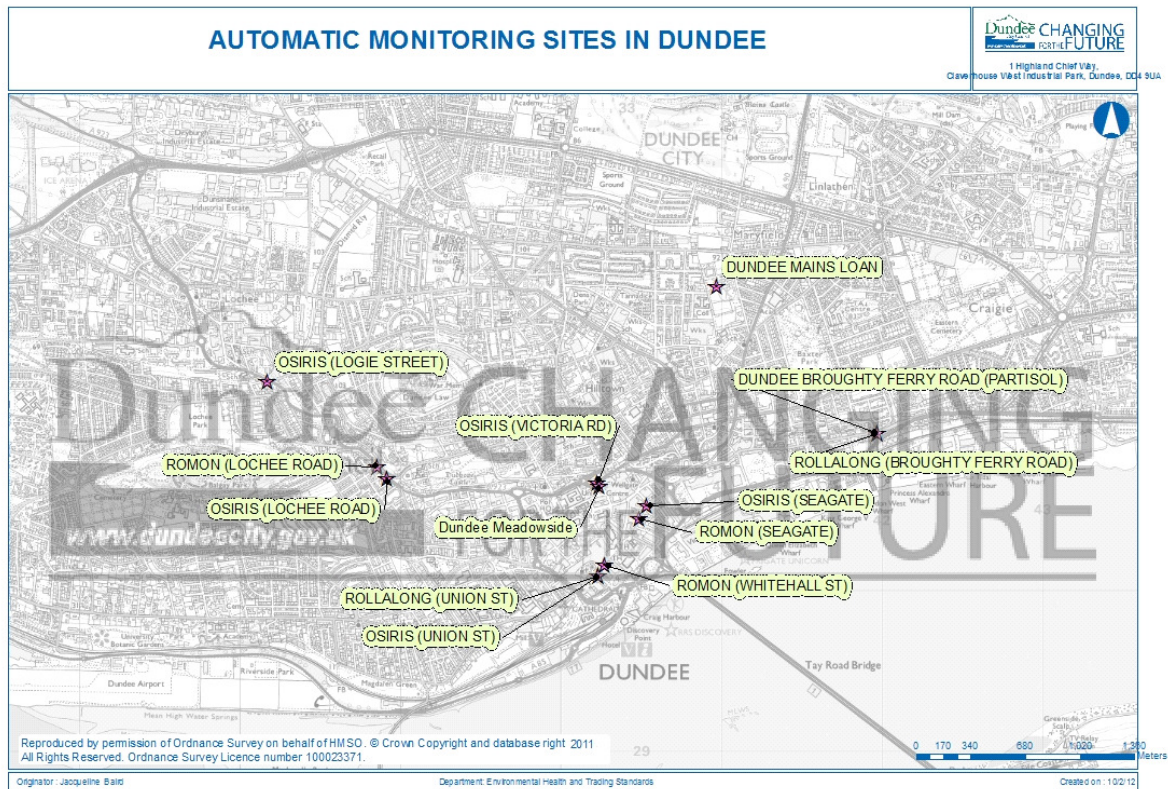


Table 2.1 Details of Automatic Monitoring Sites

Site Name	Site Type	OS Grid Ref (x,y)	Pollutants Monitored	In AQMA ? ¹	Relevant Exposure? (Y/N with distance (m) to relevant exposure) ³	Distance to kerb of nearest road (n/a if not applicable)	Worst-case Location ? ²
Broughty Ferry Road Rollalong	Urban Industrial	x=341970, y=730977	SO ₂ ^a , PM ₁₀ (TEOM)	Yes	Y - 0m	n/a	No
Broughty Ferry Road Partisol	Urban Industrial	x=341971, y=730978	PM ₁₀ (Gravimetric - Partisol)	Yes	Y - 0m	n/a	No
Lochee Road Romon	Roadside	x=338861, y=730773	NO ₂ ^b , PM ₁₀ (BAM)	Yes	Y - 2.21m	1.1m	No
Lochee Road Osiris	Kerbside	x=338920, y=730694	PM ₁₀ (Osiris)	Yes	Y - 2.2	0.6m	Yes
Logie Street Osiris	Kerbside	x=338176, y=731298	PM ₁₀ (Osiris)	Yes	Y - 1.65m	0.57m	Yes
Mains Loan	Urban Background	x=340972, y=731893	NO ₂ ^c , PM ₁₀ (TEOM)	Yes	N - 0m	n/a	No
Seagate Romon	Roadside	x=340487, y=730446	NO ₂ ^b , PM ₁₀ (BAM)	Yes	Y - 2.0m	1.1m	No
Seagate Osiris	Kerbside	x=340539, y=730528	PM ₁₀ (Osiris)	Yes	Y - 1.64m	0.63m	No
Union Street Rollalong	Roadside	x=340235, y=730091	NO ₂ ^b , PM ₁₀ (TEOM)	Yes	Y - 3.3m	1m	Yes
Union Street Osiris	Roadside	x=340235, y=730090	PM ₁₀ (Osiris)	Yes	Y - 3.1m	1.12m	Yes
Victoria Road Osiris	Kerbside	x=340230, y=730673	PM ₁₀ (Osiris)	Yes	Y - 2.7m	0.3m	No
Whitehall Street Romon	Roadside	x=340278, y=730156	NO ₂ ^b	Yes	Y - 1.25m	3.26m	No
Meadowside Romon	Roadside	x=340243, y=730635	NO ₂ ^d , PM ₁₀ (BAM)	Yes	Y - 0.42m	3.3m	Yes

Notes:

¹The whole of Dundee is an AQMA for NO₂ and PM₁₀

² Explanation provided in Box 3.1 of LAQM.TG(09): *Where results are presented for new monitoring sites, then a description of the sites should be provided. This should include the reason they were set up, for example, to represent worst-case relevant exposure alongside a particular road.*

³ Explanation provided in Box 3.1 of LAQM.TG(09), *When describing sites, it should be made clear whether they represent relevant exposure. For instance, if the site is kerbside, it would be appropriate to say that "the nearest relevant exposure is residential properties set back 5 m from the kerb."*

a UV fluorescence ML 9850A

b chemiluminescence ML 9841A

c chemiluminescence Thermo 42i

d chemiluminescence ML 2041

2.1.2 Non-Automatic Monitoring Sites

In addition to the continuous monitoring network, Dundee City Council operated 94 diffusion tube sites in 2011. Details of these monitoring locations can be found in **Table 2.2** and their locations are shown in **Figures 2.2a to 2.2c**

The diffusion tubes are supplied by Gradko and analysed by Tayside Scientific Services utilising the 20% Triethanolamine (TEA) in water preparation method. Tayside Scientific Services participate in the Workplace Analysis Scheme for Proficiency (WASP) for NO₂ diffusion tube analysis, and the Annual Field Inter-Comparison Exercise. These provide strict performance criteria for participating laboratories to meet, thereby ensuring NO₂ concentrations reported are robust. The lab' follows the procedures set out in the Working Group on Harmonisation of Diffusion Tubes Practical Guidance that was published in February 2008¹, and is UKAS accredited for the analysis of nitrogen dioxide. Tayside Scientific Services has demonstrated satisfactory performance over the past five quarterly WASP rounds.²

With regard to the application of a bias adjustment factor for the diffusion tubes, the technical guidance LAQM.TG (09) and Review and Assessment Helpdesk recommends use of a local bias adjustment factor where available and relevant to diffusion tube sites.

Six local co-location studies were undertaken in 2011, which generated the following bias adjustment factors:

- Dundee Lochee Road - 1.11 (insufficient data capture, i.e. less than 75%)
- Dundee Seagate - 0.93 (insufficient data capture, i.e. less than 75%)
- Dundee Union Street - 0.78
- Dundee Whitehall Street - 0.77
- Dundee Meadowside - 0.94 (insufficient data capture, i.e. less than 75%)
- Dundee Mains Loan - 0.65

The roadside sites with sufficient data capture were used to calculate an overall local bias correction factor:

- Dundee City Council - 0.78

The national bias correction factor³ for Tayside Scientific Services was 0.78 (based on eight co-location studies; the three above that had sufficient data capture and five others (Diffusion tube bias factors spreadsheet - Issue 03/12)). The individual calculations of bias adjustment for the roadside local co-location studies in 2011 are shown in **Appendix C**.

¹ AEA Energy & Environment (2008), Diffusion Tubes for Ambient NO₂ Monitoring : Practical Guidance for Laboratories and Users

² [http://laqm.defra.gov.uk/documents/WASP-Rounds-108-115-\(January-2010-December-2011\).pdf](http://laqm.defra.gov.uk/documents/WASP-Rounds-108-115-(January-2010-December-2011).pdf)

³ DEFRA Web site - National bias adjustment factors: <http://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html>

Figure 2.2a Map of Nitrogen Dioxide Diffusion Tubes on the West of the City

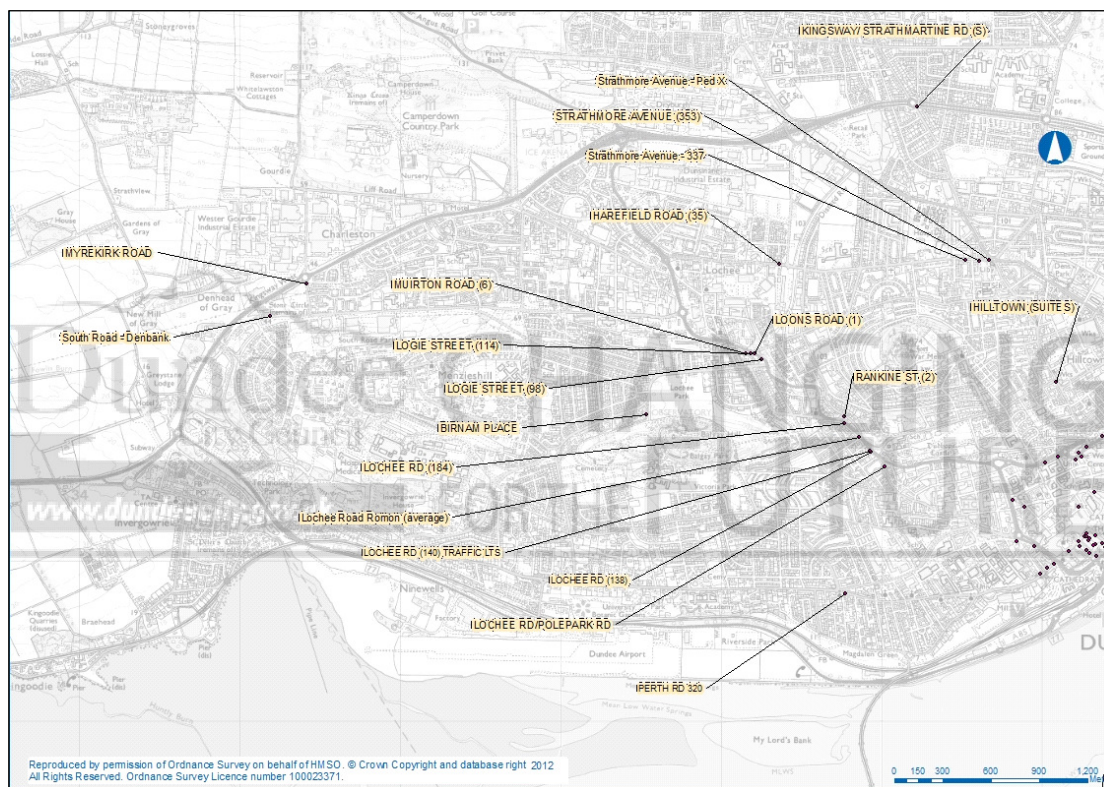


Figure 2.2b Map of Nitrogen Dioxide Diffusion Tubes on the East of the City

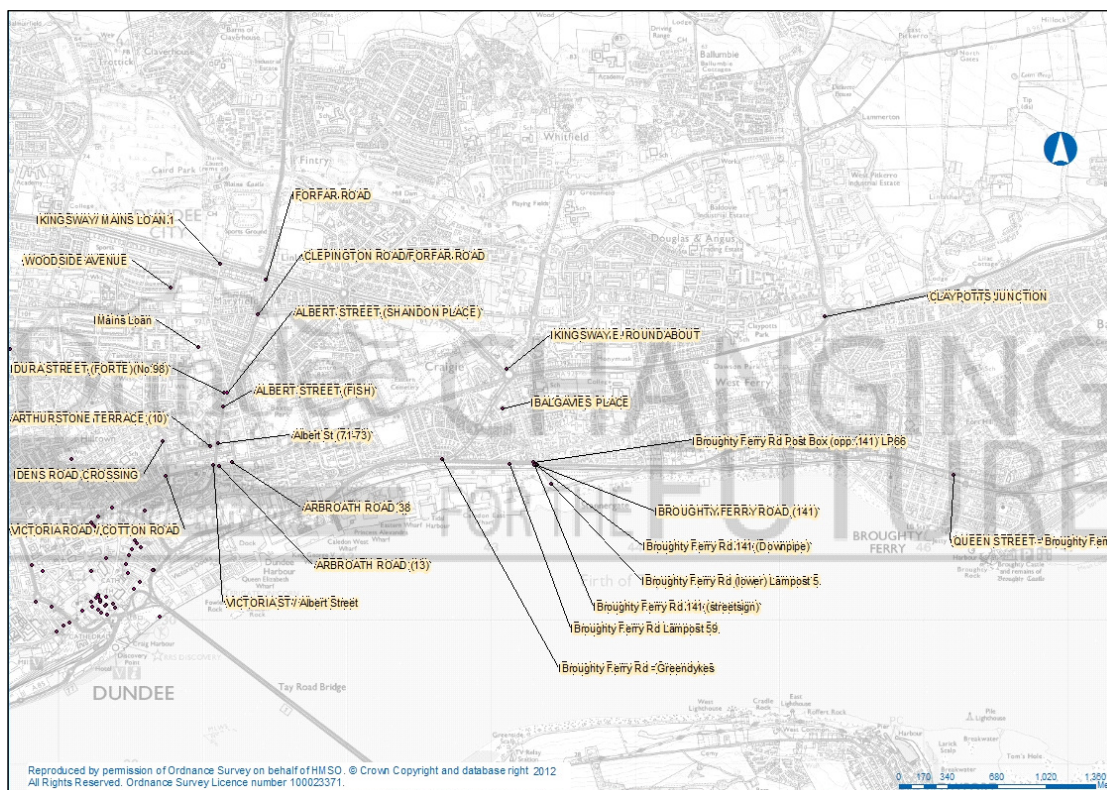


Figure 2.2c Map of Nitrogen Dioxide Diffusion Tubes in the City Centre

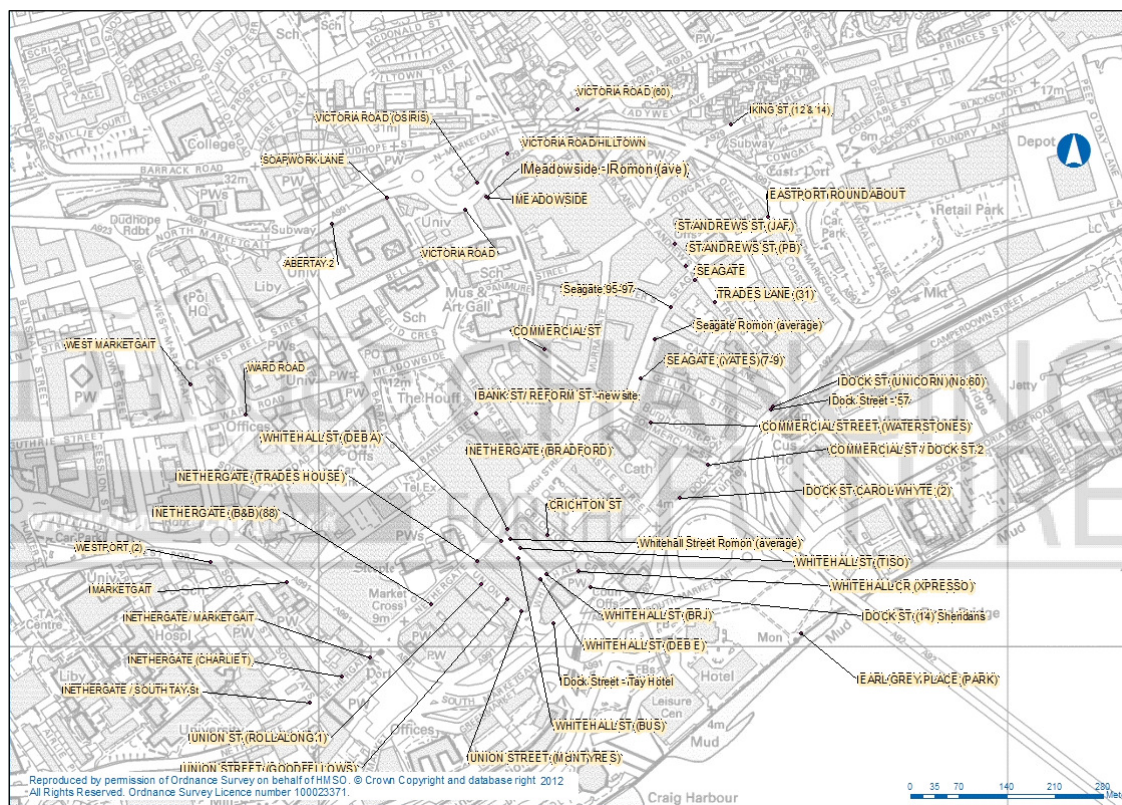


Table 2.2 Details of Nitrogen Dioxide Non-Automatic Monitoring Sites

LOCATION	Site type	x	y	Tube co-located with continuous analyser? (y/n)	Distance from tube to receptor façade (metres)	Distance from tube to kerb of nearest road (metres)	Does this location represent worst case exposure ?
ABERTAY 2	R	340019	730612	n	n/a	1.95	n
ALBERT ST (SHANDON PL)	R	341171	731574	n	7.57	1.09	n
ALBERT ST (71-73)	K	341106	731223	n	2.93	0.91	n
ALBERT ST (FISH)	K	341139	731476	n	2.27	0.57	y
ARBROATH RD (13)	K	341111	731070	n	2.52	0.73	y
ARBROATH RD (38)	K	341202	731097	n	2.52	0.73	n
ARTHURSTONE TCE (10)	K	341051	731203	n	1.75	0.89	y
BALGAVIES PL Average	UB	343082	731465	n	n/a	n/a	n
BANK ST/ REFORM ST	K	340228	730337	n	1.31	0.51	y
BIRNAM PL	UB	337531	730914	n	n/a	n/a	n
BROUGHTY FERRY RD (141 Downpipe)	R	343317	731072	n	0.20	4.32	y
BROUGHTY FERRY RD (141)	R	343322	731073	n	1.98	1.32	y
BROUGHTY FERRY RD (Greendykes)	R	342662	731112	n	7.72	4.10	n
BROUGHTY FERRY RD (L/P 59)	R	343129	731082	n	6.08	2.03	n
BROUGHTY FERRY RD (L/P 66)	R	343297	731096	n	8.50	2.10	n
BROUGHTY FERRY RD (ST. SIGN)	R	343302	731075	n	0.20	3.82	n
BROUGHTY FERRY RD LOWER (L/P 5)	UB	343415	730944	n	n/a	0.89	n
CLAYPOTTS JUNCTION	R	345315	732103	n	12.00	8.00	n
CLEPINGTON RD/ FORFAR RD	K	341385	732121	n	8.28	0.78	y
COMMERCIAL ST	K	340328	730431	n	2.90	0.60	y

LOCATION	Site type	x	y	Tube co-located with continuous analyser? (y/n)	Distance from tube to receptor façade (metres)	Distance from tube to kerb of nearest road (metres)	Does this location represent worst case exposure ?
COMMERCIAL ST (WATERSTONES)	R	340481	730325	n	2.00	2.60	y
COMMERCIAL ST /DOCK ST	R	340565	730263	n	0.17	2.78	y
CRICHTON ST	K	340331	730162	n	4.08	0.53	y
DENS RD (CROSSING)	R	340725	731238	n	2.49	1.20	y
DOCK ST (57)	R	340656	730343	n	3.25	2.53	n
DOCK ST (CAROL WHYTE) 2	R	340524	730216	n	0.34	5.13	y
DOCK ST (SHERIDANS)	K	340395	730086	n	3.24	0.78	y
DOCK ST (TAY HOTEL)	K	340340	730033	n	3.24	0.92	n
DOCK ST (UNICORN)(60)	R	340659	730348	n	1.74	3.86	y
DURA ST (FORTES)(98)	K	341150	731576	n	1.65	0.57	n
EARL GREY PL (PARK)	UB	340699	730019	n	n/a	n/a	n
EASTPORT ROUNDABOUT	R	340651	730623	n	1.56	1.00	y
FORFAR ROAD	K	341437	732360	n	7.68	0.67	y
HAREFIELD RD (35)	K	338360	731855	n	11.75	0.53	y
HILLTOWN (SUITES)	R	340088	731116	n	0.50	1.66	n
KING ST (12/14)	K	340598	730757	n	1.84	0.60	y
KINGSWAY EAST ROUNDABOUT	R	343107	731740	n	14.30	2.90	n
KINGSWAY/ MAINS LOAN	R	341124	732468	n	15.40	6.20	y
KINGSWAY/ STRATHMARTINE RD (S)	K	339221	732836	n	16.80	0.64	n
LOCHEE RD (138)	K	338936	730680	n	2.06	0.44	n
LOCHEE RD (140 TRAFFIC LTS)	R	338927	730685	n	0.25	2.22	y
LOCHEE RD (184)	K	338767	730856	n	3.19	0.73	y
LOCHEE RD (ROMON) Average	R	338861	730773	y	2.25	0.60	n
LOCHEE RD/POLEPARK RD	K	339016	730586	n	9.21	0.95	y

LOCATION	Site type	x	y	Tube co-located with continuous analyser? (y/n)	Distance from tube to receptor façade (metres)	Distance from tube to kerb of nearest road (metres)	Does this location represent worst case exposure ?
LOGIE ST (114)	R	338184	731293	n	0.53	1.73	y
LOGIE ST (98)	K	338252	731258	n	1.26	0.86	n
LOONS RD (1)	R	338211	731293	n	0.50	1.90	y
MAINS LOAN Average	UB	340972	731893	y	n/a	n/a	n
MARKETGAIT	R	339953	730094	n	3.50	1.30	y
MEADOWSIDE	R	340245	730651	n	1.26	1.00	y
MEADOWSIDE (ROMON) Average	R	340243	730653	y	0.33	1.85	y
MUIRTON RD (6)	R	338152	731293	n	0.30	1.11	y
MYREKIRK RD	K	335420	731733	n	16.40	0.95	n
NETHERGATE (B&B)(88)	K	340163	730061	n	5.00	0.86	y
NETHERGATE (BRADFORD)	R	340274	730171	n	2.51	1.25	y
NETHERGATE (CHARLIE T)	K	340033	729957	n	1.84	0.86	y
NETHERGATE (TRADES HOUSE)	R	340230	730124	n	2.72	1.26	y
NETHERGATE/ MARKETGAIT	R	340074	729984	n	3.60	1.33	y
NETHERGATE/ SOUTH TAY ST	R	339987	729919	n	0.38	2.24	y
PERTH RD 320	K	338776	729798	n	3.78	0.42	y
QUEEN ST B/F	R	346207	731007	n	0.00	2.85	y
RANKINE ST (2)	R	338768	730900	n	0.40	1.76	y
SEAGATE	R	340545	730532	n	0.19	1.94	n
SEAGATE (97)	R	340511	730492	n	0.19	2.39	y
SEAGATE (ROMON) Average	R	340487	730446	y	1.76	0.66	n
SEAGATE (YATES)(7-9)	R	340467	730388	n	0.90	1.70	n
SOAPWORK LANE	R	340099	730650	n	F.EQ.	3.51	y
SOUTH ROAD (DENBANK)	R	335188	731528	n	0.28	1.79	y

LOCATION	Site type	x	y	Tube co-located with continuous analyser? (y/n)	Distance from tube to receptor façade (metres)	Distance from tube to kerb of nearest road (metres)	Does this location represent worst case exposure ?
ST ANDREWS ST (JAF)	K	340516	730584	n	1.77	0.71	y
ST ANDREWS ST (PB)	K	340532	730551	n	2.38	0.50	y
STRATHMORE AVE (337)	K	339522	731875	n	1.45	0.55	n
STRATHMORE AVE (353)	K	339609	731871	n	1.45	0.67	y
STRATHMORE AVE (PED X)	R	339667	731878	n	0.95	1.05	n
TRADES LANE (31)	K	340575	730500	n	1.82	0.44	y
UNION ST (GOODFELLOWS)	K	340274	730069	n	1.60	0.46	y
UNION ST (McINTYRES)	K	340293	730051	n	1.60	0.73	y
UNION ST (ROLLALONG) Average	R	340235	730091	y	3.25	1.20	y
VICTORIA RD	R	340212	730633	n	3.00	1.22	y
VICTORIA RD (60)	R	340375	730779	n	0.56	2.18	y
VICTORIA RD (Osiris)	K	340230	730673	n	2.70	0.30	y
VICTORIA RD / COTTON RD	K	340740	730996	n	1.30	0.82	y
VICTORIA RD / HILLTOWN	R	340274	730714	n	2.01	1.15	n
VICTORIA ST / ALBERT ST	K	341071	731072	n	1.70	0.75	y
WARD RD	R	339893	730336	n	0.64	2.24	y
WEST MARKETGAIT	K	339814	730380	n	2.34	0.67	y
WESTPORT (2)	R	339842	730122	n	2.50	0.46	y
WHITEHALL CR (XPRESSO)	K	340376	730109	n	3.00	0.88	y
WHITEHALL ST (BRJ)	K	340330	730106	n	3.57	0.78	y
WHITEHALL ST (BUS)	R	340289	730128	n	3.17	2.51	n
WHITEHALL ST (DEB A)	K	340265	730153	n	5.57	0.88	n
WHITEHALL ST (DEB E)	K	340322	730098	n	4.55	0.75	y
WHITEHALL ST (ROMON) Average	R	340278	730156	y	1.70	3.26	n

LOCATION	Site type	x	y	Tube co-located with continuous analyser? (y/n)	Distance from tube to receptor façade (metres)	Distance from tube to kerb of nearest road (metres)	Does this location represent worst case exposure ?
WHITEHALL ST (TISO)	R	340293	730142	n	2.67	3.00	y
WOODSIDE AVE Average	UB	340776	732307	n	n/a	0.55	n

Notes:

The whole of Dundee is an AQMA for NO₂ and PM₁₀.

K= Kerside, R= Roadside, UB= Urban Background.

F.EQ = Façade Equivalent i.e. Tube not at façade but at an equivalent distance from the road as the nearest façade.

Locations highlighted blue are Background locations

2.2 Comparison of Monitoring Results with AQ Objectives

2.2.1 Nitrogen Dioxide

Automatic Monitoring Data

The results of the automatic monitoring stations for nitrogen dioxide are shown in **Table 2.3** and **Figure 2.3**. Several of the automatic monitoring sites had less than 9 months data in 2011 and hence the results needed to be annualised as described in Box 3.2 of LAQM TG.(09). The sites chosen for the annualisation and the resulting factors are detailed in **Appendix D**.

Table 2.3 Results of Automatic Monitoring for Nitrogen Dioxide: Comparison with Annual Mean Objective and Hourly Mean Objective

Location	Site type	NAQS NO ₂ Objectives & annual data statistics	Annual Results ^{a,b,c}					
			2006	2007	2008	2009	2010	2011
Lochee Road	R	Annual mean (Objective 40(ug/m ³))	49.0	52.8	52.9	54.2	55.0	58.2
		Data capture (%)	63.4*	93.0	92.0	87.5*	94.7	39.2*
		No. of exceedences of the hourly mean (200ug/m ³), not to be breached >18 times per year	0	0	4	23	67	43
		99.8 th Percentile of the hourly means (ug/m ³)	141.0	157.5	175.6	206.2	242.6	241.6
Seagate	R	Annual mean (Objective 40(ug/m ³))	43.0	49.1	51.4	48.4	51.0	52.2
		Data capture (%)	60.7*	93.9	81.6*	74.3*	80*	80.9*
		No. of exceedences of the hourly mean (200ug/m ³), not to be breached >18 times per year	0	1	0	1	0	2
		99.8 th Percentile of the hourly means (ug/m ³)	119.0	141.2	141.3	152.8	134.8	156.5
Union Street	R	Annual mean (Objective 40(ug/m ³))	39.0	35.8	42.9	45.2	40.0	35.6
		Data capture (%)	59.9*	99.3	99.7	99.7	90.7	99.5
		No. of exceedences of the hourly mean (200ug/m ³), not to be breached >18 times per year	0	0	11	2	0	0
		99.8 th Percentile of the hourly means (ug/m ³)	133.0	132.1	182.3	165.2	141.9	133.1
Whitehall Street	R	Annual mean (Objective 40(ug/m ³))	39.8	42.0	46.7	37.8	36.0	34.7
		Data capture (%)	85.1*	90.6	75.6*	93.2	88.9*	83.6*
		No. of exceedences of the hourly mean (200ug/m ³), not to be breached >18 times per year	0	0	0	0	0	0
		99.8 th Percentile of the hourly means (ug/m ³)	106.0	136.8	139.4	111.3	101.1	117.8
Meadowside	R	Annual mean (Objective 40(ug/m ³))						66.4
		Data capture (%)						52.3*
		No. of exceedences of the hourly mean (200ug/m ³), not to be breached >18 times per year						0
		99.8 th Percentile of the hourly means (ug/m ³)						157.3
Mains Loan	UB	Annual mean (Objective 40(ug/m ³))						11.6
		Data capture (%)						75.5*
		No. of exceedences of the hourly mean (200ug/m ³), not to be breached >18 times per year						0
		99.8 th Percentile of the hourly means (ug/m ³)						80.7

^a All monitoring sites are located within an AQMA for NO₂ and PM₁₀ annual mean.

^b Monitoring period and data capture percentage is for the full calendar year.

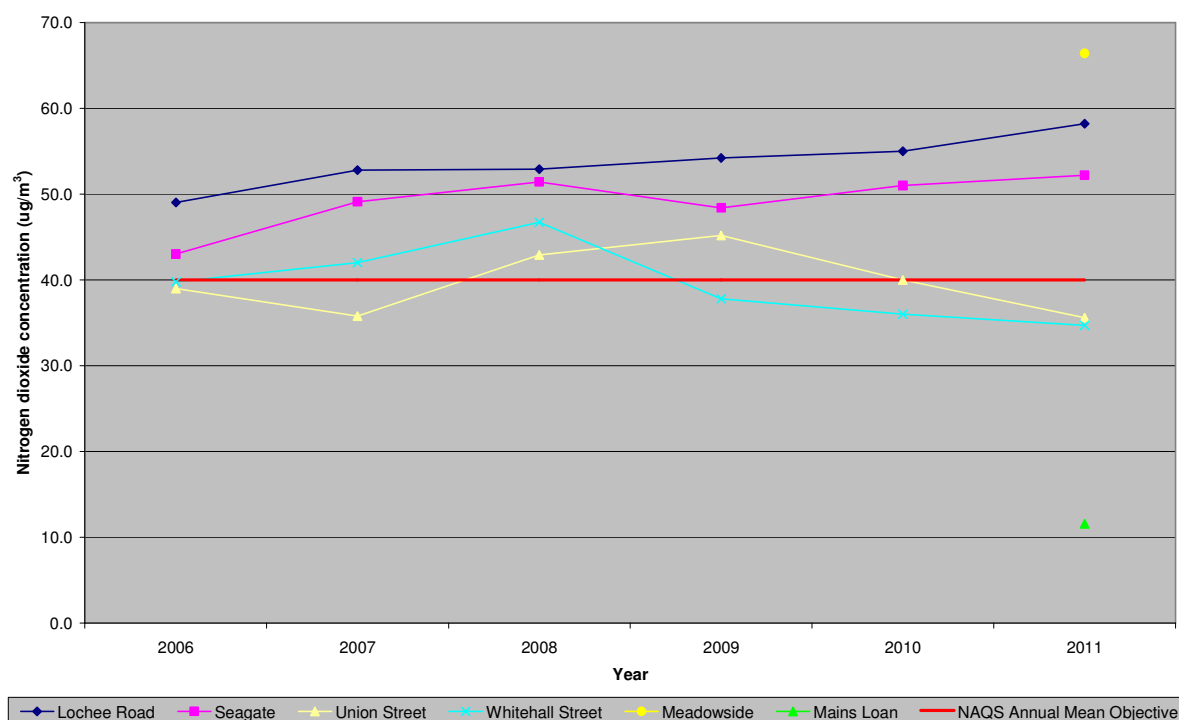
^c Exceedences of the air quality objectives are shown in bold.

* Data capture less than the recommended 90%

Results in the shaded cells have been period adjusted according to the methodology outlined in Box 3.2 of LAQM TG(09).

R=Roadside UB=Urban Background

Figure 2.3 Annual Mean Nitrogen Dioxide Concentrations at Real-time Monitors from 2006 to 2011



Annual Mean Concentrations

Exceedences of the annual mean NAQS for nitrogen dioxide were recorded at three stations in 2011: Lochee Road, Seagate and Meadowside. The new monitor in Meadowside recorded the highest annual mean NO₂ concentration of all the NO₂ monitoring locations. These are known hotspot locations and are located within an AQMA declared as a result of exceedences of the annual mean. Annual mean concentrations at these locations were still estimated to exceed the standard when predicted to façade using the methodology detailed in Box 2.3 of LAQM.TG(09), i.e. Lochee Road 46.6 µg/m³, Seagate 43.8 µg/m³ and Meadowside 64.5 µg/m³.

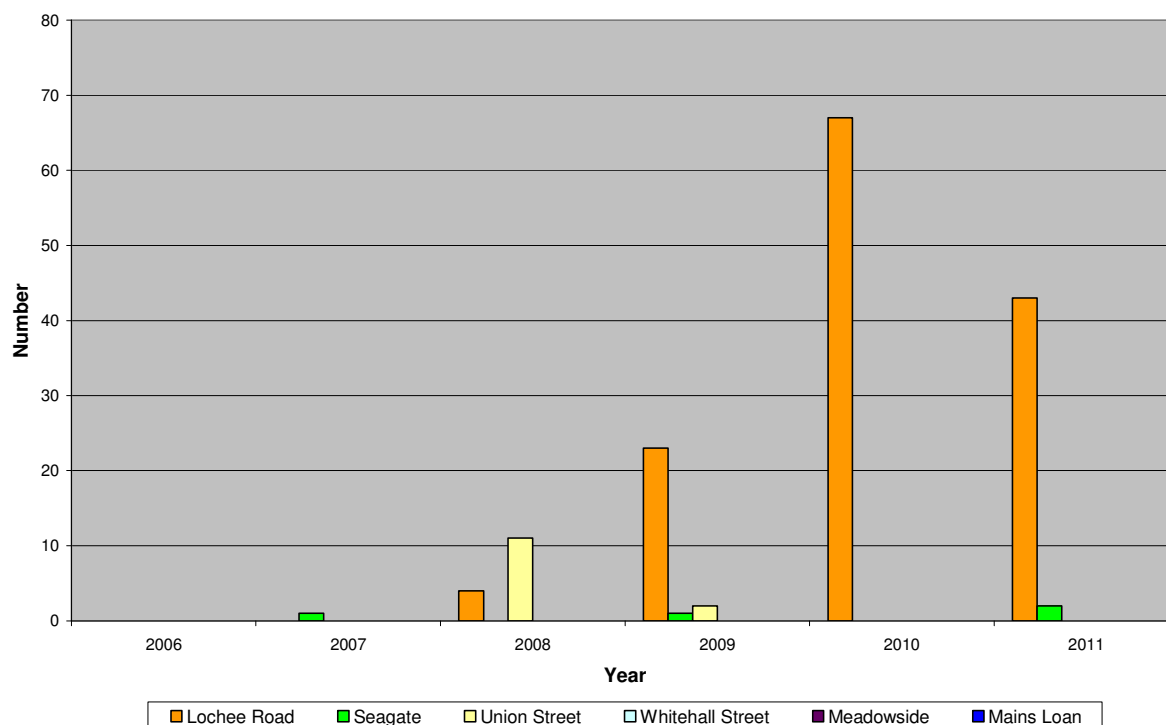
Figure 2.3 also shows the trend in NO₂ concentrations at real time monitoring locations between 2006 and 2011. NO₂ concentrations have increased at the monitoring locations in Lochee Road and Seagate. NO₂ concentrations have remained relatively stable at Union Street (with year to year fluctuations) and have decreased slightly at the Whitehall Street monitor.

Hourly Mean Concentrations

Figure 2.4 shows the number of exceedences of the NO₂ hourly mean objective (200µg/m³) (18 allowed) at each of the real time monitoring locations in Dundee between 2006 and 2011. This shows that the objective was met at all the monitoring locations except Lochee Road in 2009, 2010 and 2011. Severe winter weather in 2009, 2010 and the beginning of 2011 is thought to have contributed significantly to the number of exceedences recorded in these years. The monitoring site is located on the north-west arterial route which can become increasingly congested during severe adverse weather when alternative routes are difficult for drivers to negotiate.

An analysis of the frequency of the 43 exceedences recorded in 2011 is shown in **Figure 2.5**. The monitoring station had low data capture in 2011 and only captured data during the winter months.

Figure 2.4 Number of Exceedences of the NO₂ Hourly Mean Objective (200µg/m³) (18 Allowed) at Real Time Monitoring Locations in Dundee between 2006 and 2011



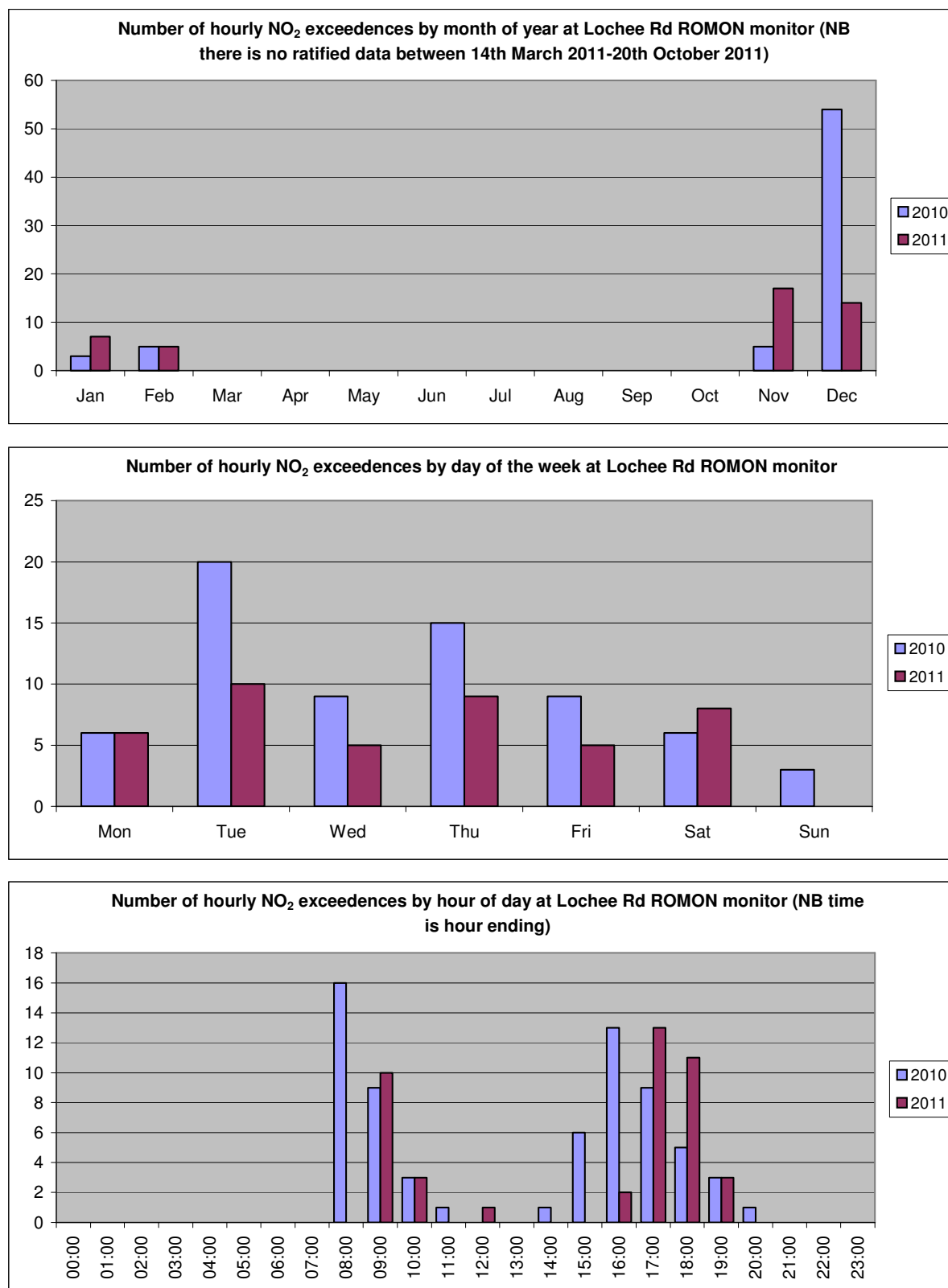
The winter weather was less severe at the end of 2011 than in 2010 and this is reflected in the number of exceedences recorded. The seasonality of higher winter concentrations is particularly evident when viewed using the Openair trend level hour plot (see **Appendix J**). The majority of exceedences occurred during the morning and evening peak traffic periods and on weekdays although there was an increase in the number of exceedences occurring on Saturdays in 2011.

The Rankine Street and Dudhope Terrace junctions with Lochee Road are being studied as part of the Air Quality Action Plan measures. This is to determine if improvements to the Urban Traffic Management Control (UTMC) systems and a re-allocation of road space will help to improve traffic flow through this junction and alleviate congestion. Previously it was reported that the need for an AQMA in respect of the hourly NO₂ objective would be kept under review. In response to the Progress Report 2011, the Scottish Government's consultants recommended that *"Should the monitoring data continue to show exceedences, the simplest course of action may be for the Council to amend their current AQMA to include the hourly objective..."*⁴ In view of the ongoing exceedences of the hourly NO₂ objective at Lochee Road, and the above advice, it is considered necessary to amend the current AQMA order.

Despite an annual mean in excess of 60 µg/m³, the real-time monitor in Meadowside did not record any exceedences of the hourly objective. However, the new monitoring station was only installed in June 2011 so a true comparison with the hourly objective is not possible. The potential for exceedences of the hourly objective at this location will be kept under review.

⁴ Progress Report Appraisal Report PR-648

Figure 2.5 Analysis of the Frequency of Exceedences of the Hourly NO₂ Objective at Automatic Monitoring Site on Lochee Road



Diffusion Tube Monitoring Data

The nitrogen dioxide diffusion tube data for 2011 are summarised in the **Table 2.4**. The full 2011 dataset (monthly mean values) is included in **Appendix E**. Several of the diffusion tube locations had less than 9 months data in 2011 and hence the results needed to be annualised as described in Box 3.2 of LAQM.TG(09). The sites chosen for the annualisation and the resulting factors are detailed in **Appendix D**. The local bias-correction factor (**0.78**) derived for Dundee sites has been applied to the 2011 results.

The 2011 data show that concentrations measured at 19 diffusion tube sites exceeded the annual mean NO₂ Standard. As the Dundee AQMA encompasses the whole local authority area all of these locations are within the existing AQMA. Further consideration of these sites was made with regard to the likely exposure at nearest residential receptors using the LAQM distance calculator tool. Of these, the predicted concentrations were estimated to exceed the NAQS at receptors at 7 sites. All of these locations are in known areas of exceedence. Uncertainties associated with the distance calculator tool suggest that there are at least a further 11 locations where the objective may be exceeded.

Table 2.4 Results of Nitrogen Dioxide Diffusion Tubes in 2011

Location	x	y	Site Type	2006 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2007 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.86)	2008 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.87)	2009 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.83)	2010 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.79)	2011 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2011 Data Capture %	2011 Annual mean NO ₂ at receptor (µg/m ³)
Abertay	340047	730629	kerbside	42.5	46.5	48.5					
Abertay 2	340019	730612	roadside				47.2	42.5	40.1	100.0	n/a
Albert Street (71-73)	341106	731223	kerbside						29.7	100.0	26.1
Albert Street (Fish)	341139	731476	kerbside	30.0	30.7	32.8	34.7	33.9	29.2	100.0	25.7
Albert Street (Shandon Place)	341171	731574	roadside	32.3	34.3	39.0	39.0	38.2	35.1	100.0	27.5
Albert Street 1	341104	731210	kerbside	32.1	33.0	37.9	37.4	36.0			
Arbroath Road (13)	341111	731070	kerbside	37.4	38.0	40.2	45.4	40.8	36.6	100.0	31.1
Arbroath Road (38)	341202	731097	kerbside						34.6	100.0	31.1
Arthurstone Terrace (10)	341051	731203	kerbside	22.6	23.1	25.4	25.2	24.9	21.4	100.0	20.5
Balgavies Place	343082	731465	urban background	15.3	17.6	18.9	18.6	19.1	17.1	100.0	n/a
Bank St/ Reform St	340228	730337	kerbside	26.4	29.4	28.2	30.9	27.7	26.6	100.0	24.5
Birnam Place	337531	730914	urban background	9.6	10.8	11.7	11.0	11.4	9.6	100.0	n/a
Brook Street (B.F.)	346293	730872	kerbside	21.8	22.9	23.1					
Broughty Ferry Rd (L/P 59)	343129	731082	roadside						22.2	75.0	20.6
Broughty Ferry Rd (L/P 66)	343297	731096	roadside						34.2	66.7	27.7
Broughty Ferry Rd (141 Downpipe)	343317	731072	roadside						36.5	50.0	36.2

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Location	x	y	Site Type	2006 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2007 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.86)	2008 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.87)	2009 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.83)	2010 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.79)	2011 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2011 Data Capture %	2011 Annual mean NO ₂ at receptor (µg/m ³)
Broughty Ferry Rd (141)	343322	731073	roadside	35.6	40.4	45.3	46.9	44.2	42.5	100.0	37.6
Broughty Ferry Rd (Greendykes)	342662	731112	roadside						32.6	75.0	28.1
Broughty Ferry Rd (St. Sign)	343302	731075	roadside						27.3	75.0	27.2
Broughty Ferry Rd Lower (L/P 5)	343415	730944	urban background						17.1	75.0	n/a
Claypotts Junction	345315	732103	roadside	22.7	24.6	28.0	27.5	29.0	25.4	100.0	24.4
Cleington Road/ Forfar Road	341385	732121	kerbside	33.5	36.8	38.5	40.7	39.8	34.7	100.0	26.5
Commercial St	340328	730431	kerbside	31.3	33.5	36.2	34.2	31.2	27.8	100.0	24.4
Commercial St/Dock St 2	340565	730263	roadside	35.6	38.6	41.9	42.2	41.3	37.6	100.0	37.3
Commercial Street (Waterstones)	340481	730325	roadside	34.9	40.2	47.4	43.2	43.3	38.0	100.0	35.1
Crichton St	340331	730162	kerbside	28.6	31.6	34.0	33.7	31.3	29.0	100.0	24.5
Dens Road (Crossing)	340725	731238	roadside	30.2	35.2	36.0	36.6	34.9	31.7	100.0	28.3
Dock St (14)	340395	730086	kerbside	37.1	46.7	43.8	43.1	42.0	36.3	100.0	28.9
Dock St (57)	340656	730343	roadside						43.4	41.7	38.1
Dock St (Carol Whyte) (2)	340524	730216	roadside	36.3	37.8	37.5	38.2	38.3	34.2	100.0	33.9
Dock St (Tay Hotel)	340340	730033	kerbside						24.2	100.0	22.1
Dock St (Unicorn)(60)	340659	730348	roadside	33.3	37.6	40.8	39.6	42.2	36.3	50.0	34.3
Dura Street (Forte) (98)	341150	731576	kerbside	34.0	39.4	41.6	43.0	41.1	36.4	100.0	31.7
Earl Grey Place (Park)	340699	730019	urban background	20.2	20.6	20.7	21.8	23.2	19.4	100.0	n/a
Eastport Roundabout	340651	730623	roadside	30.5	35.5	35.9	35.2	34.4	33.1	100.0	30.1
Forfar Road	341437	732360	kerbside	40.2	45.7	50.2	52.6	49.1	45.6	91.7	32.3
Harefield Road (35)	338360	731855	kerbside	29.2	32.6	36.0	32.5	29.8	27.7	91.7	21.9

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Location	x	y	Site Type	2006 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2007 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.86)	2008 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.87)	2009 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.83)	2010 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.79)	2011 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2011 Data Capture %	2011 Annual mean NO ₂ at receptor (µg/m ³)
Hilltown (Suites)	340088	731116	roadside	31.0	33.2	35.4	35.6	34.2	29.5	100.0	28.8
King St (12 & 14)	340598	730757	kerbside	26.4	28.7	30.1	31.1	29.1	26.5	100.0	24.1
Kingsway E. Roundabout	343107	731740	roadside	33.9	40.0	42.6	44.9	40.7	40.7	83.3	30.0
Kingsway/ Mains Loan 1	341124	732468	roadside	29.9	34.1	37.8	35.1	36.7	31.3	100.0	25.7
Kingsway/ Pitkerro Rd	341963	732303	roadside	26.6	30.7	26.7					
Kingsway/ Strathmartine Rd (S)	339221	732836	kerbside	37.4	43.3	45.0	43.2	46.3	39.4	91.7	25.9
Lochee Rd (138)	338936	730680	kerbside	45.5	52.6	57.4	56.9	56.9	52.7	100.0	42.1
Lochee Rd (140) Traffic Lts	338927	730685	roadside	45.3	53.4	57.0	57.2	57.4	51.9	100.0	51.0
Lochee Rd (184)	338767	730856	kerbside	31.9	38.1	39.1	40.2	39.7	36.9	83.3	30.7
Lochee Rd (Romon) mean of 3 tubes	338861	730773	kerbside	39.2	49.2	51.4	51.2	50.4	47.2	100.0	38.7
Lochee Rd/Polepark Rd	339016	730586	kerbside	26.8	30.9	32.3	33.9	33.4	29.0	100.0	23.5
Logie Street (114)	338184	731293	roadside	46.9	52.2	58.2	57.0	56.9	53.7	100.0	51.5
Logie Street (98)	338252	731258	kerbside	32.7	35.2	34.5	35.0	33.4	31.9	91.7	29.3
Loons Road (1)	338211	731293	roadside	36.1	39.1	45.3	43.9	44.8	38.4	100.0	37.3
Mains Loan mean of 3 tubes	340972	731893	urban background						12.2	75.0	n/a
Marketgait	339953	730094	roadside	29.3	33.0	35.8	34.7	32.5	30.8	100.0	27.0
Meadowside	340245	730651	roadside	52.1	61.4	63.5	55.8	57.2	53.0	100.0	47.1
Meadowside (Romon) mean of 3 tubes	340243	730653	roadside						56.4	66.7	54.9
Muirton Road (6)	338152	731293	roadside	26.1	28.4	29.2	30.4	30.4	26.5	100.0	26.0
Myrekirk Road	335420	731733	kerbside	27.5	32.9	32.3	35.1	34.9	29.5	100.0	22.4
Nethergate (B&B)(88)	340163	730061	kerbside	40.0	43.1	49.1	48.6	48.1	44.8	100.0	34.5

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Location	x	y	Site Type	2006 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2007 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.86)	2008 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.87)	2009 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.83)	2010 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.79)	2011 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2011 Data Capture %	2011 Annual mean NO ₂ at receptor (µg/m ³)
Nethergate (Bradford)	340274	730171	roadside	35.8	37.4	43.2	41.9	38.7	38.0	100.0	33.2
Nethergate (Charlie T)	340033	729957	kerbside	34.8	39.1	38.4	38.2	37.5	32.5	100.0	29.1
Nethergate (Trades House)	340230	730124	roadside	34.5	39.6	44.6	41.8	38.9	38.1	100.0	33.0
Nethergate/ Marketgait	340074	729984	roadside	29.8	36.0	35.2	35.4	33.9	30.2	100.0	26.6
Nethergate/South Tay St	339987	729919	roadside	25.4	29.6	30.1	29.3	29.8	24.4	100.0	24.1
Perth Rd / Hawkhill	338742	729828	kerbside	23.5	25.0	22.9					
Perth Rd 320	338776	729798	kerbside			36.5	39.9	37.6	36.0	100.0	28.6
Queen St B/F	346207	731007	roadside			29.8	31.3	30.1	25.1	100.0	25.1
Rankine St (2)	338768	730900	roadside	31.7	39.9	42.6	44.9	45.5	40.5	100.0	39.4
Seagate	340545	730532	roadside	39.0	42.3	45.9	44.9	42.3	40.2	100.0	39.7
Seagate (97)	340511	730492	roadside						46.2	100.0	45.7
Seagate (Yates)(7-9)	340487	730446	roadside	35.1	40.5	38.3	41.5	39.4	35.6	91.7	33.8
Seagate(Romon) mean of 3 tubes	340467	730388	kerbside	42.3	47.5	50.8	51.4	48.9	45.0	100.0	38.3
Soapwork Lane	340099	730650	roadside	29.6	35.0	35.8	36.9	35.4	32.8	91.7	32.8
South Road (Denbank)	335188	731528	roadside						34.6	91.7	34.0
St Andrews St (JAF)	340516	730584	kerbside	32.7	34.8	40.4	36.9	36.7	33.5	91.7	29.7
St Andrews St (PB)	340532	730551	kerbside	35.0	41.5	41.6	41.5	40.4	38.1	91.7	31.7
St Mary Flats	339039	730624	roadside	18.4	20.6	19.8					
Strathmore Ave (Ped. X)	339667	731878	roadside						26.7	91.7	25.5
Strathmore Avenue (337)	339522	731875	kerbside						29.9	100.0	27.0
Strathmore Avenue (353)	339609	731871	kerbside	35.0	38.0	42.6	40.3	39.9	35.5	100.0	31.6
Trades Lane (31)	340575	730500	kerbside	29.2	36.3	33.3	32.8	32.6	29.4	100.0	26.0

Dundee City Council

Location	x	y	Site Type	2006 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2007 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.86)	2008 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.87)	2009 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.83)	2010 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.79)	2011 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2011 Data Capture %	2011 Annual mean NO ₂ at receptor (µg/m ³)
Union St (Rollalong) mean of 3 tubes	340235	730091	roadside	39.1	43.4	44.7	45.3	40.7	36.2	100.0	31.0
Union Street (Goodfellows)	340274	730069	kerbside	28.2	32.4	34.1	32.6	32.1	26.9	41.7	24.4
Union Street (McIntyres)	340293	730051	kerbside	29.0	32.7	33.2	33.5	32.8	28.9	58.3	26.3
Victoria Road	340212	730633	roadside	32.1	36.7	38.4	37.5	36.2	30.9	100.0	27.4
Victoria Road (10)	340225	730667	roadside	29.7	32.9	34.0					
Victoria Road (60)	340375	730779	roadside	35.2	41.1	43.8	44.0	40.8	38.6	91.7	37.4
Victoria Road (Osiris)	340230	730673	kerbside				38.5	37.5	33.8	100.0	27.7
Victoria Road / Cotton Road	340740	730996	kerbside	31.3	36.6	37.4	38.1	36.5	34.0	100.0	30.9
Victoria Road/Hilltown	340274	730714	roadside	47.8	55.8	60.9	59.5	57.9	52.8	100.0	45.4
Victoria St/Albert St	341071	731072	kerbside	31.7	34.1	35.2	36.5	35.2	33.8	91.7	30.1
Ward Rd	339893	730336	roadside			34.5	35.7	33.3	32.4	100.0	31.5
West Bell St	339815	730395	roadside			36.0					
West Marketgait	339814	730380	kerbside				44.1	38.2	35.0	100.0	30.0
Westport (2)	339842	730122	roadside	33.6	38.9	41.3	42.1	37.5	37.0	100.0	30.6
Whitehall Cr (Xpresso)	340376	730109	kerbside	27.2	30.3	30.6	30.4	29.5	26.1	100.0	23.5
Whitehall St (Brj)	340330	730106	kerbside	32.2	36.3	37.8	35.8	35.5	33.1	100.0	27.9
Whitehall St (Bus)	340289	730128	roadside	42.8	48.6	51.7	48.6	43.4	45.7	100.0	40.0
Whitehall St (Deb A)	340265	730153	kerbside	38.5	43.4	50.3	46.9	42.5	41.4	100.0	32.0
Whitehall St (Deb E)	340322	730098	kerbside	32.2	36.9	39.6	38.3	37.1	34.7	100.0	28.2
Whitehall St (Romon) mean of 3 tubes	340278	730156	roadside	33.2	38.5	42.7	38.9	36.5	36.0	100.0	33.9
Whitehall St (Tiso)	340293	730142	roadside	34.8	38.8	42.6	40.2	37.1	35.8	91.7	32.8

Dundee City Council

Location	x	y	Site Type	2006 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2007 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.86)	2008 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.87)	2009 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.83)	2010 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.79)	2011 Annual mean NO ₂ conc (µg/m ³) adjusted for bias (0.78)	2011 Data Capture %	2011 Annual mean NO ₂ at receptor (µg/m ³)
Woodside Avenue mean of 3 tubes	340776	732307	urban background	15.6	18.1	18.5	17.7	17.5	15.4	100.0	n/a

^a All diffusion tube are located within an AQMA for NO₂ and PM₁₀ annual mean.

^b Monitoring period and data capture percentage is for the full calendar year.

^c The means shown in the highlighted cells have been “annualised” as in Box 3.2 of LAQM.TG(09), the methodology was detailed in the USA 2009.

^d Exceedences of the air quality objectives are shown in bold & red. Orange values denote those at risk of exceeding the objective.

^e Definitions and siting criteria for each site type can be found in Box A1.2 (LAQM TG:09)

The diffusion tubes monitoring sites where NO₂ concentrations exceeded the annual mean objective were assessed using the procedures and equations set out in LAQM.TG(09) (Box2.3), to determine whether exceedences are likely to occur at the nearest relevant receptor. The average of three urban-background monitoring locations (Balgavies Place, Earl Grey Place (Park) and Woodside Avenue) was used to provide the background concentration (17.3µg/m³) for these comparisons. Background sites were selected in accordance with the selection criteria contained in Box A1.2 of LAQM.TG(09). Of the 19 sites that recorded an exceedence in 2011, all were located within the AQMA.

There is considerable uncertainty associated with the use of the distance calculator tool. An example of this can be illustrated using two of the diffusion tube sites on Lochee Road. Lochee Rd (138) is located at kerbside and Lochee Rd (140) is located close to (25cm) the residential façade at the same location. When the distance calculator is used to predict the drop-off in pollutant concentrations between the two tubes it calculates that pollution levels will drop from 52.7µg/m³ to 42.7µg/m³, i.e. a drop off of 10µg /m³. The actual monitored value at the façade tube was 51.9µg/m³, a decrease of 0.8µg/m³. Similarly the two tubes in Meadowside are located at kerbside and close to the façade. The distance calculator predicts that pollutant concentrations will reduce from 53µg/m³ to 48.3µg/m³, i.e. a drop off of 4.7µg /m³. The actual monitored value at the façade tube was 56.4µg/m³, an increase of 3.4µg/m³. The real-time monitor at the same location as the façade tube recorded an annualised annual mean of 66.4µg /m³ (52.3% data capture).

The following 7 sites exceeded the NAQS annual mean when the distance calculator tool was used to estimate concentrations at relevant receptors:

Table 2.5 Predicted Exceedences of NO₂ Annual Mean at Façade of Receptors

GIS ID	LOCATION	x	y	2011 Annual mean NO ₂ concentration (bias corrected) (µg/m ³)	2011 Predicted Annual mean NO ₂ concentration at Receptor (µg/m ³)
30	Lochee Rd (138)	338936	730680	52.7	42.1
31	Lochee Rd (140) Traffic Lts	338927	730685	51.9	51.0
37	Logie Street (114)	338184	731293	53.7	51.5
41	Meadowside	340245	730651	53.0	47.1
149	Meadowside (Romon) Mean of 3 tubes	340243	730653	56.4	54.9
150	Seagate (97)	340511	730492	46.2	45.7
70	Victoria Road/Hilltown	340274	730714	52.8	45.4

A further 11 sites were close to exceeding the NAQS annual mean when the distance calculator tool was used to estimate concentrations at relevant receptors:

Table 2.6 Locations at risk of Exceeding NO₂ Annual Mean at Façade of Receptors

GIS ID	LOCATION	x	y	2011 Annual mean NO ₂ concentration (bias corrected) (µg/m ³)	2011 Predicted Annual mean NO ₂ concentration at Receptor (µg/m ³)
139	Broughty Ferry Rd (141 Downpipe)	343317	731072	36.5	36.2
11	Broughty Ferry Rd (141)	343322	731073	42.5	37.6
84	Commercial St/Dock St 2	340565	730263	37.6	37.3
156	Dock St (57)	340656	730343	43.4	38.1
158	Lochee Rd (Romon) Mean of 3 tubes	338861	730773	47.2	38.7
39	Loons Road (1)	338211	731293	38.4	37.3
49	Rankine St (2)	338768	730900	40.5	39.4
50	Seagate	340545	730532	40.2	39.7
159	Seagate(Romon) Mean of 3 tubes	340467	730388	45.0	38.3
68	Victoria Road (60)	340375	730779	38.6	37.4
75	Whitehall St (Bus)	340289	730128	45.7	40.0

The LAQM.TG(09) guidance considers that there could be a potential risk of breaching the hourly NO₂ standard, where the annual mean NO₂ concentration is greater than (>) 60µg/m³. There were no diffusion tubes with an annual mean NO₂ concentration >60µg/m³ in 2011.

2.1.1.1 Trends in Real-time Monitor and Diffusion Tube NO₂ Concentrations in Areas of Concern

Figure 2.6 shows the difference between 2006 and 2011 bias corrected diffusion tube annual mean results for those 72 tube sites that have been present for six years. 19 locations have lower concentrations than in 2006 and 53 have higher concentrations. The greatest increases in pollutant concentrations over this time period have been recorded along the city centre bus corridor, the north-west arterial route and associated access roads, major junctions on the Kingsway and at Stannergate Junction on Broughty Ferry Road.

The **Figures 2.7 to 2.33** show the detailed trends in real-time monitor and bias-corrected diffusion tube NO₂ concentrations between 2006 and 2011 in areas of concern throughout the city. These include:

- | | |
|-----------------------------|-------------------------|
| • Union Street | • Whitehall Street |
| • Seagate | • Nethergate |
| • Victoria Rd / Meadowside | • Albert St / Dura St. |
| • Lochee Road | • Logie St |
| • Albert St. / Arbroath Rd. | • Kingsway / Forfar Rd. |
| • Main Bus Corridor | • Inner Ring Road |
| • Stannergate Junction | • Strathmore Avenue |

All of these locations have been described in previous review and assessment reports except for Strathmore Avenue which is a street canyon on a busy cross city route. There are ground floor receptors in this street that are only a pavement's width from the road and the nearest receptor to the diffusion tube is close to a bus stop.

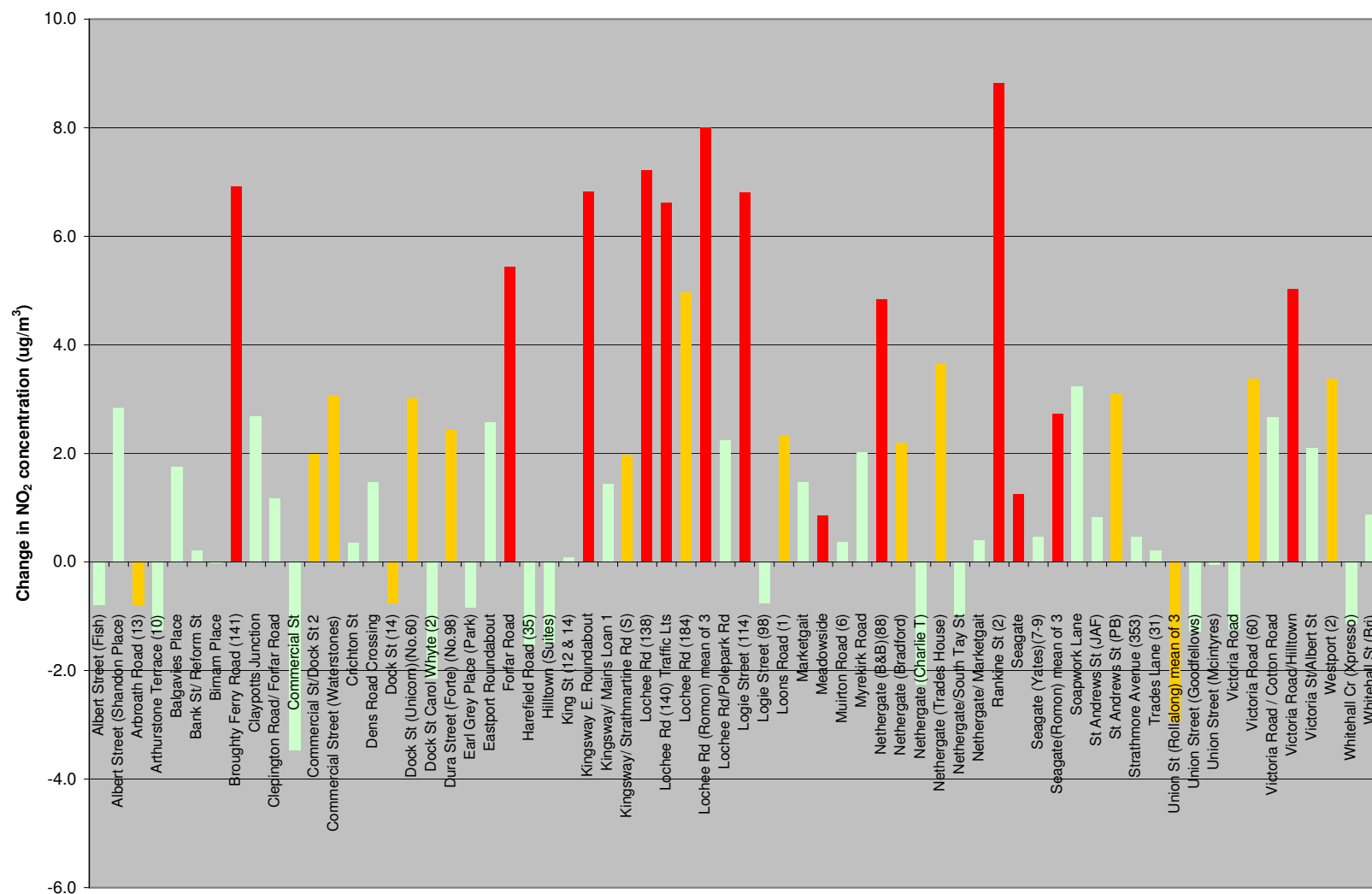
NO₂ concentrations increased in 2011 at two of the automatic monitoring stations (Lochee Road and Seagate) and decreased at Union Street and Whitehall Street.

Concentrations of NO₂ measured by diffusion tubes decreased at all but one location in 2011 (Whitehall Street).

From the long-term trends presented in **Figures 2.7 to 2.33** it is evident that NO₂ concentrations do not show a consistent downward trend and in most cases concentrations remain higher in 2011 than in 2006 when the AQMA was declared.

Figure 2.6 Change in NO₂ concentrations at 72 Diffusion tube monitoring locations between 2006 and 2011

(N.B. Red columns are locations where the annual mean air quality objective is exceeded, and orange columns are locations at risk of exceeding.)



Union Street & Whitehall Street

Figure 2.7 NO₂ Monitoring Locations in Union Street and Whitehall Street

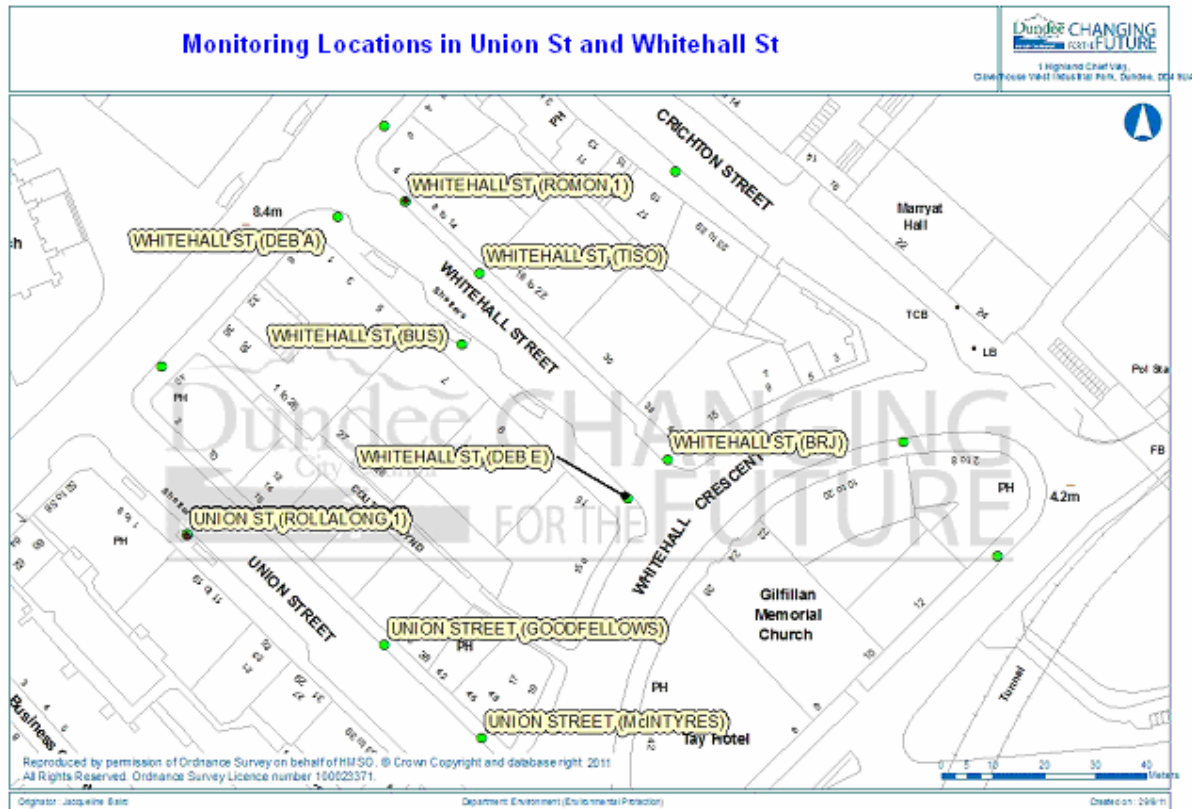


Figure 2.8 Trends in NO₂ Concentrations in Union St.

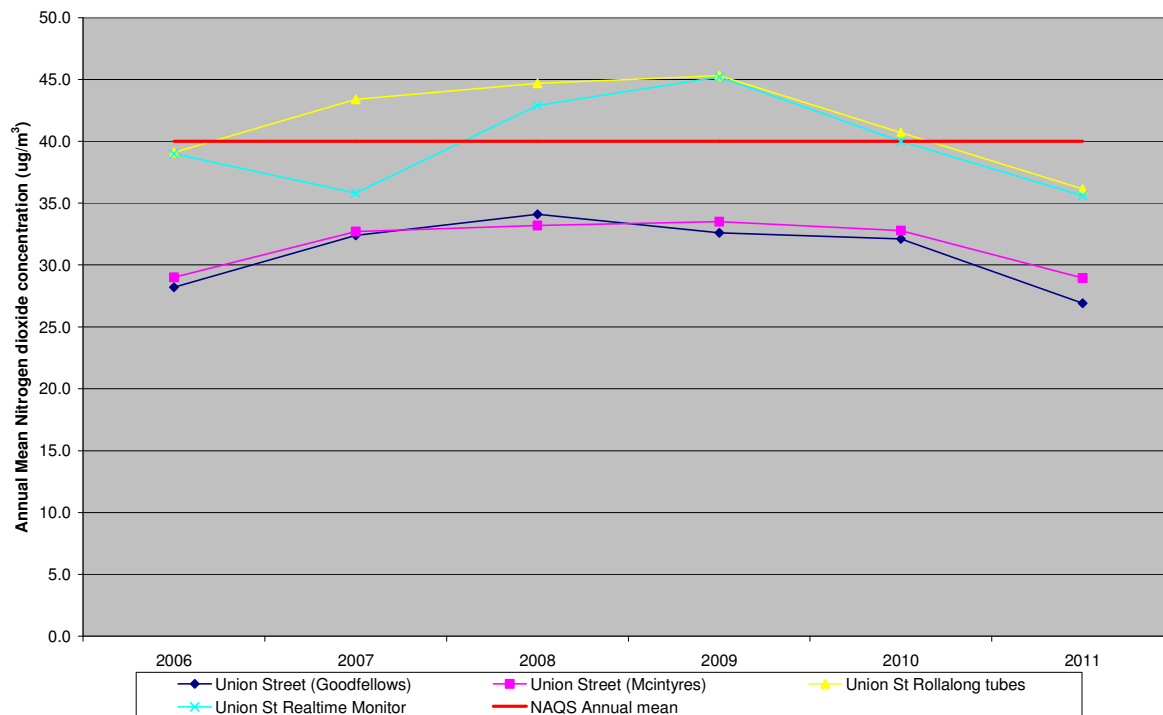
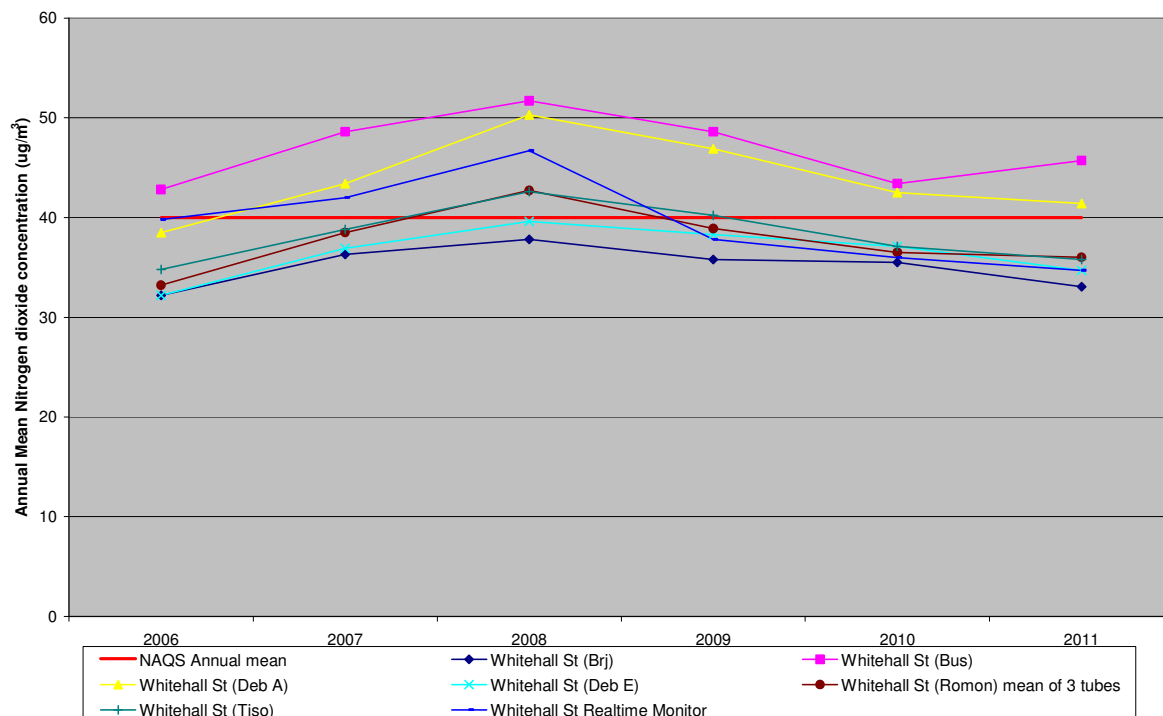


Figure 2.9 Trends in NO₂ Concentrations in Whitehall St.



Seagate

Figure 2.10 NO₂ Monitoring Locations in Seagate

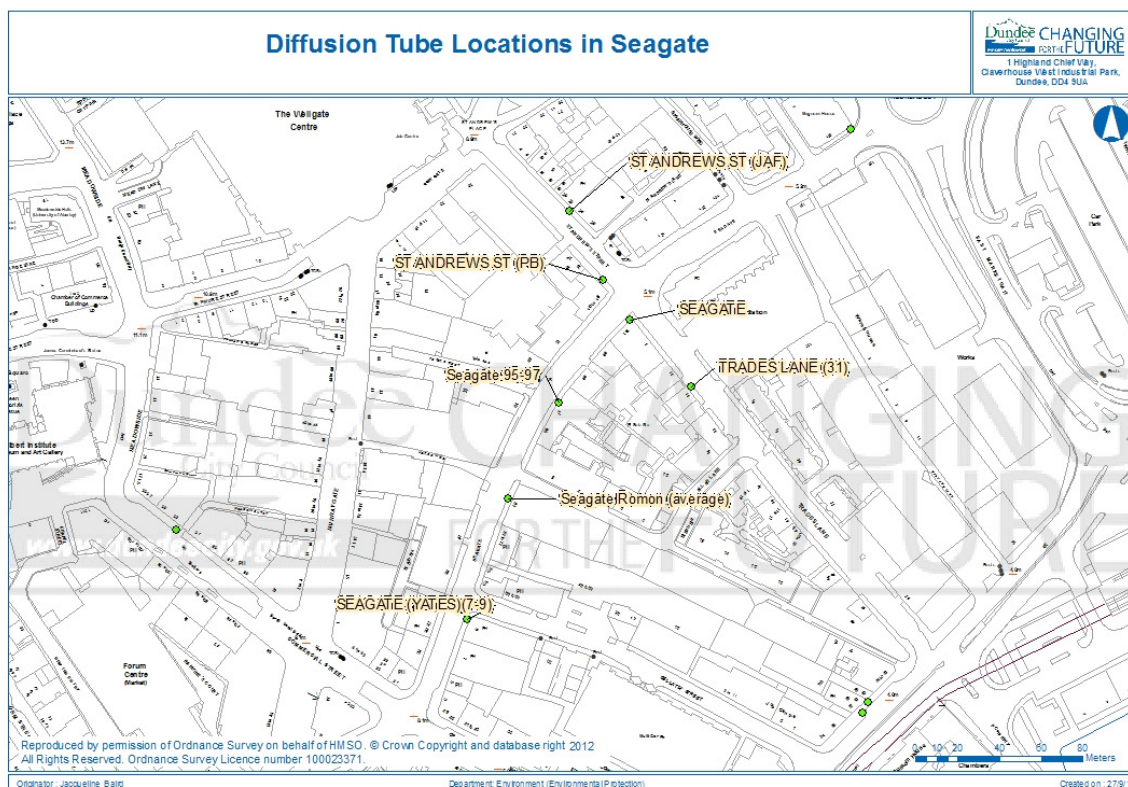
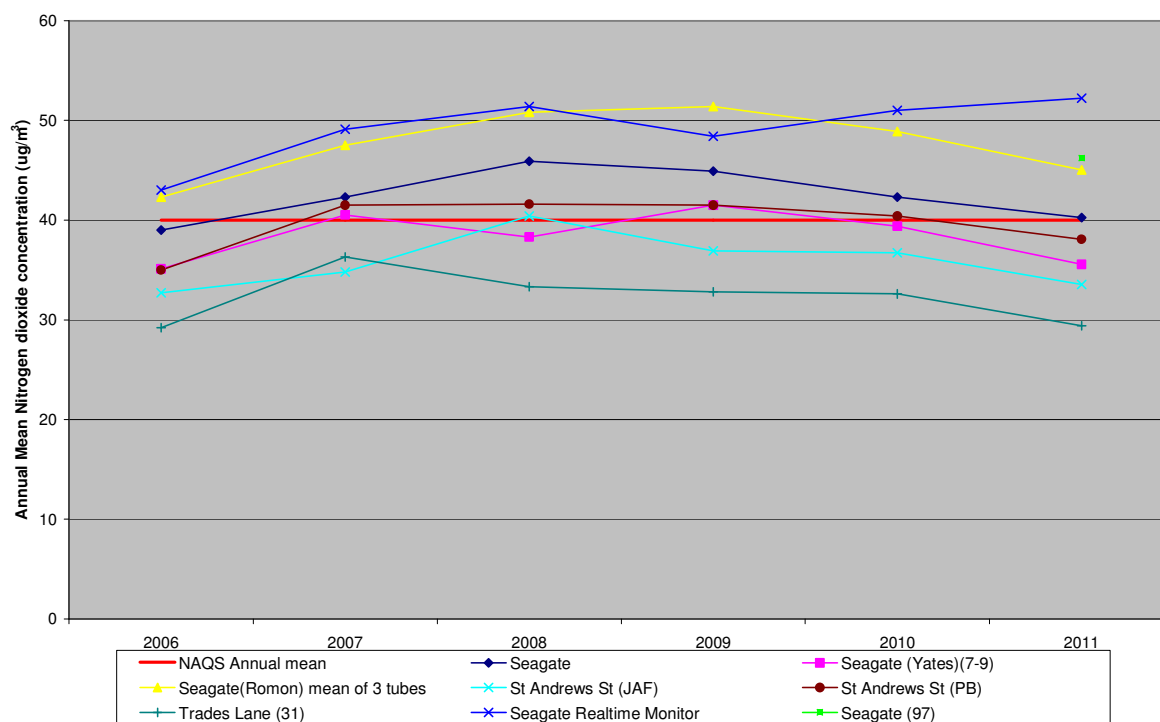


Figure 2.11 Trends in NO₂ Concentrations in Seagate.



Nethergate

Figure 2.12 NO₂ Diffusion Tube Locations in Nethergate

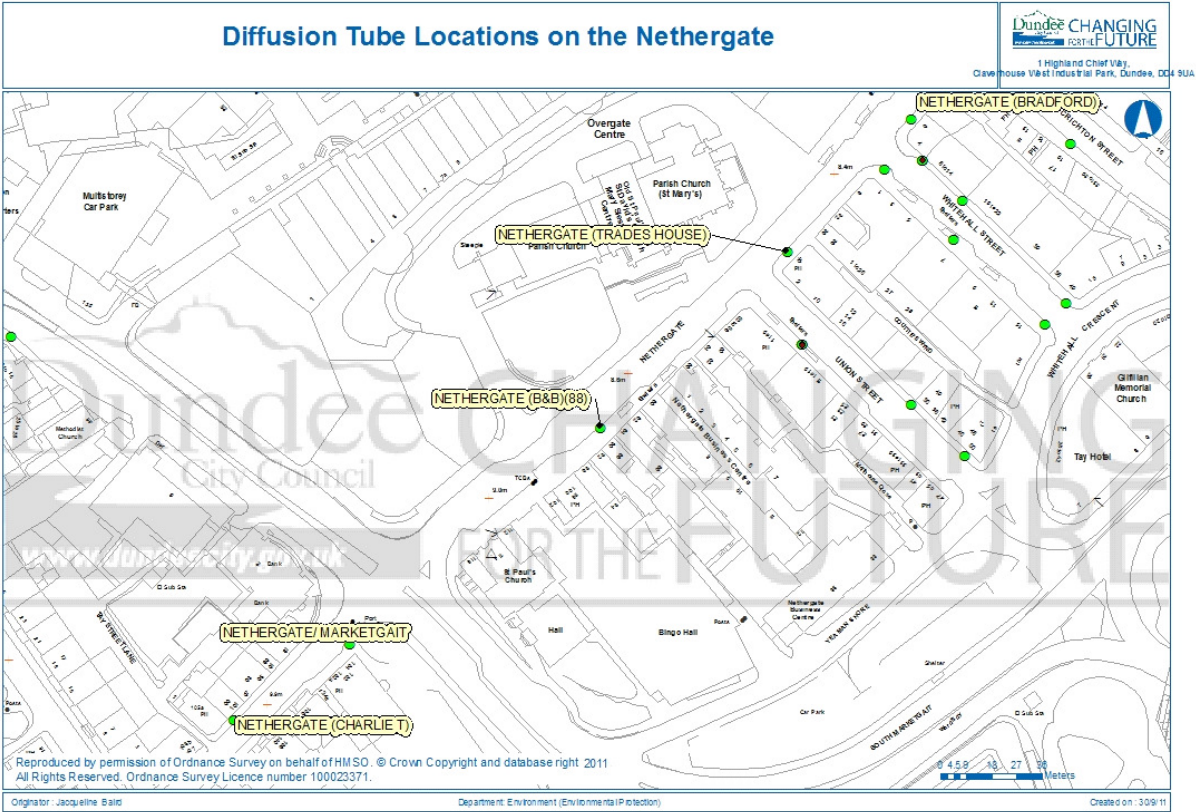
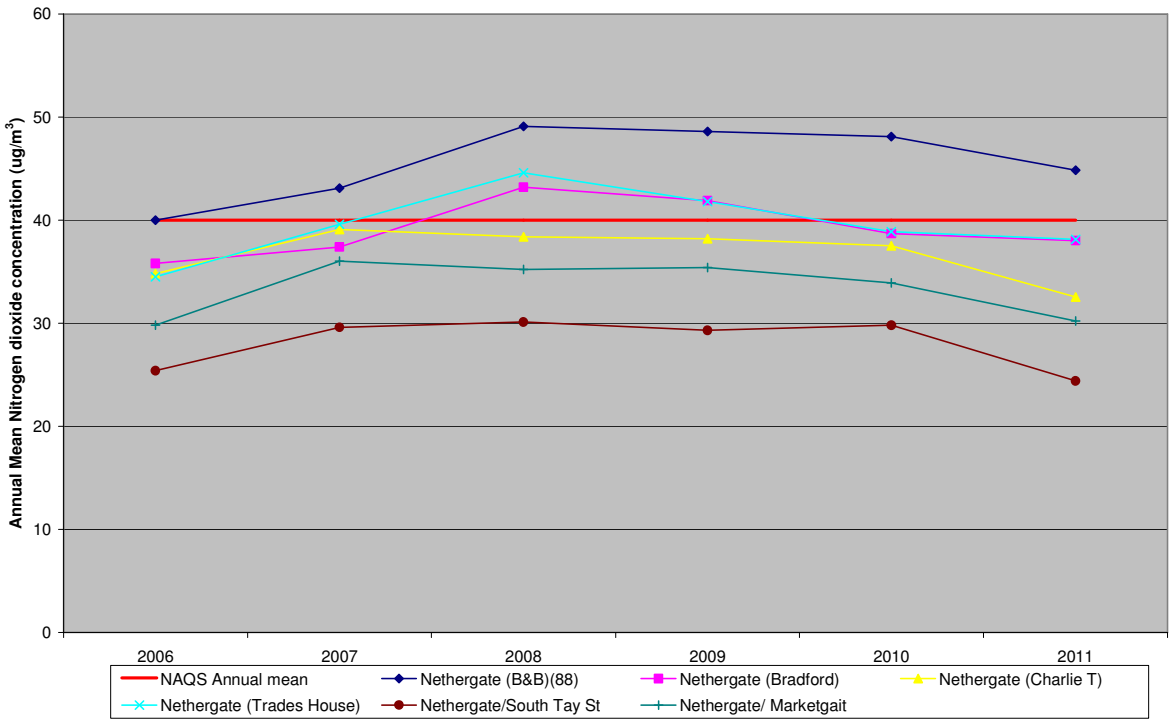


Figure 2.13 Trends in NO₂ Diffusion Tube Concentrations in Nethergate.



Victoria Road / Meadowside

Figure 2.14 NO₂ Diffusion Tube Locations in Victoria Road / Meadowside

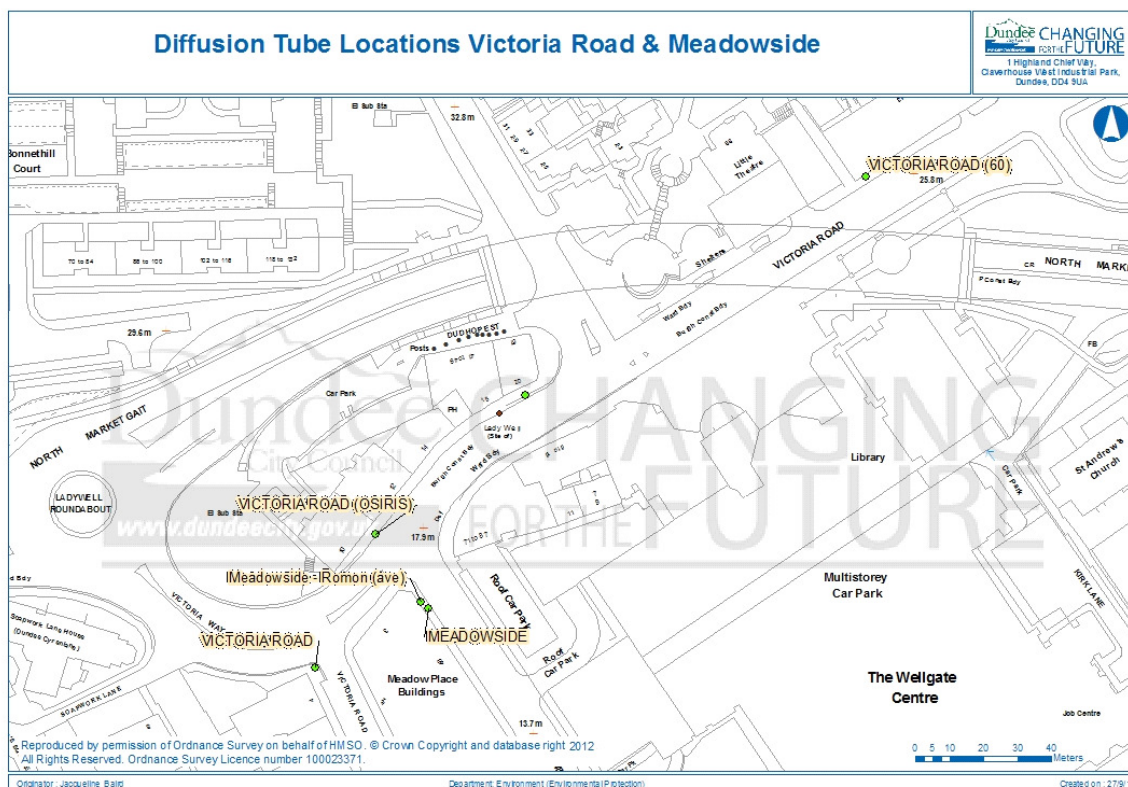
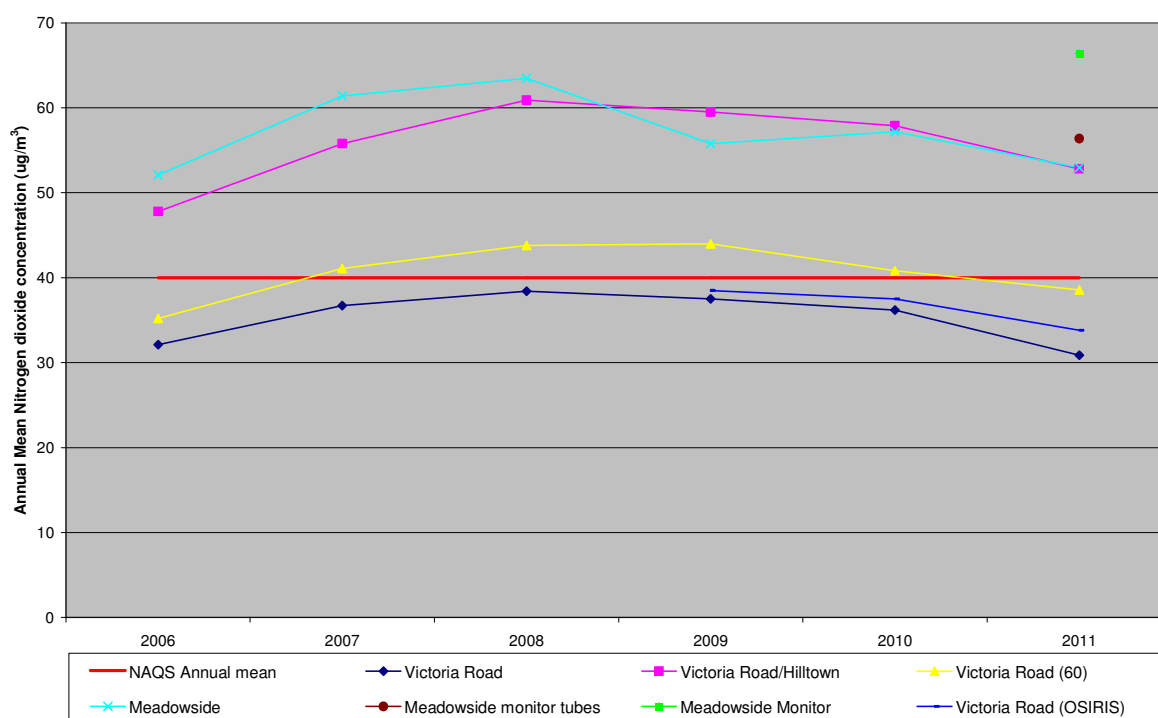


Figure 2.15 Trends in NO₂ Diffusion Tube Concentrations in Victoria Road / Meadowside.



Albert Street / Dura Street

Figure 2.16 NO₂ Diffusion Tube Locations in Albert Street / Dura Street

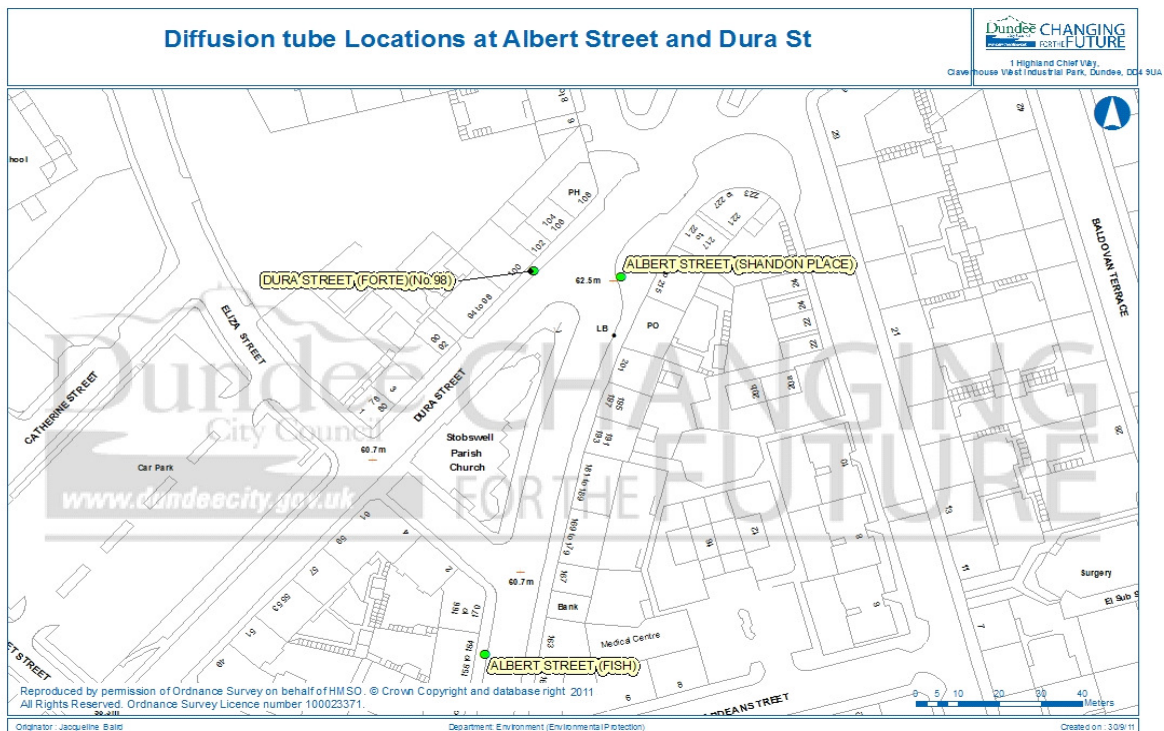
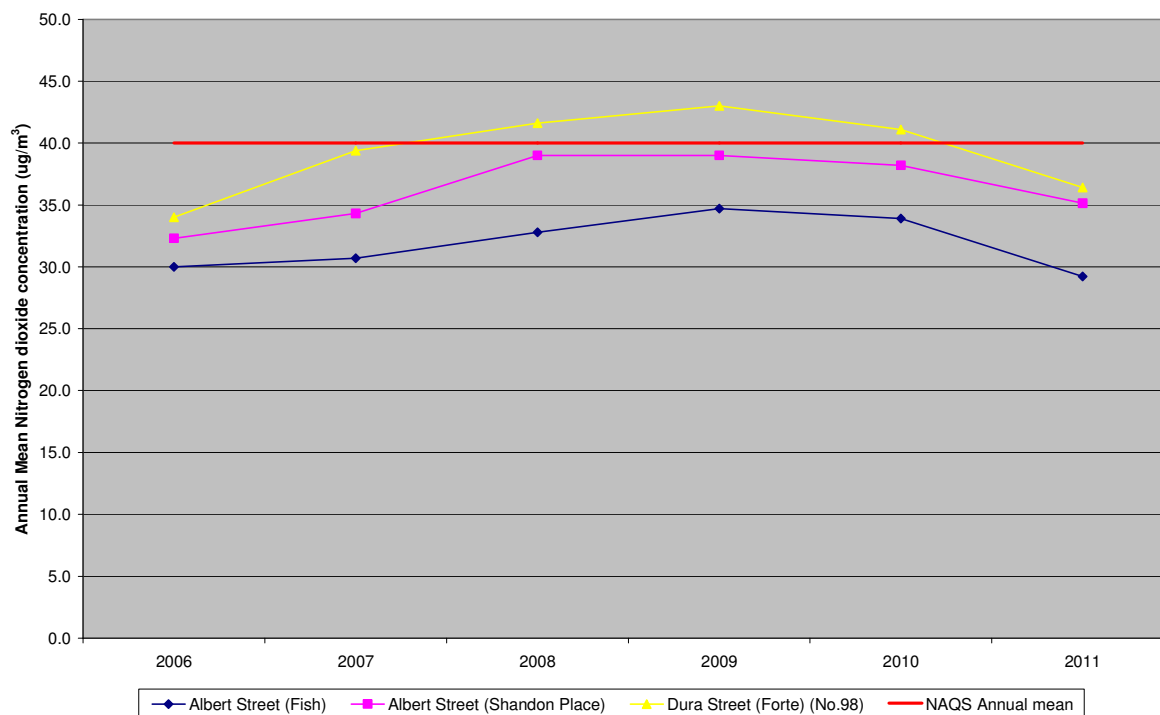


Figure 2.17 Trends in NO₂ Diffusion Tube Concentrations in Albert Street / Dura Street.



Lochee Road

Figure 2.18 NO₂ Monitoring Locations in Lochee Road

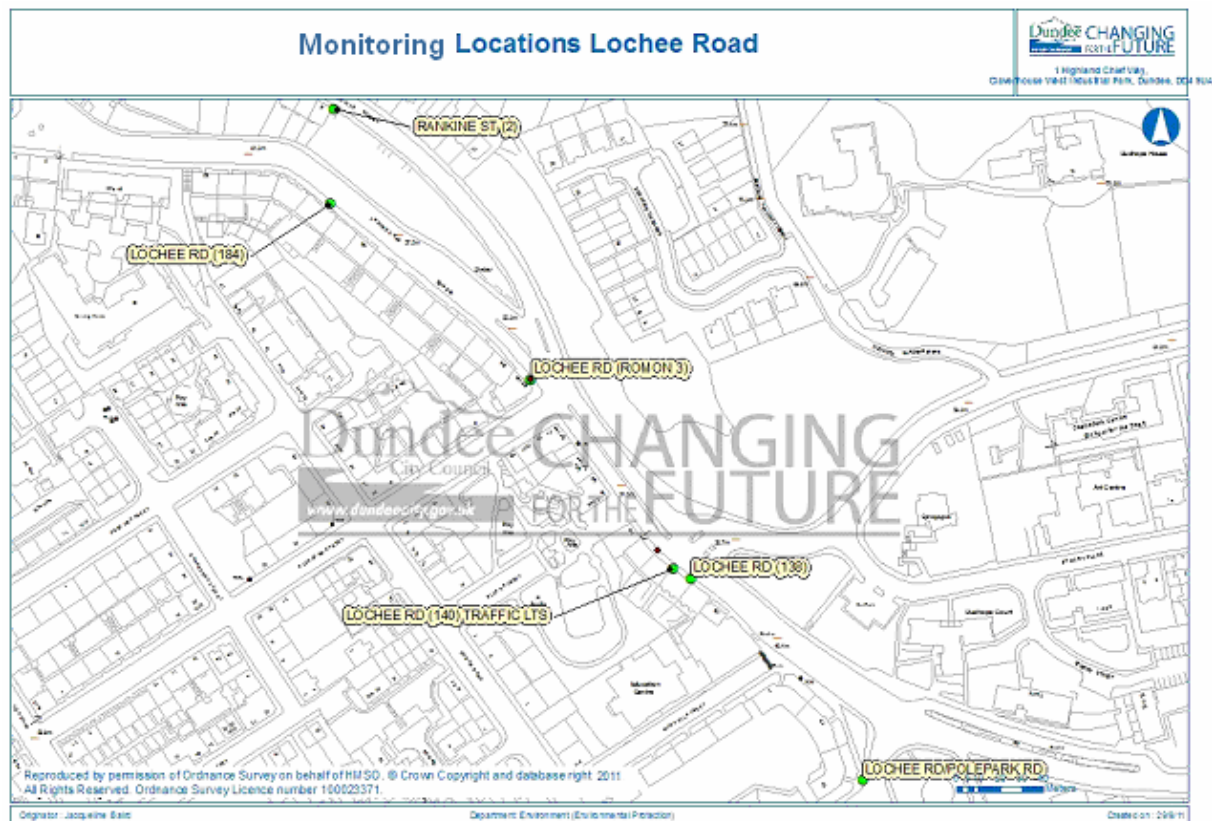
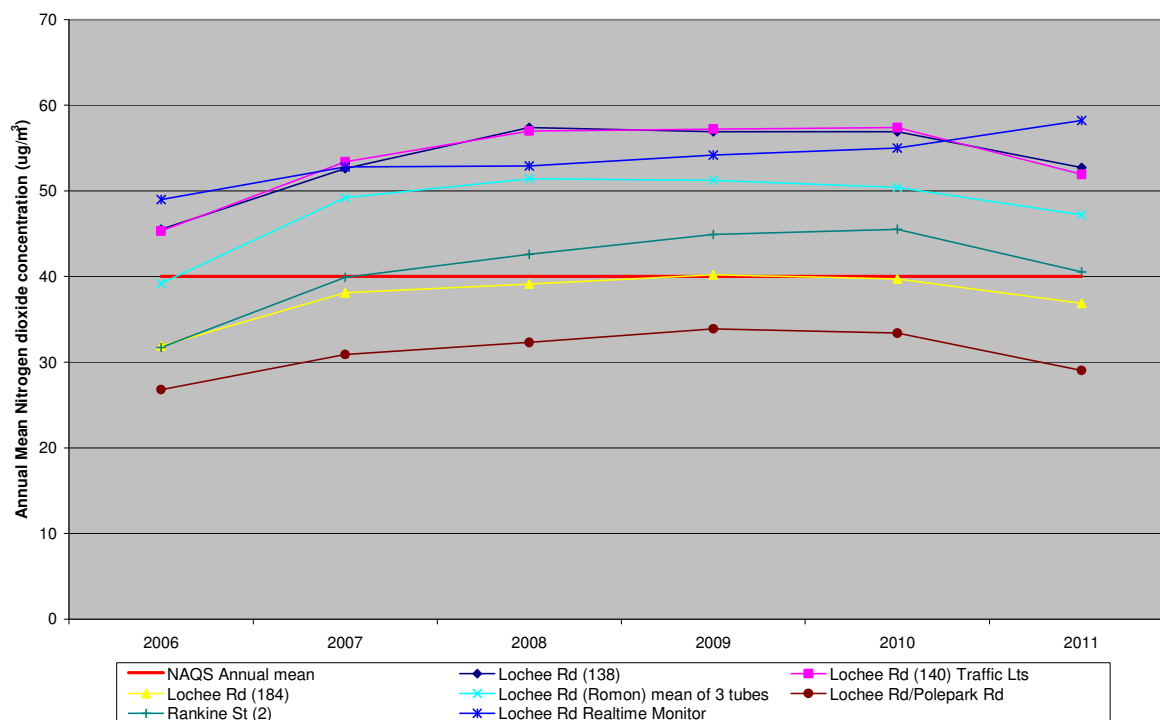


Figure 2.19 Trends in NO₂ Concentrations in Lochee Road



Logie Street

Figure 2.20 NO₂ Diffusion Tube Locations in Logie Street

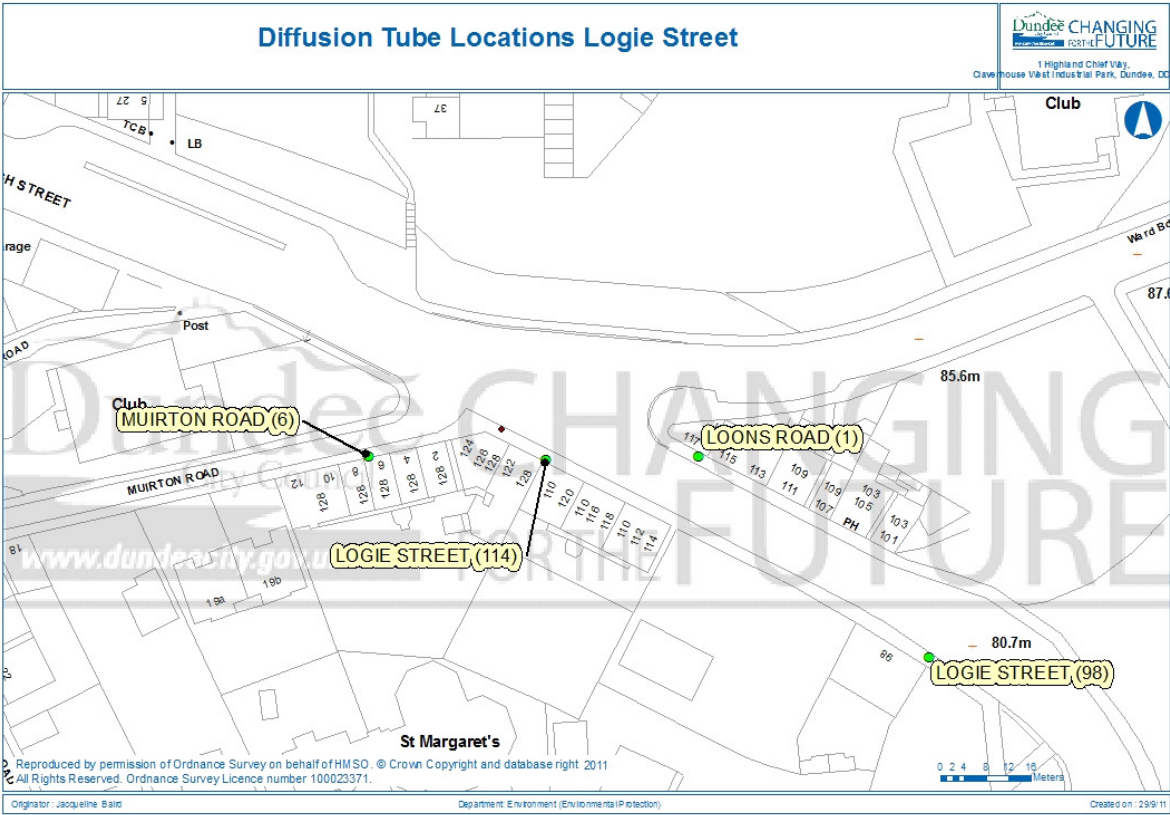
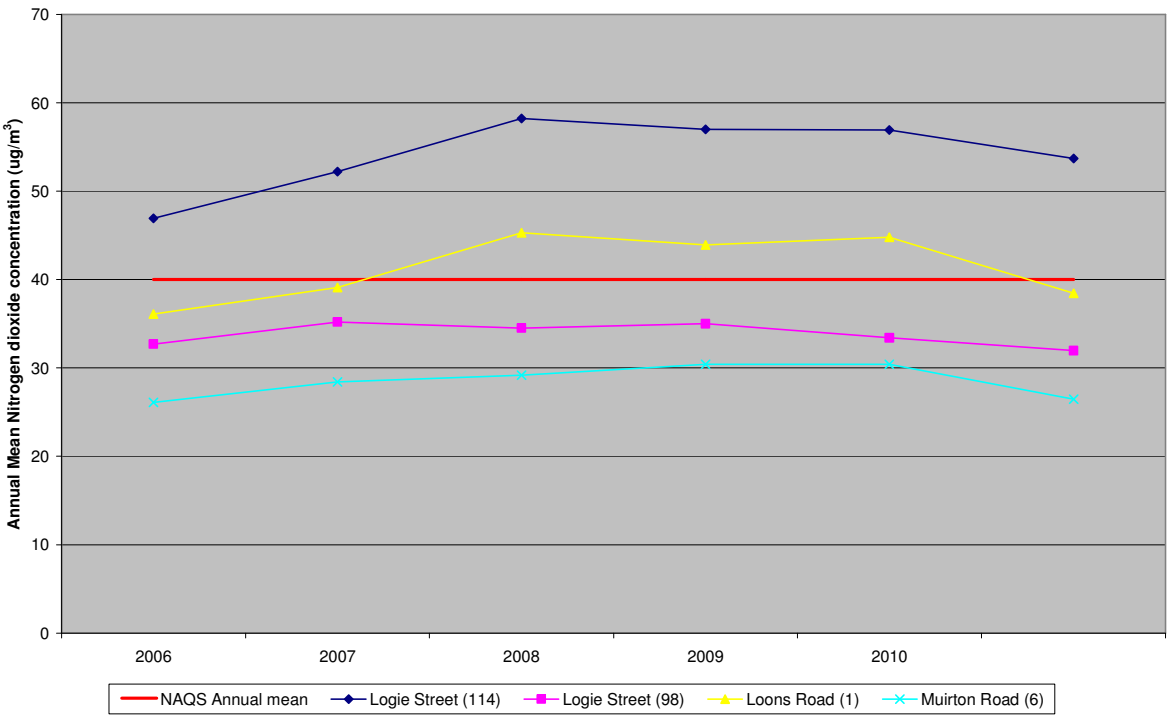


Figure 2.21 Trends in NO₂ Diffusion Tube Concentrations in Logie St.



Albert Street / Arbroath Road

Figure 2.22 NO₂ Diffusion Tube Locations in Albert St. / Arbroath Road

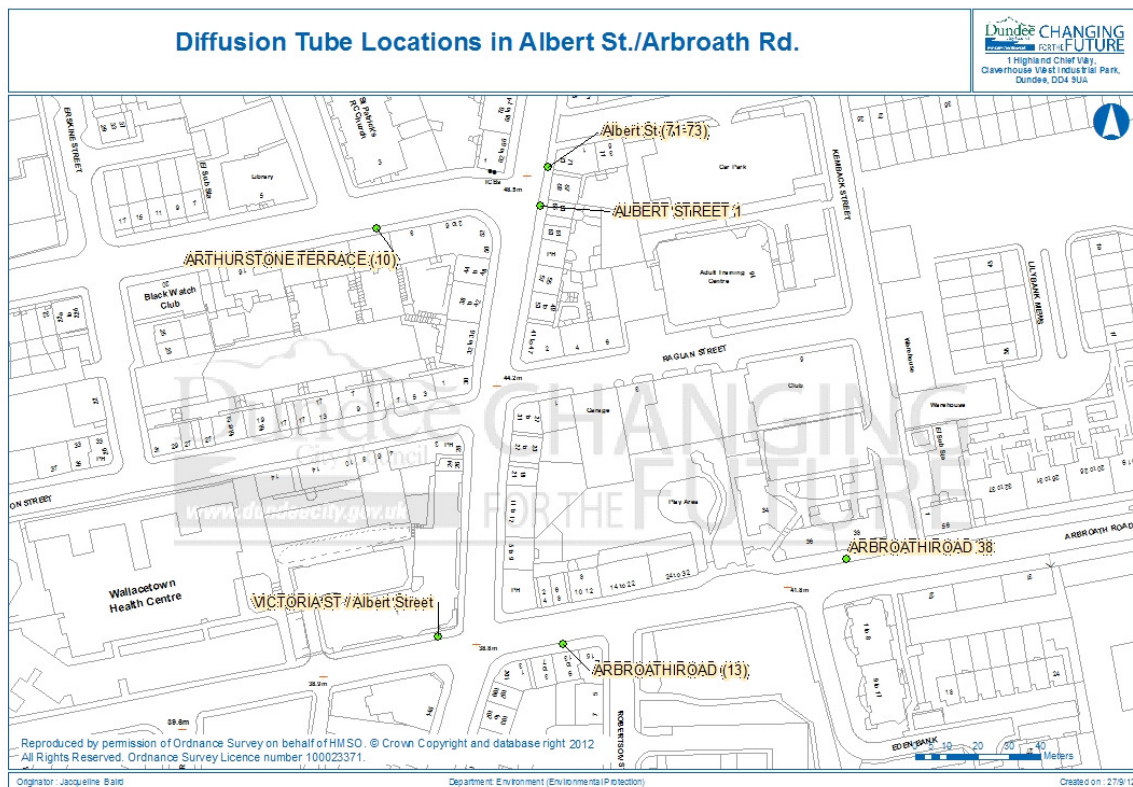
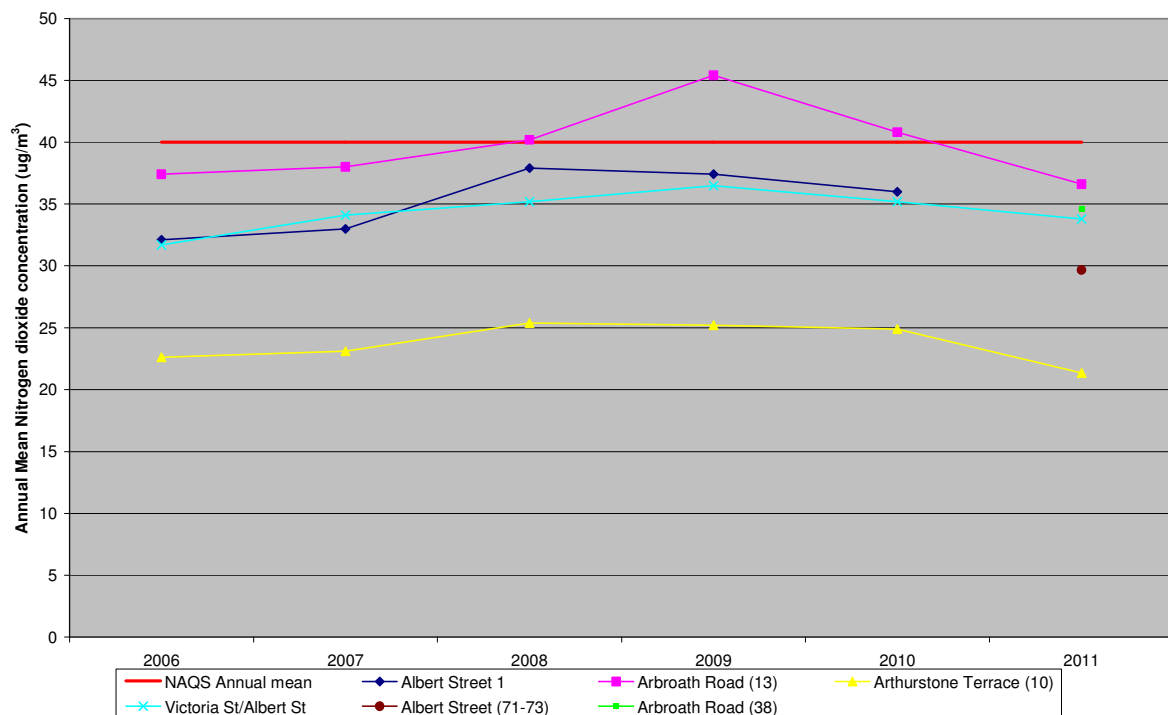


Figure 2.23 Trends in NO₂ Diffusion Tube Concentrations in Albert St. / Arbroath Road



Kingsway / Forfar Road.

Figure 2.24 NO₂ Diffusion Tube Locations on/near the Kingsway

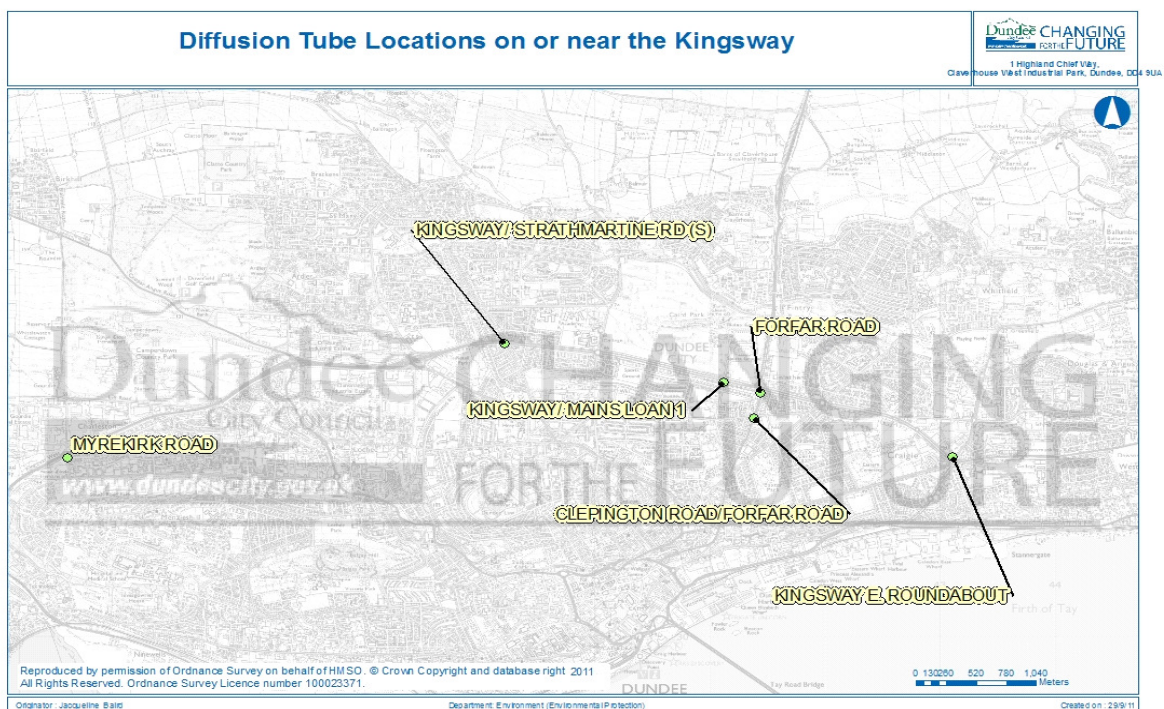
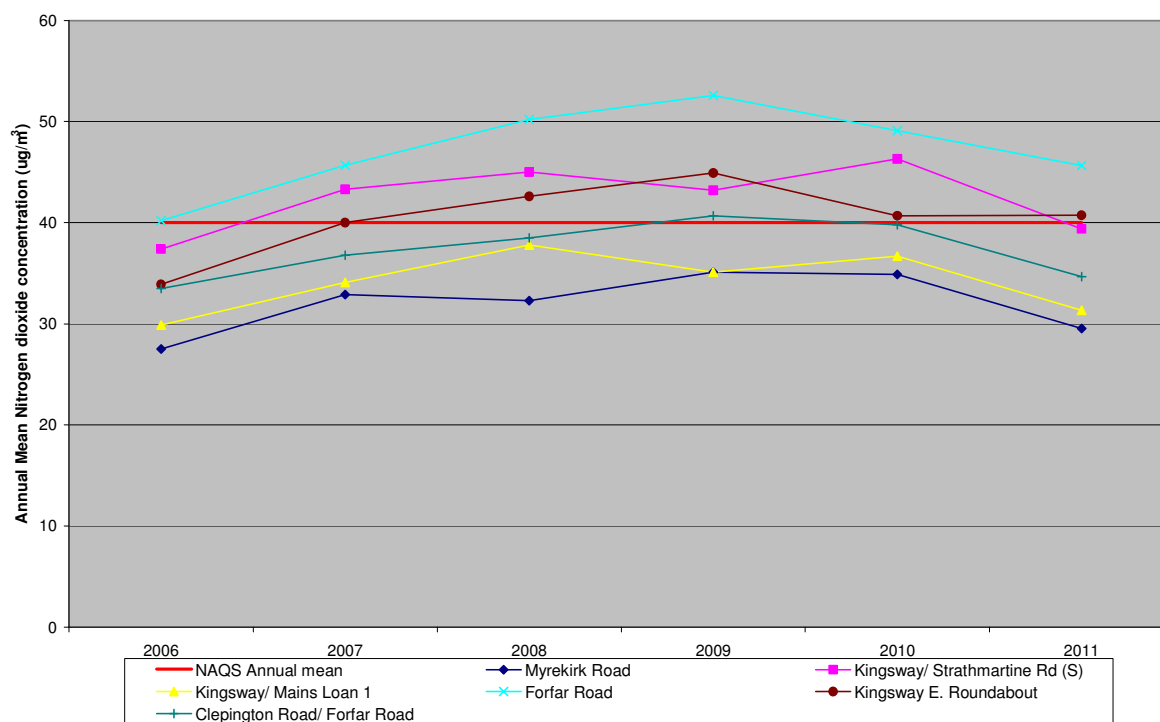


Figure 2.25 Trends in NO₂ Diffusion Tube Concentrations on/near the Kingsway



Bus Corridor

Figure 2.26 NO₂ Diffusion Tube Locations on Bus Corridor

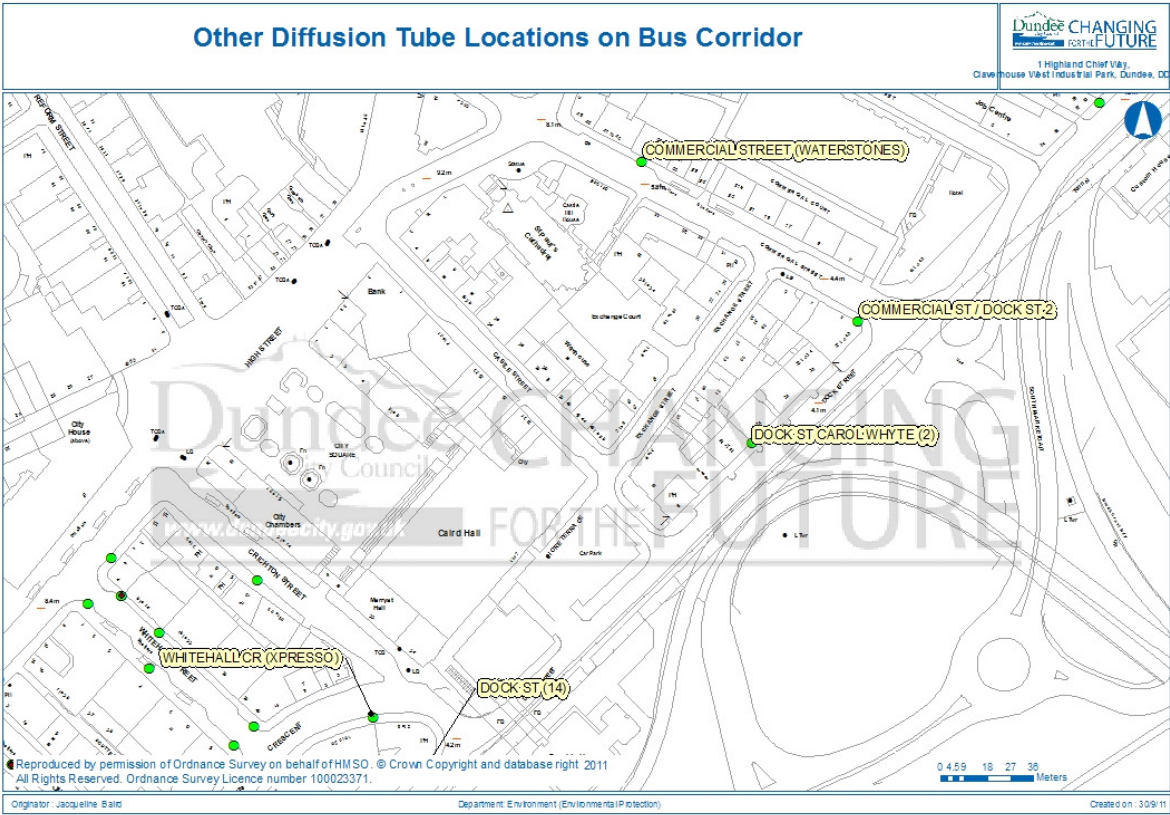
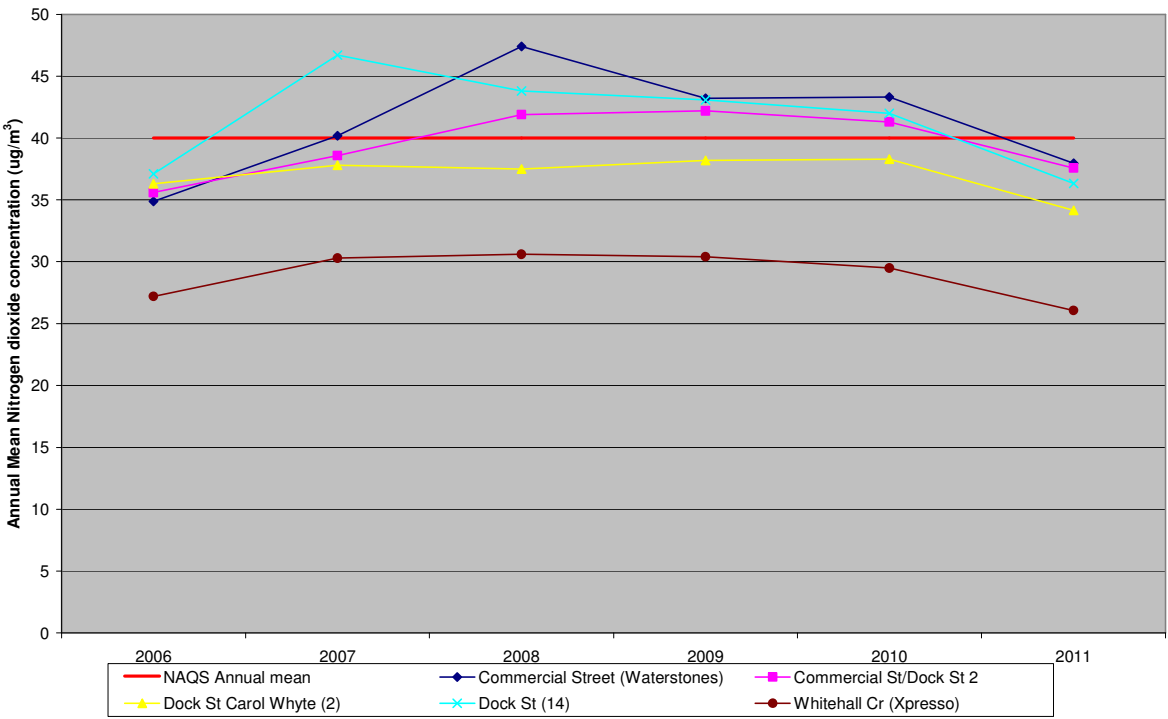


Figure 2.27 Trends in NO₂ Diffusion Tube Concentrations on Bus Corridor



Inner Ring Road

Figure 2.28 NO₂ Diffusion Tube Locations on Inner Ring Road

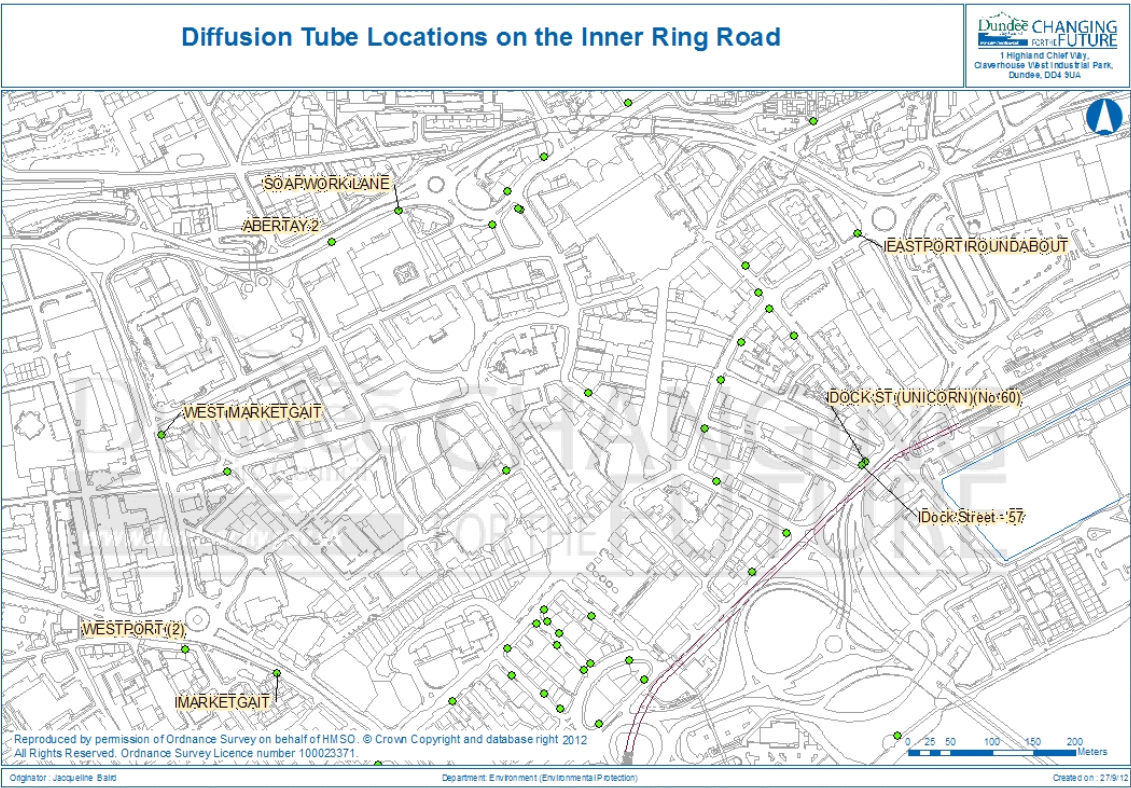
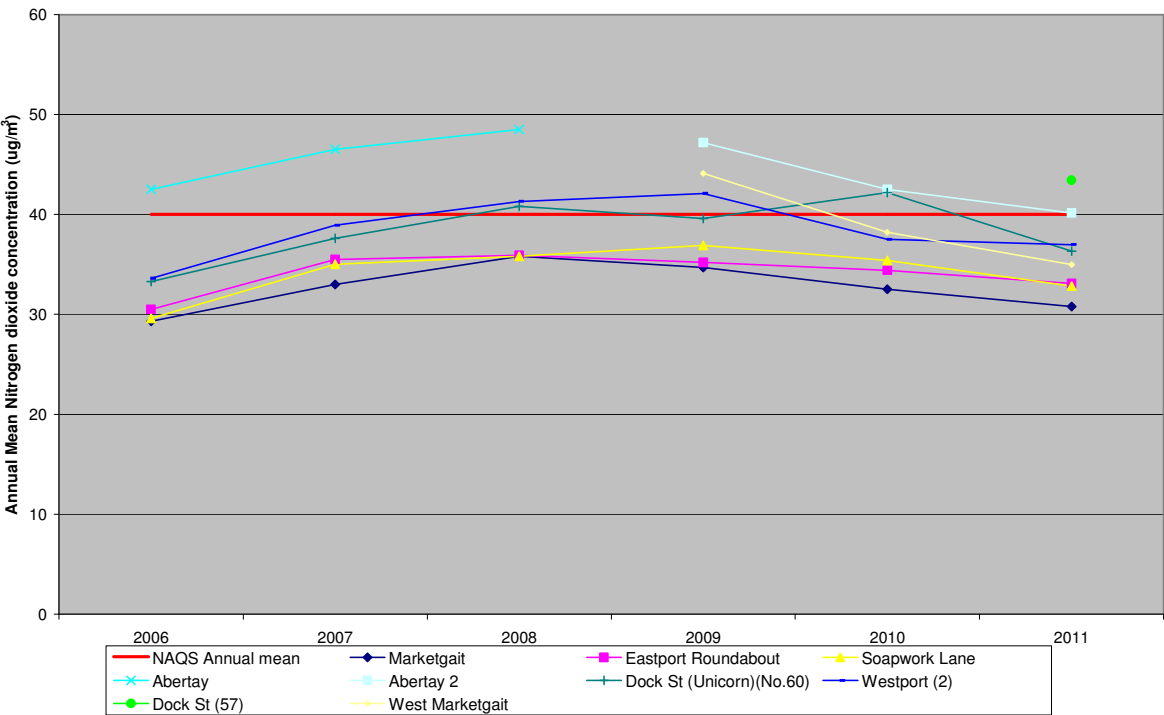


Figure 2.29 Trends in NO₂ Diffusion Tube Concentrations on Inner Ring Road



Stannergate Junction

Figure 2.30 NO₂ Diffusion Tube Location at Stannergate Junction

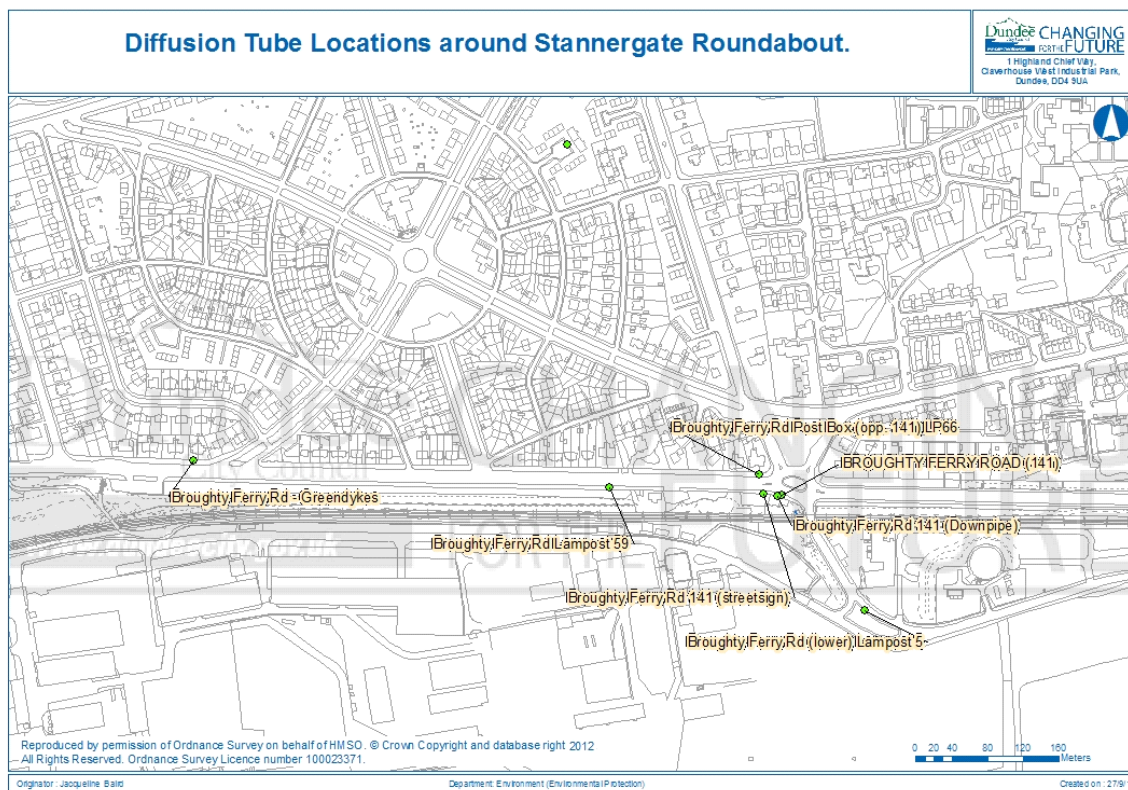
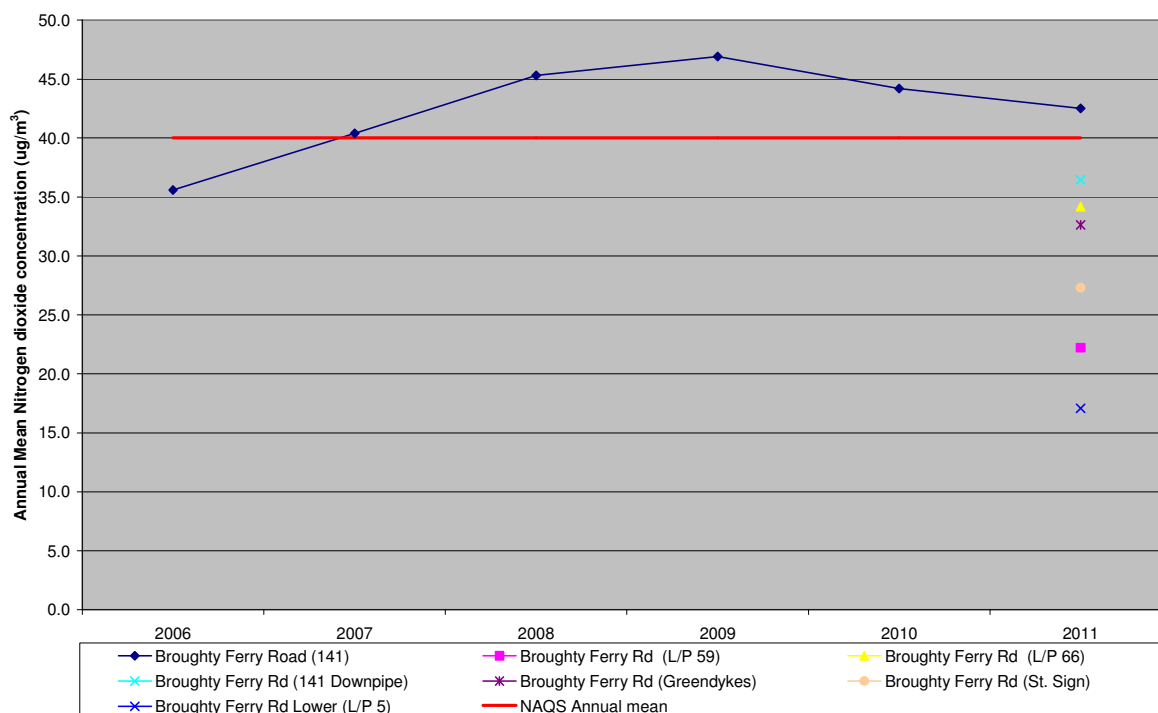


Figure 2.31 Trends in NO₂ Diffusion Tube Concentration at Stannergate Junction



Strathmore Avenue

Figure 2.32 NO₂ Diffusion Tube Location at Strathmore Avenue

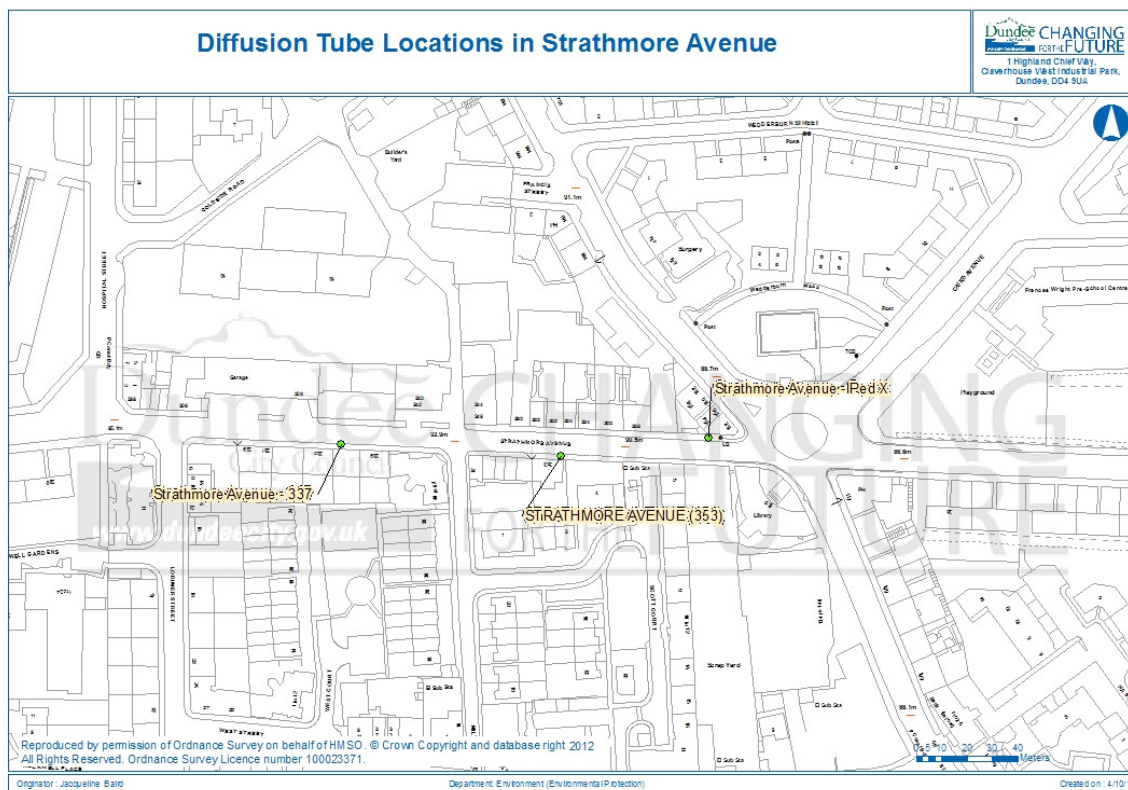
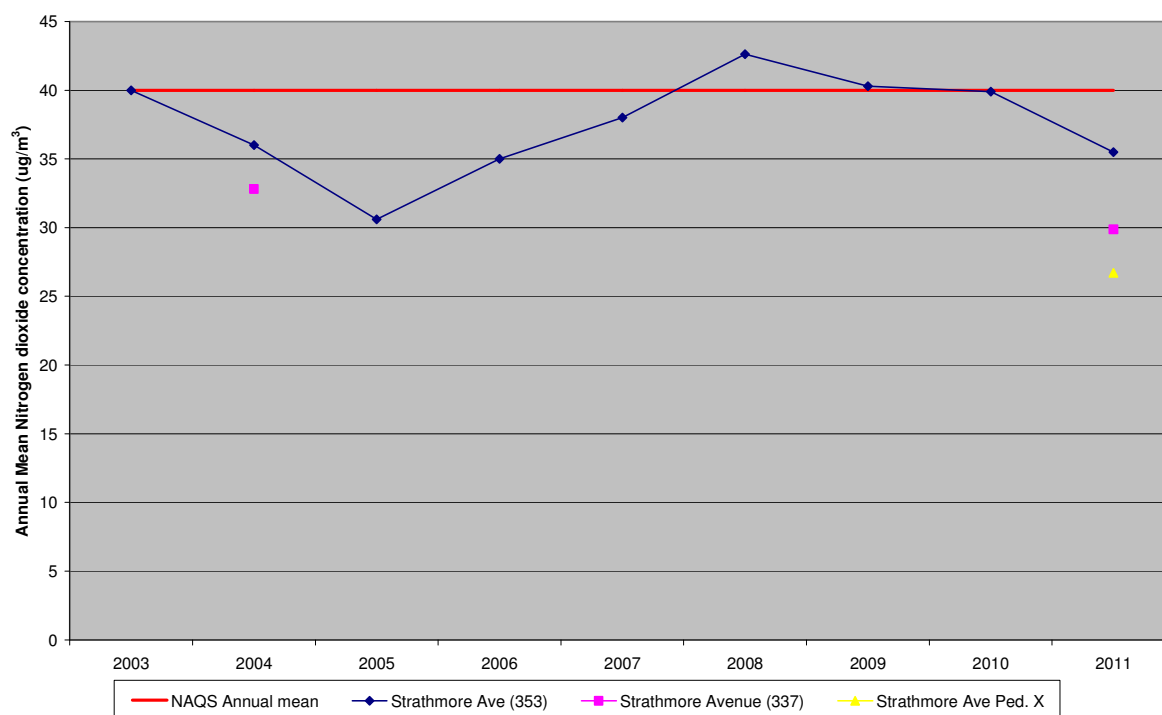


Figure 2.33 Trends in NO₂ Diffusion Tube Concentration at Strathmore Avenue



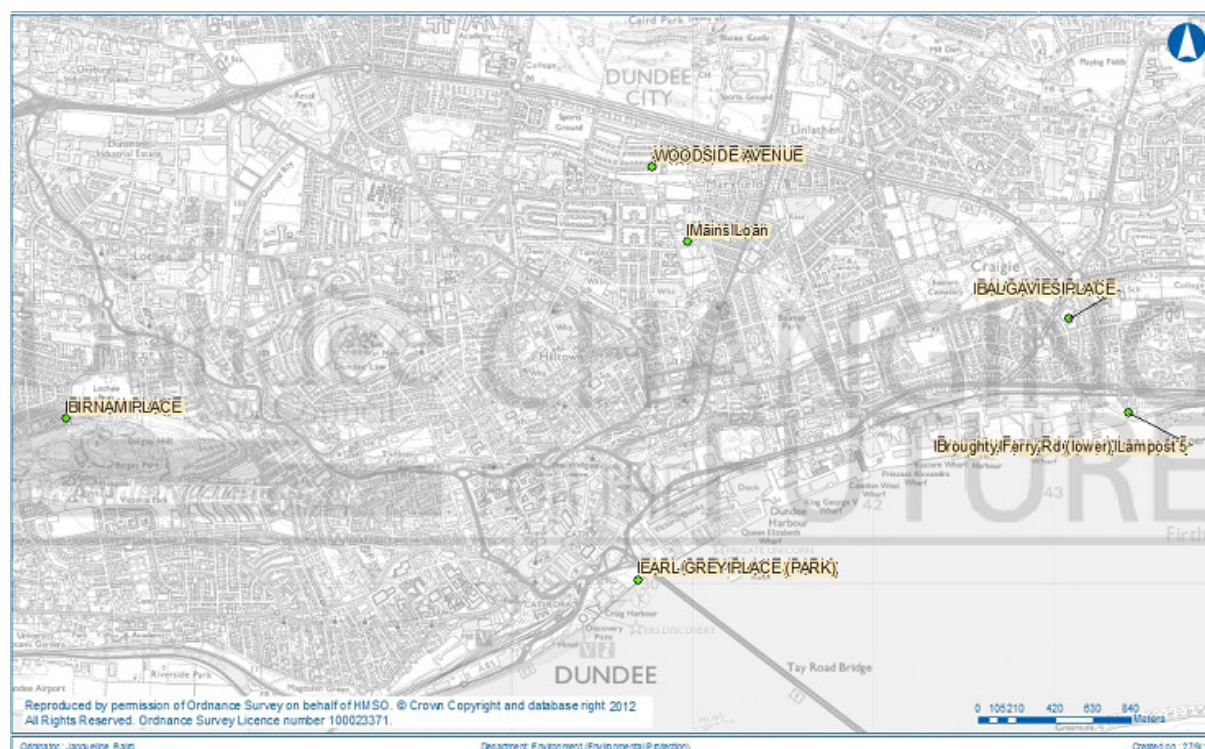
2.1.1.2 Trends in NO₂ Monitoring Concentrations at Urban Background Locations

Dundee City Council operated 6 urban background NO₂ monitoring locations in 2011. Diffusion tubes were deployed at all sites and co-located with the new automatic analyser at Mains Loan. These locations are shown in **Figure 2.34**. The 2011 NO₂ annual mean urban background concentrations were generally lower than the Scottish Government modelled background NO₂ concentrations published as (1km x 1km) maps⁵ in April 2012 (see **Table 2.7**).

Table 2.7 Comparison of Measured Background NO₂ Results for 2011 with Scottish Government Background Map Data (Released April 2012)

Location	Grid Square	Measured Annual Mean (bias 0.78) (µg/m ³)	Scottish Government Mapped Concentration (µg/m ³)
Birnam Place	337500 : 730500	9.6	14.2
Woodside Avenue	340500 : 732500	15.4	19.3
Balgavies Place	343500 : 731500	17.1	18.3
Earl Grey Place	340500 : 730500	19.4	26.7
Mains Loan Tubes (Mean of 3 tubes)	340500 : 731500	12.2	21.6
Mains Loan Automatic Monitor	340500 : 731500	11.6	21.6
Broughty Ferry Road (Lower)	343500 : 730500	17.1	19.2

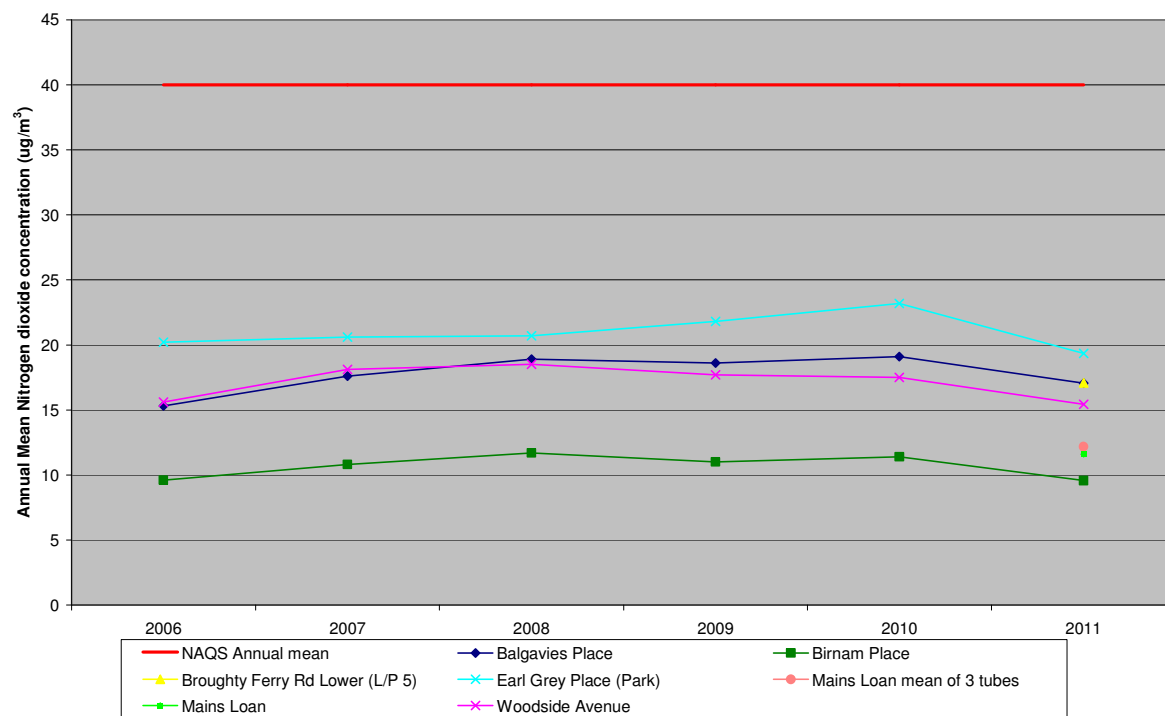
Figure 2.34 Urban Background NO₂ Monitoring Locations



⁵ http://www.scottishairquality.co.uk/maps.php?n_action=data

NO₂ concentrations at urban background locations have remain relatively stable over the past 6 years. This is illustrated in **Figure 2.35**.

Figure 2.35 Trends in NO₂ Concentrations at Urban Background Locations



2.2.2 PM₁₀

Dundee City Council undertook automatic monitoring of PM₁₀ at ten sites in the city in 2011. These are all located within the Dundee AQMA (NO₂ and PM₁₀ annual mean) with one at an urban background location, another downwind of an industrial facility in the port, and the rest either at busy roads and junctions in the city centre or by main arterial routes.

Dundee City Council uses four types of measurement methods for PM₁₀ monitoring:

- The Partisol sampler is an equivalent method with the EU reference method for measuring particulates. The Partisol gravimetric sampler collects daily samples onto a filter for subsequent weighing to determine the PM₁₀ concentration;
- The tapered element oscillating microbalance (TEOM) system determines particulate concentrations by continuously weighing particles that are deposited onto a filter. This is an approved analyser for detailed and further assessments although it is not gravimetric equivalent;
- The Beta Attenuation Monitor (BAM). These devices draw sampled air at a constant flowrate through a section of paper tape, on which particles from the air are collected. At the beginning and end of the sampling period (1 to 24 hours), transmission of beta particles through the tape (from a source inside the instrument) is measured. The difference between the two measurements, caused by the particulate matter collected on the tape, is used to determine the concentration; and
- The Osiris particulate monitors supplied by Turnkey Instruments are nephelometers, which size and count individual particles as they pass through a laser beam. These are indicative analysers which are suitable as a screening tool for LAQM. Annual means compare favourably with TEOM monitored means but peak values tend to be exaggerated, so these results should be treated with some caution.

Locations of the analysers across the city are:

- Partisol at Broughty Ferry Road (with TEOM co-location);
- TEOM at Union Street (with Osiris co-location);
- TEOM at Mains Loan, and
- Four Osiris monitors located at Seagate, Victoria Road, Lochee Road and Logie Street.
- Three BAM monitors located alongside the NO₂ monitors in Lochee Road, Seagate and Meadowside.

Details and locations of these monitoring stations can be found in **Table 2.1** and **Figure 2.1**, respectively.

The Partisol and the BAM are considered to be “gravimetric equivalent” analysers in the “*UK Equivalence Programme for Monitoring of Particulate Matter*” and as such can be compared directly with the prescribed objectives. The TEOM and Osiris monitors are not gravimetric equivalent and, as such, data is required to be adjusted to enable comparison with the prescribed objectives. Prior to the introduction of the LAQM.TG(09) methodology of applying the volatile correction model, Dundee City Council derived local factors from co-location studies to enable adjustment of both TEOM and Osiris data. AEA were commissioned by the Scottish Government to provide VCM correction for TEOMs from 2008. Therefore the DCC 2011 TEOM and Osiris data have been corrected using the AEA VCM correction factors.

Comparison of the equivalent daily averages for the 2011 Partisol and TEOM co-location study at Broughty Ferry Road showed that locally TEOMs under-read compared to the Partisol and so all TEOM results have been factored by the local factor of **1.092**.

Comparing equivalent hourly averages in 2011 for the TEOM and Osiris at Union Street found that the Osiris was over-reading compared to the TEOM. This meant the Osiris had to be multiplied by a factor of **0.954** to be equivalent to the TEOM. Consequently, the annual mean Osiris results presented in this report have been adjusted prior to gravimetric correction factors being applied. The factored monitoring results for 2011 are shown in **Table 2.8** and **Table 2.8a**.

Several of the automatic monitoring sites had less than 9 months data in 2011 and hence the results needed to be annualised as described in Box 3.2 of LAQM.TG(09). The sites chosen for the annualisation and the resulting factors are detailed in **Appendix D**.

Table 2.8 Results of PM₁₀ Automatic Monitoring: Comparison with Annual Mean Objective

Location (Monitor type)	Site Type	Correction factor	Data Capture for 2011 (%)	Annual mean concentrations (µg/m ³)
		VCM/Local		2011
Broughty Ferry Rd (Partisol)	UI	N/A	99.7	15.2
Broughty Ferry Rd (TEOM)	UI	VCM	98.6	16.1
		Local (2011 - 1.092)	98.8	15.3
Mains Loan (TEOM)	UB	VCM	93.1	12.8
		Local (2011 - 1.092)	93.2	11.8
Union St (TEOM)	R	VCM	99.4	18.8
		Local (2011 - 1.092)	99.5	18.2
Union St (Osiris)	R	VCM	92.0	18.9
		Local (2011 - 1.092)	92.2	18.3
Victoria Rd (Osiris)	K	VCM	93.8	19.5
		Local (2011 - 1.092)	93.9	19.0
Logie St (Osiris)	K	VCM	93.9	21.6
		Local (2011 - 1.092)	94.0	21.2
Lochee Rd (Osiris)	K	VCM	93.9	26.3
		Local (2011 - 1.092)	94.0	26.2
Seagate (Osiris)	K	VCM	93.8	23.6
		Local (2011 - 1.092)	94.0	23.3
Lochee Rd (BAM)	R	0.8333	72.0*	19.4
Seagate (BAM)	R	0.8333	62.2*	17.1
Meadowside (BAM)	R	0.8333	50.6*	23.3

Notes

Monitoring period & data capture percentage is for the full calendar year

Exceedences of the air quality objectives are shown in bold

* denotes where data capture is less than the recommended 90%.

Results with data capture below 75% have been annualised as in Box 3.2 of LAQM.TG(09) and are shaded grey

K= Kerbside, R=Roadside, UI=Urban Industrial, UB=Urban Background

Table 2.8a Results of PM₁₀ Automatic Monitoring: Comparison with 24-hour Mean Objective

Location (Monitor type)	Site Type	Correction factor	Data Capture for 2011 (%)	Number of Exceedences of daily mean objective (50 µg/m ³) (7 allowed)
		VCM/Local		2011
Broughty Ferry Rd (Partisol)	UI	N/A	99.7	1 (41.9)
Broughty Ferry Rd (TEOM)	UI	VCM	98.6	0 (40.3)
		Local (2011 - 1.092)	98.6	0 (32.2)
Mains Loan (TEOM)	UB	VCM	92.6	0 (33.4)
		Local (2011 - 1.092)	92.6	0 (26.4)
Union St (TEOM)	R	VCM	100	1 (42.8)
		Local (2011 - 1.092)	100	1 (39.1)
Union St (Osiris)	R	VCM	91.8	5 (48.0)
		Local (2011 - 1.092)	91.8	3 (44.8)
Victoria Rd (Osiris)	K	VCM	93.7	11 (53.7)
		Local (2011 - 1.092)	93.7	3 (47.7)
Logie St (Osiris)	K	VCM	94.0	17 (53.8)
		Local (2011 - 1.092)	94.0	8 (51.9)
Lochee Rd (Osiris)	K	VCM	94.0	30 (70.4)
		Local (2011 - 1.092)	94.0	26 (63.2)
Seagate (Osiris)	K	VCM	94.0	23 (65.0)
		Local (2011 - 1.092)	94.0	14 (59.7)
Lochee Rd (BAM)	R	0.8333	72.3*	2 (43.5)
Seagate (BAM)	R	0.8333	63.0*	1 (38.1)
Meadowside (BAM)	R	0.8333	50.4*	4 (49.8)

Notes

Monitoring period & data capture percentage is for the full calendar year

Exceedences of the air quality objectives are shown in bold

* denotes where data capture is less than the recommended 90%.

The 98th percentile is shown in brackets

K= Kerbside, R=Roadside, UI=Urban Industrial, UB=Urban Background

Annual Mean Concentrations

Monitoring results in **Table 2.8** indicate the 2004 PM₁₀ Objectives are being met. However, there were exceedences of the 2010 PM₁₀ annual mean objectives recorded at kerbside Osiris units (Lochee Rd., Logie St., Victoria Rd., Seagate), Union Street (TEOM and Osiris) and at two of the new BAMs located on Lochee Road and at Meadowside. Unlike the Osiris and TEOM in Union Street, it should be noted that the new BAMs in Lochee Road and Seagate are not at the same locations as the Osiris monitors in those streets. In both cases the Osiris units, which are lamppost mounted, are closer to the worst case location than it is possible to site the BAMs. This is likely to account for why the Osiris annual means are higher than those recorded at the BAMs in Seagate and Lochee Road. Road works from May to November in 2011 are thought to have contributed to the annual mean exceedence in Union Street.

Daily Mean Concentrations

Monitoring results in **Table 2.8a** show that the majority of exceedences of the daily mean of 50µg/m³ (7 allowed) were recorded at the Osiris monitoring units in Lochee Road, Logie Street, Victoria Road, and Seagate. Osiris' are indicative monitors and have a tendency to over-estimate the number of exceedences, e.g. the Osiris co-located with the TEOM at Union Street recorded five exceedences and the TEOM only one.

An analysis of the frequency of these exceedences is shown in **Table 2.8b**. This showed that the majority of the exceedences occurred during light winds, with 19 during easterly winds and 15 during westerly winds. There was also a large number occurring during March and April. A comparison of Dundee daily PM₁₀ concentrations with urban background monitoring locations in Scotland for each of the identified exceedence episodes is shown in **Figures 2.36 to 2.41**. This showed that the majority of the episodes coincided with raised background concentrations.

Some were clearly local events and an examination of the council road reports identified road works in the vicinity of the monitors showing exceedences in each of these events. On the week beginning 24/01/2011 there were temporary traffic lights for one week in Logie Street due to gas main repairs. This may also have had an impact on traffic flows near the monitor in Lochee Road which also showed an exceedence at this time. On the week beginning 03/10/2011 Union Street was closed for carriageway resurfacing which coincided with exceedences at Union Street TEOM and Osiris. On the week beginning 07/11/2011 there were off peak lane restrictions and installation of tactile paving at the Seagate - Trades Lane junction which coincided with an exceedence at the Seagate Osiris monitoring unit.

Further analysis of the data from 2006 – 2011 at three long-term sites using the Openair trend level hour tool can be seen in **Appendix J**. This clearly shows a seasonal pattern across most years of raised concentrations in springtime at all three monitoring locations. This is indicative of a transboundary influence on locally monitored concentrations of PM₁₀. In contrast the plot for Union Street shows the raised concentrations during working hours in Autumn 2011 that coincided with extensive road works in the street canyon.

Table 2.8b Comparison of Daily Exceedence Events in Dundee with Wind Speed and Direction and Urban Background Sites

Dates of exceedences of the NAQS 24hr PM ₁₀ in Dundee					Average wind direction & speed (degrees, m/s)	Roadside							Downwind of Port		Urban background					
						Dundee Lochee (BAM-G)	Dundee Lochee Rd (OSIRIS-VCM)	Dundee Logie St (OSIRIS-VCM)	Dundee Meadowside (BAM-G)	Dundee Victoria Rd (OSIRIS-VCM)	Dundee Seagate (BAM-G)	Dundee Seagate (OSIRIS-VCM)	Dundee Union St (TEOM-VCM)	Dundee Union St (OSIRIS-VCM)	Dundee Broughty Ferry Road (TEOM-VCM)	Dundee Broughty Ferry Rd (PARTISOL)	Dundee Mains Loan (TEOM-VCM)	Aberdeen Errol Pl (VCM)	Edinburgh St Leonards (VCM)	Falkirk Grangemo uth MC (VCM)
1	28/01/11	Fri	W	1.3	no data	55.1	45.5	no data	16.7	no data	24.6	21.7	21.6	14.0	17.1	10.8	11.4	16.4	no data	23.8
2	18/02/11	Fri	ESE	3.3	no data	59.6	47.9	no data	56.0	no data	60.6	39.8	46.8	37.6	38.8	37.6	37.6	34.3	30.5	25.8
	21/02/11	Mon	SE	2.0		55.2	35.7		40.5		47.0	36.5	33.9	30.3	32.5	28.2	33.5	28.2	29.5	23.6
	24/02/11	Thu	WSW	2.0		50.8	44.3		36.8		38.8	28.3	36.0	22.4	15.0	18.7	17.9	17.3	22.8	19.1
	28/02/11	Mon	WSW	1.2		111.0	78.0		47.1		75.8	44.7	43.7	41.3	40.8	29.0	22.7	28.3	43.4	35.7
	01/03/11	Tue	WSW	1.2		79.0	51.9		32.4		44.7	39.2	36.6	28.3	32.9	19.5	21.1	24.0	34.6	30.8
	02/03/11	Wed	WSW	1.6		64.8	45.7		38.8		47.5	40.4	39.4	33.3	29.2	26.5	33.8	31.0	37.9	36.0
	03/03/11	Thu	S	0.7		59.7	42.5		54.4		57.0	39.8	46.8	35.0	30.0	26.8	15.1	41.8	43.8	34.3
	04/03/11	Fri	SW	0.8		88.2	70.4		60.7		67.0	48.8	50.4	46.3	36.0	34.2	7.5	29.7	34.4	38.7
	05/03/11	Sat	ESE	1.4		76.4	68.7		54.4		74.0	42.8	46.3	37.4	29.4	33.3	22.9	30.3	33.0	30.5
	06/03/11	Sun	SW	2.0		66.0	51.0		41.8		58.0	33.3	39.5	29.2	28.5	25.6	31.0	25.8	28.0	28.1
07/03/11	Mon	WSW	2.2	72.8	54.4	46.3	59.0	38.1	43.5	31.6	31.5	28.0	29.1	29.5	38.7	31.3				
3	17/03/11	Thu	WSW	1.5	no data	50.3	35.2	no data	33.7	no data	34.4	26.9	31.5	24.5	22.1	17.0	22.3	26.2	23.3	25.1
	23/03/11	Wed	W	1.4		60.0	42.0		26.8		36.7	30.3	31.2	26.9	21.5	no data	9.3	15.2	22.8	18.6
	24/03/11	Thu	WNW	1.3		63.8	38.6		28.0		35.7	30.5	26.9	29.6	21.9	18.0	no data	21.8	31.0	29.0
	25/03/11	Fri	SSW	1.1		59.2	51.1		29.2		40.5	29.6	26.0	27.4	26.5	16.5		24.5	27.5	27.9
	28/03/11	Mon	SSE	1.2		86.7	53.3		41.9		45.4	30.0	35.2	31.0	27.3	16.9		16.4	17.7	26.7
4	09/04/11	Sat	E	1.8	23.8	47.9	50.9	no data	39.0	no data	42.4	21.8	no data	25.1	15.0	19.8	11.1	27.3	28.3	25.8
	10/04/11	Sun	SW	1.5	38.9	63.2	52.0		47.5		53.6	33.2		32.8	17.9	28.5	24.8	30.3	35.0	29.7
	15/04/11	Fri	WSW	1.7	39.1	55.4	45.5		22.6		30.5	25.0	22.8	23.8	19.8	16.6	19.0	16.5	22.3	19.2
	18/04/11	Mon	E	1.4	35.2	50.9	43.8		42.8		50.2	24.0	27.0	30.8	34.0	20.8	19.3	23.6	30.5	26.7
	19/04/11	Tue	ESE	1.3	48.9	69.3	64.6		54.8		59.2	41.9	43.7	44.2	41.9	38.0	32.1	47.3	46.4	48.2
	20/04/11	Wed	E	1.3	47.9	71.8	63.3		56.8		58.3	40.0	42.9	45.4	37.3	39.1	32.8	34.3	46.3	49.1
	21/04/11	Thu	ESE	1.7	36.8	55.0	51.7		47.5		50.3	37.9	38.7	43.4	39.8	45.3	23.2	38.8	51.3	49.5
	22/04/11	Fri	E	1.8	41.6	54.6	50.8		50.4		54.7	41.3	42.2	43.5	44.8	39.3	28.8	31.5	41.4	39.0
	23/04/11	Sat	W	1.3	43.6	61.0	50.3		50.8		56.4	37.5	45.5	33.0	39.4	32.1	39.9	31.1	27.7	27.5
	26/04/11	Tue	ENE	1.8	26.6	50.2	46.9		40.3		47.6	28.6	31.8	29.9	29.8	24.6	18.0	22.5	22.0	22.0
	27/04/11	Wed	E	1.8	25.9	61.2	45.5		44.6		50.3	27.5	35.4	32.1	27.3	26.2	19.3	23.1	23.8	20.5
	05/05/11	Thu	ENE	1.7	27.4	50.6	44.0		53.2		60.0	32.3	40.7	35.7	46.9	30.8	28.3	31.7	25.8	25.8
07/05/11	Sat	ENE	2.3	38.8	63.9	50.0	66.6	66.6	33.3	50.1	32.7	57.7	30.8	45.4	31.3	27.4	19.2			
5	06/10/11	Thu	WSW	3.3	no data	8.8	8.0	14.4	5.5	7.1	6.6	127.8	126.7	5.6	4.6	4.7	13.1	9.4	6.6	10.8
6	24/10/11	Mon	SE	5.6	51.0	47.0	49.0	61.9	45.3	49.4	63.8	37.8	43.0	40.7	40.4	no data	44.9	29.7	31.3	23.7
	25/10/11	Tue	ESE	4.1	54.2	54.9	57.9	66.8	51.5	53.8	68.3	35.9	50.4	37.7	39.2		45.0	18.2	19.8	15.1
7	08/11/11	Tue	ESE	2.1	40.5	44.4	46.4	51.0	44.6	42.1	387.0	37.3	41.5	40.2	no data	no data	25.2	35.9	31.8	26.5
	09/11/11	Wed	ESE	2.3	41.4	48.8	50.5	52.3	47.3	38.9	78.1	36.2	48.8	35.0	36.3	32.9	30.3	27.5	26.4	19.6
	11/11/11	Fri	ESE	4.1	40.9	47.3	47.4	47.0	45.6	37.0	55.5	39.4	50.6	35.1	37.5	33.5	32.7	32.0	31.3	23.2
8	16/11/11	Wed	ESE	1.9	36.8	41.1	43.6	43.1	38.8	36.3	53.2	42.9	45.1	37.3	39.2	33.2	31.3	31.6	35.0	29.7
No. of exceedences					2	30	17	4	11	1	23	1	5	0	1	0	0	0	2	1

Notes: Average wind speed & direction were derived from Broughty Ferry Rd and Mains Loan monitoring sites.

Values shown in bold & red are exceedences of the daily mean objective for PM₁₀ (50ug/m³), values shown in orange are between 40 & 50 ug/m³ and indicate raised PM₁₀ concentrations.

Figure 2.36 Comparison of Dundee PM₁₀ Monitoring Sites and Urban Background Locations from 24/01/2011 to 01/02/2011

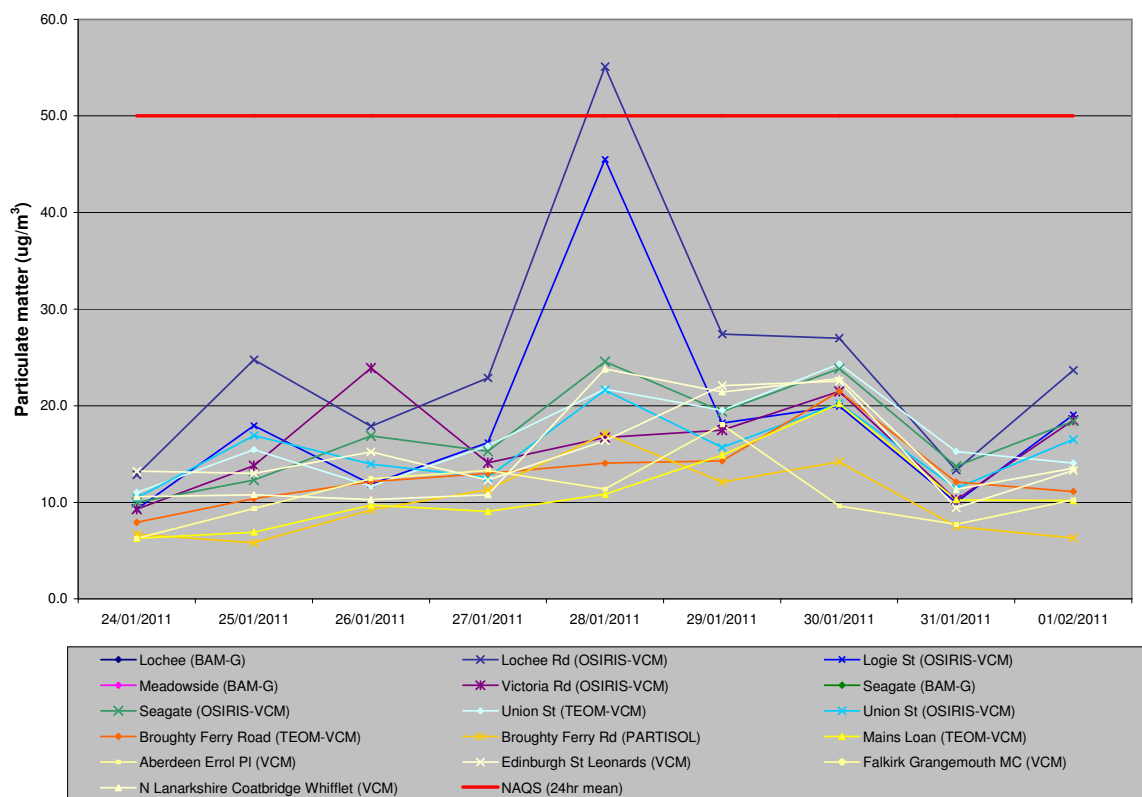


Figure 2.37 Comparison of Dundee PM₁₀ Monitoring Sites and Urban Background Locations from 14/02/2011 to 10/03/2011

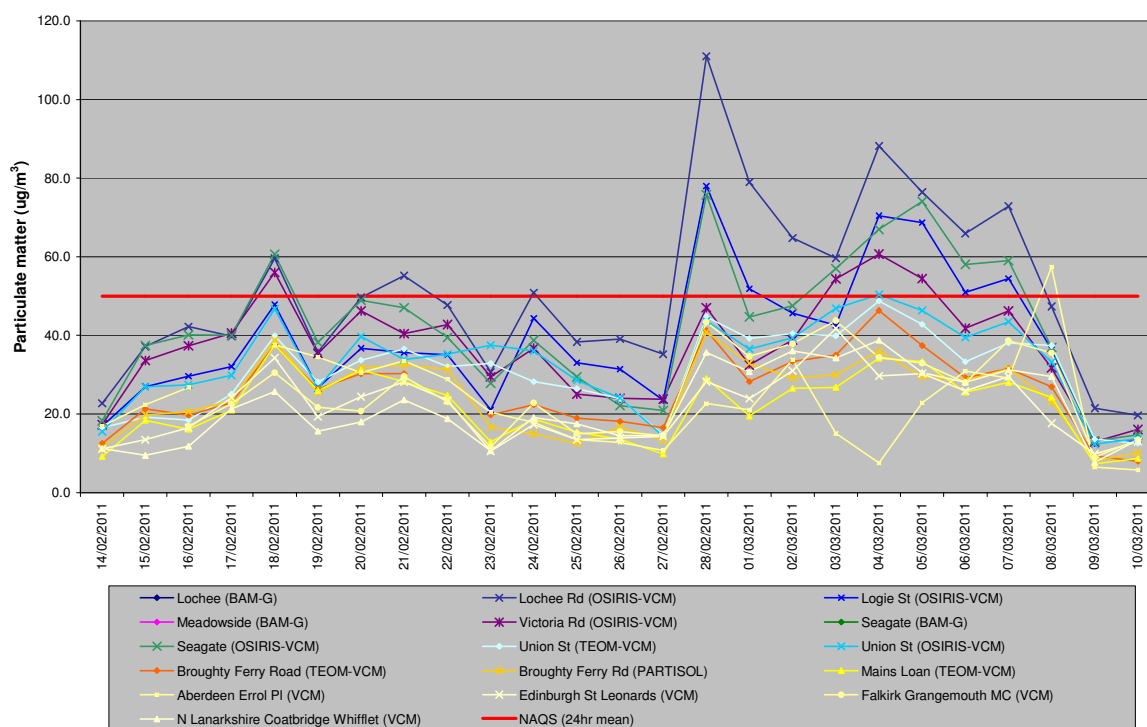


Figure 2.38 Comparison of Dundee PM₁₀ Monitoring Sites and Urban Background Locations from 13/03/2011 to 02/04/2011

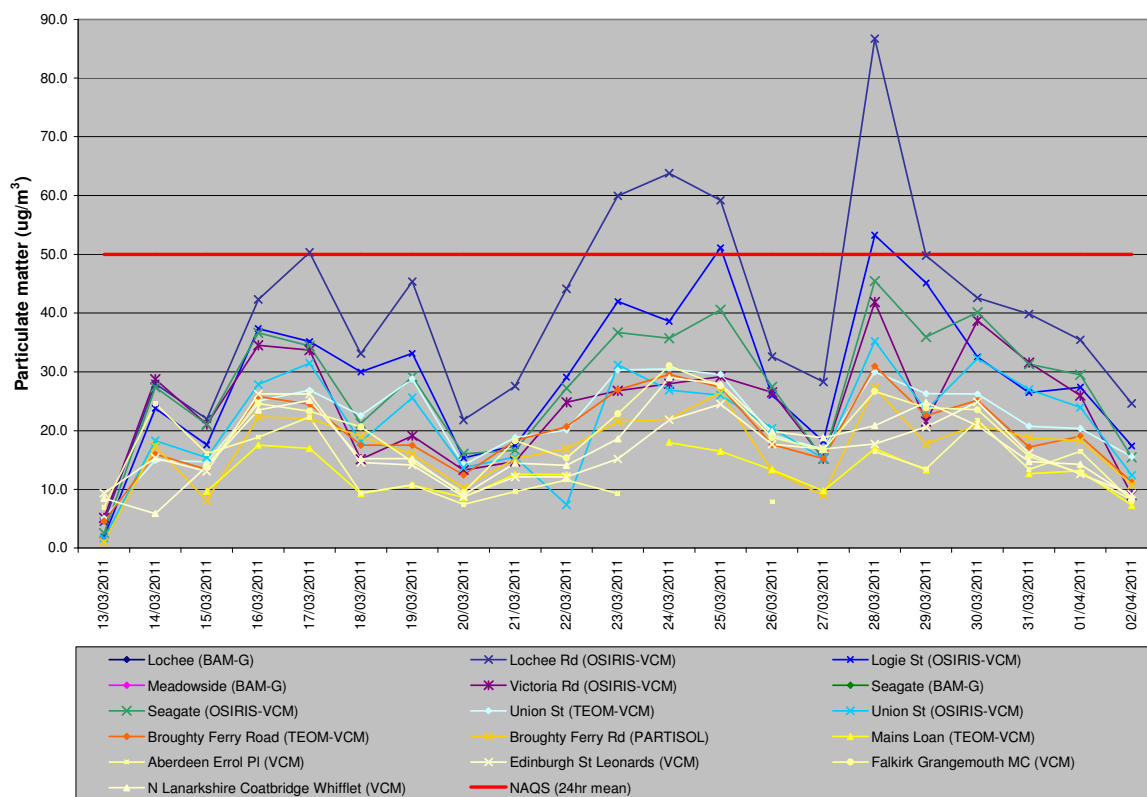


Figure 2.39 Comparison of Dundee PM₁₀ Monitoring Sites and Urban Background Locations from 06/04/2011 to 09/05/2011

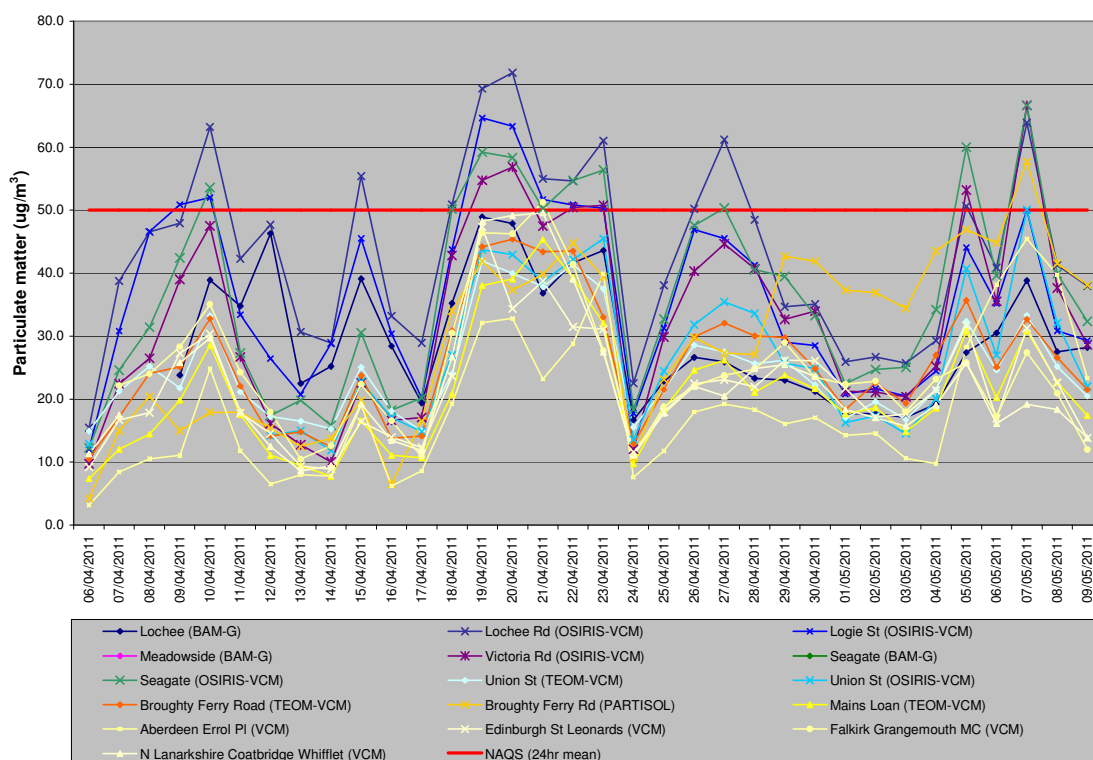


Figure 2.40 Comparison of Dundee PM₁₀ Monitoring Sites and Urban Background Locations from 25/09/2011 to 08/10/2011

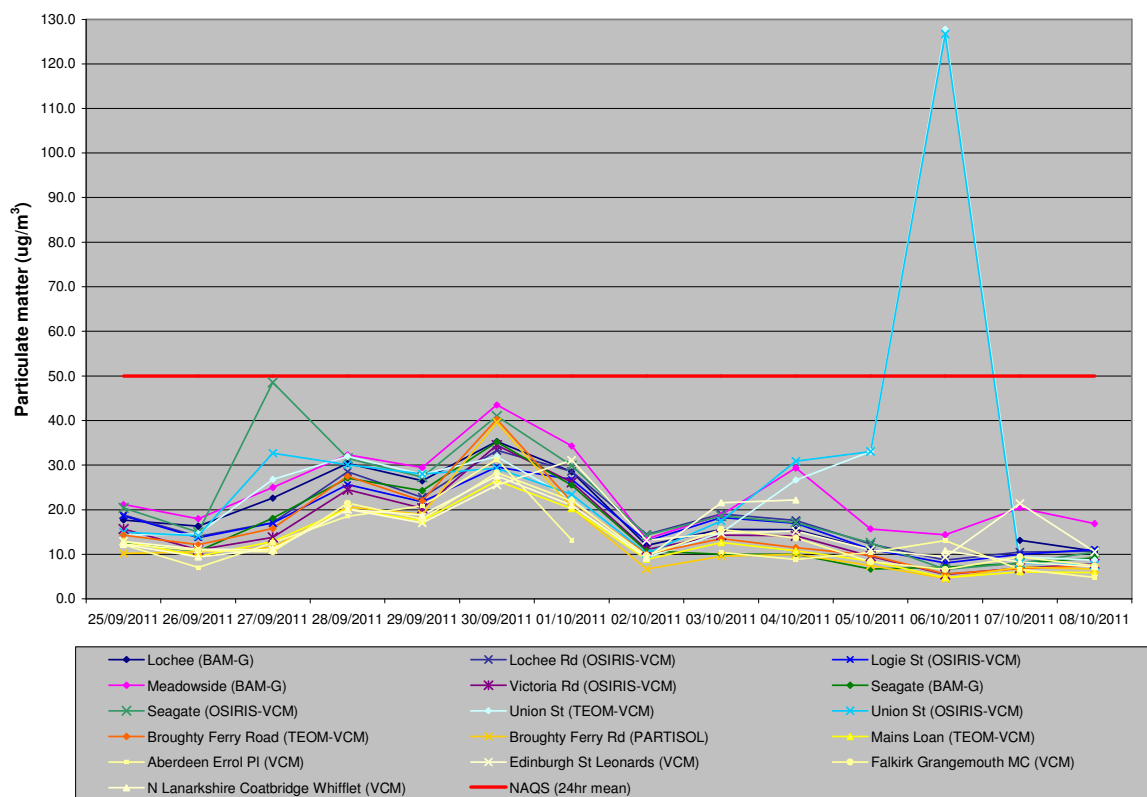
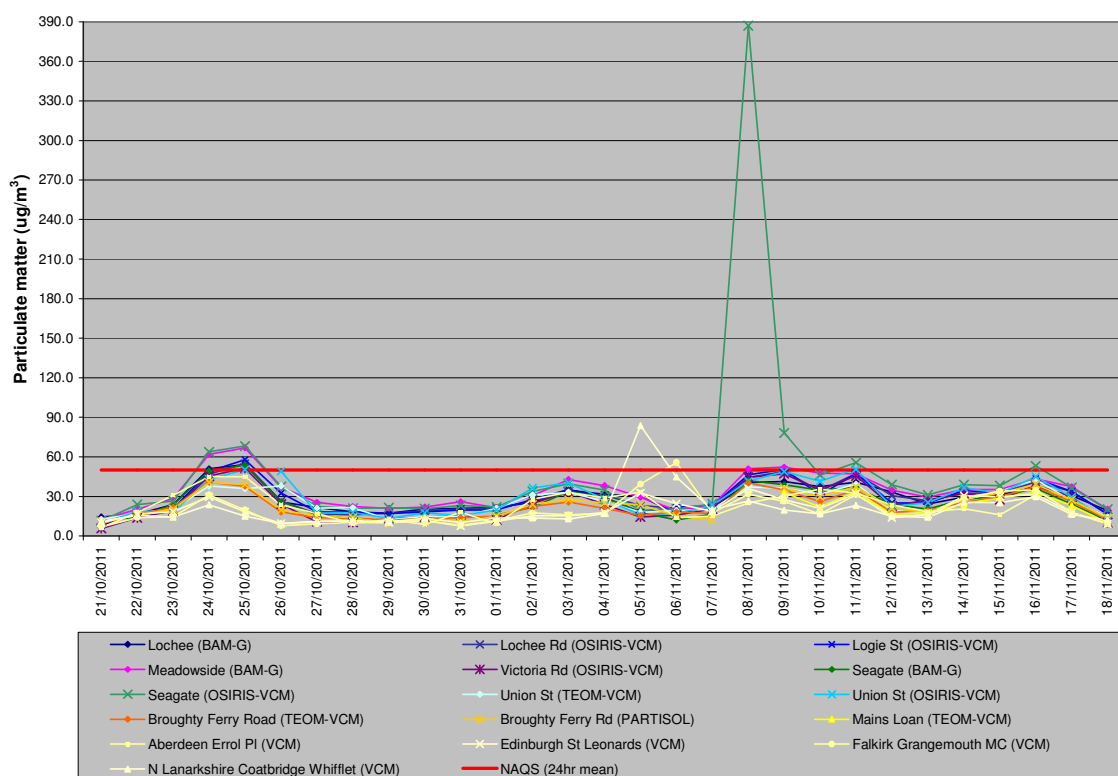


Figure 2.41 Comparison of Dundee PM₁₀ Monitoring Sites and Urban Background Locations from 21/10/2011 to 18/11/2011

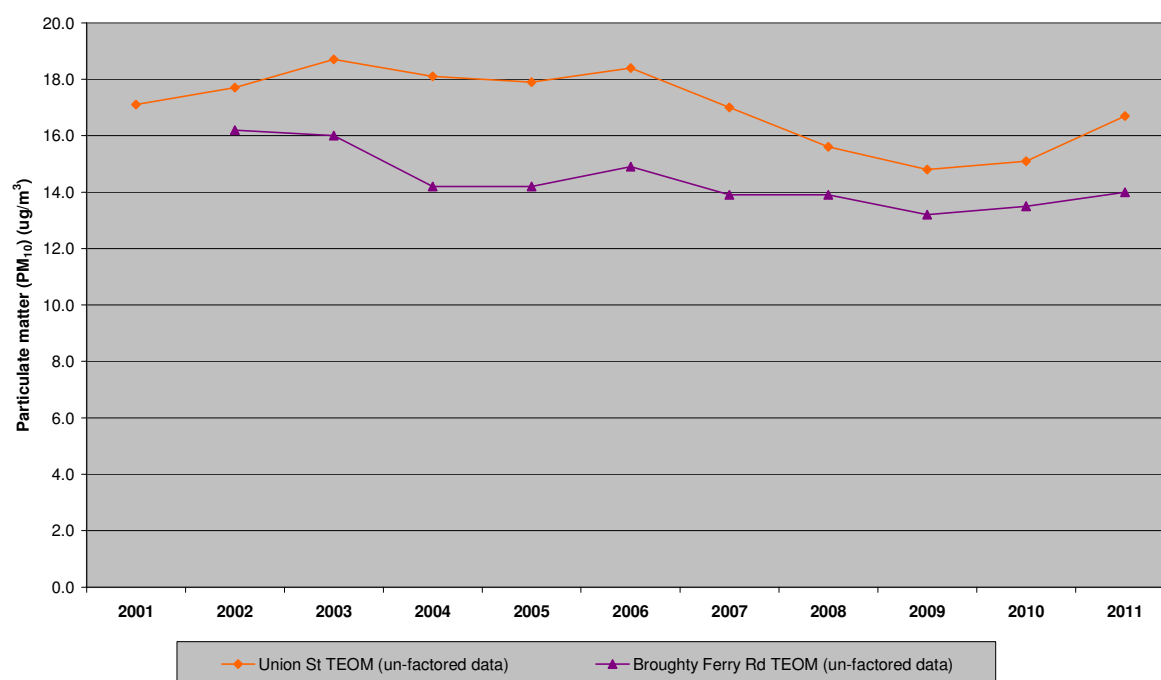


2.2.2.1 Trends in Annual Mean PM₁₀ Concentrations

A minimum of 5 years data is required to show a reliable trend. VCM adjusted concentrations are only available for the last 4 years, therefore the following examination of trends in PM₁₀ concentrations is based on either un-factored data or data adjusted by Dundee City Council's locally derived gravimetric factors (the data and derivation of local factors for earlier years have been reported in previous LAQM reports). Concentrations at roadside and kerbside sites are known to be affected by localised or short-term factors such as road works and traffic flow changes. Year on year fluctuations are also possible as a consequence of climatic effects and transboundary pollution episodes.

Trends in un-factored TEOM monitored concentrations between 2001 and 2011 are shown in **Figure 2.42** for the two long-term TEOM sites - Union Street (Roadside) and Broughty Ferry Road (Urban Industrial). A downward trend in PM₁₀ concentrations is evident at both sites between 2006 and 2009. Since then concentrations have risen slightly each year although both locations measured an increase in annual mean PM₁₀ between 2010 and 2011. The greater rise at Union Street may have been accounted for by road works.

Figure 2.42 Trend in Un-factored PM₁₀ Concentrations at Long Term TEOM Monitoring Sites



Trends in local-factored TEOM and Osiris monitored annual mean concentrations between 2006 and 2011 are shown in **Table 2.9** and **Figure 2.43**, along with results from the Partisol and the BAMs (gravimetric equivalent). Mains Loan and Broughty Ferry have remained relatively stable since 2006. Seagate Osiris shows a general upward trend. Victoria Road, Lochee Road and Logie Street showed a downward trend till 2009 but have increased since then. Union Street showed a downward trend till 2010 but increased in 2011. Road works from May to November in 2011 are thought to have contributed to the annual mean exceedence in Union Street.

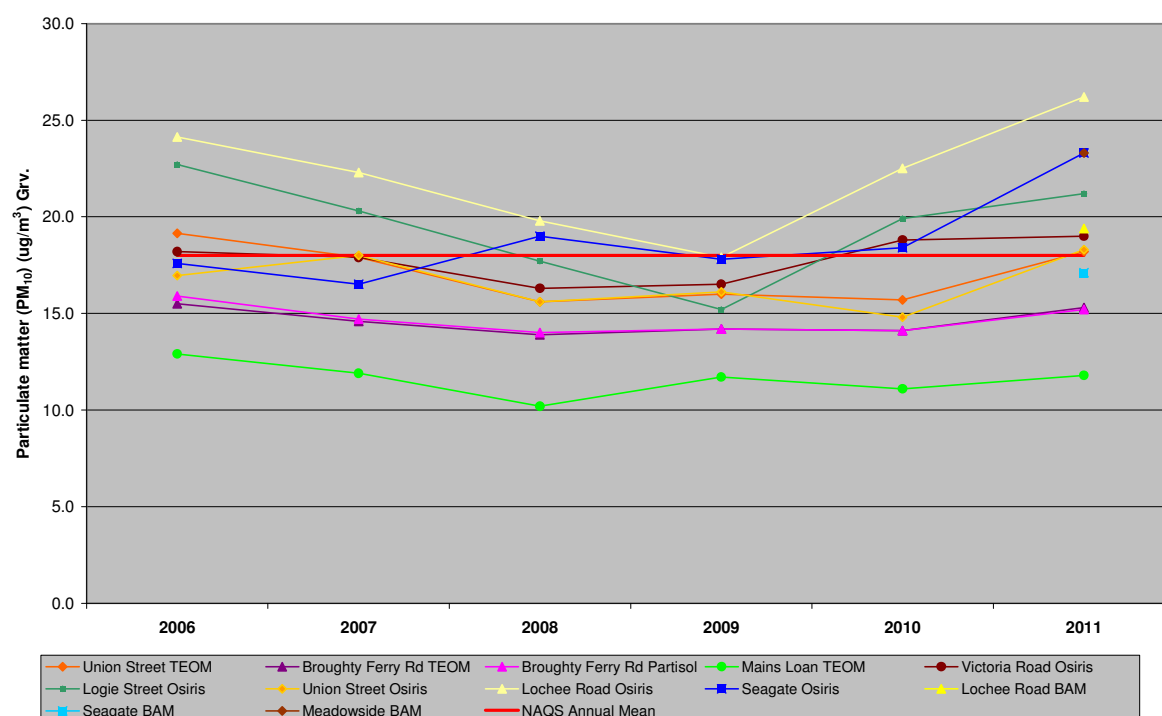
Table 2.9 Annual Mean PM₁₀ Concentrations 2006-2011 adjusted by local gravimetric factors and VCM method

Location/Monitor		2006	2007	2008	2009	2010	2011
Union Street TEOM	Local	19.1	17.9	15.6	16.0	15.7	18.2
	VCM	n/a	n/a	16.9	16.5	17.0	18.8
Broughty Ferry Rd TEOM	Local	15.5	14.6	13.9	14.2	14.1	15.3
	VCM	n/a	n/a	15.2	14.8	15.6	16.1
Broughty Ferry Rd Partisol	Grav.	15.9*	14.7	14.0	14.2	14.1	15.2
Mains Loan TEOM	Local	12.9*	11.9	10.2	11.7	11.1	11.8
	VCM	n/a	n/a	11.4	12.6	12.6	12.8
Victoria Road Osiris	Local	18.2	17.9	16.3	16.5	18.8	19.0
	VCM	n/a	n/a	17.6	17.1	21.0	19.5
Logie Street Osiris	Local	22.7*	20.3	17.7	15.2	19.9	21.2
	VCM	n/a	n/a	19.0	15.8	22.1	21.6
Union Street Osiris	Local	17.0	18.0	15.6	16.1	14.8	18.3
	VCM	n/a	n/a	16.9	16.6	16.8	18.9
Lochee Road Osiris	Local	24.1	22.3	19.8	17.9	22.5	26.2
	VCM	n/a	n/a	21.1	18.3	24.8	26.3
Seagate Osiris	Local	17.6	16.5	19.0	17.8*	18.4	23.3
	VCM	n/a	n/a	20.3	18.1*	20.5	23.6
Lochee Road BAM	Grav.	n/a	n/a	n/a	n/a	n/a	19.4*
Seagate BAM	Grav.	n/a	n/a	n/a	n/a	n/a	17.1*
Meadowside BAM	Grav.	n/a	n/a	n/a	n/a	n/a	23.3*

NB: Concentrations in bold are greater than the NAQS Annual mean (18ug/m³)

* denotes less than 75% data capture, mean has been annualised

Figure 2.43 Trends in Annual Mean PM₁₀ Concentrations 2006-2011 adjusted by local gravimetric factors



The 2011 PM₁₀ annual mean urban background concentration was generally in good agreement with the Scottish Government modelled background PM₁₀ concentrations published as (1km x 1km) maps⁶ in April 2012 (see **Table 2.10**).

Table 2.10 Comparison of Measured Background PM₁₀ Results for 2011 with Scottish Government Background Map Data.

Location	Grid Square	Measured Annual Mean PM ₁₀ (µg/m ³)	Scottish Government Mapped Concentration (µg/m ³)
Mains Loan (VCM)	340500:731500	12.8	12.6
Mains Loan (Local)		11.8	

2.2.2.2 Trends in Daily Mean PM₁₀ Concentrations

Trends in the number of exceedences of the daily mean local-factored TEOM and Osiris monitored concentrations between 2006 and 2011 are shown in **Table 2.11** and **Figure 2.44**, along with results from the Partisol and the BAMs (gravimetric equivalent). A decline in the number of exceedences of the daily mean PM₁₀ objective is evident across most of the monitoring locations between 2006 and 2009 but from then the number of exceedences increased at Logie Street and Lochee Road. Logie Street and Lochee Road are located on the north-west arterial route. Numbers of exceedences at Seagate have remained relatively level until a large rise in 2011. Seagate Osiris is situated on the main bus corridor through the city centre. There was a doubling of the number of exceedences recorded in Seagate and Lochee Road between 2010 and 2011.

Table 2.11 Number of Exceedences of PM₁₀ Daily Mean Objective 2010 (50µg/m³- 7 allowed) 2006-2011 adjusted by local gravimetric factors and VCM method

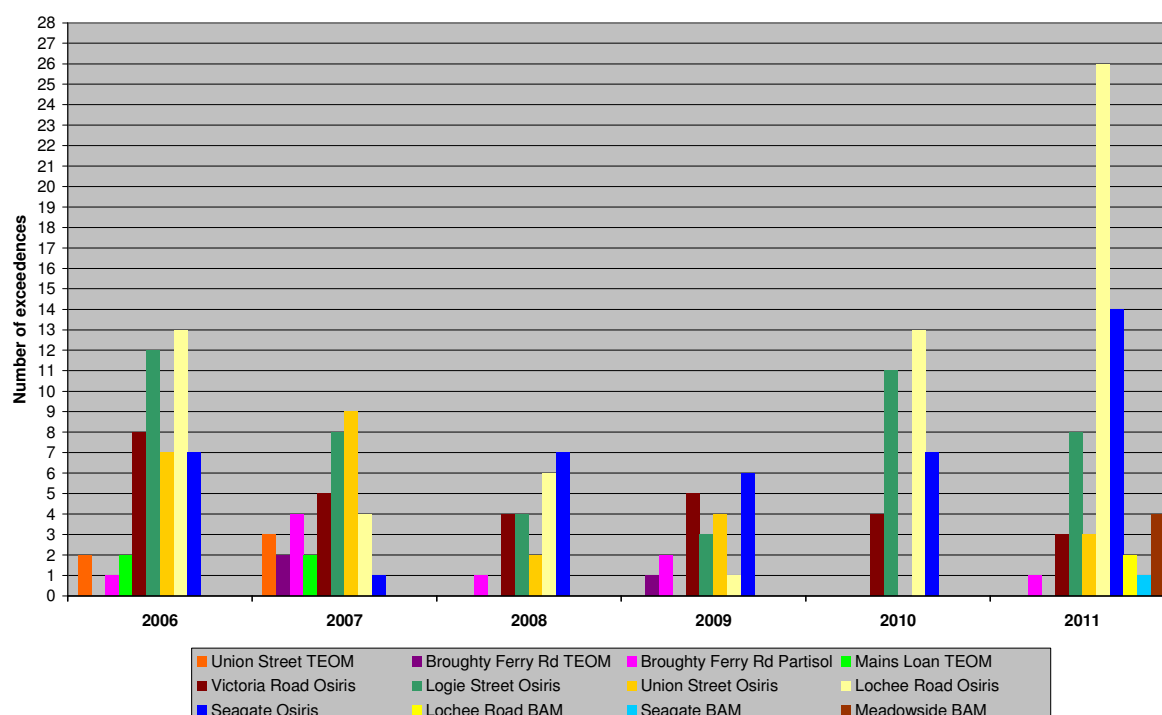
Location/Monitor		2006	2007	2008	2009	2010	2011
Union Street TEOM	Local	2	3	0	0	0	1
	VCM	n/a	n/a	0	2	0	1
Broughty Ferry Rd TEOM	Local	0	2	0	1	0	0
	VCM	n/a	n/a	0	2	0	0
Broughty Ferry Rd Partisol	Grav.	1*	4	1	2	0	1
Mains Loan TEOM	Local	2*	2	0	0	0	0
	VCM	n/a	n/a	0	0	0	0
Victoria Road Osiris	Local	8	5	4	5	4	3
	VCM	n/a	n/a	7	6	7	11
Logie Street Osiris	Local	12*	8	4	3	11	8
	VCM	n/a	n/a	9	0	12	17
Union Street Osiris	Local	7	9	2	4	0	3
	VCM	n/a	n/a	4	6	0	5
Lochee Road Osiris	Local	13	4	6	1	13	26
	VCM	n/a	n/a	10	4	16	30
Seagate Osiris	Local	7	1	7	6*	7	14
	VCM	n/a	n/a	12	8*	9	23
Lochee Road BAM	Grav.	n/a	n/a	n/a	n/a	n/a	2*
Seagate BAM	Grav.	n/a	n/a	n/a	n/a	n/a	1*
Meadowside BAM	Grav.	n/a	n/a	n/a	n/a	n/a	4*

NB: 'bold' means the number of 24hr averages greater than 50µg/m³ has breached that allowed (i.e. 7)

* denotes less than 75% data capture

⁶ http://www.scottishairquality.co.uk/maps.php?n_action=data

Figure 2.44 Trends in Number of Exceedences of PM₁₀ Daily Mean Objective 2010 (50µg/m³, 7 allowed) 2006-2011 adjusted by local gravimetric factors



2.2.2.3 Trends in 98.08th Percentile PM₁₀ Concentrations

In certain circumstances, where the measured data capture is less than 90%, it may be more appropriate to express short-term concentrations as percentile values that approximate to the permitted number of exceedences. Generally, if the value of the 98.08th percentile is greater than 50 µg/m³ then it is likely that the allowed number of daily mean exceedences will have been breached. Trends in the 98.08th Percentile of the daily mean local-factored TEOM and Osiris monitored concentrations between 2006 and 2011 are shown in **Table 2.12** and **Figure 2.45**, along with results from the Partisol and the BAMs (gravimetric equivalent). PM₁₀ concentrations have remained relatively stable at the background site (Mains Loan) and the urban industrial site (Broughty Ferry Road). Roadside and kerbside sites show greater year to year fluctuations with a general downward trend evident in Logie Street and Victoria Road. The downward trend at Lochee Road reversed in 2009 since then there has been a significant increase. The trend in Seagate was stable until a significant increase in 2011.

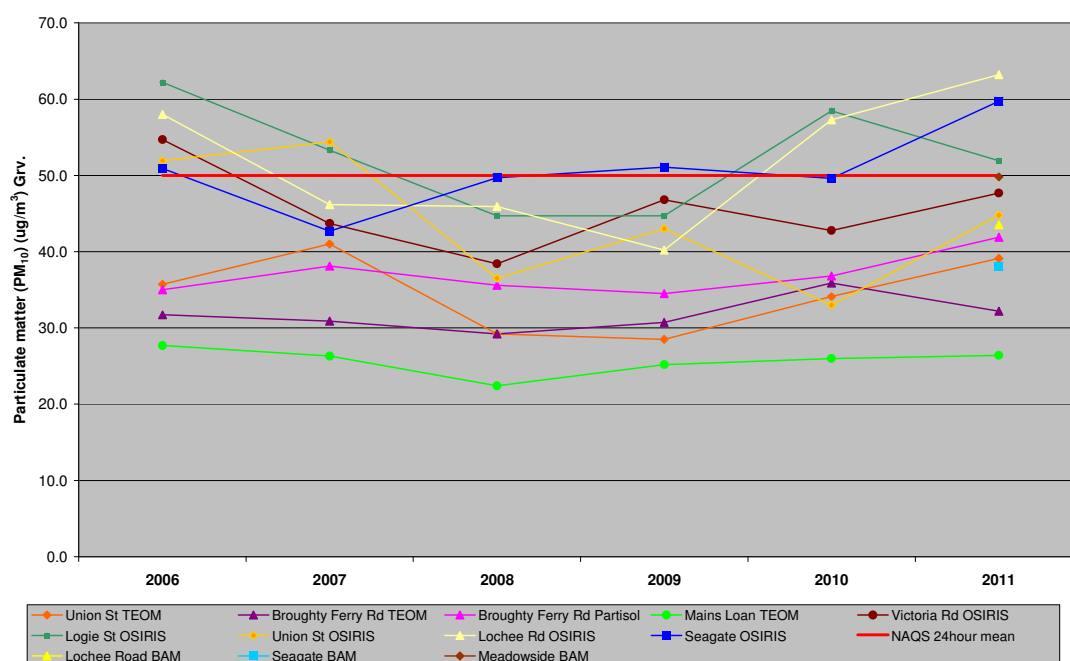
Table 2.12 98.08th Percentile of PM₁₀ Daily Mean Objective 2010 (50µg/m³) 2006-2011 adjusted by local gravimetric factors and VCM method

Location/Monitor		2006	2007	2008	2009	2010	2011
Union St TEOM	Local	35.7	41.0	29.2	28.5	34.1	39.1
	VCM	n/a	n/a	40.3	33.4	37.7	42.8
Broughty Ferry Rd TEOM	Local	31.7	30.9	29.2	30.7	35.9	32.2
	VCM	n/a	n/a	37.8	35.3	39.8	40.3
Broughty Ferry Rd Partisol	Grav.	35.0*	38.1	35.6	34.5	36.8	41.9
Mains Loan TEOM	Local	27.7*	26.3	22.4	25.2	26.0	26.4
	VCM	n/a	n/a	30.7	31.3	30.0	33.4
Victoria Rd OSIRIS	Local	54.7	43.7	38.4	46.8	42.8	47.7
	VCM	n/a	n/a	50.4	47.7	49.8	53.7
Logie St OSIRIS	Local	62.2*	53.3	44.7	44.7	58.5	51.9
	VCM	n/a	n/a	54.9	38.7	62.7	53.8
Union St OSIRIS	Local	51.9	54.4	36.5	43.0	33.0	44.8
	VCM	n/a	n/a	47.0	47.9	38.8	48.0
Lochee Rd OSIRIS	Local	58.0	46.2	45.9	40.2	57.3	63.2
	VCM	n/a	n/a	57.9	44.0	62.5	70.4
Seagate OSIRIS	Local	50.9	42.7	49.7	51.1*	49.6	59.7
	VCM	n/a	n/a	56.6	53.5*	52.7	65.0
Lochee Road BAM	Grav.	n/a	n/a	n/a	n/a	n/a	43.5*
Seagate BAM	Grav.	n/a	n/a	n/a	n/a	n/a	38.1*
Meadowside BAM	Grav.	n/a	n/a	n/a	n/a	n/a	49.8*

NB: Concentrations in bold are greater than the NAQS 24hour mean (50µg/m³)

* denotes less than 75% data capture

Figure 2.45 Trends in 98.08th Percentile of PM₁₀ Daily Mean Objective 2010 (50µg/m³) 2006-2011 adjusted by local gravimetric factors



2.2.3 Sulphur Dioxide

Dundee City Council measures SO₂ at one location - at Broughty Ferry Road. The monitor is located close to residential receptors located downwind of an urban industrial facility and the port. The UV fluorescence analyser is operated under similar protocols to the AURN stations and the unit is audited twice yearly by AEA. Data are ratified with reference to the Technical Guidance (LAQM.TG09).

Results for 2011 are shown in **Table 2.13** below, along with the results for previous years. Concentrations of SO₂ are very low and all the objectives were met. The number of exceedences of each objective is given alongside the relevant percentile value.

Table 2.13 Results of SO₂ Automatic Monitoring at Broughty Ferry Road: Comparison with Objectives

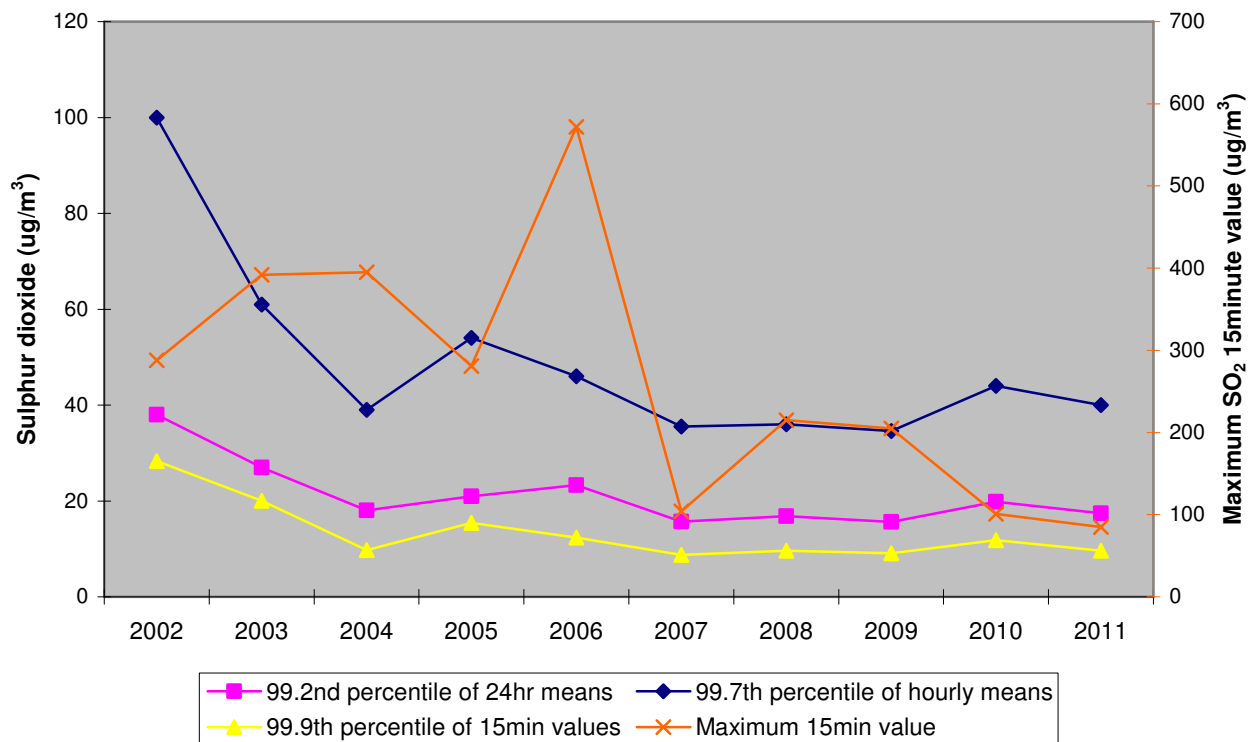
NAQS Objective		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
daily average	No. of exceedences (>125ug/m ³)	0	0	0	0	0	0	0	0	0	0
	Max (ug/m ³)	69.7	53.7	33.3	54	50.1	19.6	24.5	17.4	27.4	11.0
	99.2 nd percentile (ug/m ³)	37.6	27.2	18.3	21.3	23.3	15.7	16.8	15.6	19.8	17.4
	data capture %	92.1	97.3	100	94.8	96.2	99.7	97.5	93.4	96.4	82.7
hourly average	No. of exceedences (>350ug/m ³)	0	0	0	0	0	0	0	0	0	0
	Max (ug/m ³)	208	267	294	235	277.5	68.8	137.8	119.8	92.3	66.5
	99.7 th percentile (ug/m ³)	100	61	39	54	46	36	36	35	44	40
	data capture %	92	97.5	100	95	96.6	99.6	97.5	93.4	96.5	83
15min average	No. of exceedences (>266ug/m ³)	1	6	5	2	5	0	0	0	0	0
	Max (ug/m ³)	288	392	395	281	572	104	215	205	101	85
	99.9 th percentile (ug/m ³)	165	117	57	90	72	51	56	53	69	56
	data capture %	90.4	95.4	97.9	93	94.5	97.5	95.6	91.5	94.5	81.3

*Data for all years has been fully ratified. Data capture percentages are for a full calendar year.

Exceedences are highlighted in bold. The monitoring station is located within an AQMA for NO₂ and PM₁₀ (annual means) only.

Figure 2.46 shows the trend in maximum (15min) SO₂ concentrations and each of the relevant percentiles for each of the SO₂ objectives, i.e. 99.9th for 15min, 99.7th for hourly and 99.2nd for 24-hour means (see **Table 2.13** for a description of each of the objectives). This shows an overall decline in SO₂ concentrations between 2002 and 2011, but with a levelling off since 2006. This is largely consistent with the introduction of lower-sulphur fuel (required by regulations since 1st January 2003) at the nearby upwind industrial facility (bitumen refinery). The last exceedences of the 15min objective were recorded in 2006, but in total these were well below the 35 allowed in any calendar year. These exceedences were investigated previously and were associated with certain shipping activities/movements within the port when the wind was from the pollution source towards the monitoring station.

Figure 2.46 Trends in Maximum (15min) SO₂ Concentrations and Relevant Percentiles from 2002 to 2011



Comparison of the 2011 wind rose (**Figure 2.47**) and corresponding SO₂ pollution rose (**Figure 2.48**) for the measurements recorded at Broughty Ferry Road monitoring station shows that, despite the majority of the winds being westerly, the main source of SO₂ is borne on winds from the west southwest and southwest. The fact that these winds are comparatively light further suggests that the source of the pollution is local and probably emanating from the nearby industrial facility.

Figure 2.47 Wind Rose for Broughty Ferry Road Monitoring Station 2011

Wind Rose RATIFIED Broughty Ferry Road 01/01/2011 01:00-31/12/2011 24:00

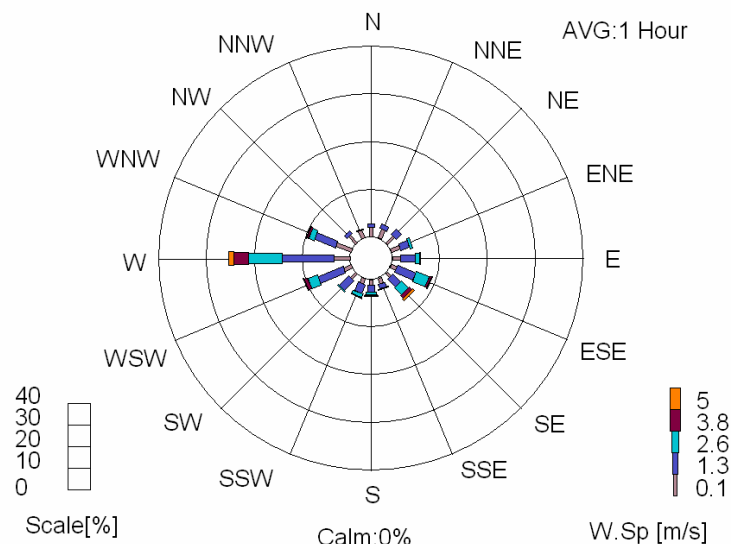
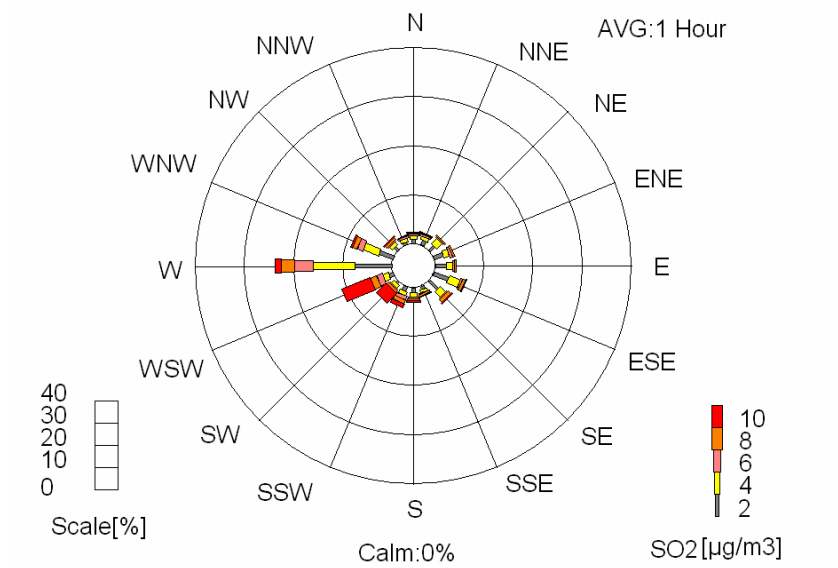


Figure 2.48 Pollution Rose for Broughty Ferry Road Monitoring Station 2011

Pollution Rose RATIFIED Broughty Ferry Road 01/01/2011 01:00-31/12/2011



2.2.4 Summary of Compliance with AQS Objectives

Dundee City Council has measured concentrations of NO₂ above the annual mean objective at relevant locations within the AQMA, previously declared for NO₂ and PM₁₀ annual mean (i.e. the whole council area). However, uncertainties associated with the distance calculator tool used to estimate NO₂ concentrations at façade suggest that the number of locations where the objective is breached at façade will exceed the number estimated (7).

Dundee City Council has measured concentrations of NO₂ above the 1-hour objective at one location (Lochee Road) for three consecutive years. This is thought to have occurred as a result of traffic congestion caused by the impact of the severe winter weather on the road network in 2009 and 2010. The winter weather was less severe in 2011 and the number of exceedences was still greater than the 18 allowed (43). In view of the ongoing exceedences of the hourly NO₂ objective at Lochee Road, and the advice of the Scottish Government's consultants⁷, it is considered necessary to amend the current AQMA order.

PM₁₀ objectives for 2004 are being met at all locations within the city, however Dundee City Council has measured concentrations of PM₁₀ above the 2010 annual mean at Osiris units (Lochee Road, Logie Street, Victoria Road and Seagate), Union Street (TEOM & Osiris) and at two of the new BAMs (Lochee Road and Meadowside). The new BAMs had low data capture in 2011 and the results have been annualised.

Only the kerbside Osiris units recorded more than 7 exceedences of the 24-hour objective. Osiris units are indicative monitors and have a tendency to over-estimate the number of exceedences. The council installed reference equivalent PM₁₀ analysers (BAMs) in Lochee Road, Seagate and at the Victoria Rd / Meadowside junction in 2011. The data capture at these monitors was low and the number of exceedences recorded did not exceed the 7 allowed but the 98.08th percentile was close to 50 µg/m³ at Meadowside. The need to amend the AQMA order in relation to the daily mean will be reviewed as more data becomes available.

New monitoring data for 2011 show all the objectives for SO₂ are being achieved.

⁷ Progress Report Appraisal Report PR-648

3 Road Traffic Sources

This section deals with any changes in the Local Authority area that may affect air quality. It is only necessary to consider locations which:

- have not been assessed during the earlier rounds,
- have experienced a significant change in traffic flows
- have a new development, or
- have new exposure that has not been assessed previously.

Updated road traffic data obtained from Dundee City Council Transport Division and the Department for Transport⁸ are shown in **Appendix F**. As mentioned in Section 2.1 “Road Traffic Data” of the 2009 Updating and Screening Assessment, additional 2007 peak hour counts used to update the council's Paramics traffic model remained to be reviewed. All road traffic data was screened and compared to data considered in previous rounds of review and assessment. The remaining 75 traffic counts were then assessed according to the Updating and Screening Assessment criteria to determine whether any DMRB⁹ screening modelling needed to be undertaken. The assessments are shown in **Appendix F** and outcomes of these DMRB assessments and verification exercise are shown in **Appendix G**. The DMRB assessments predicted no exceedences of any of the air quality objectives. Consideration of these outcomes has been taken into account in the following sections.

3.1 Narrow Congested Streets with Residential Properties Close to the Kerb

These are streets where buildings on either side reduce dispersion of ground-level pollutants and there is slow moving traffic that is frequently stopping and starting owing to pedestrian crossings, parked vehicles etc. throughout much of the day (not just during rush hours).

No new/newly identified congested streets which meet the general characteristics set out in the guidance i.e. traffic flows above 5,000 vehicles per day, frequent stop-start flows, average speed less than 25 kph, and residential properties within 2m of the kerb have been identified. There are existing streets, with similar criteria within the Dundee City AQMA, such as Seagate, Union Street, Commercial Street, Crichton Street, Nethergate, Victoria Street, Meadowside, Albert Street and Dock Street, but these are within known areas of exceedence and have been previously assessed.

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

⁸ <http://www.dft.gov.uk/traffic-counts/cp.php?la=Dundee+City#countpointstable>

⁹ Design Manual for Roads and Bridges Version 1.03c (July 2007)

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

The main areas where it is likely that the public may spend one hour or more close to traffic are streets with many shops and streets with outdoor cafes and bars, namely:

- The city centre, a significant proportion of which is pedestrianised;
- Perth Road
- High Street, Lochee; and,
- Brook Street, Broughty Ferry.

These areas have been monitored for nitrogen dioxide using diffusion tubes and the annual mean concentrations have been found to be below $60\mu\text{g}/\text{m}^3$ indicating that it is unlikely that the short-term objective will be exceeded. Since the last USA, there has been an increase in the number of pavement cafes and seating areas, however there are no new/newly identified busy streets where people may spend 1 hour or more close to traffic.

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

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

There are some streets where traffic flows are not necessarily high (fewer than 20,000 vehicles per day) but there is an unusually high proportion of buses and/or HGVs. An unusually high proportion can be taken to be greater than 20%. The assessment of these streets should consider both NO_2 and PM_{10} .

Traffic data assessed for the Updating and Screening Assessment show no newly identified roads with high flows of buses and heavy goods vehicles >20%. Previous traffic counts indicated the following streets have heavy goods vehicles >20%: Meadowside, High Street, Nethergate, Union Street, Whitehall Crescent. Previous assessments, using traffic counts prior to 2006, also indicate Seagate, St Andrews Street, Whitehall Street, Dock Street, Commercial Street and King Street have >20%. These are all within known areas of exceedence and have been previously assessed.

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

3.4 Junctions (Including busy roads and junctions in Scotland)

Concentrations are usually higher close to junctions owing to the combined impact of traffic emissions from more than one road and to the higher emissions due to stop start driving. The assessment of junctions considers both NO₂ and PM₁₀. It is only necessary to include busy roads or junctions not considered in previous Review and Assessment reports, and/or where there has been a significant increase (>10% AADT) in traffic flows since the last assessment, and/or where there is new relevant exposure. Generally in terms of NO₂ a busy junction can be taken to be one with more than 10,000 vehicles per day. Due to the stricter PM₁₀ objective in Scotland the following criteria are also used to define “busy”:

- Roads and/or junctions with more than **5,000** vehicles per day (AADT), where the annual mean PM₁₀ background in 2010 is expected to be **above 15 µg/m³**.
- Roads and/or junctions with more than **10,000** vehicles per day (AADT), where the annual mean PM₁₀ background in 2010 is expected to be **below 15 µg/m³**.

The Scottish Government predicted 2010 PM₁₀ background concentrations (April 2012 release) for Dundee did not include any 1km grid squares with a value greater than 15 µg/m³.

Screening of the new traffic data, presented in **Appendix F**, identified some areas meeting the criteria which had not been previously assessed and some that had experienced an increase in traffic flows of greater than 10%. The DMRB screening model was used to predict the annual mean NO₂ and PM₁₀ and the number of 24 hour exceedences for PM₁₀. The results are presented in **Appendix G**. No exceedences of the air quality objectives were predicted.

In addition, alterations to the Kingsway / Myrekirk Road roundabout, which forms part of the trunk road network through the city, are included as part of a new superstore development. The air quality assessment that accompanied the proposals predicted a new exceedence of the PM₁₀ annual mean standard as a result of the development¹⁰. A condition requiring post development pollution monitoring has been applied to the planning consent. A strategic transport project to improve access to the port may result in an increase in HGVs entering the port from the east. The eastern port access is close to the existing hotspot at Stannergate junction. Additional monitoring has been deployed in both these areas during 2012.

As part of the Central Waterfront Development Masterplan (2001-2031), (described previously in the Progress Report 2005), the council’s leisure facility located on the South Marketgait is to be relocated to the East Marketgait. The traffic impact assessment concluded that the redistribution of traffic to the new facility would not have a significant impact on the overall operation of the road network. Subsequent work by the transport consultant for the project determined that the increase in daily traffic flows on road links leading to the development would not exceed 10% (see **Appendix H**).

Dundee City Council has assessed new/newly identified junctions meeting the criteria in Section A.4 of Box 5.3 in LAQM.TG(09), and concluded that it will not be necessary to proceed to a Detailed Assessment.

¹⁰ <http://idoxwam.dundee.gov.uk/WAM133/doc/Report-345111.PDF?extension=.PDF&id=345111&location=VOLUME2&contentType=application/pdf&pageCount=1>

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

The assessment of new roads considers both NO₂ and PM₁₀ where traffic flows exceed 10,000 vehicles per day and there is relevant exposure within 10m.

Since the last USA a new link road has been constructed as part of the Whitfield Regeneration Programme. Traffic on this road is not expected to exceed 5,000 vehicles per day and hence no further assessment is required.

New junctions and roads have been constructed and others are proposed as part of the Central Waterfront Development Masterplan 2001 – 2031. There are currently no relevant receptors near the locations of the recent network changes. The need for review and assessments of these roads and junctions will be examined in subsequent reports as necessary.

There are no other newly constructed roads since the previous USA, other than small roads serving new developments. These roads have flows significantly below 10,000 vehicles per day.

Dundee City Council confirms that there are no new/proposed roads that meet this criterion.

3.6 Roads with Significantly Changed Traffic Flows

The assessment of roads with more than 10,000 vehicles per day that have experienced “large” increases in traffic considers both NO₂ and PM₁₀. A “large” increase in this instance is taken to be more than a 25% increase in traffic flow. It is only necessary to consider any roads with significantly changed traffic flows that have not already been considered in parts **3.1 to 3.5**. In Scotland, owing to the stricter PM₁₀ objective **Section 3.4** considers increases in traffic flows of 10% or greater and therefore there is no need to proceed further with this part.

Dundee City Council has assessed new/newly identified roads with significantly changed traffic flows, and concluded that it will not be necessary to proceed to a Detailed Assessment.

3.7 Bus and Coach Stations

The assessment considers both the hourly and annual mean standards for nitrogen dioxide at bus stations with >2,500 bus movements per day, where the travelling public are not enclosed and where residential premises are closer than 10m to the buses. The assessment criteria have been relaxed in recent years from a previous threshold of >1,000 movements per day. There are no new bus stations since the last review and although there are residences within 10m of the Seagate bus station the daily bus movements from the existing local bus station are estimated to be only 698¹¹.

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

¹¹ Personal Communications from Martin Gallagher (Stagecoach) 2012-05-22 and Mike Dean (CityLink) 2012-05-23

4 Other Transport Sources

4.1 Airports

The assessment for airports considers nitrogen dioxide. If there are no airports that meet the criteria, there is no need to proceed further with the assessment.

Although there is relevant exposure within 1000m of the Dundee Airport terminal, in 2010/2011 passenger figures were 70,089 and 60,259 in 2011/12¹², and there were no freight only flights. This is below the threshold for assessment of 10 million passengers per annum or freight equivalent.

Dundee City Council confirms that there are no airports in the Local Authority area that meet the criteria for assessment.

4.2 Railways (Diesel and Steam Trains)

The assessment for stationary trains considers sulphur dioxide, while the assessment for moving diesel trains considers nitrogen dioxide. If there are no railways carrying diesel or steam trains in the Local Authority area, there is no need to proceed further with this part.

4.2.1 Stationary Trains

The only site in Dundee where trains may be stationary for more than 15 minutes is Dundee Railway Station. The station has an enclosed passenger waiting area. There are no receptors within 15 metres of the main station. There are no sidings within the city where trains are routinely stationary for periods in excess of 15 minutes.

There is also a station in Broughty Ferry where there is potential exposure as there is no indoor waiting area at the station. However, very few trains stop at the station and these trains are not stationary for periods in excess of 15 minutes.

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

¹² Personal Communication from Dundee Airport Manager 2012-05-31

4.2.2 Moving Trains

The requirement to assess nitrogen dioxide emissions from moving diesel locomotives was introduced in 2009. The LAQM.TG(09) guidance lists the heavily trafficked rail lines that require to be assessed in Table 5.1. None of these pass through Dundee.

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

4.3 Ports (Shipping)

The assessment for shipping considers sulphur dioxide emissions (for the 15 minute standard) from busy ports, where the shipping movements range from 5,000 to 15,000 per year and where there is relevant exposure within 250 metres of the berths. If there are no ports or shipping, there is no need to proceed further with this part. There are both residential and other outdoor relevant exposure locations within 250 metres (in some cases as close as ~130m). However, the estimated number of shipping movements for Dundee Port was only 632 in 2011¹³.

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

¹³ Personal Communication from Dr. Derek McGlashan Environment and Energy Manager - Forth Ports Limited 2012-04-09

5 Industrial Sources

5.1 Industrial Installations

Industrial sources are controlled by the Scottish Environment Protection Agency (SEPA) under the Pollution Prevention and Control Regulations. Local authorities also have controls over smaller industrial and commercial sources, largely through the Clean Air Act and its associated control of the stack heights. As a result of these controls, there are relatively few sources that may be relevant to local authorities under the Local Air Quality Management (LAQM) regime. The majority of these sources will have been addressed during previous rounds of Review and Assessment and the focus is, therefore, on new installations and those with significantly changed emissions or new exposure.

The technical guidance (LAQM.TG(09)) states that the assessment of industrial installations should consider all of the regulated pollutants, although those most likely to require further work are sulphur dioxide, NO₂, PM₁₀ and benzene. A list of industrial processes in the city which are regulated by the Scottish Environmental Protection Agency (SEPA) is provided in **Appendix I**. This Appendix also includes a screening assessment of all the SEPA regulated processes. Those highlighted thus “*” in the table and the notes are discussed in the relevant sections below.

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

SEPA were consulted in January 2012 and confirmed that there were no new or proposed installations since the last USA. As reported in the Progress Report 2011, an existing Part B process had received a variation to its permit to allow the use of a waste wood fuelled heating system. An air quality assessment accompanied the application and no exceedences of the NAQS objectives were predicted.

In the last USA it was reported that a new clinical waste treatment process had applied to SEPA for a variation to their permit and the council had requested that an air quality assessment be included with the application. SEPA have advised that the application for the variation was withdrawn.

Dundee City Council has assessed new/proposed industrial installations, and concluded that it will not be necessary to proceed to a Detailed Assessment.

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

SEPA were consulted in January 2012 and confirmed there were no installations with substantially increased emissions or new relevant exposure since the last USA.

In the previous USA it was reported that new residential exposure had been introduced closer to an industrial process in Kemback Street. As described previously, this process did not require to be assessed but a screening assessment was carried out using available emissions data from SEPA for CO, NO_x and SO₂. The estimated emissions were well below the thresholds requiring further action. Since then SEPA have provided emissions data for total particulates¹⁴. All the total particulates were assumed to be PM₁₀ giving an emission rate of 0.00833 grams per second (0.03kg/hr). This was combined with activity data obtained previously (08:00 to 14:00, 5 days a week for 52 weeks) to give an estimated annual emission rate of 0.5 tonnes per annum. This was well below the maximum emission rate of 10.7 tonnes per annum obtained from the Industrial Emissions Calculator (v.2) (Tab "Annual PM₁₀ combustion Fig 8.5" >100 degrees centigrade) using the following inputs:

Diameter - 1.8m

Stack Height - 32m

Building Height - 20m

2010 Background (including roadside contribution)¹⁵ - 16µg/m³

Dundee City Council has assessed industrial installations with new relevant exposure in their vicinity, and concluded that it will not be necessary to proceed to a Detailed Assessment.

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

SEPA were consulted in January 2012 and confirmed there were no new or significantly changed installations since the last USA.

In the previous USA, an industrial process in Balgray Street had been identified as having been re-classified. It was previously listed as a coating / lithographic process and, according to Annex 2 Appendix E of LAQM.TG(03), was not a process likely to require review and assessment and had not been previously assessed. The operators applied to SEPA for a substantial variation to their operating permit in June 2010. In this instance, the process activity was described as 'rubber conversion' which, according to Annex 2 Appendix E of LAQM.TG(03), could potentially require review and assessment. During the consultation process the council requested that modelling be undertaken to determine if the National Air Quality Objectives for any relevant LAQM pollutants were likely to be breached at any sensitive receptors. An air quality assessment was carried out by the operators at SEPA's request; this did not predict any exceedences of the NAQS objectives¹⁶.

Dundee City Council has assessed new/proposed industrial installations, and concluded that it will not be necessary to proceed to a Detailed Assessment.

¹⁴ TUVNEL Report 2011-327-DFL001_PPC-E-20032-VN01_Discovery Flexibles_Dundee_July11_MR_V2.xls

¹⁵ Value taken from Receptor 7 FA/DA worst case receptor within 5 Stack Heights

¹⁶ Catalyst Environmental Report Ref No: CEK-0325 for Flint Group Print Media

5.2 Major Fuel (Petrol) Storage Depots

The assessment considers benzene, with respect to the 2010 objective.

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

5.3 Petrol Stations

The assessment considers benzene with respect to the 2010 objective. Large petrol stations, where the annual throughput is more than 2000m³ of petrol (2 million litres per annum) and with a busy road nearby (i.e. >30,000 annual average daily traffic flows), require consideration where there is relevant exposure (e.g. residential properties) within 10m of the pumps. All existing petrol stations have been assessed previously and there are no residences within 10m of the pumps. A new petrol station is proposed as part of a new supermarket development; however there are no relevant receptors within 10m of the petrol pumps and therefore it does not meet the criteria for assessment.

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

5.4 Poultry Farms

Farms housing in excess of: 400,000 birds if mechanically ventilated; 200,000 birds if naturally ventilated; and, 100,000 birds for any turkey unit, require consideration if there is residential exposure within 100m of the poultry units. The assessment needs to consider only PM₁₀.

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

6 Commercial and Domestic Sources

6.1 Biomass Combustion – Individual Installations

This item is a relatively new requirement and the assessment considers both PM₁₀ and nitrogen dioxide objectives. Biomass burning can lead to an increase in PM₁₀ emissions owing to the process of combustion. Aerosol formation from volatile materials distilled from the wood is also an issue. Compared to conventional gas-burning, biomass burning can also result in an increase in the overall NO_x emissions due to the fuel-derived portion that is not present in gas combustion.

Since the last USA a new biomass heating system has become operational in an office block¹⁷ and, as reported in the 2011 Progress Report, a mixed use building including a health centre and other community facilities has been granted planning permission as part of the Whitfield Regeneration Project¹⁸. This building is being designed by the council architects and biomass has been identified as the preferred option to meet CO₂ reduction targets. Detailed dispersion modelling was undertaken for both of these installations and no exceedences of the NAQS objectives were predicted.

Dundee City Council has assessed new biomass combustion plant, and concluded that it will not be necessary to proceed to a Detailed Assessment. However, biomass installations require further investigation, as there is insufficient information at present to assess this adequately. This will be assessed and reported in subsequent LAQM reports as information becomes available.

6.2 Biomass Combustion – Combined Impacts

There is the potential that many small biomass combustion installations (including domestic solid-fuel burning), whilst individually acceptable, could in combination lead to unacceptably high PM₁₀ concentrations, particularly in areas where PM₁₀ concentrations are close to or above the objectives. Previous reviews of PM₁₀ from solid fuel combustion only considered domestic properties and concluded that it was unlikely that any (500m x 500m square) areas of the city contained more than 50 houses using solid fuel as a primary source of heating. The vast majority of Dundee is urban in character, covered by smoke control areas and connected to the gas grid. Since the last USA there has been a rise in gas prices and an increase in the availability of exempt appliances for burning solid fuels, especially wood. Wood is comparatively more polluting than smokeless fuels. Anecdotally the council have received an increasing number of enquiries and complaints about wood burning. The impact of domestic biomass combustion in most areas is thought to be small at present, but could become more important in future.

Dundee City Council has not identified any areas of the city which meet the criteria for assessment detailed in the LAQM FAQ¹⁹. However, these sources require further investigation, as there is insufficient information at present to assess this adequately. This will be assessed and reported in subsequent LAQM reports as information becomes

¹⁷ "Atmospheric Dispersion Modelling for Nitrogen Dioxide and Particulate Matter – Proposed Hilcrest Wood Fuel Plant Explorer Road, Dundee" Bureau Veritas Technical Report No. AGGX0829/BV/AQ/2526. January 2008

¹⁸ "Air quality assessment: biomass heating scheme, Whitfield Core Life Services building" AEA Ref: ED57641- Issue Number 2, September 2012

¹⁹ <http://laqm.defra.gov.uk/laqm-faqs/faq36.html> "How can I identify areas in my district where burning of solid fuels such as coal, smokeless fuel or wood (i.e. biomass) might be leading to exceedences of the 2004 daily mean PM10 air quality objective (and the 2010 annual mean objective in Scotland)?"

available.

6.3 Domestic Solid-Fuel Burning

PM₁₀ from domestic solid fuel burning is covered under the Biomass combustion – combined impacts section above. Therefore, this part considers sulphur dioxide emissions only from significant areas of residential properties that use solid fuel to heat their houses. ‘Significant’ areas are described as those of about 500 x 500 m with more than 100 houses burning coal/smokeless fuel as their primary source of heating. The criteria for assessment has not changed since previous rounds of review and assessment which did not identify any areas where domestic coal/solid fuel burning was likely to give rise to exceedences of the objective for SO₂.

Dundee City Council has not identified any areas of significant domestic fuel use in the Local Authority area that meet the criteria.

7 Fugitive or Uncontrolled Sources

The assessment of new fugitive and uncontrolled sources considers the PM₁₀ objectives. This includes consideration of quarries, landfill sites, opencast coal mining, waste transfer sites and materials handling (i.e. ports, major construction sites). Only locations not covered by previous rounds of review and assessment, or where there is new relevant exposure, require consideration. In the case of proposed new sources, these are only required to be considered if planning approval has been granted.

A Detailed Assessment is required where there is relevant exposure near to the source of fugitive emissions and there are recent complaints about dust or a visual inspection indicates significant dust emissions or dust tracked out of the site onto public roads.

If the relevant exposure is away from off-site roads used as access routes to the site then “near” is defined in relation to the local background PM₁₀ concentrations, taken from the Air Quality Archive background concentration maps as follows:

For 2004 objectives, near is within:

- 1000 m for a background >28µg/m³;
- 400 m for a background >26µg/m³; and
- 200 m for any background.

For 2010 objectives, near is within:

- 1000 m for a background >17µg/m³;
- 400 m for a background >16µg/m³; and
- 200 m for any background.

These distances are from the source which may not always coincide with the boundary of the site. The Scottish Government predicted 2010 PM₁₀ background concentrations (April 2012 release) for Dundee did not include any 1km x 1km grid squares with a value greater than 16 µg/m³ (the highest value was 14.7 µg/m³).

If the relevant exposure is within 50m of an off-site road used to access the site and there are visible deposits on the road, then these sections of road, which may extend up to 1000m from the site entrance, are considered to be “near”, as long as the background is above 25 µg/m³ for the 2004 objectives and 11µg/m³ for the 2010 objectives.

As reported in the previous review there are new residences (i.e. relevant exposure) in the City Quay development that are within 200m of potential materials handling areas of the port. Raised concentrations of particulate matter, though not exceeding the daily objective, have been recorded at the downwind monitor at Broughty Ferry Road. Wind speed and direction are significant factors in the dispersion of such emissions and the potential for complaints. The flats had not been occupied for very long at the time of the last review. Since then the council have not received any dust complaints from these flats about activities at the port.

In addition, major infrastructure changes are taking place in the Central Waterfront Development Area which is bordered on the north by residential properties. The council has not received dust complaints. Owing to the proximity of residents there is a potential for complaints as activities move closer to the houses and this will be kept under review.

Dundee City Council confirms that there are no new/newly identified fugitive or uncontrolled sources of particulate matter emissions in the Local Authority area.

8 Conclusions and Proposed Actions

8.1 Conclusions from New Monitoring Data

New monitoring data for 2011 confirms the need for the Air Quality Management Area (AQMA) in relation to exceedences of the NO₂ and PM₁₀ National Air Quality Strategy (NAQS) annual mean objectives and the subsequent Air Quality Action Plan (AQAP).

Dundee City Council has measured concentrations of NO₂ above the annual mean objective at relevant locations within the AQMA, previously declared for NO₂ and PM₁₀ annual mean (i.e. the whole council area). However, uncertainties associated with the distance calculator tool used to estimate NO₂ concentrations at façade suggest that the number of locations where the objective is breached at façade will exceed the number estimated (7). NO₂ annual mean concentrations decreased between 2010 and 2011 at the majority of monitoring locations except Whitehall Street. Throughout the city NO₂ annual mean concentrations have generally increased since the AQMA was declared in 2006. The greatest increases in pollutant concentrations have been recorded along the city centre bus corridor, the north-west arterial route and associated access roads, major junctions on the Kingsway and at Stannergate Junction. In Strathmore Avenue additional monitoring has shown that the potential problem area is highly localised and in 2011 the NO₂ annual mean objective was met at this location.

Dundee City Council has measured concentrations of NO₂ above the 1-hour objective at one location (Lochee Road) for three consecutive years. This is thought to have occurred as a result of traffic congestion caused by the impact of the severe winter weather on the road network in 2009 and 2010. The winter weather was less severe in 2011 and the number of exceedences was still greater than the 18 allowed (43). In view of the ongoing exceedences of the hourly NO₂ objective at Lochee Road, and the advice of the Scottish Government's consultants²⁰, it is considered necessary to amend the current AQMA order to include the hourly objective. Despite recording an annual mean in excess of 60 µg/m³, the real-time monitor in Meadowside did not record any exceedences of the hourly objective. However, the new monitoring station was only installed in June 2011 (52.3% data capture) so a true comparison with the hourly objective is not possible. The potential for exceedences of the hourly objective at this location will be kept under review.

PM₁₀ objectives for 2004 are being met at all locations within the city, however Dundee City Council has measured concentrations of PM₁₀ above the 2010 annual mean at Osiris units (Lochee Road, Logie Street, Victoria Road and Seagate), Union Street (TEOM & Osiris) and at two of the new BAMs (Lochee Road and Meadowside). The new BAMs had low data capture in 2011 and the results have been annualised. At most locations PM₁₀ concentrations between 2006 and 2009 remained level or decreased slightly. Monitoring locations on the north-west arterial route (Logie Street and Lochee Road) showed a significant increase in PM₁₀ concentrations in 2010 and 2011. Annual mean concentrations also increased in Seagate in 2011 and in Union Street. Road works from May to November in 2011 are thought to have contributed to the annual mean exceedence in Union Street.

²⁰ Progress Report Appraisal Report PR-648

Only the kerbside Osiris units recorded more than 7 exceedences of the 24-hour objective. Osiris units are indicative monitors and have a tendency to over-estimate the number of exceedences, although the doubling of the number of exceedences recorded at Lochee Road and Seagate between 2010 and 2011 is significant. The council installed reference equivalent PM₁₀ analysers (BAMs) in Lochee Road, Seagate and at the Victoria Rd / Meadowside junction in 2011. The data capture at these monitors was low and the number of exceedences recorded did not exceed the 7 allowed but the 98.08th percentile was close to 50 µg/m³ at Meadowside. The need to amend the AQMA order in relation to the daily mean will be reviewed as more data becomes available.

New monitoring data for 2011 show the objectives for SO₂ are being achieved. SO₂ concentrations have declined at the Broughty Ferry Road monitoring station between 2002 and 2011; this is thought to be largely due to the introduction of low sulphur fuels at a nearby industrial process in the port. From 2002 to 2006 occasional exceedences of the 15min mean objective were recorded as a result of certain shipping activities/movements within the port; these were well within the number allowed.

8.2 Conclusions from Assessment of Sources

The Updating and Screening Assessment has reviewed road transport, other transport, industrial installations, commercial and domestic sources and fugitive emissions. No significant roads or other sources were identified which warranted detailed assessment.

The assessment of road traffic sources identified two roundabouts, "Kingsway/Myrekirk" and Stannergate, where new developments may impact on air quality. Additional monitoring has been deployed in these areas.

It is considered that biomass sources require further investigation as there is insufficient information at present to assess this adequately.

8.3 Proposed Actions

The Updating and Screening Assessment 2012 did not identify the need to proceed to a detailed assessment for any pollutant. Proposed actions arising from the Updating and Screening Assessment 2012 are as follows:

- Take forward the amendment of the current AQMA order to include the hourly objective for nitrogen dioxide (NO₂);
- Review the need to amend the AQMA order to include the daily mean objective for particulate matter (PM₁₀) as more data becomes available;
- Review the results of additional monitoring installed at Kingsway/Myrekirk and Stannergate roundabouts as information becomes available;
- Review the nitrogen dioxide diffusion tube monitoring network in light of trends in monitoring results and new exposure;
- Further investigate sources of biomass/solid fuel combustion in the local authority area to enable appropriate screening, and report findings in subsequent LAQM reports as information becomes available; and
- Undertake the 2013 Progress Report.

9 References

This report includes references where appropriate throughout the text as footnotes.

Appendices

- Appendix A: Pollution Reports
- Appendix B: VCM Methodology
- Appendix C: Bias Calculations for Diffusion Tube Co-location Studies
- Appendix D: Annualisation of Data
- Appendix E: Monthly Diffusion Tube Results
- Appendix F: Road Traffic Data
- Appendix G: DMRB Calculations
- Appendix H: Percentage Increase in Daily Traffic Flows Surrounding New Leisure Centre
- Appendix I: List of Industrial Processes
- Appendix J: Openair: Trend Level Hour Plots Appendix

APPENDIX A - POLLUTION REPORTS

Produced by AEA on behalf of Dundee City Council

DUNDEE UNION STREET 1st January to 31st December 2011

These data have been fully ratified by AEA

POLLUTANT	NO ₂	NO _x	PM ₁₀ [*]
Maximum hourly mean	176 µg m ⁻³	1008 µg m ⁻³	731 µg m ⁻³
Maximum running 24-hour mean	106 µg m ⁻³	433 µg m ⁻³	129 µg m ⁻³
Maximum daily mean	101 µg m ⁻³	418 µg m ⁻³	128 µg m ⁻³
Average	36 µg m ⁻³	105 µg m ⁻³	19 µg m ⁻³
Data capture	99.5 %	99.5 %	99.4 %

*PM₁₀ as measured by a TEOM using the VCM for Gravimetric Equivalent.

All gaseous pollutant mass units are at 20°C and 1013 mb. Particulate matter concentrations are reported at ambient temperature and pressure.

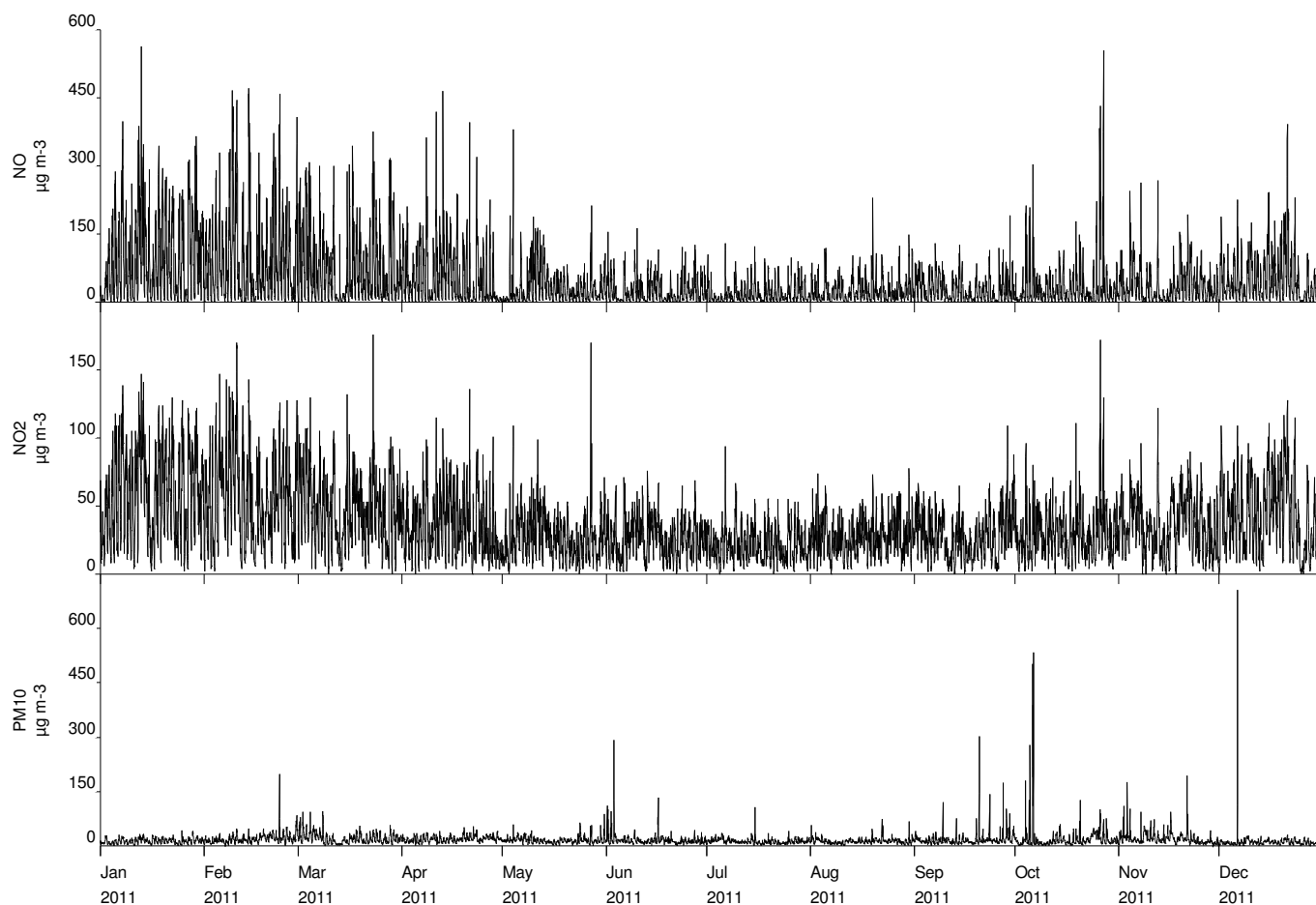
NO_x mass units are NO_x as NO₂ µg m⁻³

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m ⁻³	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m ⁻³	0	0
PM ₁₀ Particulate Matter (Gravimetric)	Daily mean > 50 µg m ⁻³	1	1
PM ₁₀ Particulate Matter (Gravimetric)	Annual mean > 18 µg m ⁻³	1	-

Note: For a strict comparison against the objectives there must be a data capture of >90% throughout the calendar year

Produced by AEA on behalf of Dundee City Council

**Dundee Union Street
Hourly Mean Data for 1st January to 31st December 2011**



Date Created: 31/05//2012

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Produced by AEA on behalf of Dundee City Council

DUNDEE WHITEHALL STREET 1st January to 31st December 2011

These data have been fully ratified by AEA

POLLUTANT	NO ₂	NO _x
Maximum hourly mean	141 µg m ⁻³	764 µg m ⁻³
Maximum running 24-hour mean	94 µg m ⁻³	326 µg m ⁻³
Maximum daily mean	80 µg m ⁻³	257 µg m ⁻³
99.8th percentile of hourly means	118 µg m ⁻³	-
Average	35 µg m ⁻³	98 µg m ⁻³
Data capture	83.6 %	83.6 %

All gaseous pollutant mass units are at 20°C and 1013 mb.

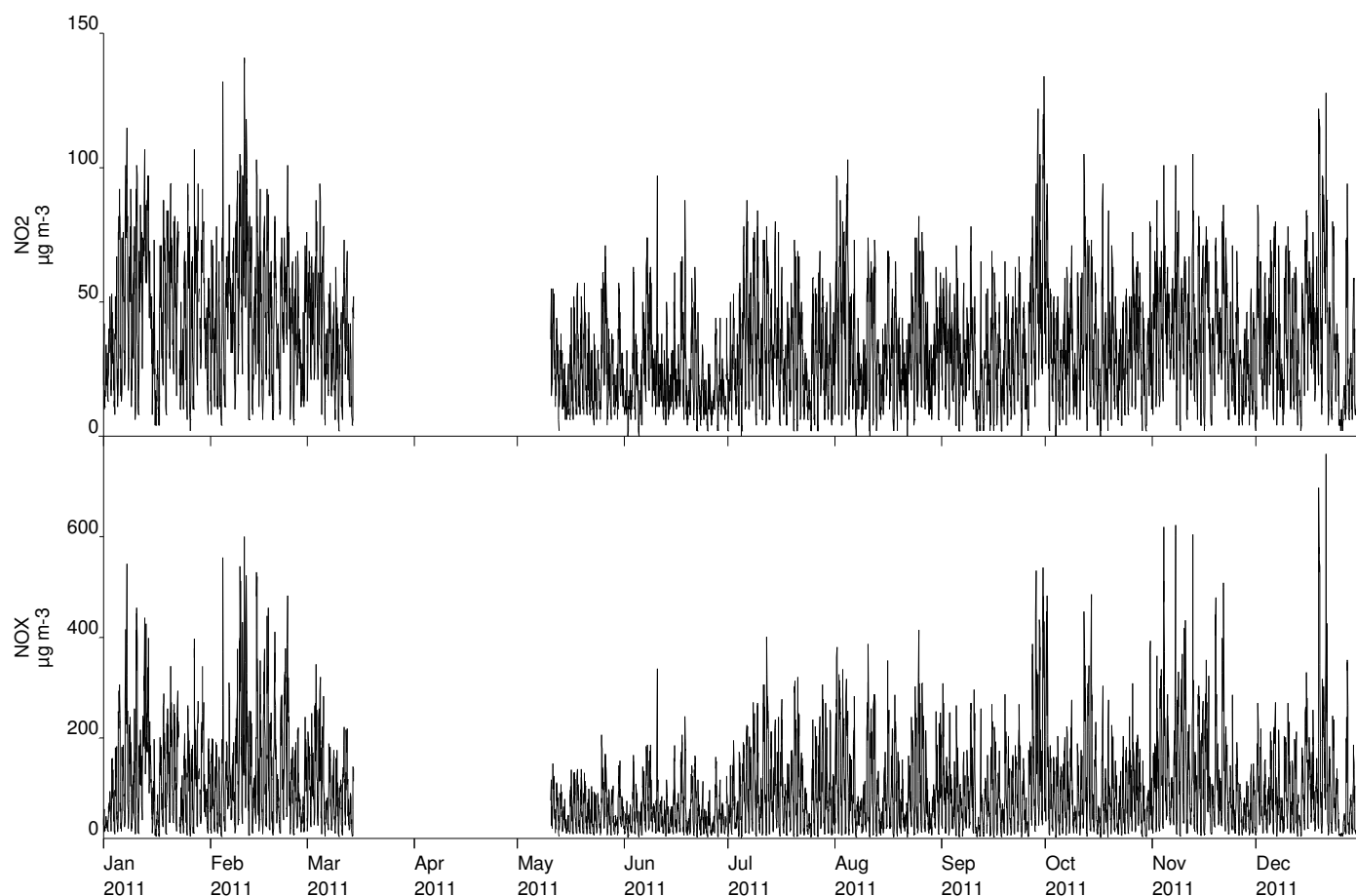
NO_x mass units are NO_x as NO₂ µg m⁻³

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m ⁻³	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m ⁻³	0	0

Note: For a strict comparison against the objectives there must be a data capture of >90% throughout the calendar year

Produced by AEA on behalf of Dundee City Council

Dundee Whitehall Street
Hourly Mean Data for 1st January to 31st December 2011



Date Created: 25/03/2012

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Produced by AEA on behalf of Dundee City Council

DUNDEE SEAGATE

1st January to 31st December 2011

These data have been fully ratified by AEA

POLLUTANT	PM ₁₀ [*]	NO ₂	NO _x
Maximum hourly mean	90 µg m ⁻³	243 µg m ⁻³	974 µg m ⁻³
Maximum running 24-hour mean	56 µg m ⁻³	125 µg m ⁻³	468 µg m ⁻³
Maximum daily mean	54 µg m ⁻³	111 µg m ⁻³	430 µg m ⁻³
99.8th percentile of hourly means	-	157 µg m ⁻³	-
98.08th percentile of daily means	39 µg m ⁻³	-	-
Average	16 µg m ⁻³	52 µg m ⁻³	187 µg m ⁻³
Data capture	62.2 %	80.9 %	80.9 %

*PM₁₀ instruments:

BAM using a gravimetric factor of 0.83333 for Indicative Gravimetric Equivalent from 9th May 2011

All gaseous pollutant mass units are at 20°C and 1013 mb.

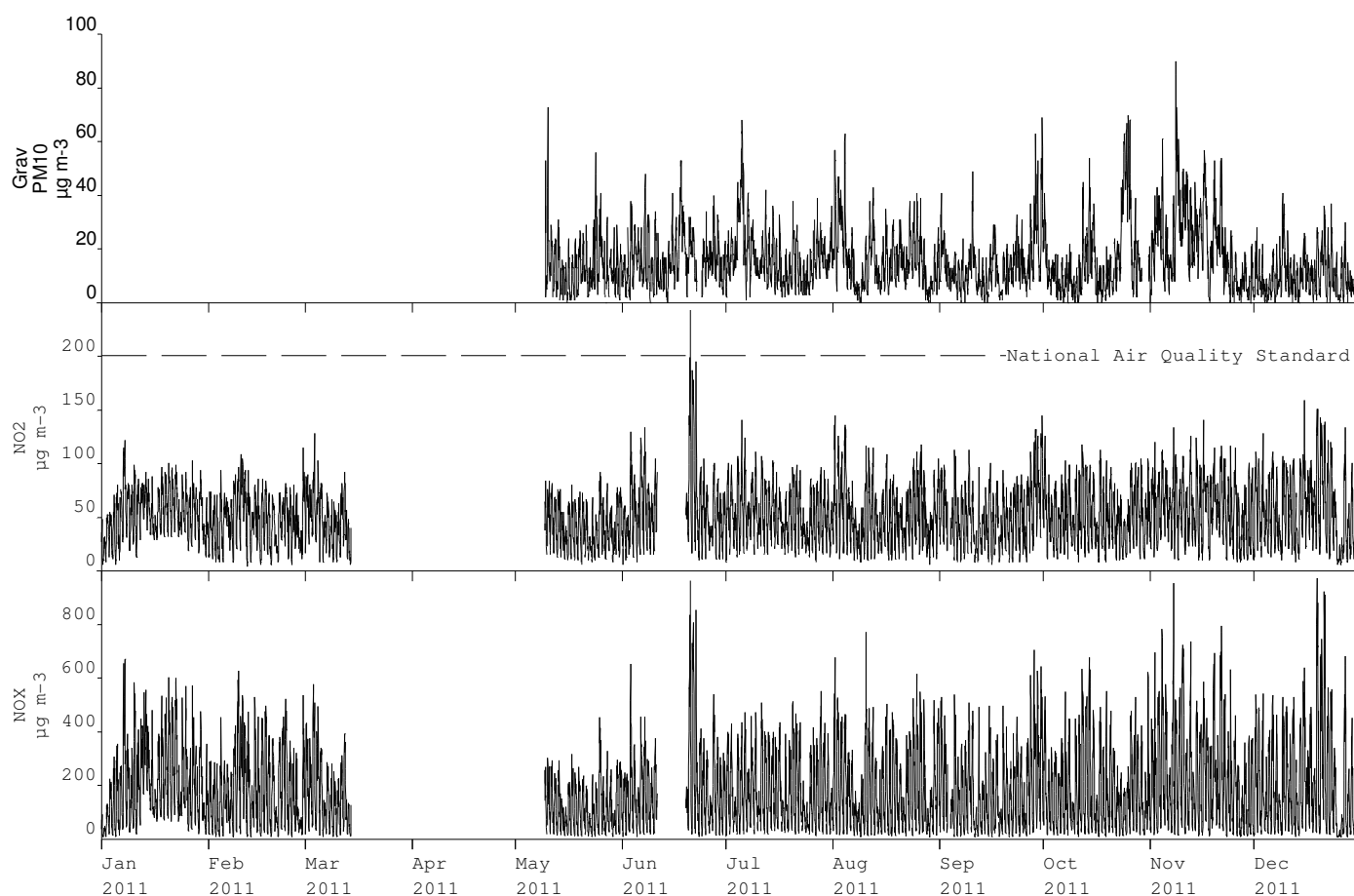
NO_x mass units are NO_x as NO₂ µg m⁻³

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
PM ₁₀ Particulate Matter (Gravimetric)	Daily mean > 50 µg m ⁻³	1	1
PM ₁₀ Particulate Matter (Gravimetric)	Annual mean > 18 µg m ⁻³	0	-
Nitrogen Dioxide	Annual mean > 40 µg m ⁻³	1	-
Nitrogen Dioxide	Hourly mean > 200 µg m ⁻³	2	1

Note: For a strict comparison against the objectives there must be a data capture of >90% throughout the calendar year

Produced by AEA on behalf of Dundee City Council

**Dundee Seagate
Hourly Mean Data for 1st January to 31st December 2011**



Date Created: 25/03/2012

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Produced by AEA on behalf of Dundee City Council

DUNDEE MEADOWSIDE 1st January to 31st December 2011

These data have been fully ratified by AEA

POLLUTANT	PM ₁₀ [*]	NO ₂	NO _x
Maximum hourly mean	119 µg m ⁻³	185 µg m ⁻³	1513 µg m ⁻³
Maximum running 24-hour mean	70 µg m ⁻³	107 µg m ⁻³	596 µg m ⁻³
Maximum daily mean	67 µg m ⁻³	92 µg m ⁻³	534 µg m ⁻³
99.8th percentile of hourly means	-	159 µg m ⁻³	-
98.08th percentile of daily means	49 µg m ⁻³	-	-
Average	21 µg m ⁻³	58 µg m ⁻³	248 µg m ⁻³
Data capture	50.6 %	52.3 %	52.3 %

* PM₁₀ instruments:

BAM using a gravimetric factor of 0.83333 for Indicative Gravimetric Equivalent from 15th June 2011

All gaseous pollutant mass units are at 20°C and 1013 mb.

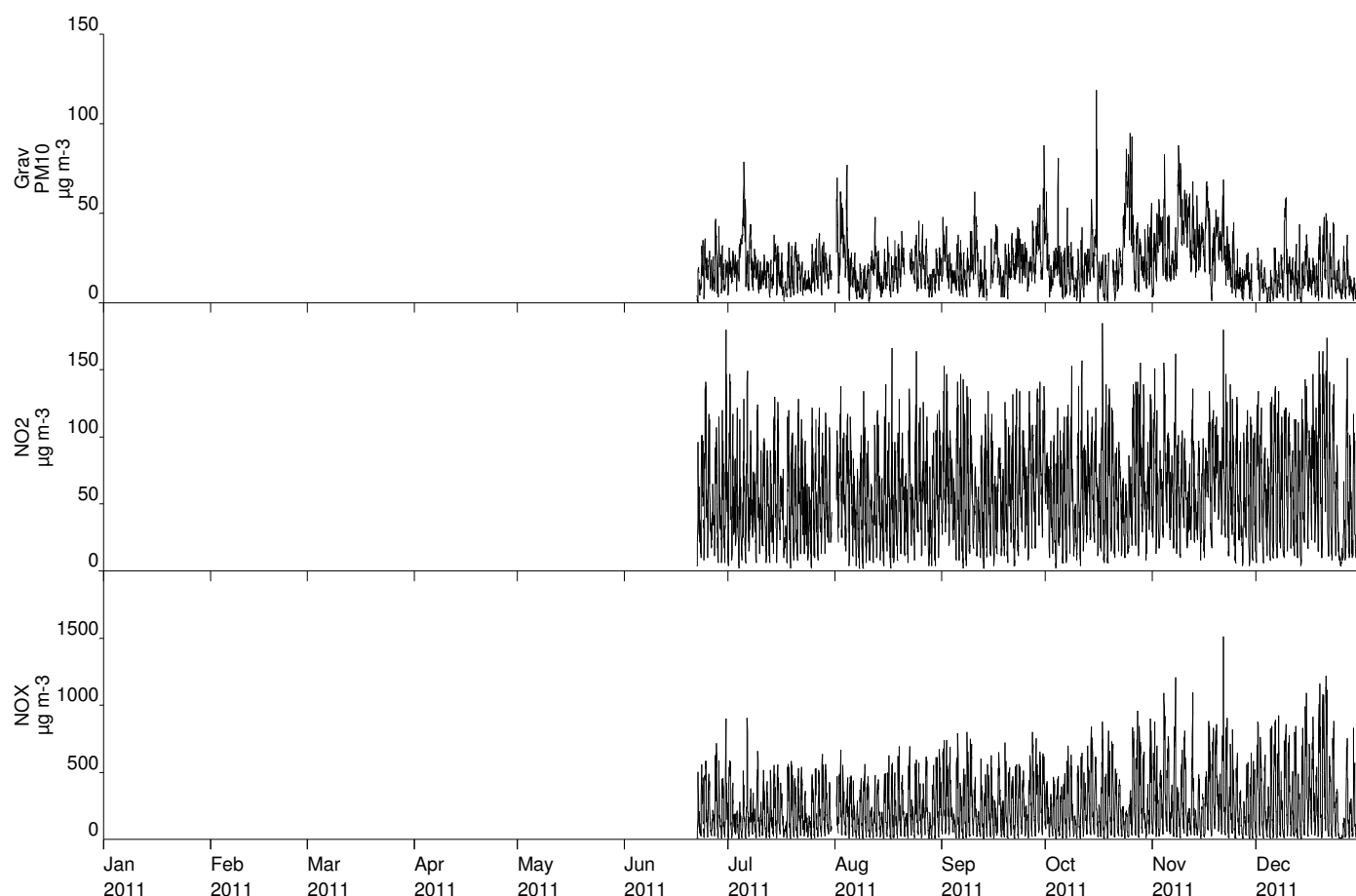
NO_x mass units are NO_x as NO₂ µg m⁻³

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
PM ₁₀ Particulate Matter (Gravimetric)	Daily mean > 50 µg m ⁻³	4	4
PM ₁₀ Particulate Matter (Gravimetric)	Annual mean > 18 µg m ⁻³	1	-
Nitrogen Dioxide	Annual mean > 40 µg m ⁻³	1	-
Nitrogen Dioxide	Hourly mean > 200 µg m ⁻³	0	0

Note: For a strict comparison against the objectives there must be a data capture of >90% throughout the calendar year

Produced by AEA on behalf of Dundee City Council

Dundee Meadowside
Hourly Mean Data for 1st January to 31st December 2011



Date Created: 25/03/2012

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Produced by AEA on behalf of Dundee City Council

DUNDEE MAINS LOAN

1st January to 31st December 2011

These data have been fully ratified by AEA

POLLUTANT	NO ₂	NO _x	PM ₁₀ [*]
Maximum hourly mean	96 µg m ⁻³	374 µg m ⁻³	73 µg m ⁻³
Maximum running 24-hour mean	58 µg m ⁻³	117 µg m ⁻³	51 µg m ⁻³
Maximum daily mean	48 µg m ⁻³	104 µg m ⁻³	45 µg m ⁻³
99.8 th percentile of hourly means	82 µg m ⁻³	-	-
Average	10 µg m ⁻³	13 µg m ⁻³	13 µg m ⁻³
Data capture	75.5 %	75.5 %	93.1 %

+ PM₁₀ as measured by a TEOM using the VCM for Gravimetric Equivalent.

All gaseous pollutant mass units are at 20°C and 1013 mb. Particulate matter concentrations are reported at ambient temperature and pressure.

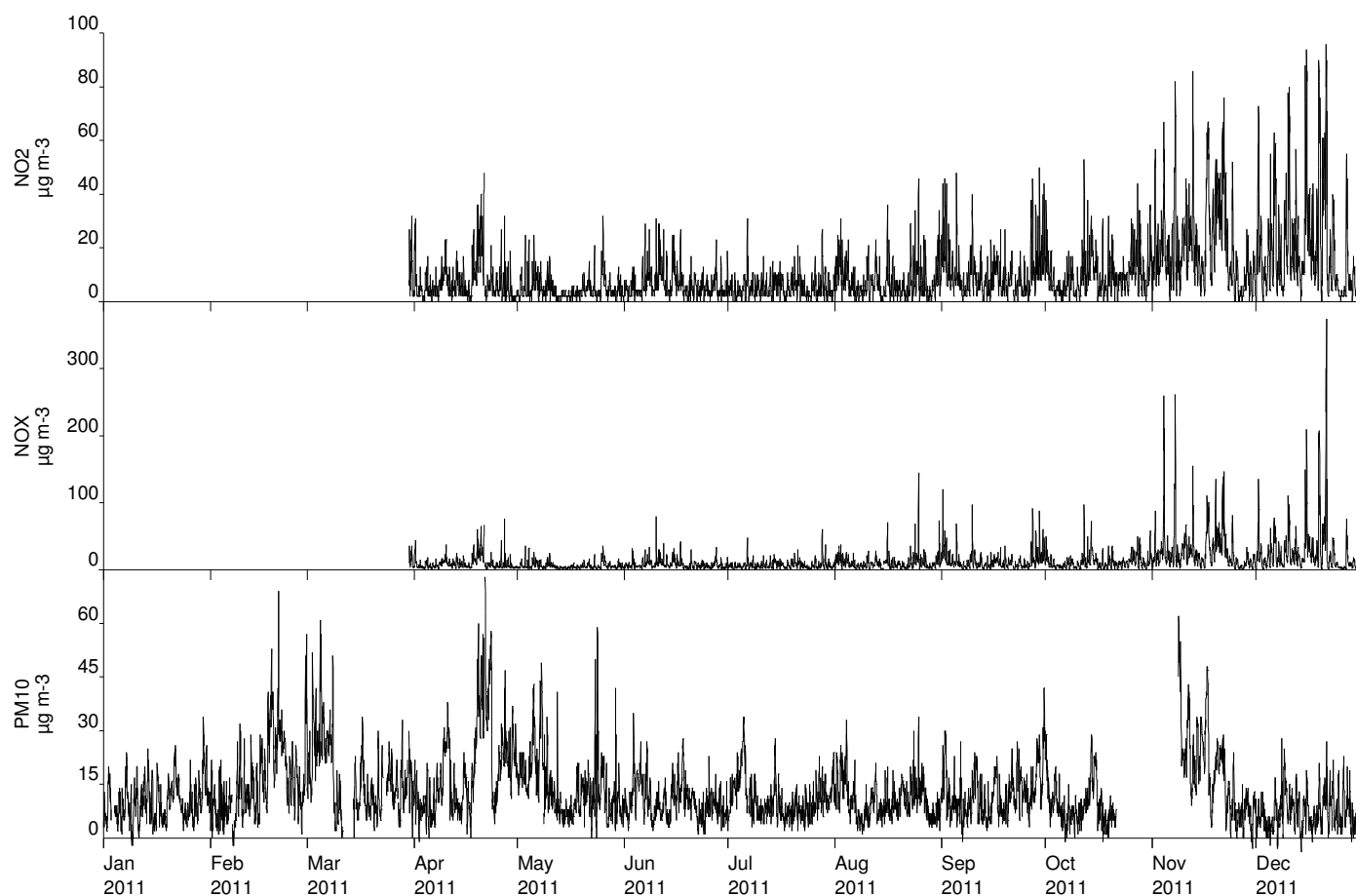
NO_x mass units are NO_x as NO₂ µg m⁻³

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m ⁻³	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m ⁻³	0	0
PM ₁₀ Particulate Matter (Gravimetric)	Daily mean > 50 µg m ⁻³	-	-
PM ₁₀ Particulate Matter (Gravimetric)	Annual mean > 18 µg m ⁻³	0	-

Note: For a strict comparison against the objectives there must be a data capture of >90% throughout the calendar year

Produced by AEA on behalf of Dundee CC

**Dundee Mains Loan
Hourly Mean Data for 01 January to 31 December 2011**



Date Created: 25/03/2012

NONE

Produced by AEA on behalf of Dundee City Council

DUNDEE LOCHEE ROAD 1st January to 31st December 2011

These data have been fully ratified by AEA

POLLUTANT	PM ₁₀ [*]	NO ₂	NO _x
Maximum hourly mean	108 µg m ⁻³	300 µg m ⁻³	1276 µg m ⁻³
Maximum running 24-hour mean	58 µg m ⁻³	136 µg m ⁻³	466 µg m ⁻³
Maximum daily mean	54 µg m ⁻³	124 µg m ⁻³	431 µg m ⁻³
99.8th percentile of hourly means	-	243 µg m ⁻³	-
98.08th percentile of daily means	44 µg m ⁻³	-	-
Average	19 µg m ⁻³	74 µg m ⁻³	199 µg m ⁻³
Data capture	71.9 %	39.2 %	39.2 %

*PM₁₀ instruments:

BAM using a gravimetric factor of 0.83333 for Indicative Gravimetric Equivalent from 8th April 2011

All gaseous pollutant mass units are at 20°C and 1013 mb.

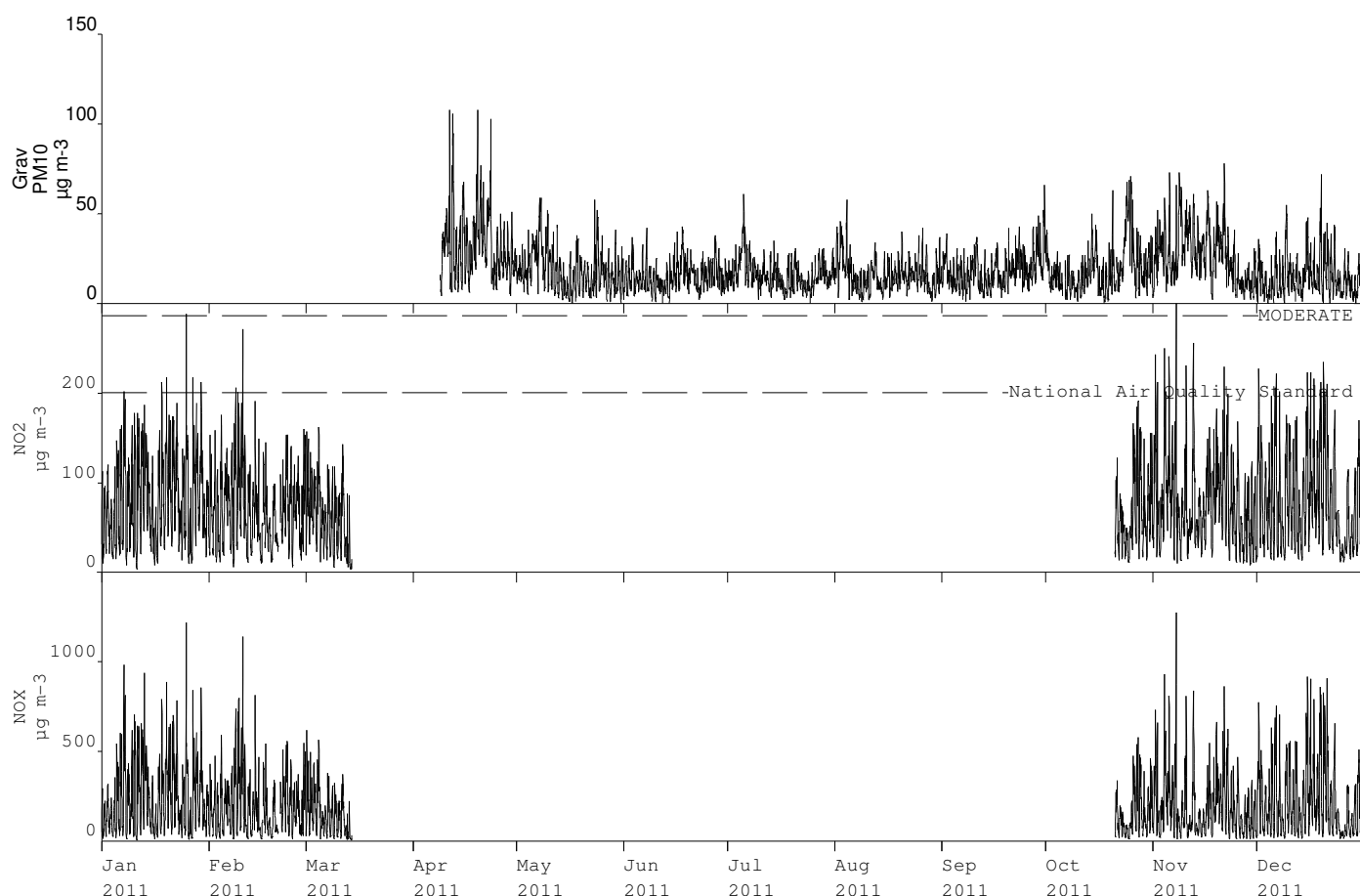
NO_x mass units are NO_x as NO₂ µg m⁻³

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
PM ₁₀ Particulate Matter (Gravimetric)	Daily mean > 50 µg m ⁻³	2	2
PM ₁₀ Particulate Matter (Gravimetric)	Annual mean > 18 µg m ⁻³	1	-
Nitrogen Dioxide	Annual mean > 40 µg m ⁻³	1	-
Nitrogen Dioxide	Hourly mean > 200 µg m ⁻³	43	26

Note: For a strict comparison against the objectives there must be a data capture of >90% throughout the calendar year

Produced by AEA on behalf of Dundee City Council

Dundee Lochee Road
Hourly Mean Data for 1st January to 31st December 2011



Date Created: 25/03/2012

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Produced by AEA on behalf of Dundee City Council

DUNDEE BROUGHTY FERRY ROAD 1st January to 31st December 2011

These data have been fully ratified by AEA

POLLUTANT	PM ₁₀ [*]	SO ₂
Maximum 15-minute mean	153 µg m ⁻³	85 µg m ⁻³
Maximum hourly mean	100 µg m ⁻³	67 µg m ⁻³
Maximum running 24-hour mean	52 µg m ⁻³	24 µg m ⁻³
Maximum daily mean	46 µg m ⁻³	21 µg m ⁻³
99.9 th percentile of 15 minute means	-	56 µg m ⁻³
99.7 th percentile of hourly means	-	40 µg m ⁻³
99.2 nd percentile of daily means	-	18 µg m ⁻³
Average	16 µg m ⁻³	6 µg m ⁻³
Data capture	98.6 %	83.0 %

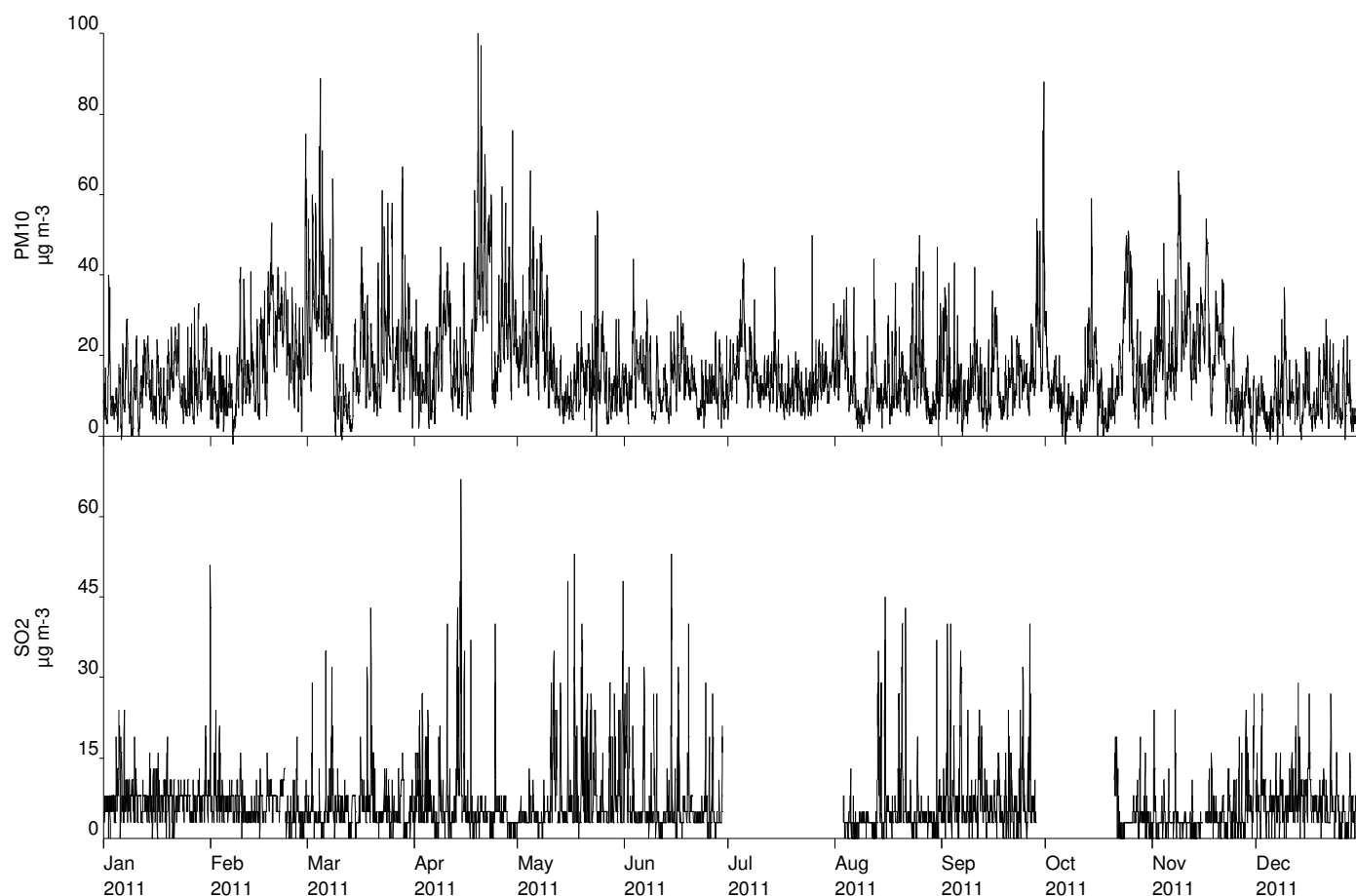
+ PM₁₀ as measured by a TEOM using the VCM for Gravimetric Equivalent

All gaseous pollutant mass units are at 20°C and 1013 mb. Particulate matter concentrations are reported at ambient temperature and pressure.

Pollutant	Air Quality Regulations (2000) and Air Quality (Scotland) Amendment Regulations 2002	Exceedences	Days
PM ₁₀ Particulate Matter (Gravimetric)	Daily mean > 50 µg m ⁻³	-	-
PM ₁₀ Particulate Matter (Gravimetric)	Annual mean > 18 µg m ⁻³	0	-
Sulphur Dioxide	15-minute mean > 266 µg m ⁻³	0	0
Sulphur Dioxide	Hourly mean > 350 µg m ⁻³	0	0
Sulphur Dioxide	Daily mean > 125 µg m ⁻³	0	0

Produced by AEA on behalf of Dundee City Council

Dundee Broughty Ferry Road
Hourly Mean Data for 1st January to 31st December 2011



Date Created: 25/03/2012

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APPENDIX B: VCM METHODOLOGY



TEOM Data Correction Using the Volatile Correction Model - 2011

Introduction

AEA has been funded by The Scottish Government to provide Volatile Correction Model (VCM) corrected TEOM (Tapered Element Oscillating Microbalance) data to Local Authorities under the Scottish Air Quality Database and Website (SAQD) project.

The VCM uses reference (volatile) particulate matter measurements provided by FDMS (Filter Dynamics Measurement System) instruments located within 130 km of the TEOM in question to assess the loss of particulate matter (PM_{10}) from the TEOM. The TEOM measurements, without the applied USEPA correction factors of $1.03x+3$ (where x is the raw TEOM measurement), are then corrected to ambient pressure and temperature using meteorological data from met monitoring sites within 260 km of the TEOM. The volatile fraction is then added back onto the TEOM measurements to give Gravimetric Equivalent mass concentrations.

This is a short summary outlining the method used by AEA for correcting the 2011 Scottish TEOM data in the Scottish database.

Method

The following data have been used as inputs to the VCM:

- Hourly average temperatures ($^{\circ}C$)
- Hourly average pressures (mbar)
- Hourly average TEOM concentrations ($\mu g\ m^{-3}$)
- Hourly average FDMS purge concentrations ($\mu g\ m^{-3}$)

For the 2011 corrections, temperature and pressure data from both Aberdeen Dyce Airport and Edinburgh Gogarbank meteorological monitoring stations were utilised. These two sites were selected as a good representation weather conditions in Aberdeen and the central belt of Scotland, respectively.

Hourly average purge measurements from all Scottish FDMS monitoring sites within the Scottish Government-run network (SAQD) and the UK national network (AURN) were used for the correction. Table 1 lists the sites used for correcting hourly TEOM data from Central Scotland and Aberdeen. A total of 3 FDMS sites were used for correcting Aberdeen TEOM data and 27 FDMS sites used for correcting data from TEOM sites located in the central belt of Scotland.

Any outliers in the FDMS purge measurements were identified using Grubbs' Test¹ on daily average data. All hourly data within a day identified as an outlier were then removed from the data set and the average of each hourly purge measurement from the FDMS sites was calculated and used in the VCM calculations.

¹ Grubbs' Test is a statistical method for identifying outliers within a dataset. For more information visit the Engineering Statistics Handbook at:

<http://www.itl.nist.gov/div898/handbook/eda/section3/eda35h.htm>



Table 1 FDMS Monitoring Sites used in VCM Correcting TEOM Data from Aberdeen and Central Scotland Monitoring Sites

TEOM Locations	FDMS Sites used in VCM	Monitoring Network
Aberdeen	Aberdeen	AURN
	Angus Forfar	SAQD
	Fife Cupar	SAQD
Central Scotland	Angus Forfar	SAQD
	Auchencorth Moss	AURN
	East Dunbartonshire Kirkintilloch	SAQD
	East Dunbartonshire Milngavie	SAQD
	East Renfrewshire Sheddens	SAQD
	Edinburgh St Leonards	AURN
	Fife Cupar	SAQD
	Fife Dunfermline	SAQD
	Fife Kirkcaldy	SAQD
	Fife Rosyth	SAQD
	Glasgow Abercromby Street	SAQD
	Glasgow Anderston	SAQD
	Glasgow Broomhill	SAQD
	Glasgow Burgher St	SAQD
	Glasgow Byres Road	SAQD
	Glasgow Centre	AURN
	Glasgow Kerbside	AURN
	Glasgow Nithsdale Road	SAQD
	Grangemouth	AURN
	Paisley Gordon Street	SAQD
	Paisley St James St	SAQD
	South Lanarkshire East Kilbride	SAQD
	South Lanarkshire Raith Interchange	SAQD
	West Dunbartonshire Clydebank	SAQD
	West Lothian Broxburn	SAQD
	West Lothian Linlithgow High Street	SAQD
	West Lothian Whitburn	SAQD

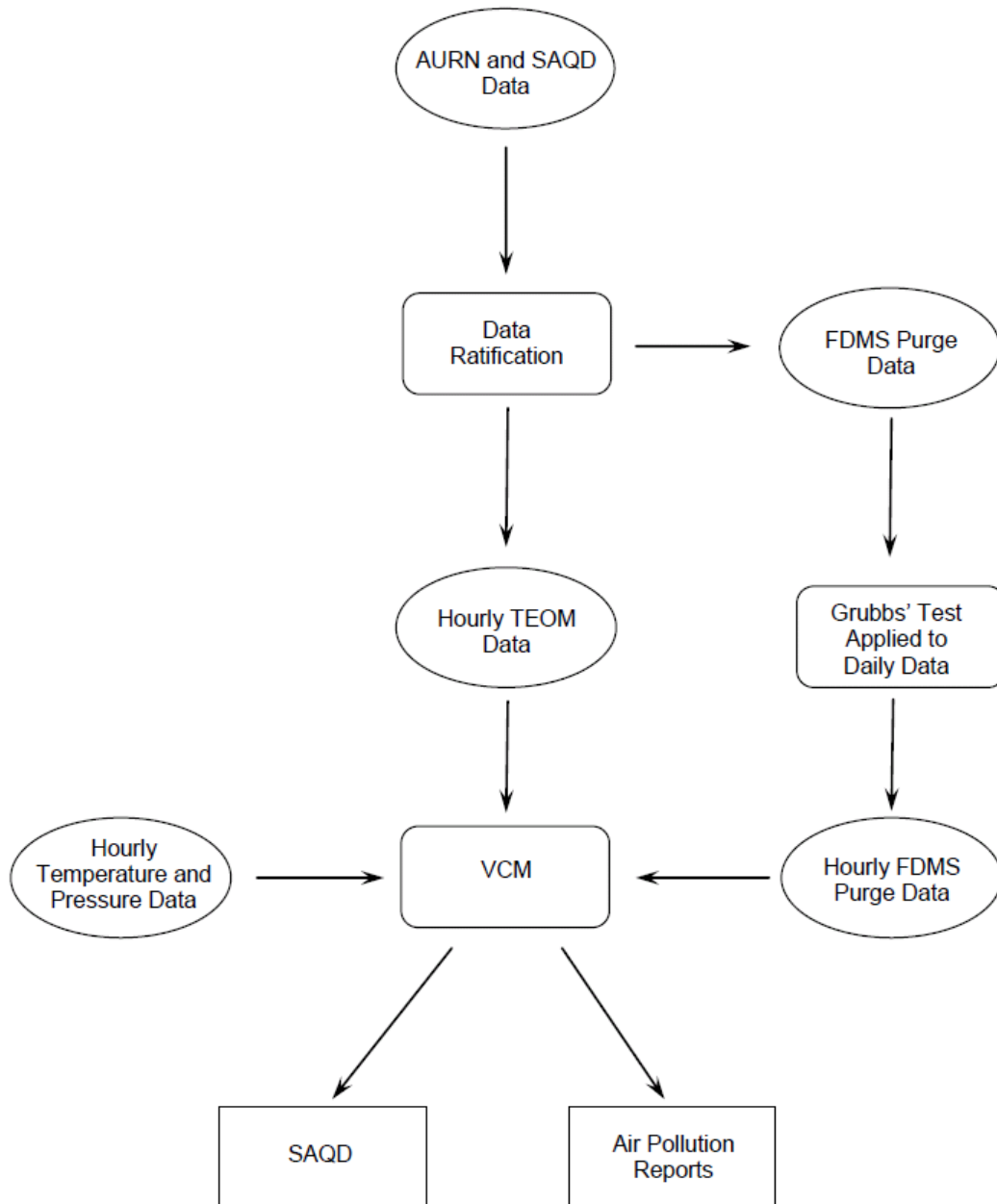
VCM and the SAQD

All 2011 VCM corrected data will be made available on the SAQD website via an additional selection option in the data download pages in March 2012.

A flow chart showing the overall process employed for VCM correcting 2011 SAQD TEOM data is shown in Figure 1.



Figure 1 Process used for VCM Correcting SAQD TEOM Data





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For further information regarding VCM or for carrying out your own correction please visit the following website:

<http://www.volatile-correction-model.info/Default.aspx>

APPENDIX C: BIAS CALCULATIONS FOR DIFFUSION TUBE CO-LOCATION STUDIES

Checking Precision and Accuracy of Triplicate Tubes



Diffusion Tubes Measurements									
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
1	05/01/2011	02/02/2011	84.9	91.0	87.7	88	3.1	3	7.6
2	02/02/2011	02/03/2011	73.6	74.1	73.4	74	0.4	0	0.9
3	02/03/2011	30/03/2011	71.9	71.5	69.2	71	1.5	2	3.6
4	30/03/2011	27/04/2011	50.5	61.9	65.2	59	7.7	13	19.2
5	27/04/2011	01/06/2011	52.2	45.3	49.1	49	3.5	7	8.6
6	01/06/2011	29/06/2011	52.2	53.6	54.3	53	1.1	2	2.7
7	29/06/2011	03/08/2011	44.7	50.3	51.1	49	3.5	7	8.7
8	03/08/2011	31/08/2011	55.8	55.0	54.4	55	0.7	1	1.7
9	31/08/2011	28/09/2011	60.9	58.4	53.3	58	3.9	7	9.6
10	28/09/2011	02/11/2011	60.9	56.5	59.5	59	2.2	4	5.6
11	02/11/2011	29/11/2011	60.8	62.9	62.2	62	1.1	2	2.7
12	29/11/2011	04/01/2012	43.0	53.1	54.2	50	6.2	12	15.3
13									

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

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
84.0	99.3	Good	Good
71.0	97.5	Good	Good
57.0	41.9	Good	Poor Data Capture
-	0.0	Good	Poor Data Capture
-	0.0	Good	Poor Data Capture
-	0.0	Good	Poor Data Capture
-	0.0	Good	Poor Data Capture
-	0.0	Good	Poor Data Capture
-	0.0	Good	Poor Data Capture
70.0	35.4	Good	Poor Data Capture
76.0	99.5	Good	Good
73.0	99.8	Good	Good

Overall survey -->

Good precision Poor Overall DC

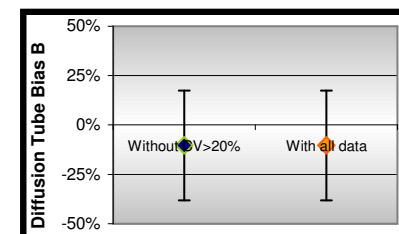
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Dundee Lochee Road

Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 4 periods of data	
Bias factor A	1.11 (0.85 - 1.61)
Bias B	-10% (-38% - 18%)
Diffusion Tubes Mean:	68 μgm^{-3}
Mean CV (Precision):	5
Automatic Mean:	76 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	76 (58 - 110) μgm^{-3}

Precision 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 4 periods of data	
Bias factor A	1.11 (0.85 - 1.61)
Bias B	-10% (-38% - 18%)
Diffusion Tubes Mean:	68 μgm^{-3}
Mean CV (Precision):	5
Automatic Mean:	76 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	76 (58 - 110) μgm^{-3}



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Checking Precision and Accuracy of Triplicate Tubes



Diffusion Tubes Measurements									
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
1	05/01/2011	02/02/2011							
2	02/02/2011	02/03/2011							
3	02/03/2011	29/03/2011							
4	29/03/2011	27/04/2011	12.9	13.4	14.1	13	0.6	4	1.5
5	27/04/2011	01/06/2011	12.6	11.4	12.6	12	0.7	6	1.7
6	01/06/2011	29/06/2011	12.6	11.6	13.7	13	1.1	8	2.6
7	29/06/2011	02/08/2011	10.5	10.4	12.8	11	1.4	12	3.4
8	02/08/2011	31/08/2011	13.0	12.4	13.4	13	0.5	4	1.3
9	31/08/2011	28/09/2011	15.9	13.4	17.1	15	1.9	12	4.7
10	28/09/2011	02/11/2011	18.5	17.2	22.0	19	2.5	13	6.2
11	02/11/2011	29/11/2011	27.8	23.3	31.4	28	4.1	15	10.1
12	29/11/2011	04/01/2012	15.4	15.1	16.8	16	0.9	6	2.3
13									

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

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
-	0		Poor Data Capture
-	0		Poor Data Capture
-	0		Poor Data Capture
8	95.7	Good	Good
4	99.6	Good	Good
7	99.9	Good	Good
5	99.4	Good	Good
7	99.4	Good	Good
10	99.6	Good	Good
11	99.6	Good	Good
21	99.4	Good	Good
18	99.7	Good	Good
Overall survey -->		Good precision	Poor Overall DC

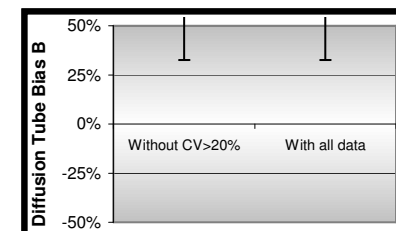
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Dundee Mains Loan
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Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 9 periods of data	
Bias factor A	0.65 (0.5 - 0.93)
Bias B	54% (8% - 101%)
Diffusion Tubes Mean:	16 μgm^{-3}
Mean CV (Precision):	9
Automatic Mean:	10 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	10 (8 - 15) μgm^{-3}

Precision	9 out of 9 periods have a CV smaller than 20%
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Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 9 periods of data	
Bias factor A	0.65 (0.5 - 0.93)
Bias B	54% (8% - 101%)
Diffusion Tubes Mean:	16 μgm^{-3}
Mean CV (Precision):	9
Automatic Mean:	10 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	10 (8 - 15) μgm^{-3}



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Checking Precision and Accuracy of Triplicate Tubes



Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 $\mu g m^{-3}$	Tube 2 $\mu g m^{-3}$	Tube 3 $\mu g m^{-3}$	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	05/01/2011	02/02/2011							
2	02/02/2011	02/03/2011							
3	02/03/2011	30/03/2011							
4	30/03/2011	27/04/2011							
5	28/04/2011	01/06/2011	60.6	59.7	59.0	60	0.8	1	2.0
6	01/06/2011	29/06/2011	63.2	62.9	62.7	63	0.3	0	0.6
7	29/06/2011	03/08/2011	60.3	56.6	61.5	59	2.6	4	6.3
8	03/08/2011	31/08/2011	62.8	60.9	64.0	63	1.6	2	3.9
9	31/08/2011	28/09/2011	66.0	61.2	67.2	65	3.2	5	7.9
10	28/09/2011	02/11/2011	53.0	60.4	65.6	60	6.3	11	15.7
11	02/11/2011	29/11/2011	59.2	69.0	68.9	66	5.6	9	14.0
12	29/11/2011	04/01/2012	51.4	52.0	57.2	54	3.2	6	7.9
13									

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

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
	0		Poor Data Capture
	0		Poor Data Capture
	0		Poor Data Capture
	0		Poor Data Capture
	0	Good	Poor Data Capture
51	26	Good	Poor Data Capture
52	95	Good	Good
52	99	Good	Good
57	100	Good	Good
61	100	Good	Good
62	100	Good	Good
60	100	Good	Good
Overall survey -->		Good precision	Poor Overall DC

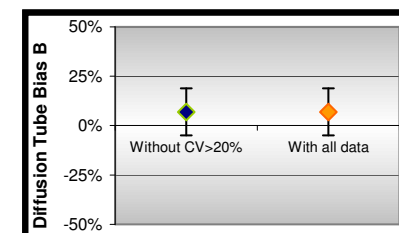
Overall survey -->

Site Name/ ID:	Dundee Meadowside
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Accuracy	(with 95% confidence interval)	
without periods with CV larger than 20%		
Bias calculated using 6 periods of data		
Bias factor A	0.94 (0.85 - 1.06)	
Bias B	6% (-6% - 18%)	
Diffusion Tubes Mean:	61	µgm⁻³
Mean CV (Precision):	6	
Automatic Mean:	57	µgm⁻³
Data Capture for periods used: 99%		
Adjusted Tubes Mean:	57 (52 - 65)	µgm⁻³

Precision	8 out of 8 periods have a CV smaller than 20%
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Accuracy		(with 95% confidence interval)
WITH ALL DATA		
Bias calculated using 6 periods of data		
Bias factor A	0.94	(0.85 - 1.06)
Bias B	6%	(-6% - 18%)
Diffusion Tubes Mean:	61	μgm^{-3}
Mean CV (Precision):	6	
Automatic Mean:	57	μgm^{-3}
Data Capture for periods used:	99%	
Adjusted Tubes Mean:	57 (52 - 65)	μgm^{-3}



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Diffusion Tubes Measurements									
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
1	05/01/2011	02/02/2011	69.5	69.8	68.3	69	0.8	1	2.0
2	02/02/2011	02/03/2011	65.5	73.0	78.8	72	6.7	9	16.6
3	02/03/2011	29/03/2011	59.9	64.3	53.6	59	5.4	9	13.4
4	29/03/2011	27/04/2011	61.2	63.6	58.4	61	2.6	4	6.5
5	27/04/2011	01/06/2011	55.9	57.4	54.8	56	1.3	2	3.2
6	01/06/2011	29/06/2011	63.7	62.7	63.6	63	0.6	1	1.4
7	29/06/2011	03/08/2011	57.5	56.1	53.3	56	2.1	4	5.3
8	03/08/2011	31/08/2011	57.6	56.4	56.2	57	0.8	1	1.9
9	31/08/2011	28/09/2011	51.2	52.3	52.5	52	0.7	1	1.7
10	28/09/2011	02/11/2011	47.9	49.7	56.3	51	4.4	9	11.0
11	02/11/2011	29/11/2011	54.7	57.2	58.6	57	2.0	3	4.9
12	29/11/2011	04/01/2012	42.8	41.4	41.8	42	0.7	2	1.8
13									

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

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
56	99.3	Good	Good
49	99.9	Good	Good
46	43.5	Good	Poor Data Capture
-	0	Good	Poor Data Capture
41	62.4	Good	Poor Data Capture
60	69.8	Good	Poor Data Capture
54	96	Good	Good
50	99.4	Good	Good
49	92.7	Good	Good
54	99.2	Good	Good
58	99.8	Good	Good
56	99.5	Good	Good
Overall survey -->		Good precision	Poor Overall DC

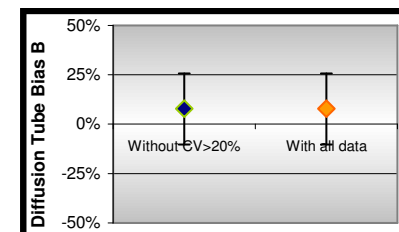
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Dundee Seagate
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Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 8 periods of data	
Bias factor A	0.93 (0.8 - 1.12)
Bias B	7% (-11% - 25%)
Diffusion Tubes Mean:	57 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	53 μgm^{-3}
Data Capture for periods used:	98%
Adjusted Tubes Mean:	53 (46 - 64) μgm^{-3}

Precision	12 out of 12 periods have a CV smaller than 20%
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Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 8 periods of data	
Bias factor A	0.93 (0.8 - 1.12)
Bias B	7% (-11% - 25%)
Diffusion Tubes Mean:	57 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	53 μgm^{-3}
Data Capture for periods used:	98%
Adjusted Tubes Mean:	53 (46 - 64) μgm^{-3}



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Diffusion Tubes Measurements									
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
1	05/01/2011	02/02/2011	67.4	70.6	68.8	69	1.6	2	4.0
2	02/02/2011	02/03/2011	65.0	64.9	64.5	65	0.3	0	0.7
3	02/03/2011	29/03/2011	59.0	59.9	54.0	58	3.2	6	7.9
4	29/03/2011	27/04/2011	54.5	53.7	53.9	54	0.4	1	1.0
5	27/04/2011	01/06/2011	35.7	39.5	40.8	39	2.7	7	6.6
6	01/06/2011	29/06/2011	39.3	40.1	40.0	40	0.4	1	1.1
7	29/06/2011	03/08/2011	33.4	30.1	31.5	32	1.7	5	4.1
8	03/08/2011	31/08/2011	36.0	39.6	39.3	38	2.0	5	5.0
9	31/08/2011	29/09/2011	40.8	44.0	42.0	42	1.6	4	4.0
10	29/09/2011	02/11/2011	41.3	36.9	40.3	40	2.3	6	5.7
11	02/11/2011	01/12/2011	39.8	44.6	42.8	42	2.4	6	6.0
12	01/12/2011	04/01/2012	39.1	38.7	37.0	38	1.1	3	2.8
13									

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

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
59.0	99.1	Good	Good
57.0	99.6	Good	Good
46.0	99.1	Good	Good
37.0	99.4	Good	Good
26.0	99.5	Good	Good
26.0	99.1	Good	Good
22.0	99.4	Good	Good
27.0	99.6	Good	Good
27.0	99.3	Good	Good
31.0	99.5	Good	Good
34.0	99.3	Good	Good
42.0	99.6	Good	Good

Overall survey -->

Good precision Good Overall
DC

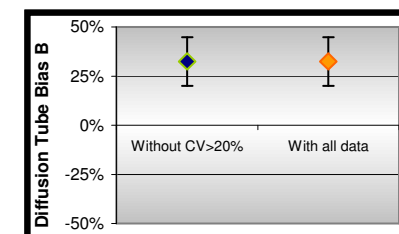
(Check average CV & DC from
Accuracy calculations)

Site Name/ ID:	Dundee Union Street
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Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 12 periods of data	
Bias factor A	0.78 (0.71 - 0.86)
Bias B	28% (16% - 40%)
Diffusion Tubes Mean:	46 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	36 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	36 (33 - 40) μgm^{-3}

Precision	12 out of 12 periods have a CV smaller than 20%
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Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 12 periods of data	
Bias factor A	0.78 (0.71 - 0.86)
Bias B	28% (16% - 40%)
Diffusion Tubes Mean:	46 μgm^{-3}
Mean CV (Precision):	4
Automatic Mean:	36 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	36 (33 - 40) μgm^{-3}



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Diffusion Tubes Measurements									
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
1	05/01/2011	02/02/2011	57.8	58.8	56.1	58	1.4	2	3.4
2	02/02/2011	02/03/2011	52.0	52.8	54.2	53	1.1	2	2.8
3	02/03/2011	29/03/2011	49.2	54.7	47.9	51	3.6	7	9.0
4	29/03/2011	27/04/2011	43.2	49.9	41.1	45	4.6	10	11.4
5	27/04/2011	01/06/2011	42.9	41.4	41.8	42	0.8	2	1.9
6	01/06/2011	29/06/2011	45.9	50.1	47.9	48	2.1	4	5.2
7	29/06/2011	03/08/2011	48.0	42.3	41.7	44	3.5	8	8.6
8	03/08/2011	31/08/2011	46.7	47.7	46.4	47	0.7	1	1.7
9	31/08/2011	28/09/2011	42.6	42.2	40.5	42	1.1	3	2.8
10	28/09/2011	02/11/2011	45.5	42.7	43.9	44	1.4	3	3.5
11	02/11/2011	01/12/2011	46.0	47.1	45.3	46	0.9	2	2.3
12	01/12/2011	04/01/2012	35.5	36.9	33.8	35	1.6	4	3.9
13									

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

Site Name/ ID:	Dundee Whitehall Street
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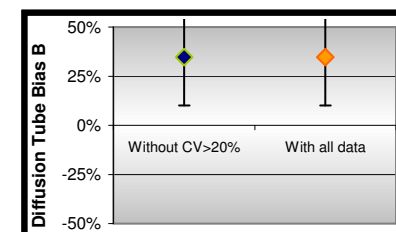
Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 9 periods of data	
Bias factor A	0.77 (0.65 - 0.95)
Bias B	30% (5% - 54%)
Diffusion Tubes Mean:	46 μgm^{-3}
Mean CV (Precision):	3
Automatic Mean:	36 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	36 (30 - 44) μgm^{-3}

Precision	12 out of 12 periods have a CV smaller than 20%
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Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 9 periods of data	
Bias factor A	0.77 (0.65 - 0.95)
Bias B	30% (5% - 54%)
Diffusion Tubes Mean:	46 μgm^{-3}
Mean CV (Precision):	3
Automatic Mean:	36 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	36 (30 - 44) μgm^{-3}

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
48.0	97.0	Good	Good
47.0	99.9	Good	Good
36.0	44.1	Good	Poor Data Capture
-	0.0	Good	Poor Data Capture
24.0	59.6	Good	Poor Data Capture
23.0	99.3	Good	Good
32.0	99.4	Good	Good
31.0	99.6	Good	Good
30.0	99.6	Good	Good
36.0	99.5	Good	Good
38.0	99.6	Good	Good
36.0	98.9	Good	Good
Overall survey -->		Good precision	Poor Overall DC

(Check average CV & DC from Accuracy calculations)



Jaume Targa, for AEA
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APPENDIX D : ANNUALISATION OF DATA

Annualisation of nitrogen dioxide (NO₂) data from continuous analysers

Locations	count	Data capture %	Annual Mean, Am	Period Mean, Pm	Ratio (Am/Pm)	Average ratio, R _a	NO ₂ Annual Mean (annualised)(ug/m ³)
Aberdeen Errol Place	4445	50.7	22.8	20.5	1.110	1.154	
Edinburgh St Leonards	4538	51.8	24.8	21.2	1.172		
Grangemouth Moray	4486	51.2	17.3	14.7	1.180		
Dundee Meadowside	4579	52.3		57.5	x Average ratio =		66.4
Aberdeen Errol Place	3261	37.2	22.8	29.8	0.765	0.787	
Edinburgh St Leonards	3373	38.5	24.8	29.8	0.833		
Grangemouth Moray	3403	38.8	17.3	22.7	0.762		
Dundee Lochee Road	3437	39.2		73.9	x Average ratio =		58.2
Aberdeen Errol Place	6455	73.7	22.8	20.2	1.126	1.166	
Edinburgh St Leonards	6534	74.6	24.8	21.4	1.162		
Grangemouth Moray	6420	73.3	17.3	14.3	1.209		
Dundee Mains Loan	6613	75.5		10.0	x Average ratio =		11.6

Ratios for annualisation of data from NO₂ tube locations

Background Locations	Balgavies PI (Average)	Birnam PI	Earl Grey PI (Park)	Woodside Ave (Average)	
Jan-11	39.4	22.0	49.4	36.8	
Feb-11	33.8	19.2	37.0	31.0	
Mar-11	23.5	13.2	24.4	21.4	
Apr-11	21.0	8.9	17.3	15.1	
May-11	16.0	8.0	16.7	11.6	
Jun-11	16.3	9.4	19.2	14.9	
Jul-11	11.1	8.2	15.5	13.4	
Aug-11	14.8	9.8	20.2	15.2	
Sep-11	20.3	10.2	20.5	15.9	
Oct-11	19.2	9.3	21.1	18.2	
Nov-11	25.8	16.7	28.4	26.1	
Dec-11	21.2	12.4	28.1	18.1	
Mean (Am)	21.9	12.3	24.8	19.8	Average Ratio R_a
Pm (Apr-Aug, Oct-Dec)	18.2	10.3	20.8	16.6	
Am/Pm	1.203	1.187	1.192	1.195	1.194
Pm Jul-Dec	18.7	11.1	22.3	17.8	
Am/Pm	1.167	1.106	1.113	1.111	1.124
Pm May-Dec	18.1	10.5	21.2	16.7	
Am/Pm	1.208	1.169	1.170	1.187	1.184
Pm Jan-May	26.7	14.3	29.0	23.1	
Am/Pm	0.818	0.861	0.857	0.855	0.848
Pm Jan-Jul	23.0	12.7	25.6	20.6	
Am/Pm	0.950	0.967	0.968	0.962	0.962
Pm Jan-Jun	25.0	13.5	27.3	21.8	
Am/Pm	0.875	0.913	0.908	0.909	0.901
Pm Jul & Sep-Dec	19.5	11.4	22.7	18.3	
Am/Pm	1.120	1.081	1.092	1.079	1.093

Annualisation of data from NO₂ Diffusion tube locations with less than 9 months data

	Broughty Ferry Rd (L/P 66)	B/Ferry Rd (141 Downpipe)	Meadowside ROMON (Average)	Union St (Goodfellows)	Union St (McIntyres)	Dock St (Unicorn)	Dock St 57
Jan-11	-	-	-	52.9	48.2	68.8	-
Feb-11	-	-	-	47.2	48.5	63.2	-
Mar-11	-	-	-	40.4	39.0	52.7	-
Apr-11	37.9	-	-	32.9	33.6	46.7	-
May-11	36.2	-	59.8	30.1	30.6	38.4	-
Jun-11	37.3	-	62.9	-	40.0	40.2	-
Jul-11	25.3	30.5	59.5	-	30.2	-	30.1
Aug-11	37.1	37.4	62.6	-	-	-	-
Sep-11	-	46.2	64.8	-	-	-	53.4
Oct-11	39.6	48.5	59.7	-	-	-	60.2
Nov-11	35.7	47.5	65.7	-	-	-	59.8
Dec-11	44.3	39.4	53.5	-	-	-	51.2
Pm Mean	36.7	41.6	61.1	40.7	38.6	51.7	50.9
Average Ratio Ra	1.194	1.124	1.184	0.848	0.962	0.901	1.093
Annual Mean	43.8	46.7	72.3	34.5	37.1	46.6	55.7

Annualisation of particulate matter (PM₁₀) data from continuous analysers

Locations	count	Data capture %	Annual Mean, Am	Period Mean, Pm	Ratio (Am/Pm)	Average ratio, R _a	PM ₁₀ Annual Mean (annualised)(u g/m ³)
Aberdeen Errol Place	8350	95.3	13.7	12.6	1.090	1.107	
Edinburgh St Leonards	8648	98.7	15.4	14.4	1.066		
Falkirk Grangemouth MC	7647	87.3	15.1	12.7	1.185		
N Lanarkshire Coatbridge Whifflet	7949	90.7	14.9	13.7	1.088		
Dundee Meadowside	4436	50.6		21.0	x Average ratio =		23.3
Aberdeen Errol Place	8350	95.3	13.7	13.7	1.007	1.024	
Edinburgh St Leonards	8648	98.7	15.4	15.3	1.005		
Falkirk Grangemouth MC	7647	87.3	15.1	14.2	1.064		
N Lanarkshire Coatbridge Whifflet	7949	90.7	14.9	14.6	1.022		
Dundee Lochee Road	6308	72.0		18.9	x Average ratio =		19.4
Aberdeen Errol Place	8350	95.3	13.7	12.9	1.062	1.101	
Edinburgh St Leonards	8648	98.7	15.4	14.4	1.065		
Falkirk Grangemouth MC	7647	87.3	15.1	12.9	1.170		
N Lanarkshire Coatbridge Whifflet	7949	90.7	14.9	13.5	1.105		
Dundee Seagate	5465	62.4		15.5	x Average ratio =		17.1

APPENDIX E : MONTHLY DIFFUSION TUBE CONCENTRATIONS

LOCATION	x	y	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Mean	Data %	Period Adj' Factor	Annual Mean	Annual Mean (Bias 0.78)
Abertay 2	340019	730612	65.4	63.5	58.3	46.1	42.2	52.3	46.0	48.7	51.4	48.7	61.1	33.6	51.4	100.0	n/a	51.4	40.1
Albert St (Shandon PI)	341171	731574	54.7	61.0	45.5	41.9	39.2	44.3	44.8	40.9	40.4	44.8	54.0	29.1	45.1	100.0	n/a	45.1	35.1
Albert St (71-73)	341106	731223	52.8	50.6	40.4	32.8	29.6	37.2	34.0	34.0	38.7	35.6	41.7	29.1	38.0	100.0	n/a	38.0	29.7
Albert St (Fish)	341139	731476	64.6	48.2	43.0	36.0	27.9	31.8	22.7	30.5	38.4	31.2	42.2	32.8	37.4	100.0	n/a	37.4	29.2
Arbroath Rd (13)	341111	731070	62.1	61.9	54.8	46.3	38.3	44.8	28.9	39.3	49.4	44.5	53.5	39.3	46.9	100.0	n/a	46.9	36.6
Arbroath Rd (38)	341202	731097	64.0	54.8	46.4	38.5	32.9	42.2	37.8	45.8	47.1	39.5	47.4	36.2	44.4	100.0	n/a	44.4	34.6
Arthursstone Tce (10)	341051	731203	41.7	36.4	28.8	21.1	20.2	23.8	21.4	25.1	27.1	27.6	34.1	21.3	27.4	100.0	n/a	27.4	21.4
Balgavies PI 1	343082	731465	36.1	33.6	21.0	20.8	15.7	16.3	11.0	14.3	20.5	19.2	24.5	21.1	21.2	100.0	n/a	21.2	16.5
Balgavies PI 2	343082	731465	38.4	33.1	23.1	20.3	16.5	16.3	10.8	14.8	19.6	19.2	26.7	19.6	21.5	100.0	n/a	21.5	16.8
Balgavies PI 3	343082	731465	43.7	34.6	26.4	21.8	15.9	16.4	11.5	15.2	20.9	19.2	26.3	22.8	22.9	100.0	n/a	22.9	17.9
Balgavies PI Average	343082	731465	39.4	33.8	23.5	21.0	16.0	16.3	11.1	14.8	20.3	19.2	25.8	21.2	21.9	100.0	n/a	21.9	17.1
Bank St/ Reform St	340228	730337	51.3	42.3	36.1	31.4	27.1	27.0	23.1	28.6	35.0	34.2	36.4	36.9	34.1	100.0	n/a	34.1	26.6
Birnam PI	337531	730914	22.0	19.2	13.2	8.9	8.0	9.4	8.2	9.8	10.2	9.3	16.7	12.4	12.3	100.0	n/a	12.3	9.6
Broughty Ferry Rd Lower (L/P 5)	343415	730944	-	-	-	25.7	20.1	17.1	10.6	18.3	21.6	24.5	32.5	26.7	21.9	75.0	n/a	21.9	17.1
Broughty Ferry Rd (L/P 66)	343297	731096	-	-	-	37.9	36.2	37.3	25.3	37.1		39.6	35.7	44.3	36.7	66.7	1.194	43.8	34.2
Broughty Ferry Rd (141 Downpipe)	343317	731072	-	-	-	-	-	-	30.5	37.4	46.2	48.5	47.5	39.4	41.6	50.0	1.124	46.7	36.5
Broughty Ferry Rd (141)	343322	731073	81.1	68.9	63.2	52.2	51.7	50.9	31.7	48.9	50.7	46.1	55.3	53.3	54.5	100.0	n/a	54.5	42.5
Broughty Ferry Rd (St. Sign)	343302	731075	-	-	-	37.4	29.5	35.4	33.7	38.9	31.4	33.8	44.2	30.6	35.0	75.0	n/a	35.0	27.3
Broughty Ferry Rd (L/P 59)	343129	731082	-	-	-	33.5	25.9	28.3	23.8	28.0	28.4	25.2	34.2	28.8	28.5	75.0	n/a	28.5	22.2
Broughty Ferry Rd (Greendykes)	342662	731112	-	-	-	41.6	41.8	42.9	39.4	38.5	43.7	47.6	44.4	36.7	41.8	75.0	n/a	41.8	32.6
Claypotts Junction	345315	732103	44.7	46.3	36.9	30.8	25.5	32.5	27.3	27.9	27.7	27.9	39.9	23.0	32.5	100.0	n/a	32.5	25.4
Cleington Rd/ Forfar Rd	341385	732121	69.6	58.5	49.2	42.5	32.4	41.0	32.6	39.2	41.4	40.7	49.3	36.9	44.4	100.0	n/a	44.4	34.7
Commercial St	340328	730431	45.4	49.7	43.7	30.8	29.2	35.5	32.7	33.3	34.3	36.4	32.4	24.7	35.7	100.0	n/a	35.7	27.8
Commercial St /Dock St	340565	730263	64.4	59.4	54.7	45.9	42.0	44.7	35.8	46.6	45.7	48.1	46.4	44.6	48.2	100.0	n/a	48.2	37.6
Commercial St (Waterstones)	340481	730325	51.3	56.5	53.1	42.2	44.0	54.5	57.5	52.6	42.6	49.3	44.4	36.0	48.7	100.0	n/a	48.7	38.0

Dundee City Council

LOCATION	x	y	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Mean	Data %	Period Adj' Factor	Annual Mean	Annual Mean (Bias 0.78)
Crichton St	340331	730162	52.9	45.8	44.7	29.8	30.3	33.1	30.4	35.6	34.1	36.8	37.5	34.5	37.1	100.0	n/a	37.1	29.0
Dens Rd (Crossing)	340725	731238	57.0	54.0	46.7	36.9	30.6	37.9	31.7	33.2	42.7	46.0	46.6	24.0	40.6	100.0	n/a	40.6	31.7
Dock St (Tay Hotel)	340340	730033	44.9	37.3	34.4	28.1	25.4	32.1	31.0	30.9	24.1	25.4	31.0	27.5	31.0	100.0	n/a	31.0	24.2
Dock St (Carol Whyte) 2	340524	730216	61.4	53.1	51.0	41.0	37.6	42.8	36.3	43.4	39.6	45.1	41.2	32.9	43.8	100.0	n/a	43.8	34.2
Dock St (Unicorn)	340659	730348	68.8	63.2	52.7	46.7	38.4	40.2	-	-	-	-	-	-	51.7	50.0	0.901	46.6	36.3
Dock St (57)	340656	730343	-	-	-	-	-	-	30.1	-	53.4	60.2	59.8	51.2	50.9	41.7	1.093	55.7	43.4
Dock St (Sheridans)	340395	730086	62.9	53.3	54.7	47.4	40.4	45.9	41.8	45.7	42.9	40.2	44.0	39.9	46.6	100.0	n/a	46.6	36.3
Dura St (Fortes)	341150	731576	69.6	57.4	55.9	36.8	35.7	45.0	43.9	44.5	46.7	43.7	46.4	34.8	46.7	100.0	n/a	46.7	36.4
Earl Grey Pl (Park)	340699	730019	49.4	37.0	24.4	17.3	16.7	19.2	15.5	20.2	20.5	21.1	28.4	28.1	24.8	100.0	n/a	24.8	19.4
Eastport Roundabout	340651	730623	58.6	55.2	44.7	42.6	36.8	40.7	38.1	37.6	38.8	39.6	44.7	31.5	42.4	100.0	n/a	42.4	33.1
Harefield Rd (35)	338360	731855	52.1	49.3	37.9	30.2	27.2	30.7	26.4	32.9	-	32.0	43.3	28.2	35.5	91.7	n/a	35.5	27.7
Forfar Road	341437	732360	81.5	70.6	66.9	57.9	46.7	51.9	49.3	58.7	-	50.3	62.5	47.4	58.5	91.7	n/a	58.5	45.6
Hilltown (Suites)	340088	731116	58.4	44.9	36.4	34.8	32.7	36.8	33.9	31.5	37.4	35.9	42.6	28.8	37.8	100.0	n/a	37.8	29.5
King St (12/14)	340598	730757	47.9	47.2	35.1	30.8	24.6	31.1	24.5	27.8	36.5	36.5	36.0	29.4	34.0	100.0	n/a	34.0	26.5
Kingsway East Roundabout	343107	731740	75.1	66.4	57.9	43.4	43.5	-	-	44.9	49.8	48.8	59.8	32.5	52.2	83.3	n/a	52.2	40.7
Kingsway/ Mains Loan	341124	732468	54.7	52.6	44.5	37.1	33.7	44.2	42.2	43.9	30.0	31.4	44.0	23.8	40.2	100.0	n/a	40.2	31.3
Kingsway/ Strathmartine Rd (S)	339221	732836	75.6	56.3	61.3	51.6	43.8	46.8	40.0	50.5	-	36.2	47.9	45.4	50.5	91.7	n/a	50.5	39.4
Lochee Rd (138)	338936	730680	90.3	88.4	75.3	69.1	55.0	63.3	58.3	63.2	60.2	62.4	66.0	59.5	67.6	100.0	n/a	67.6	52.7
Lochee Rd (140 Traffic Lts)	338927	730685	90.8	82.5	67.6	62.0	53.7	62.2	60.3	63.6	64.6	68.9	67.7	54.9	66.6	100.0	n/a	66.6	51.9
Lochee Rd (184)	338767	730856	76.3	59.8	51.4	-	38.5	39.5	35.4	39.6	-	52.2	44.3	35.7	47.3	83.3	n/a	47.3	36.9
Lochee Rd/Polepark Rd	339016	730586	56.4	52.9	38.5	34.0	28.9	31.8	28.7	32.5	32.6	34.3	43.7	32.5	37.2	100.0	n/a	37.2	29.0
Lochee Rd (Romon) 1	338861	730773	84.9	73.6	71.9	50.5	52.2	52.2	44.7	55.8	60.9	60.9	60.8	43.0	59.3	100.0	n/a	59.3	46.2
Lochee Rd (Romon) 2	338861	730773	91.0	74.1	71.5	61.9	45.3	53.6	50.3	55.0	58.4	56.5	62.9	53.1	61.1	100.0	n/a	61.1	47.7
Lochee Rd (Romon) 3	338861	730773	87.7	73.4	69.2	65.2	49.1	54.3	51.1	54.4	53.3	59.5	62.2	54.2	61.1	100.0	n/a	61.1	47.7
Lochee Rd (Romon) Average	338861	730773	87.9	73.7	70.9	59.2	48.9	53.4	48.7	55.1	57.5	59.0	62.0	50.1	60.5	100.0	n/a	60.5	47.2
Logie St (114)	338184	731293	85.0	83.8	71.6	62.8	56.5	64.6	59.3	64.3	70.4	70.6	73.9	63.5	68.9	100.0	n/a	68.9	53.7
Logie St (98)	338252	731258	61.8	53.8	44.1	-	33.9	35.1	28.4	35.5	39.4	38.3	43.6	36.6	41.0	91.7	n/a	41.0	31.9
Loons Rd (1)	338211	731293	63.5	65.8	50.4	41.8	40.3	50.5	46.4	51.4	42.9	46.4	55.3	36.5	49.3	100.0	n/a	49.3	38.4
Marketgait	339953	730094	44.1	49.5	43.2	34.9	30.8	41.8	45.9	41.4	34.1	35.1	42.9	29.6	39.4	100.0	n/a	39.4	30.8
Mains Loan Average	340972	731893	-	-	-	13.5	12.2	12.6	11.2	12.9	15.5	19.2	27.5	15.8	15.6	75.0	n/a	15.6	12.2

Dundee City Council

LOCATION	x	y	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Mean	Data %	Period Adj' Factor	Annual Mean	Annual Mean (Bias 0.78)
Meadowside	340245	730651	88.0	81.0	72.7	71.4	62.1	62.3	54.9	62.2	67.6	67.1	66.5	58.9	67.9	100.0	n/a	67.9	53.0
Meadowside (Romon)1	340243	730653	-	-	-	-	60.6	63.2	60.3	62.8	66.0	53.0	59.2	51.4	59.6	66.7	1.2	70.5	55.0
Meadowside (Romon) 2	340243	730653	-	-	-	-	59.7	62.9	56.6	60.9	61.2	60.4	69.0	52.0	60.3	66.7	1.2	71.4	55.7
Meadowside (Romon) 3	340243	730653	-	-	-	-	59.0	62.7	61.5	64.0	67.2	65.6	68.9	57.2	63.3	66.7	1.2	74.9	58.4
Meadowside (Romon) Average	340243	730653	-	-	-	-	59.8	62.9	59.5	62.6	64.8	59.7	65.7	53.5	61.1	66.7	1.184	72.3	56.4
Muirton Rd (6)	338152	731293	40.6	47.9	35.8	27.4	29.7	33.7	33.8	31.5	30.0	30.5	43.2	23.1	33.9	100.0	n/a	33.9	26.5
Myrekirk Rd	335420	731733	63.5	50.0	45.5	36.0	30.1	36.1	29.8	35.2	22.8	33.8	33.4	38.0	37.9	100.0	n/a	37.9	29.5
Nethergate (Charlie T)	340033	729957	57.8	50.9	49.2	37.5	32.9	42.1	38.9	42.7	35.9	38.1	41.8	32.8	41.7	100.0	n/a	41.7	32.5
Nethergate (B&B)	340163	730061	67.8	68.1	56.4	61.9	51.8	63.6	56.7	59.8	51.7	54.0	56.2	41.9	57.5	100.0	n/a	57.5	44.8
Nethergate (Bradford)	340274	730171	63.6	52.6	58.1	46.9	39.6	50.6	40.3	47.4	49.0	49.6	47.3	39.6	48.7	100.0	n/a	48.7	38.0
Nethergate (Trades House)	340230	730124	57.8	56.0	54.4	51.9	46.6	52.9	49.7	48.1	36.4	48.5	49.1	35.4	48.9	100.0	n/a	48.9	38.1
Nethergate/ South Tay St	339987	729919	44.4	41.9	25.5	31.5	27.6	31.4	28.8	33.5	25.5	28.4	33.7	23.0	31.3	100.0	n/a	31.3	24.4
Nethergate/ Marketgait	340074	729984	53.3	49.1	39.5	33.2	34.3	41.1	35.3	37.8	34.7	37.3	35.7	33.3	38.7	100.0	n/a	38.7	30.2
Perth Rd 320	338776	729798	61.7	63.6	53.7	38.4	37.2	41.0	40.7	41.4	45.5	44.6	47.2	38.7	46.1	100.0	n/a	46.1	36.0
Queen St B/F	346207	731007	55.7	45.6	35.6	28.9	26.4	24.9	21.0	27.5	27.2	27.5	34.1	32.4	32.2	100.0	n/a	32.2	25.1
Rankine St (2)	338768	730900	83.1	62.3	49.2	50.6	40.0	42.2	40.0	47.2	48.4	51.1	56.8	52.6	52.0	100.0	n/a	52.0	40.5
Seagate	340545	730532	63.0	58.2	56.7	51.6	47.8	51.8	48.3	47.9	48.5	54.3	52.5	38.6	51.6	100.0	n/a	51.6	40.2
Seagate (97)	340511	730492	66.0	72.3	64.9	62.6	55.7	58.8	60.2	56.6	54.4	60.0	54.1	45.6	59.3	100.0	n/a	59.3	46.2
Seagate (Romon) 1	340487	730446	69.5		59.9	61.2	55.9	63.7	57.5	57.6	51.2	47.9	54.7	42.8	56.5	91.7	n/a	56.5	44.1
Seagate (Romon) 2	340487	730446	69.8	73.0	64.3	63.6	57.4	62.7	56.1	56.4	52.3	49.7	57.2	41.4	58.7	100.0	n/a	58.7	45.8
Seagate (Romon) 3	340487	730446	68.3	78.8	53.6	58.4	54.8	63.6	53.3	56.2	52.5	56.3	58.6	41.8	58.0	100.0	n/a	58.0	45.3
Seagate (Romon) Average	340487	730446	69.2	75.9	59.3	61.1	56.0	63.3	55.6	56.7	52.0	51.3	56.8	42.0	57.7	100.0	n/a	57.7	45.0
Seagate (Yates)	340467	730388	61.4	55.8	45.9	41.5		46.3	43.5	44.7	40.5	43.2	45.9	32.7	45.6	91.7	n/a	45.6	35.6
Soapwork Lane	340099	730650	60.9	53.0	46.2	40.1	30.9	38.2	30.4	38.9		39.2	46.2	39.2	42.1	91.7	n/a	42.1	32.8
South Road (Denbank)	335188	731528	68.2	49.7		46.4	36.8	41.6	39.3	42.3	36.6	41.8	47.9	37.7	44.4	91.7	n/a	44.4	34.6
St Andrews St (Jaf)	340516	730584	55.8	52.8	37.9	40.2	36.8	44.3		41.2	38.5	39.3	51.5	34.4	43.0	91.7	n/a	43.0	33.5
St Andrews St (Pb)	340532	730551	63.1	54.9	51.9	47.2	42.8	45.5	40.0	45.5	43.9	50.4	51.9	-	48.8	91.7	n/a	48.8	38.1
Strathmore Ave (337)	339522	731875	57.1	56.6	45.3	36.9	30.3	9.1	30.7	33.9	34.8	41.1	49.0	34.9	38.3	100.0	n/a	38.3	29.9
Strathmore Ave (353)	339609	731871	57.8	59.7	49.5	46.1	35.7	46.0	41.6	43.0	37.0	36.7	55.2	37.3	45.5	100.0	n/a	45.5	35.5
Strathmore Ave (Ped X)	339667	731878	40.7	49.1	35.8	30.4		33.7	35.7	33.9	25.3	31.1	39.1	22.0	34.3	91.7	n/a	34.3	26.7

Dundee City Council

LOCATION	x	y	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Mean	Data %	Period Adj' Factor	Annual Mean	Annual Mean (Bias 0.78)
Trades Lane (31)	340575	730500	58.0	49.7	40.5	31.2	31.7	33.7	26.7	30.7	34.7	41.8	40.3	33.5	37.7	100.0	n/a	37.7	29.4
Union St (Goodfellows)	340274	730069	52.9	47.2	40.4	32.9	30.1								40.7	41.7	0.848	34.5	26.9
Union St (McIntyres)	340293	730051	48.2	48.5	39.0	33.6	30.6	40.0	30.2				-	-	38.6	58.3	0.962	37.1	28.9
Union St (Rollalong) 1	340235	730091	67.4	65.0	59.0	54.5	35.7	39.3	33.4	36.0	40.8	41.3	39.8	39.1	45.9	100.0	n/a	45.9	35.8
Union St (Rollalong) 2	340235	730091	70.6	64.9	59.9	53.7	39.5	40.1	30.1	39.6	44.0	36.9	44.6	38.7	46.9	100.0	n/a	46.9	36.6
Union St (Rollalong) 3	340235	730091	68.8	64.5	54.0	53.9	40.8	40.0	31.5	39.3	42.0	40.3	42.8	37.0	46.2	100.0	n/a	46.2	36.1
Union St (Rollalong) Average	340235	730091	68.9	64.8	57.6	54.0	38.7	39.8	31.7	38.3	42.3	39.5	42.4	38.3	46.4	100.0	n/a	46.4	36.2
Victoria Rd	340212	730633	55.5	60.2	25.0	34.9	32.3	42.3	36.7	37.3	37.6	30.9	52.3	29.9	39.6	100.0	n/a	39.6	30.9
Victoria Rd (60)	340375	730779	62.0	61.0	54.3	48.3	40.7	46.5	50.6	47.4		44.4	51.1	37.8	49.5	91.7	n/a	49.5	38.6
Victoria Rd (Osiris)	340230	730673	55.5	55.1	48.8	43.8	35.0	42.5	41.7	43.3	39.6	40.5	46.0	28.5	43.4	100.0	n/a	43.4	33.8
Victoria Rd / Cotton Rd	340740	730996	63.5	57.3	46.4	41.6	36.0	41.0	32.1	39.2	49.7	33.3	48.5	34.0	43.6	100.0	n/a	43.6	34.0
Victoria Rd / Hilltown	340274	730714	100.6	80.5	72.6	64.1	60.3	64.3	35.2	67.8	69.1	68.4	68.9	61.0	67.7	100.0	n/a	67.7	52.8
Victoria St / Albert St	341071	731072	56.1	51.7	45.5	32.1	31.4	38.1	36.4	37.9		36.2	82.5	28.8	43.3	91.7	n/a	43.3	33.8
Ward Rd	339893	730336	51.9	51.5	43.0	40.8	35.4	38.8	33.9	37.1	43.7	46.0	44.7	32.4	41.6	100.0	n/a	41.6	32.4
Westport (2)	339842	730122	66.6	57.6	47.4	44.8	41.6	43.0	36.2	39.2	47.6	50.5	53.6	40.8	47.4	100.0	n/a	47.4	37.0
West Marketgait	339814	730380	60.8	59.7	44.9	44.0	35.2	45.2	39.8	45.0	41.4	34.0	51.2	36.8	44.8	100.0	n/a	44.8	35.0
Whitehall St (Brj)	340330	730106	60.5	52.8	43.5	39.8	33.8	40.7	39.1	43.3	38.0	39.2	40.2	37.9	42.4	100.0	n/a	42.4	33.1
Whitehall St (Bus)	340289	730128	67.4	71.0	72.4	59.5	50.8	56.5	47.9	52.8	59.6	58.7	59.2	47.5	58.6	100.0	n/a	58.6	45.7
Whitehall St (Deb A)	340265	730153	70.1	58.2	58.7	54.9	48.3	55.2	49.9	51.4	50.2	45.6	54.0	40.4	53.1	100.0	n/a	53.1	41.4
Whitehall St (Deb E)	340322	730098	63.3	52.9	52.3	42.1	37.3	46.4	35.6	45.1	42.3	38.1	44.3	33.7	44.5	100.0	n/a	44.5	34.7
Whitehall St (Romon) 1	340278	730156	57.8	52.0	49.2	43.2	42.9	45.9	48.0	46.7	42.6	45.5	46.0	35.5	46.3	100.0	n/a	46.3	36.1
Whitehall St (Romon) 2	340278	730156	58.8	52.8	54.7	49.9	41.4	50.1	42.3	47.7	42.2	42.7	47.1	36.9	47.2	100.0	n/a	47.2	36.8
Whitehall St (Romon) 3	340278	730156	56.1	54.2	47.9	41.1	41.8	47.9	41.7	46.4	40.5	43.9	45.3	33.8	45.1	100.0	n/a	45.1	35.1
Whitehall St (Romon) Average	340278	730156	57.6	53.0	50.6	44.7	42.0	48.0	44.0	46.9	41.8	44.0	46.1	35.4	46.2	100.0	n/a	46.2	36.0
Whitehall St (Tiso)	340293	730142	55.2	57.0	48.7	40.3	38.6	49.4	47.2	47.0		44.3	45.6	31.5	45.9	91.7	n/a	45.9	35.8
Whitehall Cr (Xpresso)	340376	730109	43.9	44.0	40.4	20.9	29.0	34.2	30.9	32.8	29.5	32.4	36.6	26.3	33.4	100.0	n/a	33.4	26.1
Woodside Ave 1	340776	732307	35.2	31.4	19.9	12.9	12.0	14.9	13.6	15.2	15.0	17.6	26.3	18.2	19.4	100.0	n/a	19.4	15.1
Woodside Ave 2	340776	732307	39.9	31.3	21.1	15.6	10.9	14.8	13.6	15.6	15.9	18.7	27.8	16.7	20.2	100.0	n/a	20.2	15.7
Woodside Ave 3	340776	732307	35.2	30.2	23.1	16.7	11.8	14.9	13.0	14.9	16.8	18.2	24.2	19.5	19.9	100.0	n/a	19.9	15.5
Woodside Ave Average	340776	732307	36.8	31.0	21.4	15.1	11.6	14.9	13.4	15.2	15.9	18.2	26.1	18.1	19.8	100.0	n/a	19.8	15.4

APPENDIX F : ROAD TRAFFIC DATA

DCC : Results of Screening of 2007 Peak Hour Counts (taken to update the DCC paramics model) factored to 2010 AADT by SIAS Ltd (factors used presented in 2009 USA)

Junction no.	Name	Total vpd at junction predicted in 2010	Receptor within 10m	>10,000 vpd	canyon ?	Receptor within 2m	>5,000 vpd	PM10 Background >15ug/m3	>2,500 vpd	>20% HDV	DMRB Required	In FA/DA	Reason
J1	Riverside Dr / Riverside approach	25560	y	y	n	n	y	n	y	n	y	n	no previous assessment
J18	Blackness Rd / Balgay Road	10541	y	y	n	n	y	n	y	n	y	n	no previous assessment
J39	Constitution St / Rosebank St	12833	y	y	n	y	y	n	y	n	y	n	no previous assessment
J44	Riverside Dr / Tesco	29753	y	y	n	n	y	n	y	n	y	n	>10% increase
J55	Pitkerro Rd / Dalkeith Rd	14057	y	y	n	n	y	n	y	n	y	n	no previous assessment
J56	Nethergate / South Tay St.	6876	y	n	n	n	y	n	y	y	y	n	no previous assessment

	y	y											
			y	y	y								
	y				y	y							
	y							y		y			

Four combinations potentially requiring assessment though depends on what was previously assessed and how much greater the traffic flows are over last time.

DCC : SAFETY CAMERA PARTNERSHIP SITES

Site	Receptor within 10m	Receptor within 2m	2006 AADT	2011 AADT	Average Speed	% HDV	Date	DMRB required	Reasons
Drumgeith Road (Nr St. Saviours School)	y	n	12378	12670	33.1	-	2011	n	increase less than 10%
Old Glamis Road (nr Dundee College)	y	n	9059	9285	31.7	-	2011	n	less than 10,000 vpd, not narrow congested, PM background less than 15ug
Laird Street (E of Benholm Place)	y	n		2886	30.3	-	2011	n	less than 5,000 vpd
Strathmartine Road (N of Kirkton Rd) ?	y	n	12554	10035	29.1	-	2011	n	less than previous
Charlestone Drive (E of Dickson Ave)	y	n		5006	29.1	-	2011	n	PM background less than 15ug, not narrow congested
Broughty Ferry Road (W of Market St)	y	n		6977	31.2	-	2011	n	PM background less than 15ug, not narrow congested
Perth Road (E of Grosvenor Rd)	y	y		6512	29.3	-	2011	n	PM background less than 15ug, not narrow congested
Fountainbleau Drive (near Row antree Cres)	n	n		7303	32.2	-	2011	n	PM background less than 15ug, not narrow congested
Kings Cross Road (N of Lundie Ave)	n	n	11347	10851	31.1	-	2011	n	less than previously assessed also no receptors within 10m

DCC : RADAR COUNTER DATA 2011

Site	Receptor within 10m	Receptor within 2m	2006 Estimated AADT 2010	2009 Estimated AADT 2010	AADT	Average Speed	% HDV	Date	DMRB Required	Reason
Drumgeith Road (near Summerfield Ave)	y	n	13763	n/a	12663	34.5	-	Aug-11	n	less than previous
Harefield Road (near Glenesk Ave)	y	n	n/a	n/a	7733	29.2	-	Nov-11	n	less than 10,000vpd,not narrow congested, PM background less than 15ug/m3
Perth Road (near Seafield Road)	y	n	n/a	n/a	5018	23.5	-	Sep-11	n	less than 10,000vpd,not narrow congested, PM background less than 15ug/m3
Forthill Road (near Cedar Road)	y	n	n/a	n/a	5063	27.4	-	Mar-11	n	less than 10,000vpd,not narrow congested, PM background less than 15ug/m3
Brook Street (near Polepark Road)	y	y	n/a	n/a	7648	20.5	-	Mar-11	n	less than 10,000vpd,not narrow congested, PM background less than 15ug/m3
Douglas Road (near Kemnay Gardens)	n	n	n/a	n/a	9893	28	-	Jun-11	n	less than 10,000vpd,not narrow congested, PM background less than 15ug/m3
Douglas Road (near Odeon Cinema)	n	n	n/a	n/a	10074	35.2	-	Jul-11	n	no receptors within 10m

DCC : OTHER AUTOMATIC TRAFFIC COUNTER DATA

Site	Receptors within 10m	Receptors within 2m	2005 AADT	2006 AADT	2007 AADT	2008 AADT	2011 AADT	Average Speed	% HDV	Date	DMRB Needed	Reason
Riverside Avenue -South of Sw allow Roundabout	n	n		18061		17405	16091	45.4	6.10%	2011	n	no receptors
Victoria Road - West of Wellington Street	y	n		9046	14017		7742	-	-	2011	n	less than previous
Dundee Road - West of Christian Road	n	n	18180	17415			15643	-	1.30%	2011	n	less than previous
Arbroath Road @ Monymusk	y	n		27245	28290		25113	33	5.90%	2011	n	less than previous
East Marketgait - South of Seagate	n	n					17269	25.5	1.90%	2011	n	no receptors
West Marketgait (South of Dudhope)	y	n			25535		23490	28.7	-	2011	n	less than previous
West Marketgait (South of Nethergate)	y	n			21100		20959	15.9	3.10%	2011	n	less than previous
Clelington Road (West of Mains Loan)	y	n					10208	-	1.60%	2011	y	>10,000 receptors within 10m
Clelington Road (East of Johnston Ave)	y	n					13862	-	1.90%	2011	y	>10,000 receptors within 10m
Craigie Drive - East of Lavender Street	y	n		8730/8923			7976	-	4.80%	2011	n	less than 10,000vpd,not narrow congested, PM background less than 15ug/m³
Lochee Road (West of Dudhope)	y	n			17713		17289	-	-	2011	n	less than previous
Dalhousie Road - West of Kerrington Crescent	y	n		12860		12668	11892	-	-	2011	n	less than previous

DCC : ROAD TRAFFIC REDUCTION ACT SITES

Site	Receptor within 10m	Receptor within 2m	2005 AADT	2008 AADT	2010 AADT	2011 AADT	Average Speed	% HDV	Date	DMRB Required	Reason
Arbroath Road (E of Kenilworth Ave)	y	n	13189	12957	13048	13283	-	-	2011	n	increase less than 10%
Blackness Road (W of Marchfield)	y	n		6193	6360	5911	-	-	2011	n	less than previous
Broughty Ferry Road (E of Dalglish Rd?)	y	n	33981			27315	-	-	2011	n	less than previous
Dens Road (S of Hillbank Rd)	y	n	10859	11025	11323	10062	-	-	2011	n	less than previous
Forfar Road (N of Janefield Pl)	y	n	9276	8220	8278	8861	-	-	2011	n	less than 10,000vpd, not narrow congested, PM ₁₀ background less than 15ug/m ³
Hilltown (N of Stirling St)	y	y		5598	5749	5416	-	-	2011	n	less than 10,000vpd, not narrow congested, PM ₁₀ background less than 15ug/m ³
Lochee Road (N of Rankine St)	y	n	13018	13291	13384	12684	-	-	2011	n	less than previous
Perth Road (E of Windsor St)	y	n	8343	7560	7764	7053	-	-	2011	n	less than 10,000vpd, not narrow congested, PM ₁₀ background less than 15ug/m ³
Pitkerro Road (S of Baxter Park)	y	n	9159	10102	10375	8675	-	-	2011	n	less than 10,000vpd, not narrow congested, PM ₁₀ background less than 15ug/m ³
Rankine Street (N of Lochee Rd)	y	n	8098	7931	8145	7115	-	-	2011	n	less than 10,000vpd, not narrow congested, PM ₁₀ background less than 15ug/m ³
Riverside Drive (nr Airport)	n	n	18818	19054	19187	17024	-	-	2011	n	no relevant receptors
Rosebank Street (N of Kinloch St)	y	n				4426	-	-	2011	n	less than 10,000vpd, not narrow congested, PM ₁₀ background less than 15ug/m ³
Tay Bridge	n	n		25419	25597	25235	-	-	2010	n	less than previous

DEPARTMENT FOR TRANSPORT (DFT) COUNT SITES																	
2010 Traffic Data						Predicted 2010 traffic Flow assessed in 2003 USA	Estimated HDV % in 2003	Predicted 2010 traffic flow assessed in 2005 DA	Estimated HDV % in 2005	Predicted 2010 traffic flow assessed in 2006 USA	Estimated HDV % in 2006	Predicted 2010 traffic flow assessed in 2009 FA- DA	Estimated HDV % in 2007	percent increase (in AADF)	DMRB required	Reasons	
Count Point Id	Road/Location of count		Easting	Northing	All Motor Vehicles (AADF)	HDV %											
798	A90	Kingsway - E of Old Glamis Rd	340500	732650	38953	5.1									n	no relevant receptors	
1045	A92	Arbroath Rd - W of Claypotts	345000	731940	19903	3.9				29001	10				n	less than previous	
1166	A991	W Marketgait - N of Nethergate	340000	730100	21752	1.7	28956	7				20472	7.1		n	less than previous	
1170	A930	Dundee Rd West - E of Stannergate	343500	731100	17632	1.1						17799	2.3		n	less than previous	
10803	A90	Kingsway - E of Coupar Angus Road	338000	732600	39321	6.2									n	no relevant receptors	
10856	A92	Broughty Ferry Rd - W of Dalgleish Rd	342400	731100	30377	2.6				33981	6				n	less than previous	
11027	A991	N Marketgait E of Bell St Car Park	340000	730600	29456	1.2	21538	6		32787	163	29699	2.8		n	less than previous	
20857	A92	Dock St - W of Trades Lane	340700	730400	35727	2.9	34328	8		37078	4.3				n	less than previous	
20978	A929	Princes St - King St	341000	730900	1052	36.8		1059	49.8						n	less than previous	
30847	A85	Riverside Drive Nr Tesco	340000	729550	21089	2.8				18515	3.3			13.90	y	greater than 10 percent increase	
40803	A90	Kingsway West - E of Myrekirk	336000	732070	33066	6.2				32907	13			0.48	n	less than 10 percent increase	
40858	A92	East Dock St - Nr Gallacher Retail Park	341000	730600	25570	2.7									n	no relevant receptors	
40982	A929	Forfar Rd - N of Walrond St	341370	732100	8275	4.4	12506	11	11767	4.5		8684	7.8		n	less than previous	
50817	A923	Logie Street	338250	731270	16540	2.0	20730	8		17299	2	17347	5.8		n	less than previous	
50844	A972	Kingsway East - S of Longtown Road	342700	732060	27166	3.3									n	no relevant receptors	
50875	A929	Victoria Rd - W of William St	340710	730950	13384	6.4	13680	16	15413	9.8	15413	10.3			n	less than previous	
74325	A90	A90 Forfar Rd - N of Jack Martin Way	341610	734400	25028	6.1									n	no relevant receptors	
74326	A92	Arbroath Rd - E of Balgillo Rd East	347000	732620	23667	3.7									y	no previous assessment	
74327	A930	Monifeith Rd - Nr Reres Rd	347000	731070	8797	2.4				15619	7				n	less than previous	
74332	A923	Coupar Angus Rd - Camperdown Park	336500	733090	10070	2.7									n	no relevant receptors	
77104	A92	S Marketgait - below Tay Bridge Ramps	340630	730200	27510	2.9									n	no relevant receptors	
78561	A92	Arbroath Rd E of West Grange Road	348500	733150	16779	4.1									n	no relevant receptors	
78562	A923	Coupar Angus Rd - E of Leisure Park	337300	732750	10672	2.7									n	no relevant receptors	
78563	A90	A90 Forfar Rd - Nr Hebrides Drive	341570	733500	27503	6.1									n	no relevant receptors	
80321	A85	Riverside Ave - S of Riverside Place	336200	729880	14766	2.3									n	no relevant receptors	
80364	A92	Greendykes Rd - N of Balgavies Ave	343000	731500	14459	2.7				14231	6			160	n	less than 10 percent increase	
80558	A991	East Marketgait - N of Eastport	340620	730690	17908	1.3	17622	7	16779	3.6				162	n	less than 10 percent increase	
80559	A991	East Marketgait - N of King Street	340450	730750	19967	1.5	22168	4		18612	2.9				n	less than previous	

APPENDIX G: DMRB CALCULATIONS

Input Data

Location	Coordinates of Background Grid Squares (1km x 1km)		Background Concentrations			
	x	y	Year	NO _x	NO ₂	PM ₁₀
A	339500	729500	2010	32.5	19.1	11.8
B	341500	729500	2010	36.7	21.3	12.4
C	339500	729500	2010	32.5	19.1	11.8
D	338500	730500	2010	33.7	19.8	12.0
E	340500	731500	2010	39.3	22.4	12.7
F	336500	732500	2010	25.0	15.4	12.4
G	346500	732500	2010	28.4	17.3	13.6
H	340500	732500	2010	34.2	20.1	12.9
I	339500	729500	2010	32.5	19.1	11.8
J	339500	732500	2010	35.2	20.7	12.5

DMRB Inputs

Location	Link Number	Distance from link to road centre (m)	AADT (combined , veh/day)	Annual Average Speed (km/h)	Road Type (A,B,C,D)	Total % LDV (<3.5t GVW)	Total % HDV (>3.5t GVW)
A	1	9.4	3648	43.2	B	85.3	14.7
	2	8	3228	20	B	99.2	0.8
B	1	11.2	11071	40	B	97.8	2.2
	2	17.2	3549	20	B	99.5	0.5
	3	10.8	4069	20	B	99.3	0.7
C	1	13.7	24145	80	A	97.4	2.6
	2	22.5	5428	48	B	99.8	0.2
D	1	12.2	7354	48	B	94.9	5.1
	2	13.4	3187	20	B	97.6	2.4
E	1	6.3	10404	30	B	98.2	1.8
	2	5.8	744	30	B	100.0	0.0
	3	16.5	5350	30	B	97.0	3.0
F	1	19.2	33066	80.5	A	93.8	6.2
G	1	19.9	19903	64.4	A	96.1	3.9
H	1	8.2	10208	40	B	98.4	1.6
I	1	9.8	16594	50	A	98.2	1.8
	2	25.2	5386	20	B	99.7	0.3
	3	24.9	10067	50	A	97.3	2.7
J	1	10.1	13862	48	B	98.1	1.9

DMRB Results

RECEPTOR (x,y denote the DCC corporate address point)					Description	Year	Rd NO _x (1)	Verification Factor	Adj Rd NO _x (2)	Background NO _x	Adj Total NO _x (3)	Total NO ₂ (4)	PM ₁₀ Annual Mean (ug/m ³)	PM ₁₀ No. of Days >50
Location	X	Y	UPRN	Name										
A	339978	729917	009059038619	119 Nethergate	urban built up	2010	8.6	1.3164	11.3	32.5	43.8	24.33	12.7	0
B	341562	731872	009059056304	100 Dalkeith Road	urban built up	2010	12	1.3164	15.8	36.7	52.5	28.38	13.2	0
C	339159	729275	009059027341	Bridge House	open road	2010	15.9	1.3164	20.9	32.5	53.4	28.47	13.6	0
D	338249	730310	009059044050	5 Balgay Road	urban built up	2010	8.8	1.3164	11.6	33.7	45.3	25.12	13	0
E	340023	731080	009059028615	24 Constitution St	urban built up	2010	12.2	1.3164	16.1	39.3	55.4	29.53	14.4	0
F	336247	732132	009059025728	69 Brownhill Road, Dundee, DD2 4LF	urban built up	2010	19.4	1.3164	25.5	25.0	50.5	26.93	14.2	0
G	346581	732479	009059012426	Laburnum Cottage, Arbroath Road, Broughty Ferry, Dundee, DD5 3NR	urban built up	2010	11.9	1.3164	15.7	28.4	44.1	24.52	14.8	0
H	340833	732134	009059049169	107 Clepington Road	urban built up	2010 ^a	6.7	1.3164	8.8	34.2	43.0	24.18	13.7	0
I	339712	729456		Proposed Housing Riverside Drive	urban built up	2010	18.8	1.3164	24.7	32.5	57.2	30.03	14.1	0
J	339008	732361	009059085588	393 Clepington Road, Dundee, DD3 8ED	urban built up	2010 ^a	9.2	1.3164	12.1	35.2	47.3	26.22	13.6	0

^a 2011 traffic counts modelled with 2010 background to represent worst-case

Notes:

¹ Rd NO_x = Road NO_x direct from DMRB local output sheet (following Box 1 from DMRB guidance note provided at <http://laqm.defra.gov.uk/laqm-fags/>)

² Adj Rd NO_x = Rd NO_x x verification factor

³ Adj Total NO_x = Adj Rd NO_x + Background NO_x

⁴ Total NO₂ = from NO_x to NO₂ calculator (available at LAQM Support website)

Background Figures taken from the Scottish Government Background Maps (April 2012), road sector contributions were not removed from these concentrations based on advice given by LAQM helpdesk. Figures in Orange cells were derived from the NO_x to NO₂ calculator v2.1

Verification

DMRB Verification Results

Verification Sites					Background			2010		DMRB Road NO _x	Total NO ₂	Road NO ₂	Canyon ?	In canyon Total NO ₂	Verification Factor	Verification factored		
ID	Site type	Description	x	y	NO _x	NO ₂	PM ₁₀	NO ₂ tube conc (bias- corrected)	NO ₂ tube Road NO _x							Road NO _x	Total Adj NO ₂	Road adj NO ₂
V1	R	built up urban	339987	729919	32.5	19.1	11.8	29.8	24.17	8.5	23.06	3.96	n	n/a	1.3164	11.19	24.27	5.17
V2	R	built up urban	339893	730336	42.8	24.0	12.6	33.3	21.57	11	28.91	4.91	n	n/a	1.3164	14.48	30.39	6.39
V3	R	built up urban	340019	730612	51.0	27.6	13.7	42.5	37.45	16.8	34.77	7.17	n	n/a	1.3164	22.12	36.86	9.26
V4	R	built up urban	340651	730623	51.0	27.6	13.7	34.4	15.89	30	39.84	12.24	n	n/a	1.3164	39.49	43.21	15.61
V5	R	built up urban	341171	731574	36.7	21.3	12.4	38.2	41.01	24.8	32.09	10.79	n	n/a	1.3164	32.65	35.13	13.83
V6	R	built up urban	340725	731238	39.3	22.4	12.7	34.9	29.42	20.3	31.29	8.89	n	n/a	1.3164	26.72	33.86	11.46
V7	R	street canyon	338927	730685	33.7	19.8	12.0	57.4	111.18	21.8	29.48	9.68	y	39.16	5	109.00	56.87	37.07

Notes: Background Figures taken from the Scottish Government Background Maps (April 2012), road sector contributions were not removed from these concentrations based on advice given by LAQM helpdesk. Figures in Orange cells were derived from the NO_x to NO₂ calculator v2.1
Street Canyon Verification Figure is based on one site only and is not regression based. Road NO₂ was not doubled after the street canyon NO_x verification factor had been applied.

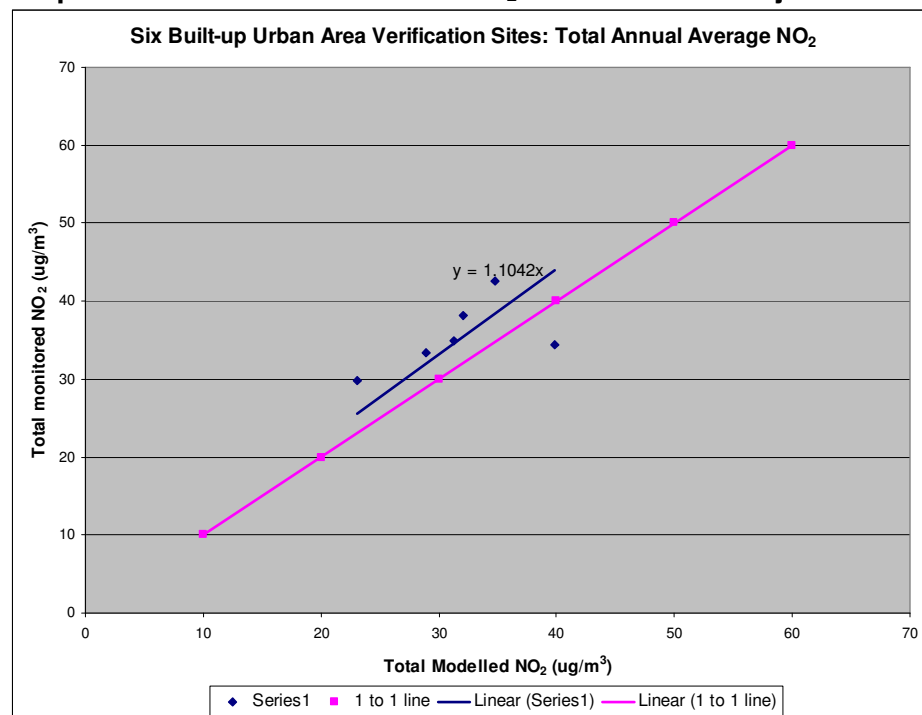
Summary of Modelled vs Monitoring NO₂ Results before Adjustment

Summary	Number
within +10%	0
within -10%	0
Within +-10%	0
within +10% to 25%	1
within -10% to 25%	4
Within +-10% to 25%	5
over +25%	0
under -25%	2
Greater +-25%	2
Within +-25%	5

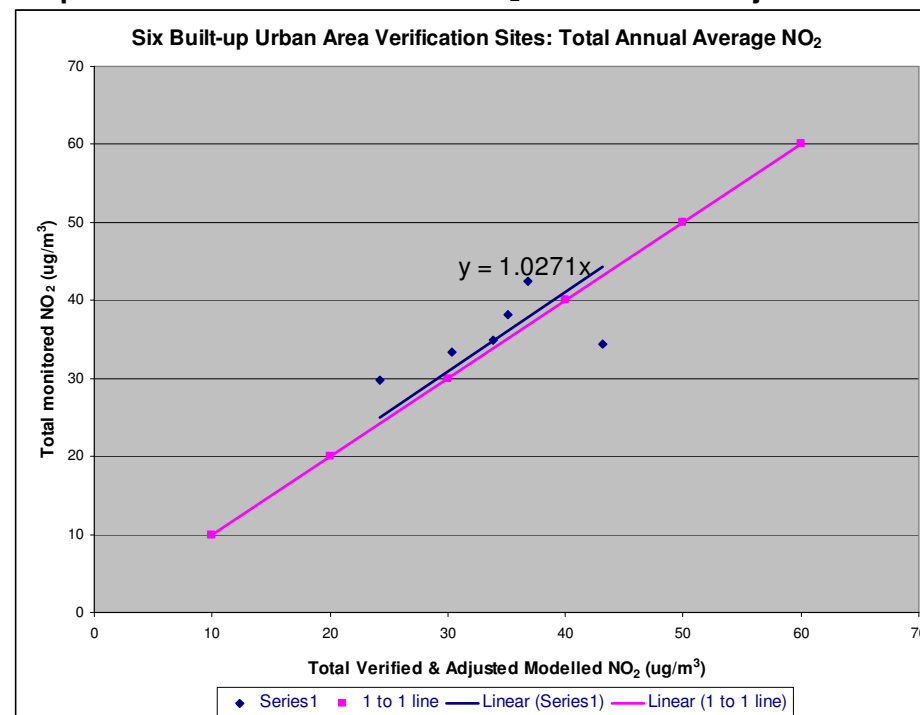
Summary of Modelled vs Monitoring NO₂ Results after Adjustment

Summary	Number
within +10%	0
within -10%	4
Within +-10%	4
within +10% to 25%	1
within -10% to 25%	2
Within +-10% to 25%	3
over +25%	0
under -25%	0
Greater +-25%	0
Within +-25%	7

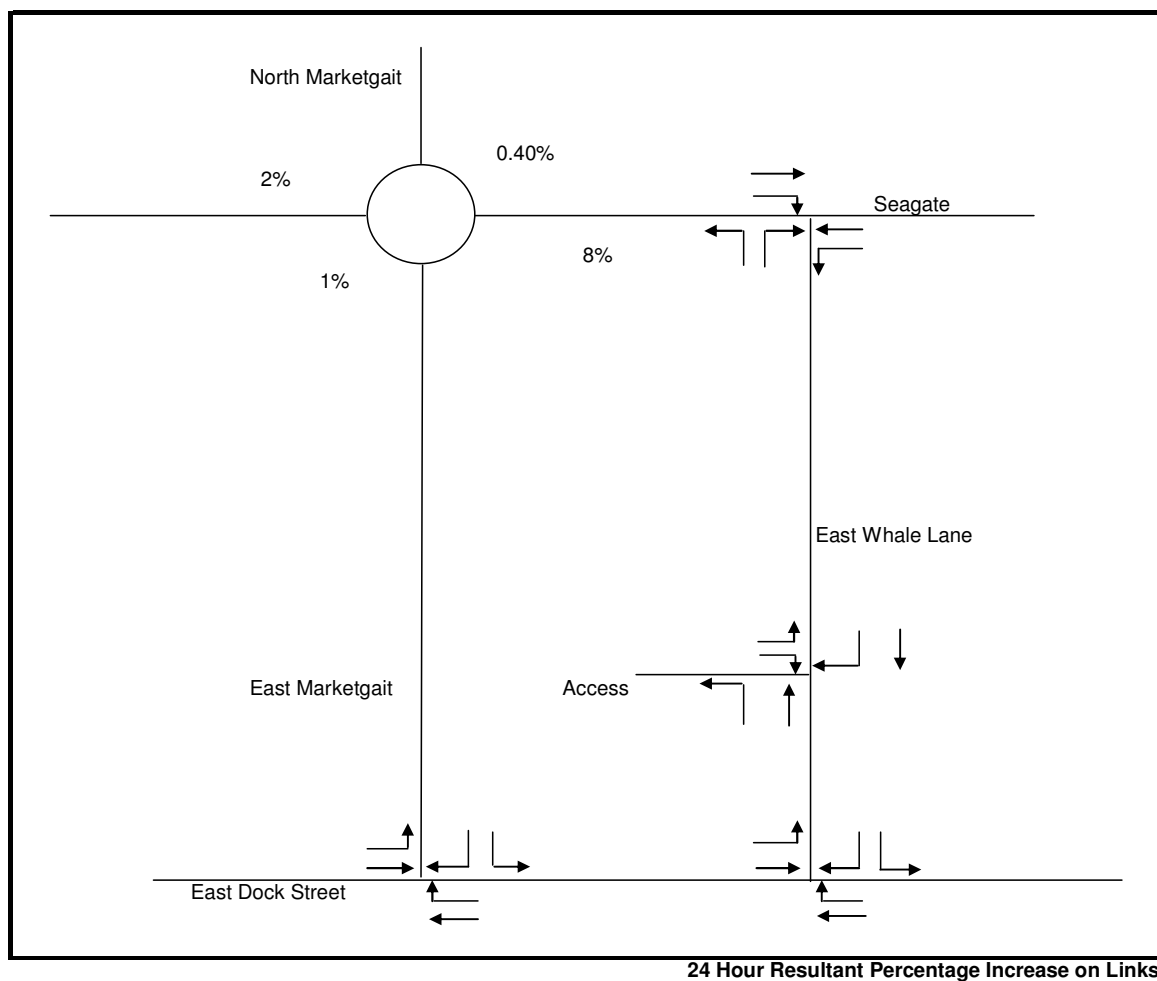
Graph of Monitored vs Modelled NO₂ Results before Adjustment



Graph of Monitored vs Modelled NO₂ Results after Adjustment



**APPENDIX H: PERCENTAGE INCREASE IN DAILY TRAFFIC FLOWS SURROUNDING
NEW LEISURE CENTRE**



24 Hour Factor 7.97

APPENDIX I : LIST OF INDUSTRIAL PROCESSES

Process Name/Address	Process Type	PG Note	New source since USA 2009?	Existing process with new exposure?	Substantial change >30% ?	Process Potentially Requiring Review & Assessment	Nomogram screening assessment required?	Detailed assessment Required?
Rockwell Solutions, Wester Gourdie, Dundee	Chapter 6: Other Activities Surface treating with organic solvents - Also Chapter 7 SED	6.4.b	No	No	No	No	No	No
Dundee Energy Recycling, Baldovie, Dundee	Chapter 5: Waste Management	5.1.c	No	No	No	Yes, previously assessed	No	No
Nynas UK AB, East Camperdown Street, Dundee DD1 3LG	Chapter 1: Energy Industries	Section 1.2 Part A Paragraph (f) (i)	No	No	No	Yes, previously assessed	No	No
Nationwide Crash Repair Centres Ltd, Liff Road,Dundee	Chapter 6: Other Activities vehicle respraying	6.4.b	No	No	No	No	No	No
Hanson Aggregates Piper Street, Dundee	Chapter 3: Mineral Industries cement batching	3.1.a.(ii)	No	No	No	Yes, previously assessed	No	No
Subsea Protection Systems	Chapter 3: Mineral Industries cement batching	3.1.b	No	No	No	Yes, previously assessed	No	No
Discovery Filling Station	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Brochtay Filling Station	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Asda Stores Filling Station Kirkton	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Tesco Stores Ltd, Methven Street, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No

Dundee City Council

Process Name/Address	Process Type	PG Note	New source since USA 2009?	Existing process with new exposure?	Substantial change >30% ?	Process Potentially Requiring Review & Assessment~	Nomogram screening assessment required?	Detailed assessment Required?
BP Kingsway West Filling Station	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Shell Caird Park	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Shell UK Ltd, East Kingsway Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Asda Stores Ltd, Milton of Craigie, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Tesco Stores Ltd, Riverside Drive, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Somerfield Ltd, Marketgait F/S, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Sainsburys Supermarket Ltd, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Jet Petrol Station, Forfar Road, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	Yes, previously assessed	No	No
Dens Metals Ltd, West Pitkerro, Dundee	Chapter 2: Production and Processing of Metals	2.2.a	No	No	No	Yes, previously assessed	No	No
Mctavish Ramsay Ltd, Barlow Ave, West Pitkerro	Chapter 6: Other Activities Timber Activity	6.6.(i)	No	No	No	No	No	No
Johnsons, Asda Dundee	Chapter 7: SED Activities	Chapter 7: SED Activities	No	No	No	No	No	No
Aggregate Industries, Longtown Street, Dundee	Chapter 3: Mineral Industries Cement Batching	3.1.a.(ii)	No	No	No	No	No	No

Dundee City Council

Process Name/Address	Process Type	PG Note	New source since USA 2009?	Existing process with new exposure?	Substantial change >30% ?	Process Potentially Requiring Review & Assessment~	Nomogram screening assessment required?	Detailed assessment Required?
Aberdeen Valet Service Dundee	Chapter 7: SED Activities	Chapter 7: SED Activities	No	Site no longer operating.	Site no longer operating.	No	No	No
Lochee Drycleaning Centre Dundee	Chapter 7: SED Activities	Chapter 7: SED Activities	No	No	No	No	No	No
Ferry Laundrette Broughty Ferry	Chapter 7: SED Activities	Chapter 7: SED Activities	No	No	No	No	No	No
Stay-Press Dry Cleaning Centre, Dundee	Chapter 7: SED Activities	Chapter 7: SED Activities	No	No	No	No	No	No
Care Clean, Dundee	Chapter 7: SED Activities	Chapter 7: SED Activities	No	No	No	No	No	No
Dignity Ltd, Dundee Crematorium, Dundee	Chapter 5: Waste Management	5.1c	No	No	No	No	No	No
Laundry On Line, Dundee	Chapter 7: SED Activities	Chapter 7: SED Activities	No	No	No	No	No	No
Wm Morrison Supermarkets Plc, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	No	No	No
Wm Morrison Supermarkets plc, I Afton Way	Chapter 7: SED Activities	Chapter 7: SED Activities	No	No	No	No	No	No
Tesco Filling Station, South Road, Dundee	Chapter 1: Energy Industries-Petrol Station	1.2.c.(ii)	No	No	No	No	No	No

Dundee City Council

Process Name/Address	Process Type	PG Note	New source since USA 2009?	Existing process with new exposure?	Substantial change >30% ?	Process Potentially Requiring Review & Assessment~	Nomogram screening assessment required?	Detailed assessment Required?
Halley Stevensons (Dyers & Finishers) Limited, Baltic Works, Annfield Road, Dundee DD1 5JH	Chapter 6: Other Activities	Section 6.4 Part A Paragraph (a)	No	No	No	No	No	No
Danpak Flexibles, Kemback St Dundee	Chapter 6: Other Activities surface treatment using organic solvents also Chapter 7 SED coating flexible packaging	6.4.b	No	No	No	No**	No	No
J T Inglis, Riverside Works, Dundee	Chapter 6: Other Activities Textile Treatment	6.4.d	No	No	No	No	No	No
Michelin Tyre Plant, Dundee	Chapter 6: Other Activities surface treatment of rubber with organic solvents also Chapter 7	6.4.b	No	No	No	Yes, previously assessed	No	No
Michelin Tyre Plant, Dundee	Chapter 1: Energy Industries, Combustion	1.1.a	No	No	No	Yes, previously assessed	No	No
D C Thomson Printers, Dundee	Chapter 6: Other Activities printing process	6.4.b	No	No	No	No	No	No
Day International Ltd, Balgray St, Dundee	Chapter 6: Other Activities surface treatment of rubber with organic solvents	6.4.b	No	No	No	Yes*, not previously assessed	No	No
RMC Readymix Ltd, Dundee	Chapter 3: Mineral Industries, Cement Batching	3.1.a.(ii)	No	No	No	No	No	No
Brown & Tawse Steelstock Ltd, Fowler RD West Pitkerro - Dundee	Chapter 6: Other Activities, paint spraying	6.4.a	No	No	No	No	No	No
Armitages Pet Products Ltd, Broughty Ferry Road- Dundee	Chapter 6: Other Activities, Pet Food Manufacture	6.8.a	No	No	No	No	No	No
Tesco Stores Ltd, Kingsway Retail Park Dundee	Chapter 1: Energy Industries, Petrol Station	1.2.c.(ii)	No	No	No	No	No	No

Dundee City Council

Process Name/Address	Process Type	PG Note	New source since USA 2009?	Existing process with new exposure?	Substantial change >30% ?	Process Potentially Requiring Review & Assessment~	Nomogram screening assessment required?	Detailed assessment Required?
Joinery and Timber Creations (65) Ltd,	Chapter 6: Other Activities, Timber Process	6.6.(i)	No	No	No	No	No	No
Ethiebeaton Quarry	Chapter 3 Mineral Activities - cement batching process 3.1a(ii), roadstone coating 3.5e, crushing and grinding 3.5c	3.1a(ii), 3.5e, 3.5c	No	No	No	No	No	No
Health Care Environmental Services, Nobel Road, Wester Gourdie Ind. Estate	Chapter 5 Waste Management PartA Treatment of Clinical waste	5.3a	No	No	No	No*	No	No

Notes

No** see Section 5.1.2

No* see Section 5.1.1

Yes* see Section 5.1.3

~ with reference to Annex 2 Appendix E TG.03

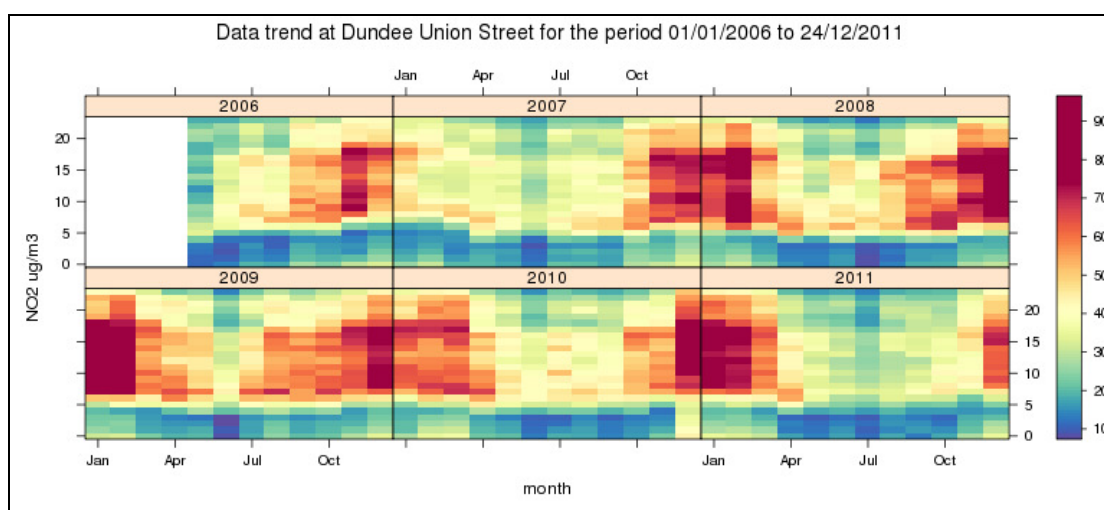
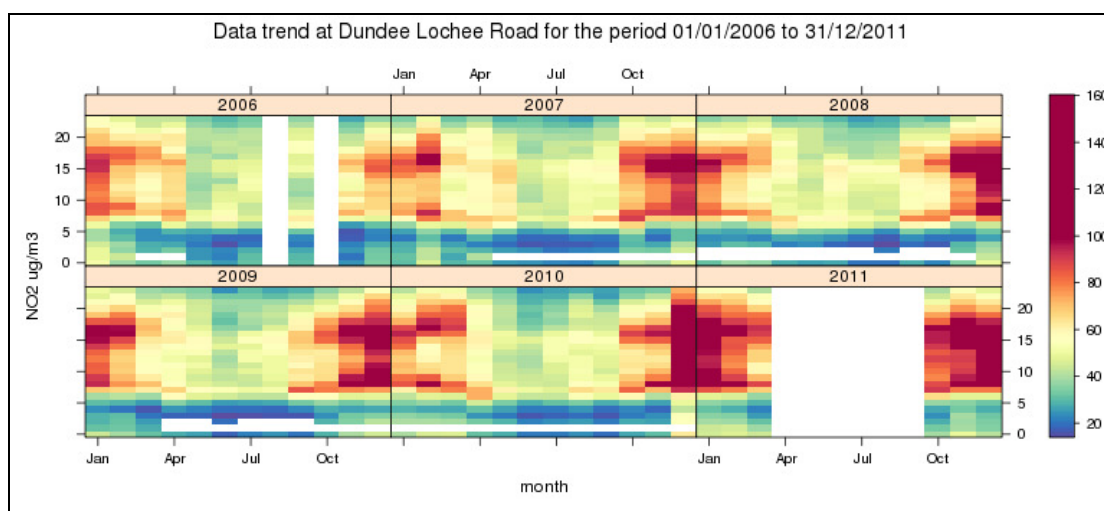
The processes coloured purple are Part A Processes.

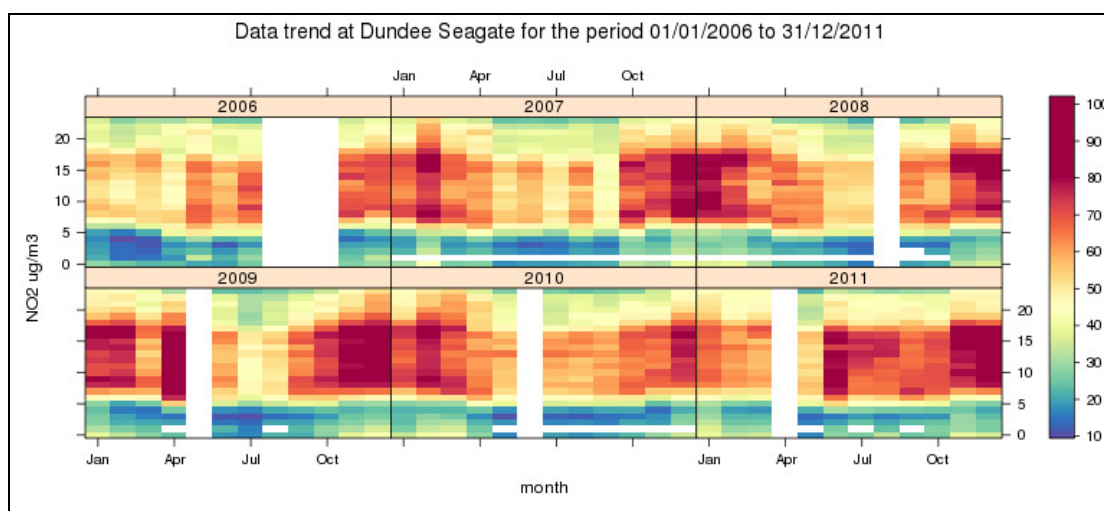
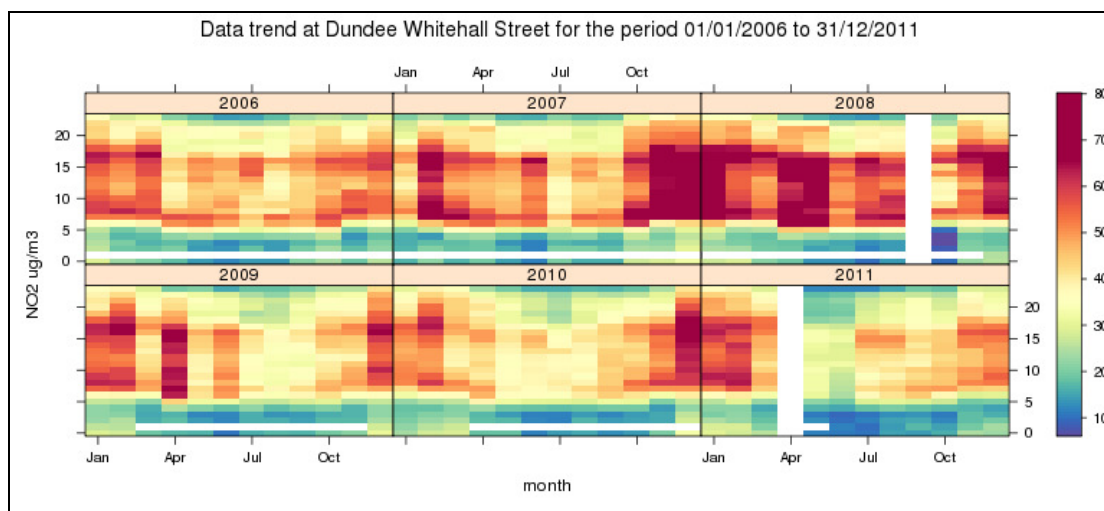
APPENDIX J : OPENAIR TREND LEVEL HOUR PLOTS

Description of the Trend Level Hour tool

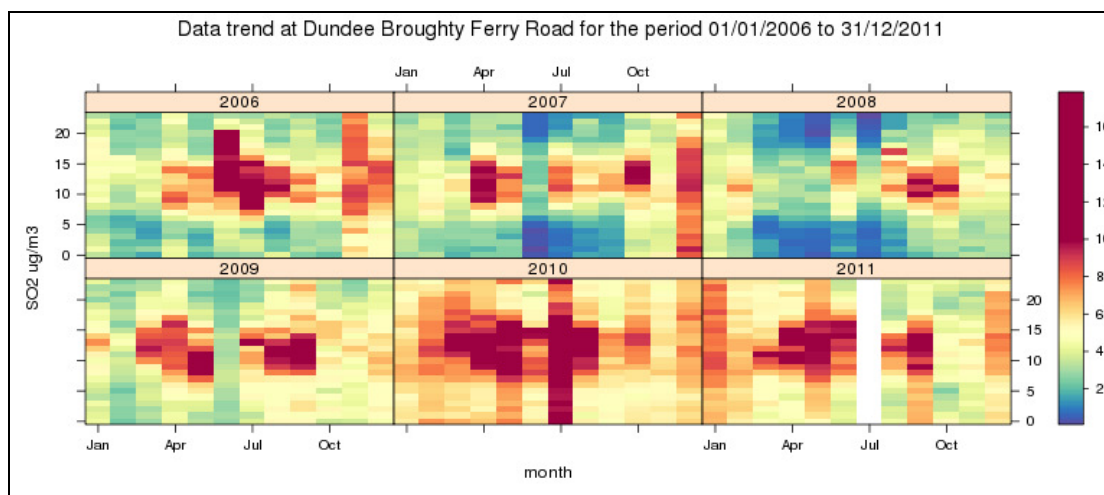
Trend level hour provides a way of rapidly showing a large amount of data in a condensed format. In a single plot, the variation in the concentration of a pollutant is shown by time of day, month of year and year. The plot therefore provides information on trends, seasonal effects and diurnal variations. Each year is presented sequentially in a separate pane. The hour of the day is represented on the vertical axis whereas time throughout the years is represented in the horizontal axis to show the seasonality. The concentration is represented by the colour scale on the right of the plot .

Average hourly Nitrogen dioxide concentrations as a monthly diurnal plot for each month from January 2006 to December 2011 at four long term continuous monitoring locations





Average hourly Sulphur dioxide concentrations as a monthly diurnal plot for each month from January 2006 to December 2011 at Broughty Ferry Road



Average hourly Particulate matter (PM₁₀) concentrations as a monthly diurnal plot for each month from January 2006 to December 2011 at three long term continuous monitoring locations

