Department of
Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

Air Pollution
in Northern Ireland 2015

RICARDO
Ricardo Energy & Environment

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Report Highlights

This is the fourteenth in a series of annual reports on air quality in Northern Ireland. It is produced by Ricardo Energy & Environment, on behalf of the Department of Agriculture, Environment and Rural Affairs. This report aims to provide the citizens of Northern Ireland, and the wider air quality community, with user-friendly information on local air quality monitoring. It contains the key results of that monitoring from throughout the region during 2015. Figure 1.1 shows the locations of all the automatic air quality monitoring sites in Northern Ireland that were in operation during part or all of 2015.

Section 2 of this report outlines the air quality legislation and policy applicable to Northern Ireland, including the Local Air Quality Management process by which district councils manage air quality at a local level. **Section 3** summarises the monitoring carried out in Northern Ireland and presents an overview of the data from 2015, including exceedances of air quality objectives.

As in previous reports, **Section 4** deals with how air pollution in Northern Ireland has changed over time, and **Section 5** covers spatial patterns in pollution. **Section 6** is used to report on topics of special interest; this year it focuses on the air quality impacts of traffic. Finally, **Section 7** provides information on how each one of us can help protect and improve the quality of the air in our region, and where to find more information.

Air quality in Northern Ireland has improved substantially in recent decades. In particular, concentrations of sulphur dioxide, a pollutant associated with coal and oil combustion, have declined significantly over the past twenty years. However some pollutants in some parts of Northern Ireland continue to exceed air quality objectives. A continued effort to reduce air pollution is therefore important, together with monitoring to assess progress and to provide sound, science-based input into policy development.

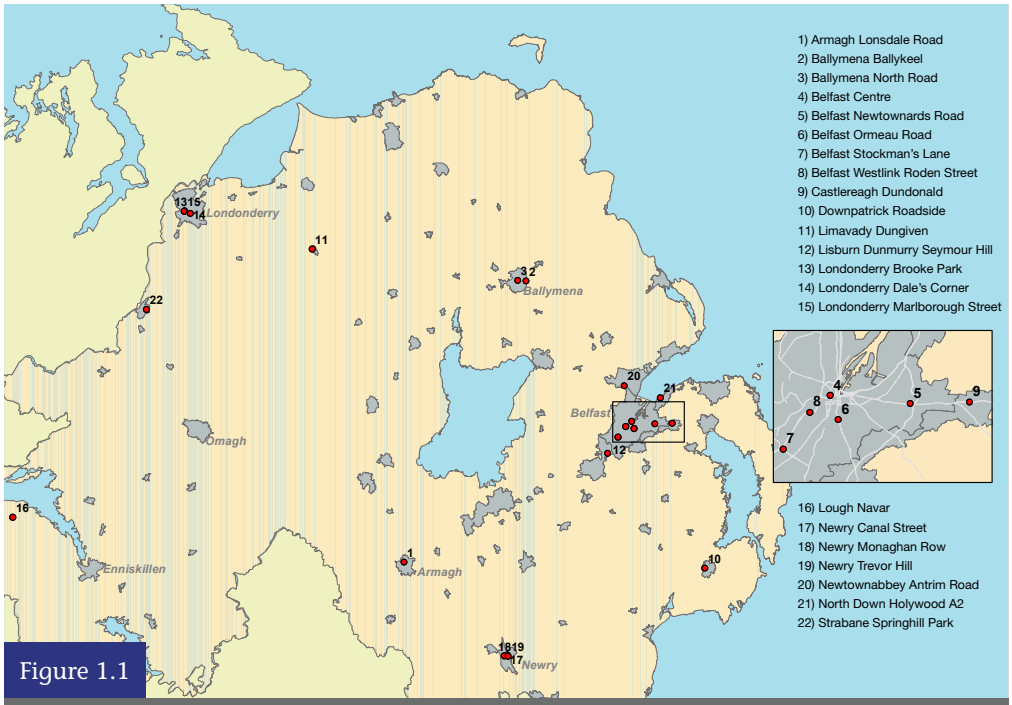

Figure 1.1

Locations of Automatic Air Quality Monitoring Sites in Northern Ireland, 2015

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Legislation and Policy

The management of air quality in Northern Ireland is currently based on the requirements of European Union (EU) Air Quality Directives, and on the UK Air Quality Strategy. These requirements are incorporated (or 'transposed') into Northern Ireland's own legislation by statutory measures, forming the basis of a strong framework for managing air quality.

Also, a target to improve air quality exists in the Northern Ireland Executive's Programme for Government.

2.1 The European Union

Much of Northern Ireland's air quality legislation has its roots within the Air Quality Directives which apply to all Member States of the European Union:

- Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (the Air Quality Directive), which relates to sulphur dioxide, oxides of nitrogen, particulate matter, lead, carbon monoxide, benzene and ozone in ambient air; and
- Directive 2004/107/EC (the Fourth Daughter Directive) relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons (PAH) in ambient air.

These Directives are incorporated into Northern Ireland's national law by the Air Quality Standards Regulations (Northern Ireland), of which the most recent revision was in 2010.

2.2 The Air Quality Standards Regulations (Northern Ireland) 2010

These Regulations transpose the provisions of the above Directives into Northern Ireland's own legislation. As well as the EU limit values and non-mandatory target values for ambient concentrations of pollutants, the Regulations set out requirements for ambient air quality monitoring, including the number of monitoring sites required, siting criteria and acceptable methodology. They also identify the duties of Northern Ireland's Government Departments in relation to achieving limit and target values. It is the responsibility of Department of Agriculture, Environment and Rural Affairs (DAERA) to inform the public about air quality in the region, particularly with regard to warning the public when information and alert thresholds are exceeded.

2.3 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, first published in 1997 and updated in 2007, provides a comprehensive framework for tackling air pollution. It was established on the basis of strong scientific evidence and a science-based understanding of the effects of air pollutants on health and the environment.

The Strategy sets objectives to be met within the UK for a suite of pollutants. The scientific basis, the objectives set and provisions contained within the Strategy are closely associated with the corresponding standards set within European Air Quality Directives, as listed above. The Strategy's provisions for some pollutants differ from those in the Directives, with these differences relating to scientific evidence and expert opinion that is specific to the UK situation. However, all the Air Quality Strategy objectives are at least as stringent as the corresponding limit values in the Air Quality Directive or 4th Daughter Directive.

The full Air Quality Strategy and its technical annexes are available online and can be downloaded from www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1.

As of late 2016, DAERA has commenced work on delivering a long term air quality strategy for Northern Ireland, which will include reviewing all current air quality policy.

Photo: Dunluce Castle on the northern coast of County Antrim, Northern Ireland

2.4 Local Air Quality Management

Local Air Quality Management (LAQM) provides the framework under the Environment Order (NI) 2002 within which air quality is managed by district councils in Northern Ireland. LAQM requires district councils to review and assess a range of air pollutants against the objectives set by the Air Quality Strategy, using a range of monitoring, modelling, observations and corresponding analyses. For locations where objectives are not expected to be met by the relevant target date, district councils are required to declare an Air Quality Management Area (AQMA), and (along with relevant authorities), to develop an Action Plan addressing the problem.

Early in 2015, there were substantial changes to Northern Ireland's district councils. Most of the former 26 district councils were merged with others, and some boundaries were changed, to form 11 new larger districts. The information in this section is based on these new council areas.

There are currently 26 AQMAs in Northern Ireland, as shown in Table 2.1. Nine councils have AQMAs: of these, five have AQMAs for NO_2 only, one has an AQMA for PM_{10} only, and three have AQMAs for PM_{10} and NO_2 (either separately or together). There are no AQMAs in place for any other pollutants. Table 2.1 and Figure 2.1 show the locations of these AQMAs, and which pollutants they address.

Table 2.1 Air Quality Management Areas in Northern Ireland (as of September 2016)

District Council	No. of AQMAs	Pollutants	Sources
Antrim and Newtownabbey	1	NO_2	Road traffic
Ards and North Down	0	–	–
Armagh, Banbridge and Craigavon	4	NO_2	Road traffic
Belfast City	4	NO_2 (3), NO_2 and PM_{10} (1)	Road traffic
Causeway Coast and Glens	1	NO_2	Road traffic
Derry City and Strabane	6	NO_2 (3), PM_{10} (3)	Road traffic, domestic emissions
Fermanagh and Omagh	0	–	–
Lisburn City and Castlereagh	1	NO_2	Road traffic
Mid and East Antrim	2	PM_{10}	Domestic emissions
Mid Ulster	5	NO_2	Road traffic
Newry, Mourne and Down	2	NO_2 (1), PM_{10} (1)	Road traffic, domestic emissions

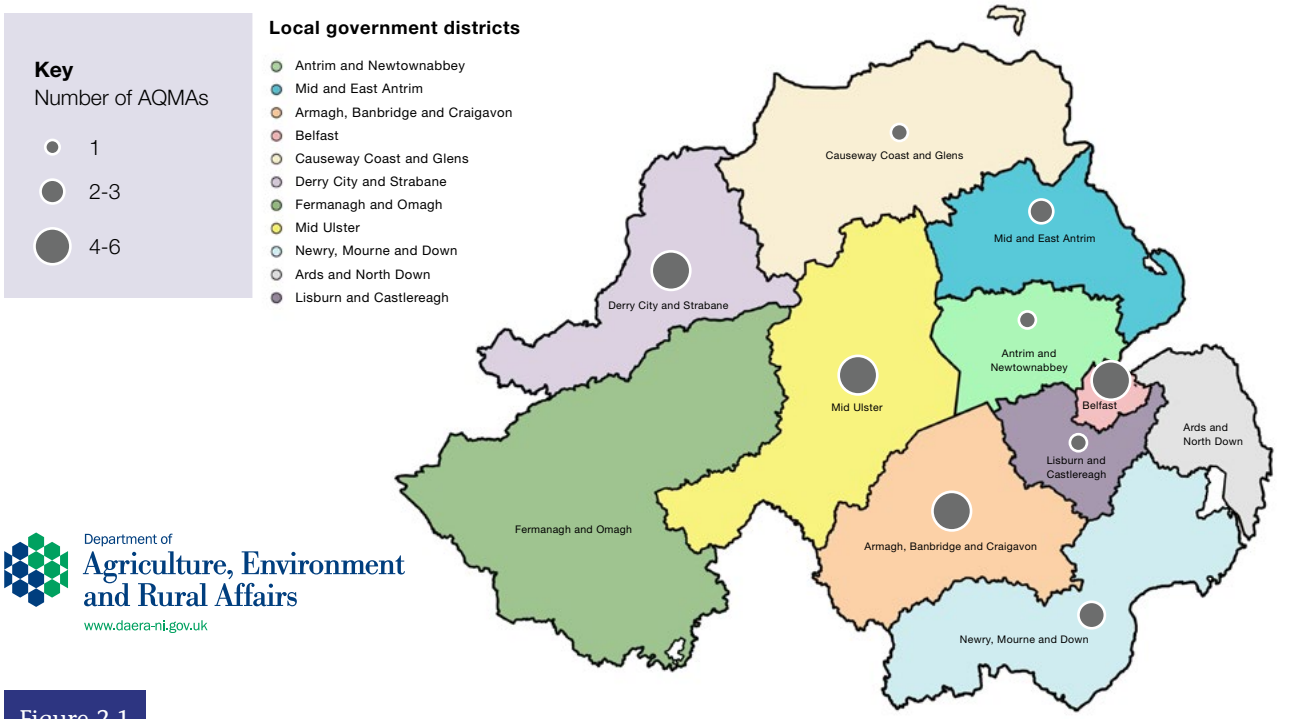

Figure 2.1

Air Quality Management Areas in Northern Ireland (source: DAERA)

3

Monitoring Results for 2015

3.1 Monitoring in Northern Ireland

A wide range of air quality monitoring is carried out in Northern Ireland. Some monitoring sites are run as part of UK-wide monitoring networks; others are operated by district councils in order to meet local objectives.

The Air Quality Directive requires Member States to be divided into 'zones' for reporting purposes. Northern Ireland comprises two reporting zones – the 'Belfast Metropolitan Urban Area' agglomeration (the conurbation of Belfast), and the 'Northern Ireland' zone (the rest of the region). The Directive then specifies how many monitoring sites (or 'stations') are needed in each zone (based on its size and population). Only sites which meet the stringent siting criteria of the Directive may be used for reporting to the European Commission. The Directive siting criteria are different from those used for LAQM: for example, sites located close to major road junctions are used in LAQM, but must not be used for Directive compliance monitoring purposes. There are also different criteria regarding relevant public exposure.

The following pollutants were monitored in Northern Ireland during 2015:

- Carbon monoxide (CO);
- Oxides of nitrogen (NO_x), comprising nitric oxide (NO) and nitrogen dioxide (NO_2);
- Sulphur dioxide (SO_2);
- Particles (as PM_{10}, $PM_{2.5}$, and black carbon);
- Ozone (O_3);
- Benzene;
- Polluting elements – including lead, arsenic, cadmium, nickel and mercury; and
- Polycyclic Aromatic Hydrocarbons (PAHs).

During 2015 there were 22 automatic air quality monitoring stations in Northern Ireland, each equipped with continuous monitoring equipment for one or more of the pollutants for which automatic methods are used: CO, NO_x, SO_2, PM_{10}, $PM_{2.5}$ and O_3. These sites (shown previously in Figure 1.1) provide hourly information on a wide range of pollutants. Data from the continuous monitoring sites are communicated rapidly to the public via the website www.airqualityni.co.uk. Public warnings are issued when levels approach or reach 'high' levels as defined by the Daily Air Quality Index (see https://uk-air.defra.gov.uk/air-pollution/daqi for an explanation of this Index).

Six of the automatic monitoring sites (Armagh Lonsdale Road, Ballymena Ballykeel, Belfast Centre, Belfast Stockman's Lane, Londonderry Brooke Park – which has since been replaced by Londonderry Rosemount - and Lough Navar) were part of the UK's national monitoring network, and were used to assess compliance with the Air Quality Directive.

Non-automatic monitoring techniques are used for benzene, metallic pollutants, black carbon and PAHs. Some of these measurements are used to assess compliance with the Air Quality Directive and Fourth Daughter Directive.

In addition, many district councils use diffusion tubes for indicative monitoring of NO_2. These low-cost, single-use samplers absorb the pollutant directly from the air and need no power supply. They measure average concentrations over a specified sampling period (typically one month), and provide a useful and economical supplement to automatic monitoring.

3.2 The Volatile Correction Model

Three out of Northern Ireland's 12 PM_{10} monitoring sites used the Tapered Element Oscillating Microbalance (TEOM) to measure PM_{10} during 2015. The relatively high operating temperature of the TEOM (necessary to prevent condensation on the filter) can result in the loss of volatile components of the particulate matter sampled, causing under-estimation of the PM_{10} concentration. It is, however, possible to correct for this using the Volatile Correction Model (VCM) developed by King's College, London. The VCM uses data from Filter Dynamic Measurement Systems (FDMS) PM_{10} analysers in the region, which

measure both the volatile and non-volatile fractions, to calculate an appropriate correction based on the location of the instrument and the period of the measurements. The resulting corrected measurements have been demonstrated as equivalent to the European reference method. To access the model and for more information, visit www.volatile-correction-model.info. The TEOM PM_{10} data presented in this report have been corrected to gravimetric equivalent using the VCM. This issue only arises for PM_{10}: there is at present no requirement to correct TEOM measurements of $PM_{2.5}$, and in any case all of Northern Ireland's $PM_{2.5}$ monitoring sites use the FDMS analyser.

3.3 Key Results for 2015

This section summarises key monitoring results from 2015, including compliance with EU limit values and the corresponding Air Quality Strategy (AQS) objectives. Further information is provided on the Northern Ireland Air website at www.airqualityni.co.uk.

Carbon monoxide was monitored using an automatic instrument at one site – Belfast Centre. The results were well within the EU limit value and AQS objective for this pollutant, and have been for many years.

Benzene was monitored at one site, Belfast Centre, which met the annual mean EU limit value and AQS objective (for the running annual mean) in 2015, as it has for many years.

Metallic and other polluting elements – including lead, arsenic, cadmium and nickel – were monitored using non-automatic techniques at Belfast Centre, as part of the Urban Metals Network. The results for 2015 were within the annual mean EU limit value and AQS objective for lead, and within the EU annual mean target values for arsenic, cadmium and nickel.

Sulphur dioxide was monitored at five automatic sites. All sites met the EU limit values for SO_2 (1-hour and 24-hour mean), and the AQS objective for the 15-minute mean.

Particulate matter – PM_{10}. Particulate matter as PM_{10} was monitored at 12 locations in 2015. Figure 3.1 shows the annual mean PM_{10} concentrations (shown by the darker coloured bars, against the left axis), and the number of exceedances of the daily mean limit value and objective (shown by the lighter coloured bars, against the right axis). Three of these sites (Newry Canal Street, North Down Holywood A2 and Lisburn Dunmurry Seymour Hill) used the TEOM instrument, so data from these sites have been corrected to gravimetric equivalent using the King's College Volatile Correction Model as explained in Section 3.2. All sites met the limit value and objective of 40 µg m^{-3} for annual mean PM_{10}, and no sites exceeded the daily mean

* Asterisk indicates sites with greater than 50% and less than 75% data capture in 2015. No site had data capture below 50%.

Figure 3.1

Annual Mean PM_{10} Concentrations and Exceedances of Daily Objective, 2015

limit value and objective of 50 µg m^{-3} on more than the maximum permitted 35 occasions during the year (after VCM correction if applicable).

Particulate matter – $PM_{2.5}$. Fine particulate matter as $PM_{2.5}$ was monitored (using the FDMS analyser) at Belfast Centre and Londonderry Brooke Park throughout 2015. (Lisburn Dunmurry Seymour Hill also monitored $PM_{2.5}$ for part of the year, but measurements were discontinued in June 2015.) Belfast Centre and Londonderry Brooke Park measured annual mean $PM_{2.5}$ concentrations well below the EU Stage 1 limit value of 25 µg m^{-3} (which had to be met by 1st Jan 2015). Levels were also below the EU Stage 2 limit value (20 µg m^{-3} to be achieved by 1st Jan 2020).

Nitrogen dioxide was monitored using automatic analysers at 15 sites during 2015. Figure 3.2 shows the annual mean NO_2 concentrations (shown by the darker coloured bars, against the left axis), and the number of exceedances of the hourly mean objective (shown by the lighter coloured bars, against the right axis). (This figure presents all sites, including two with very low data capture: Londonderry Marlborough Street which closed early in the year and therefore achieved only 16% data capture, and Armagh Lonsdale Road, which achieved only 45% data capture. The annual means for these two sites are shown by striped rather than solid shading).

Two sites exceeded the AQS objective for annual mean NO_2 concentration (40 µg m^{-3}). These sites were Belfast Stockman's Lane and Londonderry Marlborough Street (although as stated above, the latter was only operating in the early part of the year and did not obtain sufficient data for a representative annual mean). Both are urban traffic-related sites beside major roads.

Belfast Stockman's Lane is affiliated into the national network which is used for monitoring compliance with the Air Quality Directive. This site falls within the Belfast Metropolitan Urban Area reporting zone, which in 2015 and previous years has been identified as non-compliant with the EU Directive limit value for annual mean NO_2 (also 40 µg m^{-3}).

Londonderry Marlborough Street, despite closing part way through 2015, measured more than the 18 permitted exceedances of the hourly mean AQS objective for NO_2 (200 µg m^{-3}); it was the only site in Northern Ireland to do so. It closed because the premises in which it was located is undergoing major refurbishment; while this is going on it is not safe to continue operating the site.

Where data capture is less than 90%, exceedance of the hourly mean limit value is judged on whether the 99.8th percentile of hourly values has exceeded 200 µg m^{-3} rather than the number of hourly means above the objective. This was only the case for one Northern Ireland site: Londonderry Marlborough Street (which as noted above, measured more than 18 exceedances of the hourly mean objective despite only operating for part of the year).

Ozone was monitored at Belfast Centre, Londonderry Brooke Park and the rural Lough Navar site. No sites exceeded the EU target value for human health of 120 µg m^{-3} (for the maximum daily 8-hour mean) on more than the permitted 25 days, or the more stringent AQS objective of 100 µg m^{-3} on more than the permitted 10 days in 2015 (Figure 3.3), although all three sites had at least one exceedance day during 2015.

Unlike some other pollutants, levels of ozone (O_3) in Northern Ireland do not appear to be decreasing, but remain variable from year to year. Ozone exceedances happen in some years but not others (for example, there

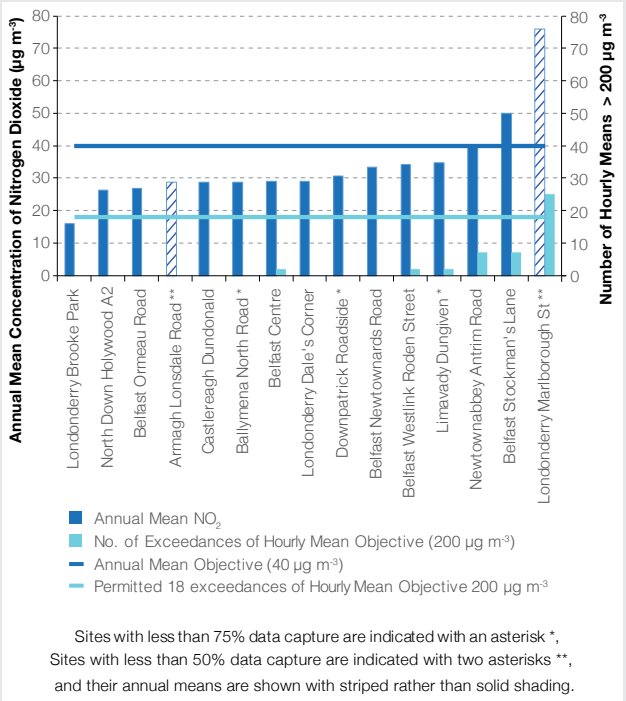

Figure 3.2

Annual Mean NO_2 Concentrations and Exceedances of Hourly Objective, 2015

were none in 2014). The reasons for this relate to how ozone is formed: it is a 'secondary' pollutant – that is, it is formed by reactions involving other pollutants, in the presence of sunlight, and over several hours. This means that the number of ozone exceedances in any given year depends substantially on weather conditions. There is also evidence that the 'hemispheric background' concentration of O_3 has increased since the 1950s due to the contribution from global human activities[1]. O_3 exceedances therefore remain possible in future.

Ozone is also a 'transboundary' pollutant: once formed it may persist for several days and be transported over long distances. This means that much of the ozone measured in a particular area may have been generated elsewhere, and so it is more difficult to reduce concentrations by local action.

[1] See the APIS webpage 'Ozone' at http://www.apis.ac.uk/overview/pollutants/overview_O3.htm

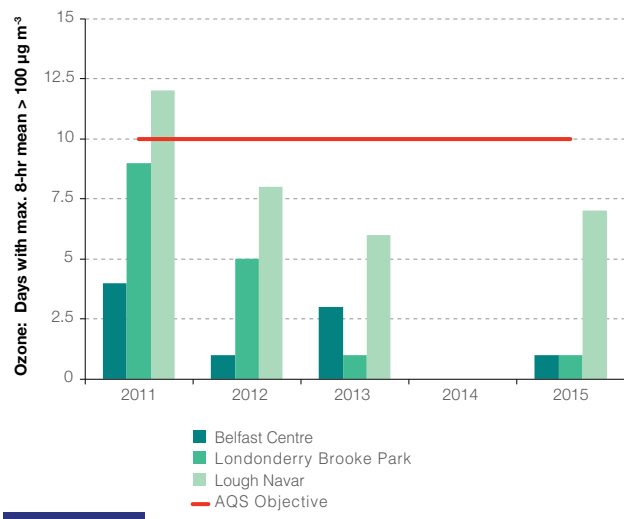

Figure 3.3

Ozone: Days with Maximum 8-hour mean > 100 µg m^{-3} for Five Years 2011-2015

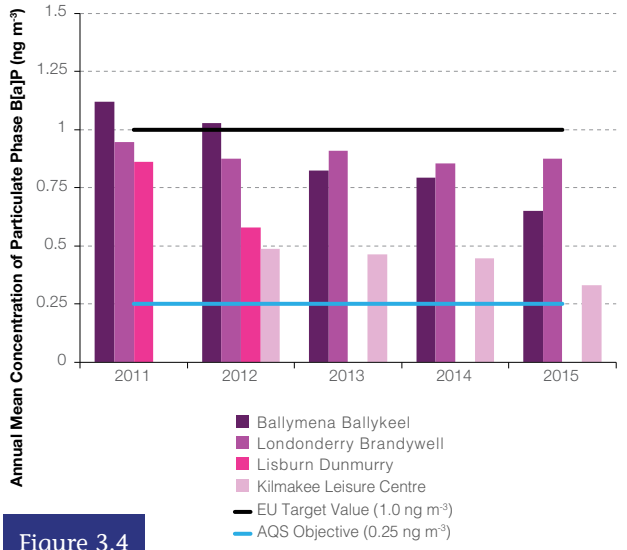

Figure 3.4

Annual Mean Concentrations of Benzo[a]pyrene for Five Years 2011-2015

Polycyclic aromatic hydrocarbons (PAH) were monitored at three sites in 2015; Ballymena Ballykeel, Londonderry Brandywell and Kilmakee Leisure Centre in Dunmurry. All are part of the UK PAH Monitoring Network. The network measures a range of PAH compounds, but one species in particular, benzo[a]pyrene (B[a]P), is used as a 'marker' for PAH compounds and is the subject of an AQS objective and EU target value. Fig 3.4 shows the annual mean concentrations at these three sites over the past five years. This graph also shows data from the old Lisburn Dunmurry site which closed in 2012. All three sites are now compliant with the EU target value of 1 ng m^{-3} for annual mean B[a]P concentration, which was to be met by 31st Dec 2012. However, all three sites continue to exceed the more stringent AQS annual mean objective of 0.25 ng m^{-3} for this PAH species, which was to have been achieved by 31st Dec 2010.

3.4 Summary

EU limit values, target values and corresponding AQS objectives, have been met by the due dates for the following pollutants in Northern Ireland –

- Particulate matter as PM_{10} and $PM_{2.5}$
- Carbon monoxide
- Benzene
- Sulphur dioxide
- The elements lead, arsenic, cadmium and nickel.

However, two monitoring sites close to busy roads in urban areas did not meet the limit values and objectives for nitrogen dioxide in 2015. Of these sites, only Belfast Stockman's Lane was used for assessment of compliance with the Air Quality Directive. This site falls within the Belfast Metropolitan Urban Area reporting zone, which in previous years has been identified as non-compliant with the EU Directive limit value for annual mean NO_2 (40 µg m^{-3}), on the basis of modelled data. Belfast Urban Area is not alone in this respect: many parts of the UK, and other Member States of Europe, have reported similar exceedances.

Ozone concentrations are affected by both long-range, local and meteorological factors. This pollutant can therefore vary considerably from year to year. Although no sites exceeded the AQS objective in 2015, O_3 exceedances remain a possibility in future. The most recent year in which any monitoring sites in Northern Ireland exceeded the AQS objective for ozone was 2011.

2015 was the third consecutive year in which all three of Northern Ireland's PAH Network monitoring sites met the EU target value for benzo[a]pyrene. However, all three sites continue to exceed the more stringent AQS objective.

4

Changes Over Time

This section looks at how air quality in Northern Ireland has changed in recent years. In this year's report, the focus is on NO_2, as this pollutant is responsible for most of the exceedances of AQS objectives that occur in Northern Ireland. This year's report concentrates on roadside monitoring sites that have reported exceedances of the annual mean AQS objective for NO_2 in recent years, and how measured concentrations are changing. The period covered here is 2008 to 2015.

As in last year's report, this section will focus on a subset of long-running sites, all of which have recorded exceedances in recent years. The sites selected are:

- Newtownabbey Antrim Road;
- Belfast Stockman's Lane;
- Belfast Newtownards Road;
- Belfast Ormeau Road
- Downpatrick Roadside.

(Downpatrick Roadside replaces the fifth site used in last year's report, Newry Trevor Hill, which ceased monitoring NO_2 in 2014 due to financial constraints).

Londonderry Marlborough Street and Limavady Dungiven have not been included despite having reported exceedances in recent years. This is because the former has now closed, and the latter has long gaps in its dataset, making it less suitable for analysing long-term trends.

Trend analysis has been carried out using Openair: a free, open-source software package of tools for analysis of air pollution data. Openair was initially developed with Natural Environment Research Council (NERC) funding [2]. The Openair project is led by Dr David Carslaw, of Ricardo Energy & Environment and the University of York. Here, the Openair 'TheilSen' tool, based on the Theil-Sen statistical method, has been used to determine trends in pollutant concentrations over several years. The trend analysis is based on monthly mean pollutant concentrations, calculated here from hourly mean data. Openair includes an option to 'de-seasonalise' the data – i.e. to make statistical modifications to the plotted data to remove the influence of seasonal cycles, thus providing a clearer indication of the overall trend over the relevant time. The 'de-seasonalise' option has been used here. When this option is used Openair also fills any gaps in the dataset by a linear interpolation method.

The Openair Theil-Sen trend graphs show the trend as a solid red line, with its 95% confidence intervals as dotted red lines. The trend is given at the top of the graph in green, with confidence intervals shown in square brackets. The trend is given as units (i.e. µg m^{-3}) per year, over the period shown. This may be followed by a symbol, with '+' indicating that the trend is statistically significant at the 0.1 level, '*' indicating significance at the 0.05 level, '**' indicating significance at the 0.01 level, and '***' indicating significance at the 0.001 level.

Trend plots have also been prepared for other pollutants: sulphur dioxide, particulate matter, ozone and total oxides of nitrogen. These are presented and discussed on the 'Trend' pages of the Northern Ireland Air website, at http://www.airqualityni.co.uk/reports.php?n_action=trend as there is not sufficient space to include them in this short report.

4.1 Newtownabbey Antrim Road

The Newtownabbey Antrim Road monitor is situated on a busy road within the Borough Council's Elmfield AQMA, declared in 2010. An Air Quality Action Plan has been in place since that time, containing a large number of measures including developing a Green Travel Plan, a programme of vehicle testing and the provision of information on the Council website to encourage change in travel behaviour.

Photo: Giant's Causeway, Antrim

[2] Carslaw, D.C. and K. Ropkins, (2012). 'Openair — an R package for air quality data analysis.' Environmental Modelling & Software. Volume 27-28, pp 52-61.

Figure 4.1 shows a de-seasonalised trend plot for NO_2 at Newtownabbey Antrim Road. This site has been in operation since 2008.

There is a downward trend in NO_2 concentration at this site, statistically significant at the 0.001 level. It should be noted that in January 2010 the monitoring station was moved back from the road, such that the distance from the inlet to the kerb increased from 1m to 3m. Although the Borough Council reported a decrease following this change, it does not account for the long-term decrease in NO_2 concentration apparent from early 2009. The annual mean has not exceeded the limit value since 2012. However, it remains close to the limit value and so further reductions in NO_2 levels are desirable.

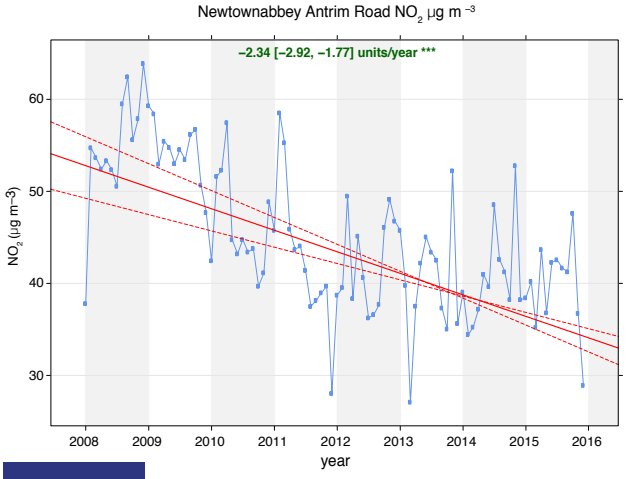

Figure 4.1

De-seasonalised Trend Plot for NO_2 at Newtownabbey Antrim Road, 2008 - 2015

4.2 Belfast Stockman's Lane

This monitoring site, which has operated since 2006, is located in an AQMA that extends along a long stretch of the M1/ Westlink corridor. Belfast City Council's Air Quality Action Plan contains a wide range of measures, many of which are aimed at improving public transport and encouraging its use, for example the Belfast Rapid Transit service (see page 14).

Figure 4.2 shows a de-seasonalised trend plot for NO_2 at Belfast Stockman's Lane from 2008 to 2015. Throughout this time it has consistently measured annual mean NO_2 concentrations well above the annual mean AQS objective and limit value of 40 µg m^{-3}.

There is a downward trend in NO_2 concentration at this site of almost 2 µg m^{-3} per year, statistically significant at the 0.001 level. If this downward trend continues, the annual mean AQS and EU Objective could be met at this site in future years. Meteorological and other factors such as traffic flow and other nearby sources will inevitably influence whether this proves to be the case.

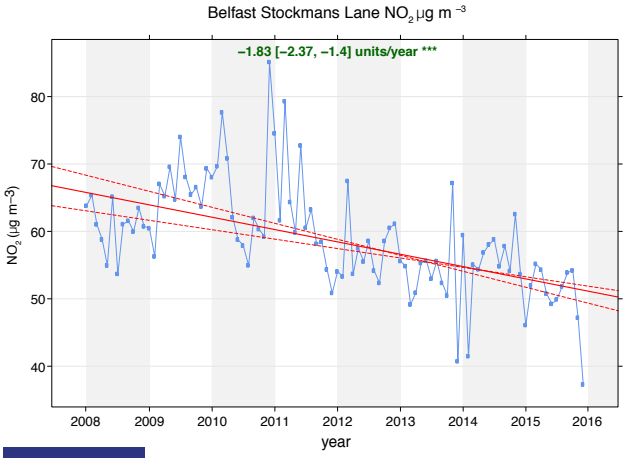

Figure 4.2

De-seasonalised Trend Plot for NO_2 at Belfast Stockman's Lane, 2008 - 2015

4.3 Belfast Newtownards Road

This monitoring site is located beside the busy Upper Newtownards Road, and is in one of Belfast City Council's AQMAs. Figure 4.3 shows a de-seasonalised trend plot for NO_2 measured at this site, from 2008 to 2015. Although there is an overall highly significant downward trend, most of the decrease appears to have happened after 2010. In this respect the pattern is similar to that observed for Belfast Stockman's Lane. Statistics from the Northern Ireland Air website confirm that annual mean concentrations (in µg m^{-3}) were consistently in the mid-40s. In 2011, however, there appears to have been a substantial decrease. From that year onwards the AQS Objective has been met at this site.

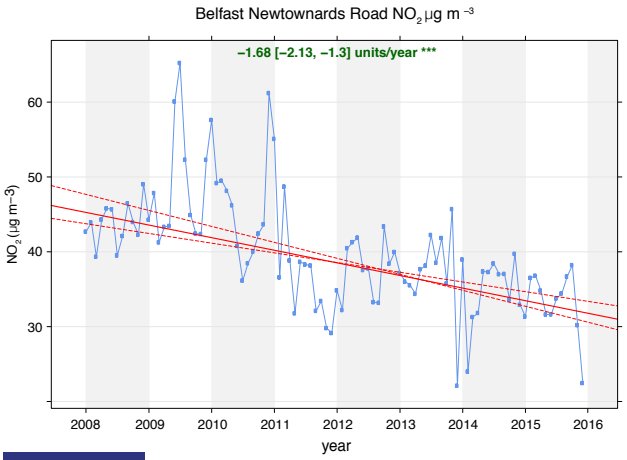

Figure 4.3

De-seasonalised Trend Plot for NO_2 at Belfast Newtownards Road, 2008 - 2015

4.4 Belfast Ormeau Road

This monitoring site is also beside a busy road and within one of Belfast City Council's AQMAs. Figure 4.4 shows a de-seasonalised trend plot for NO_2 measured at this site, from 2008 to 2015. The pattern at this site is unusual; there is little change in NO_2 concentration over the period from 2008 to 2011, but this is followed by a period of much higher concentrations throughout 2012 and early 2013. Belfast City Council's 2013 Progress Report (available for download from the Northern Ireland Air District Council Reports page at http://www.airqualityni.co.uk/laqm/district-council-reports) highlights this increase, and explains that, *"It is considered that this sharp increase may be attributed to more congestion in the area resulting from the introduction of bus corridors and changes in traffic signalling to facilitate the introduction of Belfast on the Move. It is anticipated that this congestion will be short term until Belfast on the Move and the Rapid Transit System are fully operational".* The Council will continue to monitor at the site. Data now show that NO_2 concentrations have returned to their pre-2012 levels and annual means are now well below the limit value. However, it is not showing a significant trend.

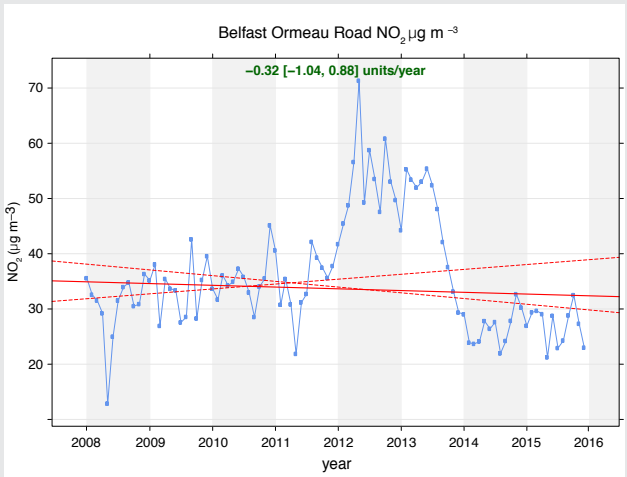

Figure 4.4

De-seasonalised Trend Plot for NO_2 at Belfast Ormeau Road, 2008 - 2015

4.5 Downpatrick Roadside

This roadside monitoring site is located near the junction of Market Street and Irish Street, in Downpatrick. It is not in an AQMA, and has only exceeded the annual mean objective for NO_2 in one year, 2014. Figure 4.5 shows a de-seasonalised trend plot for NO_2 measured at this site, from late 2010 (when it began operation) to 2015. There is no significant upward or downward trend at this site, although NO_2 concentrations appear to have been slightly higher in 2013 and 2014 before decreasing again in 2015.

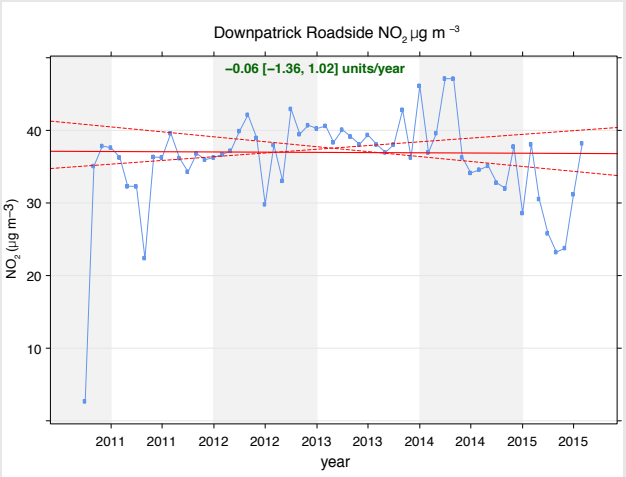

Figure 4.5

De-seasonalised Trend Plot for NO_2 at Downpatrick Roadside, 2010 - 2015

4.6 Summary

The five monitoring sites discussed in this section have all been in operation for at least four years and have measured at least one exceedance of the AQS Objective for annual mean NO_2 concentration during this time.

Both Newtownabbey Antrim Road and Belfast Newtownards Road datasets show downward trends in NO_2 concentration, although Newtownabbey Antrim Road remains close to the limit value, with an annual mean of 39.6 µg m^{-3} for 2015. Belfast Stockman's Lane, too, has recorded a decrease in NO_2 concentration, although levels here are higher and it is likely to be several years before the AQS Objective and EU limit value is met.

The increase in NO_2 at Belfast Ormeau Road during 2012-13 was due to local traffic changes in the city, but as expected this was short-term and NO_2 levels returned to their pre-2012 levels once the works were completed. Annual means are now well below the limit value.

Overall, the graphs from the Belfast sites show that the long-term roadside NO_2 concentrations in the city are mostly decreasing, although at different rates in the monitored areas.

By contrast, Downpatrick Roadside shows no significant trend over its years of operation. However, it has only ever recorded one exceedance of the annual mean objective (in 2014), and NO_2 concentrations appear to have decreased the following year.

5

Maps of Air Quality

Measurements from air quality monitoring sites in Northern Ireland have been combined with pollutant emissions estimates from the UK's National Atmospheric Emissions Inventory (NAEI) to produce detailed modelled maps – at 1 km resolution – of average or peak background pollutant concentrations across Northern Ireland for 2015.

Figure 5.1 shows modelled annual mean PM_{10} concentrations. Highest concentrations occur in the Lagan Valley, in the area around Belfast and Dunmurry. Despite this, annual mean background concentrations throughout the region are well below the AQS objective, and the area with concentrations greater than 8 µg m^{-3} is considerably reduced compared with the 2014 map.

Figure 5.2 shows corresponding annual mean benzo[a]pyrene (B[a]P) concentrations. Most of Northern Ireland has annual mean concentrations below 0.25 ng m^{-3}, with just a few small areas of higher concentration in some urban areas. However the annual mean background concentrations throughout the whole region are below the EU target (1 ng m^{-3}).

Figure 5.3 shows modelled annual mean NO_2 concentrations at background locations - i.e. at least 10m away from major roads. These are all well below the AQS objective even in central Belfast. In previous years' versions of this map, Northern Ireland's network of major roads was clearly visible, (as the presence of a major road in a grid square raises its average NO_2 concentration). However, these routes are not obvious on the 2015 map: due to lower NO_2 levels in 2015, average concentrations outside urban areas are mostly below 5 µg m^{-3} even if there is a road in the grid square.

For traffic-related pollutants, roadside concentrations, 4 m from the kerb, are also modelled. Figure 5.4 shows modelled annual mean NO_2 concentrations alongside major roads in the Belfast area. This map is very similar to the previous year's version: exceedances of the AQS objective are predicted along a small number of road links, including some city centre streets, part of the A12 (Westlink), and stretches of the A2 towards Holywood. Although the general pattern is consistent with monitoring, neither the Belfast Westlink Roden Street nor North Down Holywood A2 monitoring sites recorded an exceedance in 2015 despite the model's predictions.

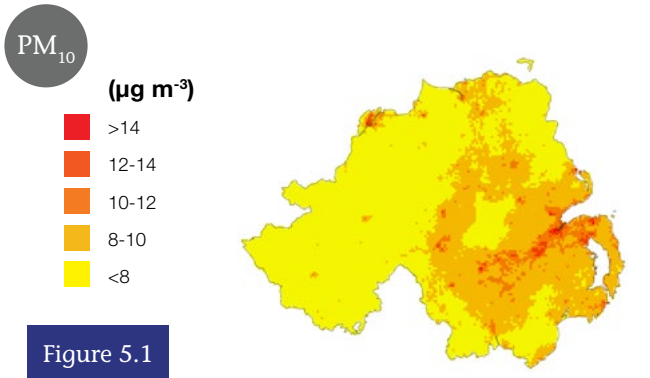

Figure 5.1

Estimated annual mean background PM_{10}, µg m^{-3}

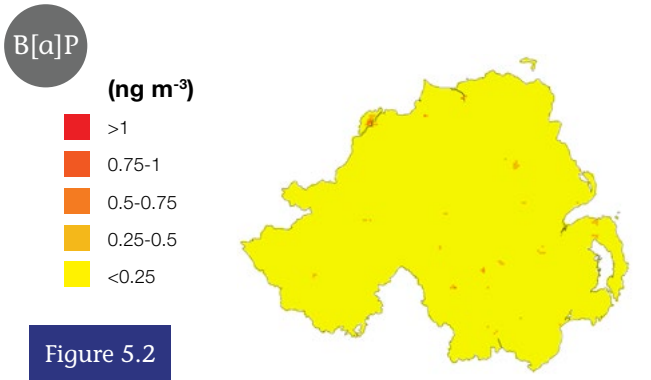

Figure 5.2

Estimated annual mean background B[a]P ng m^{-3}

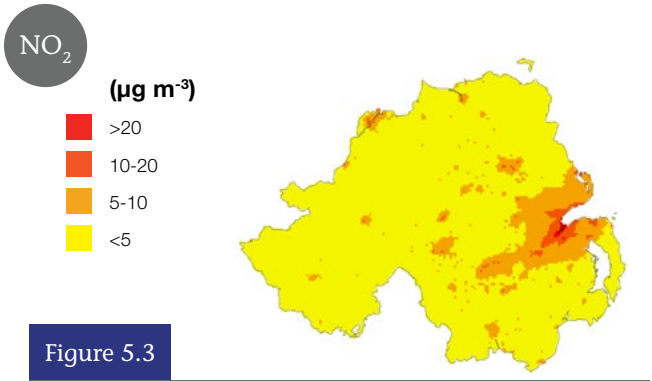

Figure 5.3

Estimated annual mean background NO_2, µg m^{-3}

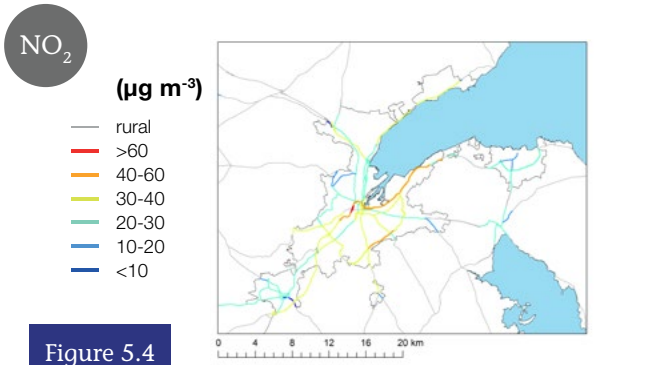

Figure 5.4

Estimated annual mean roadside NO_2, µg m^{-3} in the Belfast area

6

Air Pollution from Road Traffic

6.1 Which pollutants come from traffic?

In the context of air quality, the most important are:

- Oxides of nitrogen, primarily NO_2 and NO. A mixture of NO and NO_2 (referred to as NO_x) is emitted, and NO then undergoes reactions in the air to form NO_2.
- Particulate matter (PM): both carbon (soot) from the burning of the fuel, and also particles from tyre wear, brake wear and abrasion of the road.
- Carbon monoxide (produced when fuels containing carbon are burnt without enough oxygen to turn all the carbon to carbon dioxide).
- Volatile organic compounds – a range of carbon-containing chemical compounds from unburnt or partially-burnt fuel.

Road vehicles also emit considerable amounts of carbon dioxide (CO_2), which contributes to climate change. According to data from the Northern Ireland Greenhouse Gas Inventory, road transport accounted for 28% of Northern Ireland's CO_2 emissions, and 19% of its total greenhouse gas emissions in 2014. However, this report will only deal with the above pollutants affecting air quality.

6.2 What effects do they have?

In adults, long-term exposure to outdoor pollution has been found to affect lung function[3,4], and traffic-related air pollution has been linked with problems including asthma[5]. Children raised near busy roads may grow up with poorer lung-function in the long term[6]. (For more information about the health effects of specific pollutants, please see the previous report in this series, 'Air Pollution in Northern Ireland 2014', which can be downloaded from http://www.airqualityni.co.uk/news-and-reports/technical-reports.)

6.3 How important is traffic as a source?

The UK National Atmospheric Emissions Inventory (NAEI) at http://naei.defra.gov.uk/ estimates annual emissions of a range of pollutants from different sources. The NAEI provides the following estimates for Northern Ireland, based on 2014 (the most recent year for which data are available).

- **Oxides of nitrogen (NO_x)**: Road transport contributed 33% of Northern Ireland's total 2014 NO_x emissions, made up of 20.7% from passenger cars, 8.9% from heavy duty vehicles (HDV, i.e. heavy goods vehicles plus buses and coaches), 3.3% from light goods vehicles (LGV) and <0.1% from motorcycles (Figure 6.1).
- **Particulate matter**: 12.6% of Northern Ireland's total PM_{10} emissions came from transport (all forms): 11% of the total was specifically from road transport. These percentages only include 'primary' particles, emitted directly from source; a 'secondary' component is also formed by chemical reactions in the air, often involving other pollutants e.g. NO_x.
- **Carbon monoxide**: 21.9% of Northern Ireland's total emissions came from transport, and again the majority (20%) was from road transport.
- **Non-methane volatile organic compounds (NMVOC)**: transport (road and other) accounted for just over 4% of Northern Ireland's total 2014 emissions of NMVOC. This includes fuel evaporation from road vehicles.

In summary, road traffic contributes a significant proportion of Northern Ireland's total emissions of PM_{10}, CO and particularly NO_x. And unlike emissions from industrial sources, power stations etc., these emissions are produced near to ground level, in streets, where people are likely to be exposed to them.

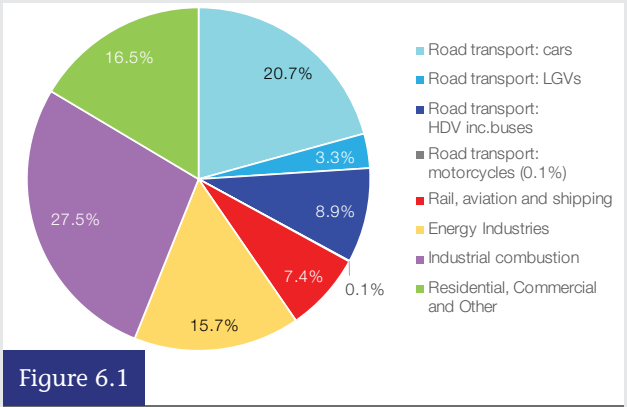

Figure 6.1

N.I.'s Estimated 2014 NOx Emissions (Data: NAEI, 2016)

[3] Forbes L.J.L. et al 'Chronic exposure to outdoor air pollution and lung function in adults' Thorax 2009;64:657-663 DOI:10.1136/thx.2008.109389.

[4] Ackermann-Liebrich U, Leuenberger P, Schwartz J, et al 'Lung function and long term exposure to air pollutants in Switzerland. Study on air pollution and lung diseases in adults (SAPALDIA) team'. Am J Respir Crit Care Med 1997;155:122–9.

[5] Künzli N. et al. 'Traffic-related air pollution correlates with adult-onset asthma among never-smokers'. Thorax 2009;64:664-670 DOI:10.1136/thx.2008.110031

[6] Gauderman W.J. 'Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study.' The Lancet Early Online Publication, 26 January 2007. DOI:10.1016/S0140-6736(07)60037-3

6.4 Which vehicles emit the most pollution?

Figure 6.2 shows the emission factors (grammes of NO_X produced per kilometre driven) – for different vehicle types, and for urban, rural and motorway driving. These are fleet-weighted (i.e. they reflect the mix of vehicle ages and models on the UK's roads in 2014). They are also 'hot exhaust' emission factors, for vehicles with engines at normal operating temperature (emissions from cold engines are often different).

Petrol cars emit considerably less NO_X than diesel cars (0.113 g/km compared with 0.656 g/km for diesel, in the case of urban driving). Motorcycles typically emit more NO_X per km than petrol cars: their engines are smaller, but catalytic converters are not compulsory. However, new legislation now restricts motorcycle NO_x emissions to 0.09 g/km, for all new models introduced from 2016.

Heavy duty vehicles typically have much higher NO_X emission factors than cars. And for all the HDV categories shown here, NO_X emission factors are higher for urban driving than for rural or motorway driving (due to various factors).

Figure 6.3 shows the emission factors for PM_{10}. For cars and LGVs, the difference between emission factors from petrol and diesel vehicles is even more marked than for NO_X. Again, HDVs emit much more PM_{10} per km on urban roads than on rural roads or motorways.

Figure 6.3 also highlights the importance of non-exhaust PM_{10} emissions: tyre wear, brake wear and road abrasion. For petrol and diesel cars, petrol LGVs, buses and HGVs, these processes together produce more PM_{10} per km than fuel combustion.

6.5 What action is being taken?

Section 2 has outlined the legislation and policy in place to regulate and improve ambient air quality. Other actions specifically targeting traffic-related pollution include the following:

- Since 1992, the European Union has implemented a series of **Euro standards** progressively reducing allowable emissions from cars and HDVs.
- 'Real Driving Emissions' (RDE) of NO_x (especially from diesel vehicles) are often higher than those measured in emissions tests. In response, the UK Government and EU are working to develop new RDE-based emissions tests.
- The **ecarni** programme has provided 431 charging points for electric vehicles throughout Northern Ireland. See https://www.ecarni.com/ for more information.
- The '**Belfast on the Move**' transport initiative (see https://www.infrastructure-ni.gov.uk/articles/aims-belfast-move) is providing a more sustainable transport system for the city centre. It includes improved public transport services, better facilities for walking and cycling and a reduction in car traffic. The initiative will be further developed in line with the introduction of the Belfast Rapid Transit.
- **Belfast Rapid Transit** (https://www.infrastructure-ni.gov.uk/topics/transport-initiatives/brt) will deliver a fast, frequent, accessible and reliable service, reducing the need for car use. Its articulated vehicles each carry 100 people, and use hybrid diesel/electric technologies for lower emissions. Three cross-city routes are scheduled to begin operation in 2018.
- Northern Ireland's Programme for Government (recently published for consultation) includes further measures to grow and support public transport: e.g. Integrated Transport Hubs, Park-and-Ride schemes, interconnecting services, integrated ticketing, and substantial expansion of rail capacity.

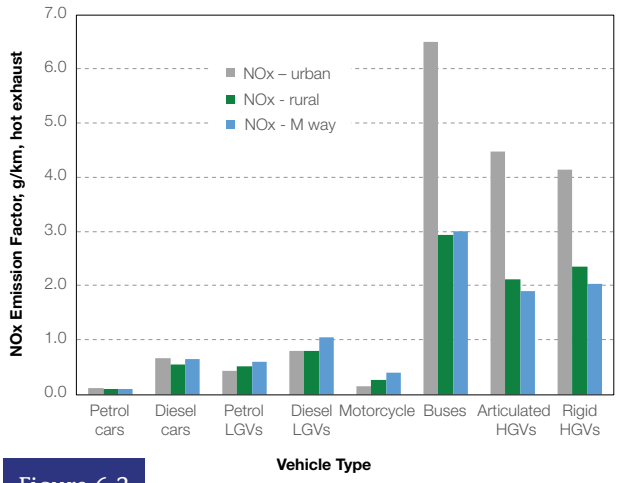

Figure 6.2

UK Fleet-Weighted Hot Exhaust NO_x Emission Factors (NAEI, May 2016)

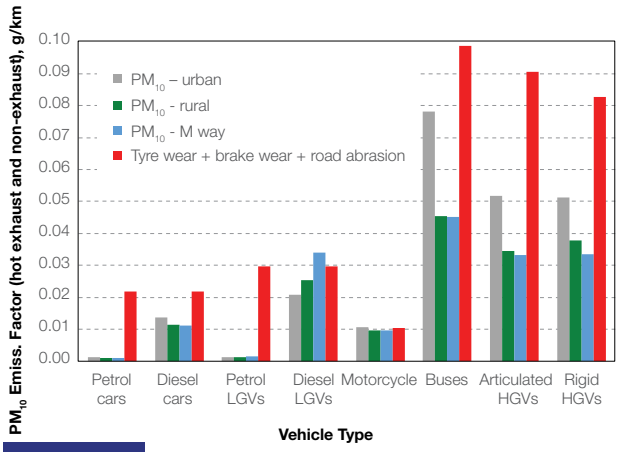

Figure 6.3

UK Fleet-Weighted PM_{10} Emission Factors (NAEI, May 2016)

7

What Can I Do To Help?

It takes energy to produce food, treat our drinking water, manufacture the things we use, heat our homes and workplaces, and transport us to the places we need to go. Most of this energy comes from the burning of fuels – producing CO_2, which contributes to climate change, and usually some air pollutants, such as NO_X and PM_{10}.

Therefore, the choices we make about how we travel, how we heat our homes, and the things we buy and use can all help to make a difference to air quality. If we can use less energy, and avoid wasting it, this will avoid releasing unnecessary pollution into the air. It will also save us money. Here are some things we can do to help, some of which are now featured on DAERA's Air Pollution and Smoke Control web page at https://www.daera-ni.gov.uk/articles/air-pollution#toc-3:

At Home:

Make sure your home is well insulated and the boiler well maintained. In most UK homes the central heating system accounts for the highest percentage of energy used[7]. Under the **Affordable Warmth Grant Scheme** you may be able to receive energy advice and help to make sure your home is well insulated. (See https://www.nidirect.gov.uk/articles/affordable-warmth-grant-scheme for more information and to see if you qualify.)

- Stay warm but don't overheat your home. 21°C is comfortable for most people.
- If you are a landlord, ensure that the homes you let are properly insulated so that your tenants do not have to waste energy to keep warm.
- Avoid wasting food – it takes energy to produce. There is plenty of useful advice on the **Love Food Hate Waste** website, at http://ni.lovefoodhatewaste.com/.
- When boiling the kettle, boil only as much water as you need (but ensure the water covers the kettle's heating element).
- If you live in a smoke control area, there are only certain types of fuels and appliances you may use to heat your home. Find out more from your district council.

Lots more energy saving advice can be found on the **NI Direct 'Energy Wise'** webpages at https://www.nidirect.gov.uk/campaigns/energy-wise.

Travelling:

- Try to drive less. Walk or cycle if possible, or use public transport – especially for short journeys.
- NIDirect's '**Active Travel and Sustainable Transport**' web page, at https://www.nidirect.gov.uk/information-and-services/travel-transport-and-roads/active-travel-and-sustainable-transport provides advice and information on more sustainable transport options, including:
  - Greener driving tips
  - The **ecarni** electric vehicle charging infrastructure, which offers a network of 431 charging points across Northern Ireland
  - Public transport
  - Car sharing.
- For more information on cycling – including Northern Ireland's Cycle to Work scheme, see the CycleNI website at http://www.cycleni.com/.
- Work-related travel is an area where many businesses could reduce their environmental impacts and make cost savings. The **NI Business Workplace Travel Planning** web page at https://www.nibusinessinfo.co.uk/content/workplace-travel-planning can show you how to create a workplace travel plan, promote a more sustainable travel culture within your business, and reduce the need for business travel by exploring options such as video conferencing.
- If you drive, keep your car well-maintained, and tyres at the correct pressure. This will help avoid wasting fuel.
- Remove roof racks and boxes when they are not needed: they will add weight and create drag, making the engine use more fuel.
- Do not wait with your engine idling – if you are going to be stationary for a minute or more, switch it off.

[7] nidirect "Central Heating" [online]. Available at http://www.nidirect.gov.uk/index/information-and-services/environment-and-greener-living/energy-wise/central-heating.htm. (Accessed 10 Oct 2016)

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Where to Find Out More on Air Quality:

The Northern Ireland Air Quality Website at www.airqualityni.co.uk provides information covering all aspects of air pollution in Northern Ireland.

DAERA's website at https://www.daera-ni.gov.uk/ provides links to information on a range of environmental issues including biodiversity, waste and pollution. DAERA's 'Protect the Environment' web page at https://www.daera-ni.gov.uk/topics/protect-environment covers air quality, climate change and local environmental issues including noise.

National and local air quality forecasts are available from:

- The Air Pollution Recorded Helpline on freephone 0800 556677;
- The Defra UK Air Information Resource (UK-AIR) at http://uk-air.defra.gov.uk/
- The Northern Ireland Air Quality website www.airqualityni.co.uk.

For information on air quality issues in your local area please contact the Environmental Health Department of your district council.