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

Air Pollution in Northern Ireland 2019

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1. Report Highlights

This is the eighteenth in a series of annual reports on air quality in Northern Ireland. It has been written and produced by Ricardo Energy & Environment, on behalf of the Department of Agriculture, Environment and Rural Affairs (DAERA).

The key purpose of this report is to summarise air quality monitoring results for Northern Ireland in 2019, in order to inform the public, government and wider air quality community in Northern Ireland. This report also contains useful information on air quality policy and legislation as well as on sources of pollution. Figure 1.1 shows the locations of all air quality monitoring sites in Northern Ireland that were in operation during part or all of 2019.

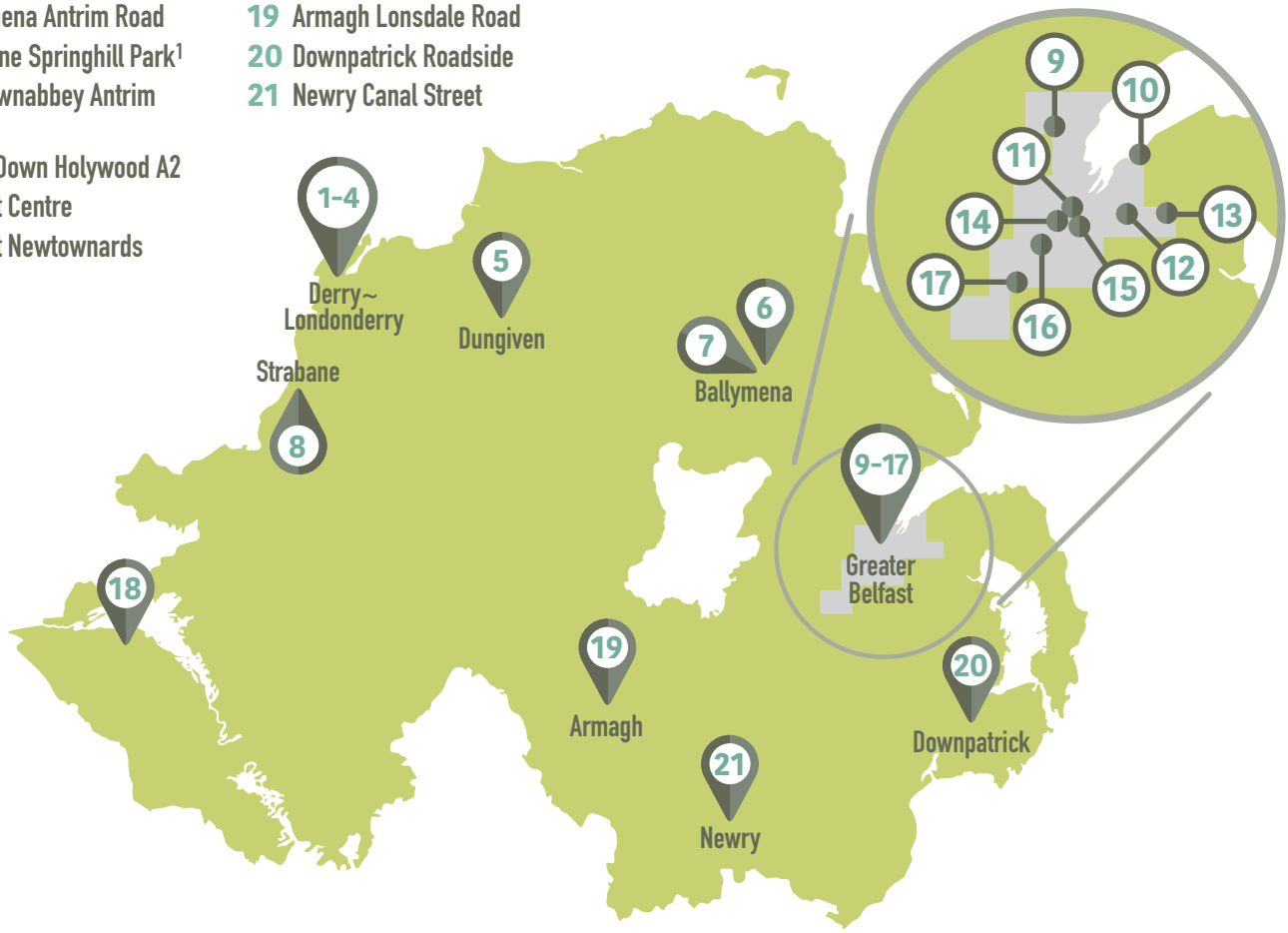
Fig. 1.1: Air Quality Monitoring Stations

1 Londonderry Rosemount
2 Londonderry Dale's Corner
3 Strathfoyle Bawnmore Place
4 Derry Brandywell
5 Limavady Dungiven
6 Ballymena Ballykeel
7 Ballymena Antrim Road
8 Strabane Springhill Park[1]
9 Newtownabbey Antrim Road
10 North Down Holywood A2
11 Belfast Centre
12 Belfast Newtownards Road
13 Castlereagh Dundonald
14 Belfast Westlink Roden Street
15 Belfast Ormeau Road
16 Belfast Stockman's Lane
17 Lisburn Dunmurry Seymour Hill[2]
18 Lough Navar
19 Armagh Lonsdale Road
20 Downpatrick Roadside
21 Newry Canal Street

21 sites operating in 2019. No sites closed down in 2018 or 2019. This map has been updated from the previous years to show the location of sites in the UK Black carbon and PAH Networks

[1] Black Carbon is measured at Strabane 2 which is at the same location as Strabane Springhill Park

[2] Black Carbon and PAHs are measured at Kilmakee Leisure Centre which is at the same location as Lisburn Dunmurry Seymour Hill



Derry/Londonderry City Centre

This report has been compiled from data supplied by Northern Ireland's network of air quality monitoring stations (Figure 1.1). Some of these are operated on behalf of DAERA, while others are managed by district councils, via the Local Air Quality Management framework, for which DAERA provides funding support. An interactive map of the automatic monitoring stations shown in Figure 1.1 can be found on the Northern Ireland Air Quality Website at www.airqualityni.co.uk.

Concentrations of sulphur dioxide, a pollutant associated with coal and oil combustion, have declined significantly over the past twenty years.

Information on the sites in Northern Ireland within the Black Carbon, PAH, Hydrocarbon, and Heavy Metals Networks, can be found on the UK-AIR website at https://uk-air.defra.gov.uk/interactive-map.

This report reviews the pollutants monitored, and highlights exceedances of air quality objectives. It also highlights emerging trends in air quality over time. Each edition of the report takes an issue to examine in-depth, and this year's focus is on particulate matter.

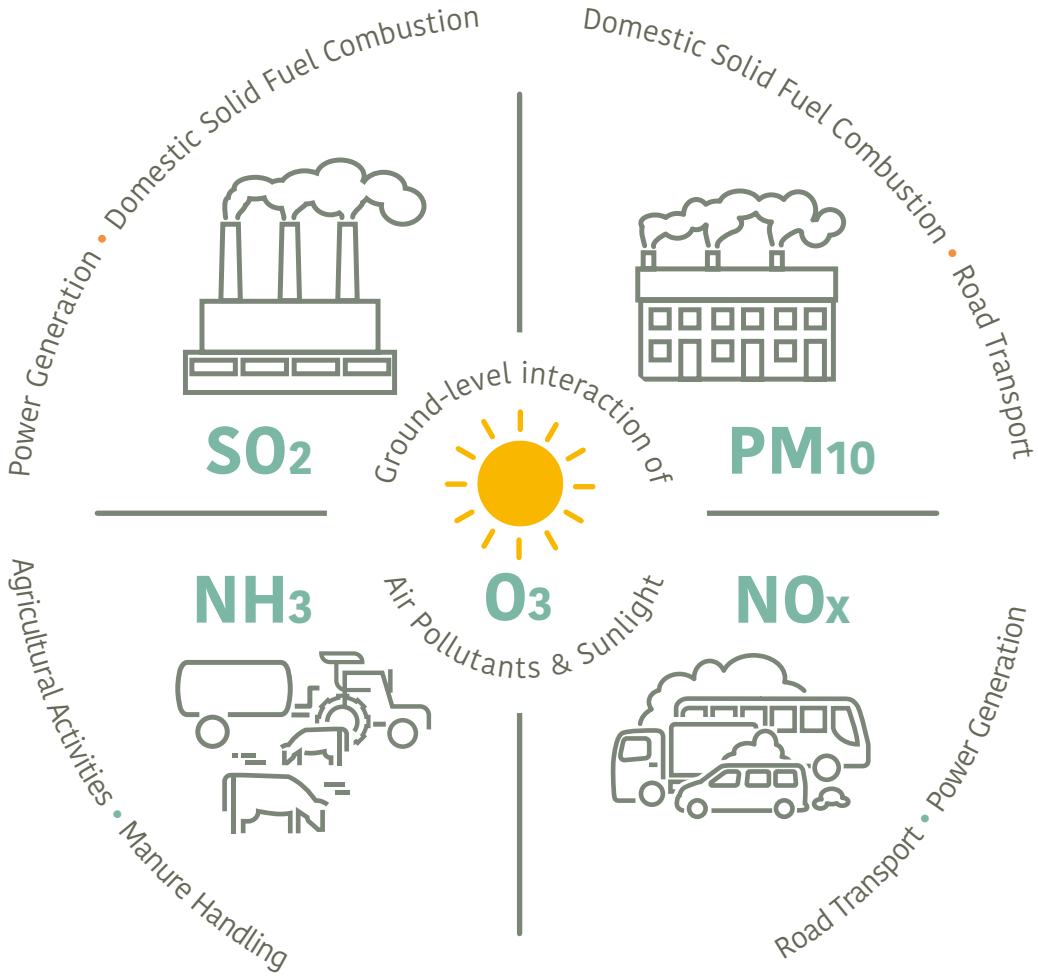
Air quality in Northern Ireland has improved substantially in recent decades. In particular, concentrations of sulphur dioxide, a pollutant associated with coal and oil combustion, have declined significantly over the past twenty years. However, some pollutants in some parts of Northern Ireland continue 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.

2. Sources of Air Pollution in NI

Figure 2.1 illustrates the most significant air pollutants for our region, and provides information on their sources:

- Nitrogen oxides (NO_x, which includes nitrogen monoxide NO and nitrogen dioxide NO_2): from combustion of fuels, most importantly in transport and energy generation. The NO_x emitted by road transport, however, poses more of a problem because it leads to increased concentrations of NO_2 at ground level in busy streets where people are present. NO_2 is a respiratory irritant: it can irritate the airways and lungs. This can worsen the symptoms of people who have lung problems.
- Sulphur dioxide, SO_2: a pollutant produced during combustion of fuels containing sulphur (such as coal), particularly from power generation, industry, and household heating. SO_2 is a respiratory irritant that can cause the airways to constrict: people with asthma are likely to be particularly sensitive to it

Figure 2.1: Main Sources of Air Pollution



Carrick-a-Rede

- Particulate matter, PM_{10} and $PM_{2.5}$: by-products of burning fuels, in particular solid fuels (e.g. domestic wood and coal burning), industrial combustion and road transport. Less than half the PM produced by road transport is from fuel combustion; the majority is from tyre and brake wear and road dust. PM_{10} particles can travel into our airways where they can cause inflammation, and a worsening of the condition of people with heart and lung diseases. $PM_{2.5}$ particles can be carried deep into the lungs: these ultrafine particles may carry surface-absorbed toxic, or carcinogenic, compounds into the body.
- Ground-level ozone, O_3: a secondary pollutant, formed by the interaction of other air pollutants in the presence of sunlight. Ozone irritates the eyes and the airways of the lungs, increasing the symptoms of those suffering from asthma and lung diseases.
- Ammonia, NH_3: a gas that is emitted from waste and agricultural activities – in particular, manure handling, storage and spreading. Ammonia contributes to air pollution because it can react with other pollutants (the oxides of nitrogen and sulphur) to produce fine particles of ammonium nitrate and ammonium sulphate.
- Polycyclic aromatic hydrocarbons, PAHs: typically formed by incomplete combustion or pyrolysis. Domestic combustion accounts for the majority of PAH emissions to the atmosphere. Several PAHs are toxic or can be carcinogenic, such as Benzo[a]pyrene, which is used as a marker compound for PAHs in the UK.

3. Legislation and Policy: What Can Be Done

During 2019, the management of air quality in Northern Ireland was based on the requirements of European Union (EU) Air Quality Directives, and on the 2007 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.

A target to improve air quality exists in the Northern Ireland Executive's Draft Programme for Government

The European Union

The UK left the European Union (EU) on 31st January 2020 and is in a transition period until 31st December 2020. During the transition period the trading relationship between the EU and UK will remain the same and current EU rules, including those on air quality, will continue to apply.

A Withdrawal Agreement has been agreed and includes the Ireland/Northern Ireland Protocol which will apply from the end of the transition or implementation period. The Protocol sets out how Northern Ireland's exit from the EU will work, and will establish that while the whole of the UK will leave the Customs Union, Northern Ireland will align with EU Regulations on goods (for example, Sanitary and Phytosanitary [SPS] measures, marketing standards, product safety standards) and customs. The detailed arrangements for the implementation of the Protocol have still to be determined and work is ongoing across DAERA to assess the impact of the Protocol for work areas, including air quality.

During 2019 (the period covered by this report) the following Directives were still applicable in Northern Ireland:

- 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.

Newcastle, Co. Down

The Air Quality Standards Regulations (Northern Ireland) 2010

These Regulations transposed 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 DAERA to inform the public about air quality in the region, particularly with regard to warning the public when levels are elevated.

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 https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1.

Table 3.1: Air Quality Management Areas in Northern Ireland

District Council	Number of AQMAs	Pollutant that triggered designation	Sources
Antrim and Newtownabbey Borough Council	1	Nitrogen dioxide	Road traffic
Armagh City, Banbridge and Craigavon Borough Council	1	Nitrogen dioxide	Road traffic
Belfast City Council	4	Nitrogen dioxide	Road traffic
Causeway Coast and Glens Borough Council	1	Nitrogen dioxide	Road traffic
Derry City and Strabane District Council	4	Nitrogen dioxide	Road traffic
Fermanagh and Omagh District Council	0	-	-
Lisburn and Castlereagh City Council	1	Nitrogen dioxide	Road traffic
Mid and East Antrim Borough Council	2	Nitrogen Dioxide (1) and PM_{10} (1)	NO_2: Road traffic PM_{10}: Domestic Heating
Mid Ulster District Council	3	Nitrogen dioxide	Road traffic
Newry Mourne and Down District Council	2	Nitrogen dioxide (1) and PM_{10} (1)	Road traffic
North Down and Ards District Council	0	-	-

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 the 11 district councils in Northern Ireland. LAQM requires district councils to review and assess a range of air pollutants against the objectives set by the UK 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. In 2019 there were 19 AQMAs in Northern Ireland, as shown in Table 3.1. Nine councils have AQMAs: of these, seven have AQMAs for NO_2 only, and two have AQMAs for PM_{10} and NO_2. There are no AQMAs in place for any other pollutants, in Northern Ireland.

4. Air Quality Monitoring Results for 2019

Monitoring in Northern Ireland/ Key Findings

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 Greater 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 to 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 2019:

- 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).

There were 21 air quality monitoring stations that operated for all or part of 2019 in Northern Ireland. Each was 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}, $PM_{2.5}$, O_3, and black carbon, and/or a non-automatic sampler for PAH. These sites (shown previously in Figure 1.1) provide 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 and the Northern Ireland Air app, which can be downloaded free of charge from https://www.airqualityni.co.uk/stay-informed. Public warnings are issued when levels approach or reach 'high' levels[1] as defined by the Daily Air Quality Index (see https://uk-air.defra.gov.uk/air-pollution/daqi for an explanation of this Index).

Seven of the automatic monitoring sites (Armagh Lonsdale Road, Ballymena Antrim Road, Ballymena Ballykeel, Belfast Centre, Belfast Stockman's Lane, 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, and PAHs. Some of these measurements are used to assess compliance with the Air Quality Strategy, the Air Quality Directive and Fourth Daughter Directive.

[1]https://www.nidirect.gov.uk/articles/air-pollution-and-health

The Volatile Correction Model

Four of Northern Ireland's ten PM_{10} monitoring sites used the Tapered Element Oscillating Microbalance (TEOM) to measure PM_{10} during 2019. 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. However, the data have been corrected 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. For more information, visit the Volatile Correction Model web page[2]. 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 used the FDMS analyser in 2019.

Upgrade of PM Monitoring Instruments in 2018

The FDMS instrument has been used to measure PM_{10} and $PM_{2.5}$ at many of Northern Ireland's monitoring sites, including those which are part of the national monitoring network.
However, many of these instruments were approaching the end of their functional lifetime. The Environment Agency therefore began a programme of upgrades, replacing old FDMS with new instruments of different types. The FDMS at Lough Navar was replaced in the summer of 2018. Belfast Centre and Derry Rosemount subsequently had their FDMS upgraded in 2019, and finally Armagh Lonsdale Road in early 2020. The upgraded PM monitoring instruments do not separately measure the volatile and non-volatile fractions of PM. As such, since the last FDMS was replaced in early 2020, there has no longer been data available for the VCM in Northern Ireland. Data for VCM correction is available for the full duration of 2019, the period covered by this report.

[2] http://www.volatile-correction-model.info/

Key Results for 2019

This section summarises key monitoring results from 2019, including compliance with EU limit values and the corresponding Air Quality Strategy (AQS) objectives. Further information is provided on the Northern Ireland Air website.

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 2019, 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 Heavy Metals Network. The results for 2019 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 during 2019. 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.

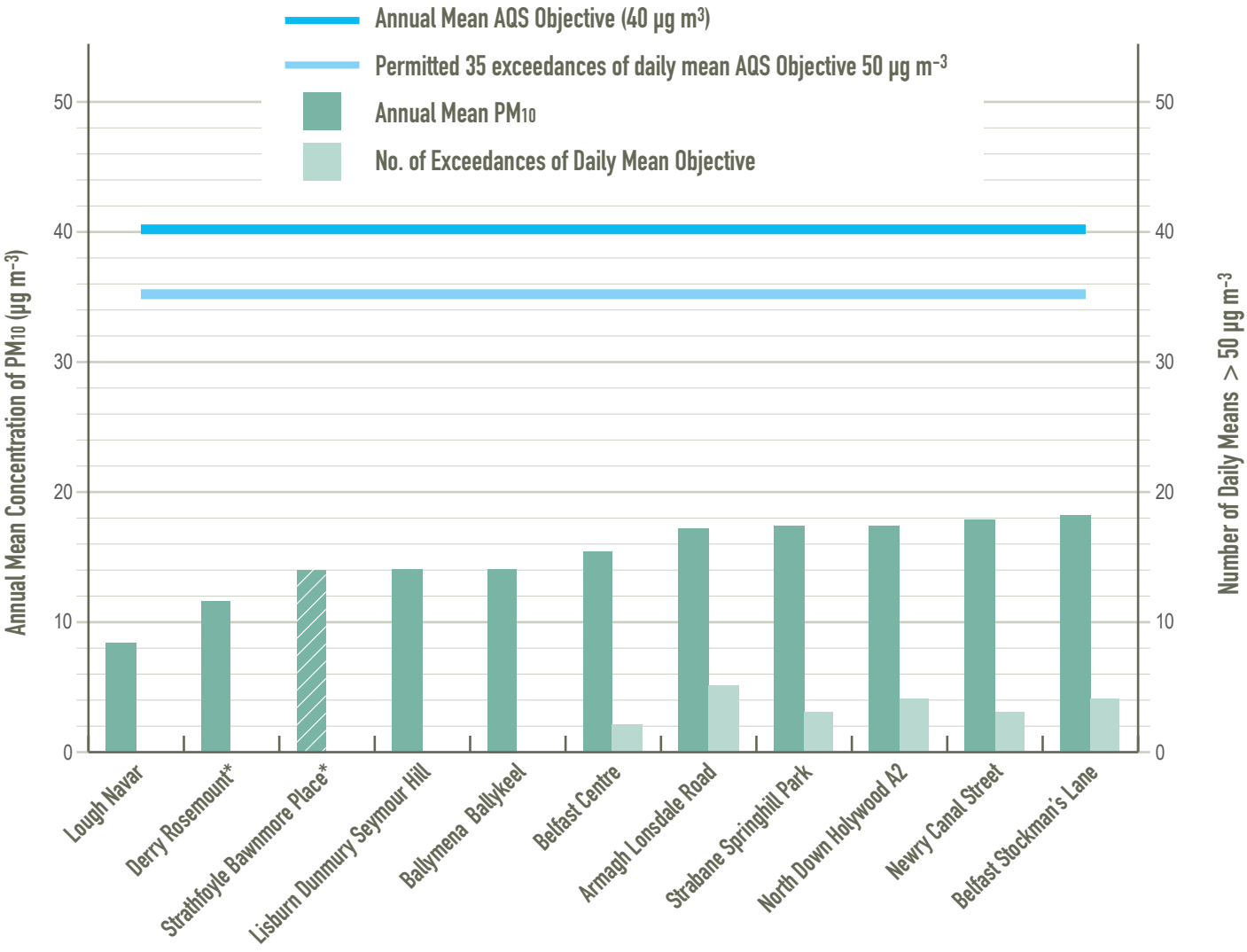
Ozone was monitored at Belfast Centre, Derry Rosemount, and the rural Lough Navar site. No sites exceeded the EU target value for human health of 120 µg m^{-3} (for the maximum daily 8-hour mean) on more than the permitted 25 days or exceeded the more stringent AQS objective of 100 µg m^{-3} on more than the permitted 10 days in 2019. Ozone concentrations in Northern Ireland are explored in more detail in section 5.

Particulate Matter PM_{10}. Particulate matter as PM_{10} was monitored at eleven locations in 2019. Figure 4.1 shows the annual mean PM_{10} concentrations (shown by the darker coloured bars), and the number of exceedances of the daily mean limit value and objective (shown by the lighter coloured bars). Four of these sites (Ballymena Ballykeel, North Down Holywood A2, Lisburn Dunmurry Seymour Hill, and Strathfoyle Bawnmore Place) used the TEOM instrument, so data from these sites have been corrected to the gravimetric equivalent using the King's College Volatile Correction Model as explained earlier in this section. For sites with less than 75% data capture, the data have been annualised to estimate the annual mean, as per the procedure laid out in LAQM.TG(16) (Box 7.9)[3]. For PM_{10}, this was the case for Strathfoyle Bawnmore Place.

[3] Local Air Quality Management - New Technical Guidance TG(16): Available at https://laqm.defra.gov.uk/technical-guidance/

To perform annualisation, data from two to four nearby continuous background monitors with capture rates greater than 85% should be used to calculate an annualisation factor. Data from Strabane Springhill Park and Ballymena Ballykeel were used to calculate an annualisation factor for PM_{10}. 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 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). Where data capture is less than 85%, the daily mean objective is judged on whether the 90.4th percentile of 24 hour mean PM_{10} concentrations has exceeded 50 µg m^{-3}, rather than the number of exceedances. This was the case for Derry Rosemount and Strathfoyle Bawnmore Place. The 90.4th percentiles at both sites were below 50 µg m^{-3}.

Figure 4.1: Annual Mean PM_{10} Concentrations and Exceedances of Daily Mean Objective, 2019

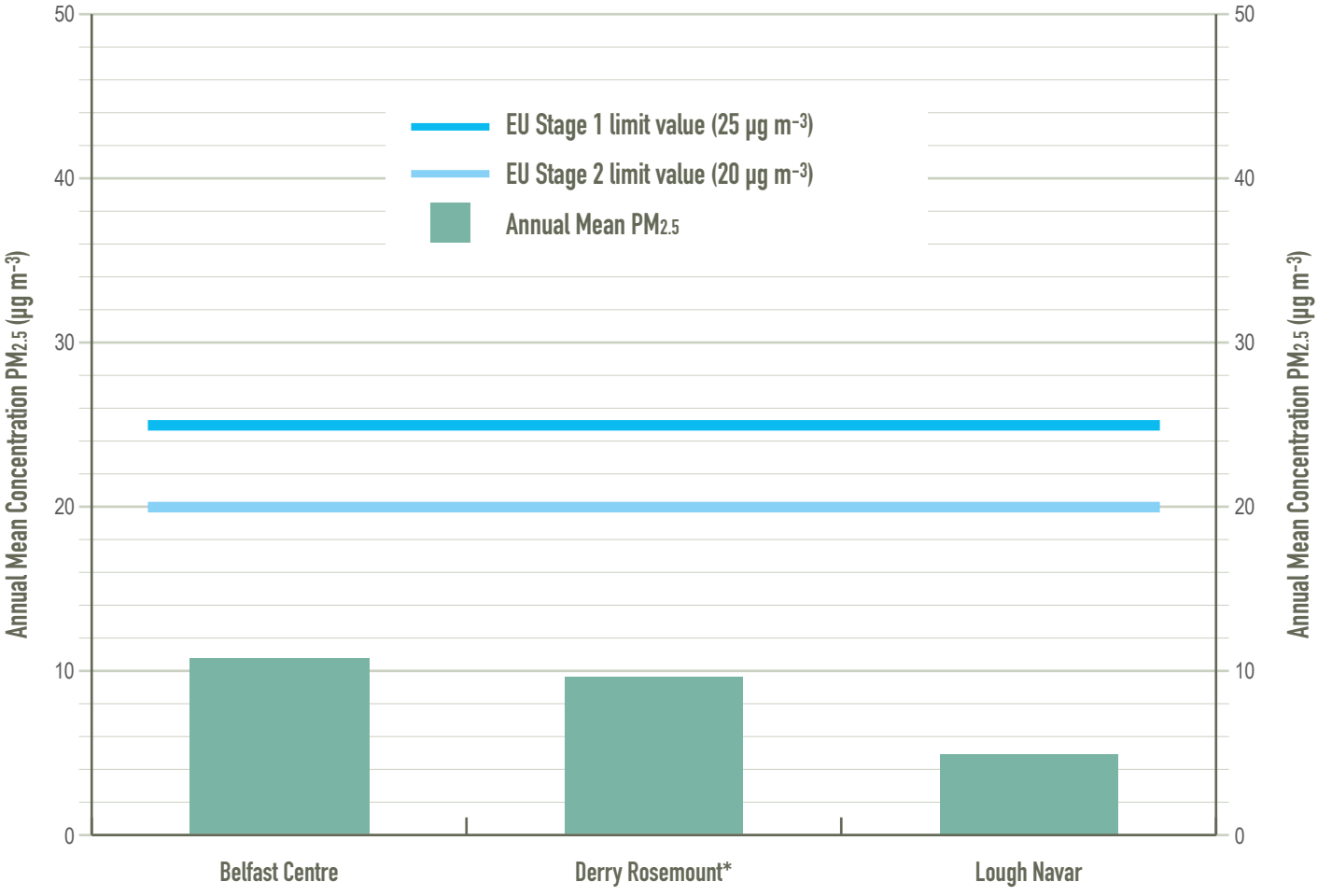


* Asterisk indicates sites with <85% data capture. Where the valid data capture is less than 75%, the means have been "annualised" and shown as a striped bar

Particulate matter $PM_{2.5}$. Fine particulate matter as $PM_{2.5}$ was monitored throughout 2019 at Belfast Centre and Derry Rosemount using the FDMS analyser and at Lough Navar using the Fidas analyser. All three sites reported 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 of 20 µg m^{-3} (which had to be achieved by 1st Jan 2020).

Nitrogen Dioxide was monitored using automatic analysers at 16 sites during 2019. Figure 4.3 shows the annual mean NO_2 concentrations (shown by the darker coloured bars), and the number of exceedances of the hourly mean objective (shown by the lighter coloured bars). For sites with less than 75% data capture, the data have been annualised to estimate the annual mean using the same procedure as described for PM_{10}. This was the case for Limavady Dungiven and Belfast Centre. Data from Derry Rosemount and Ballymena Ballykeel were used to calculate an annualisation factor and estimate the annual mean for Limavady Dungiven. In the case of Belfast Centre, there was only one nearby background site with data available, therefore annualisation in this case was performed using data from four nearby roadside sites.

Figure 4.2: Annual Mean $PM_{2.5}$ Concentrations and Exceedances of Daily Mean Objective, 2019



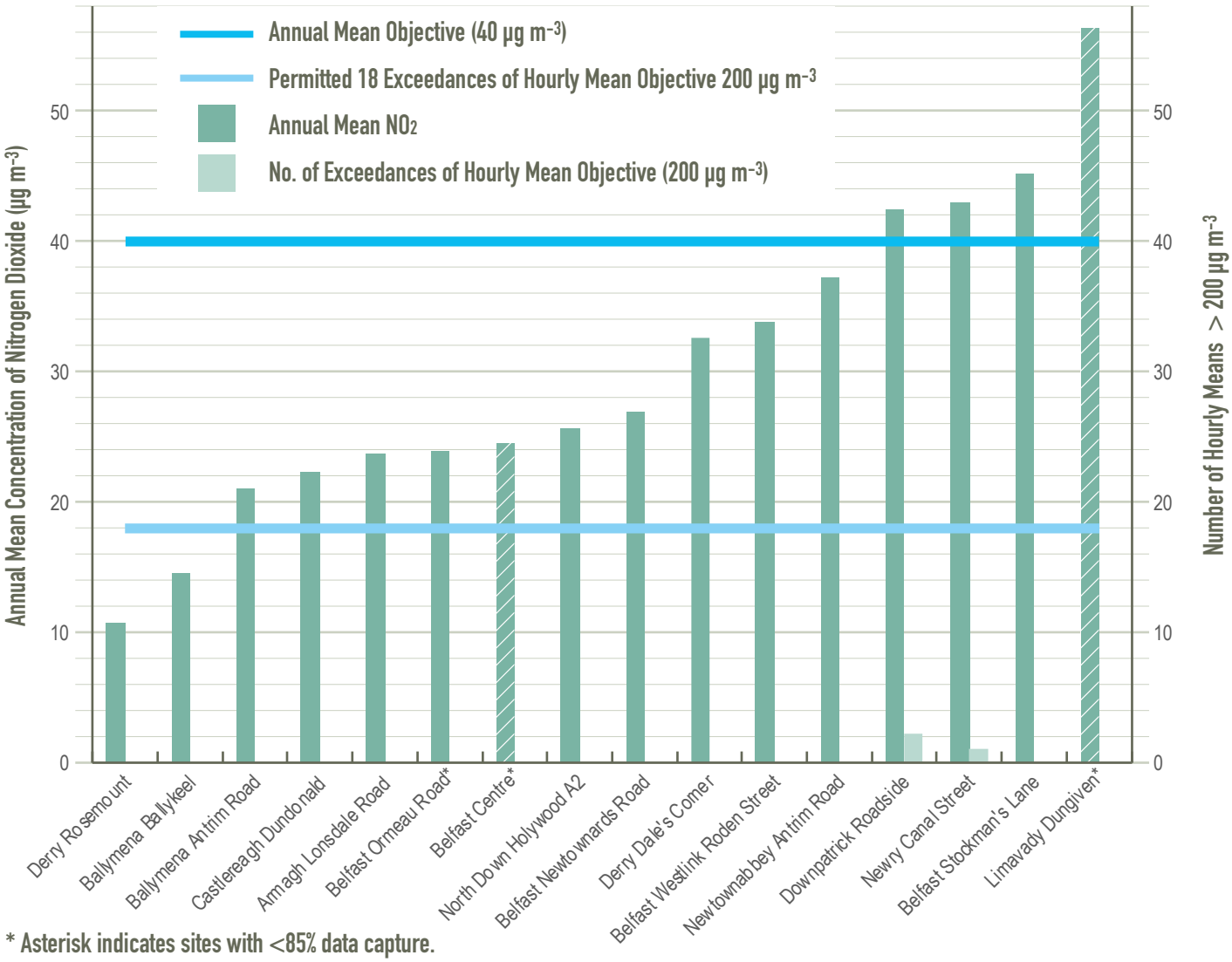
* Asterisk indicates sites with <85% data capture.

Three sites with sufficient data for a valid annual mean exceeded the AQS objective for annual mean NO_2 concentration (40 µg m^{-3}). These were as follows: Downpatrick Roadside (43 µg m^{-3}), Newry Canal Street (43 µg m^{-3}), and Belfast Stockman's Lane (45 µg m^{-3}). Limavady Dungiven also exceeded the NO_2 AQS objective with an estimated annual mean of 57 µg m^{-3}. All four of the above are traffic-related sites beside major or busy roads.

No sites exceeded the hourly mean limit value of 200 µg m^{-3} on more than the permitted 18 occasions. Where data capture is less than 85%, exceedance of the hourly mean objective 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. Three sites had capture rates below 85% in 2019: Belfast Ormeau Road, Belfast Centre, and Limavady Dungiven, however, at all three sites the 99.8th percentile of hourly values was below 200 µg m^{-3}.

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 2019 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}). None of the other sites that exceeded the AQS objective for this pollutant are used for Directive compliance monitoring.

Figure 4.3: Annual Mean NO_2 Concentrations and Exceedances of Hourly Objective, 2019

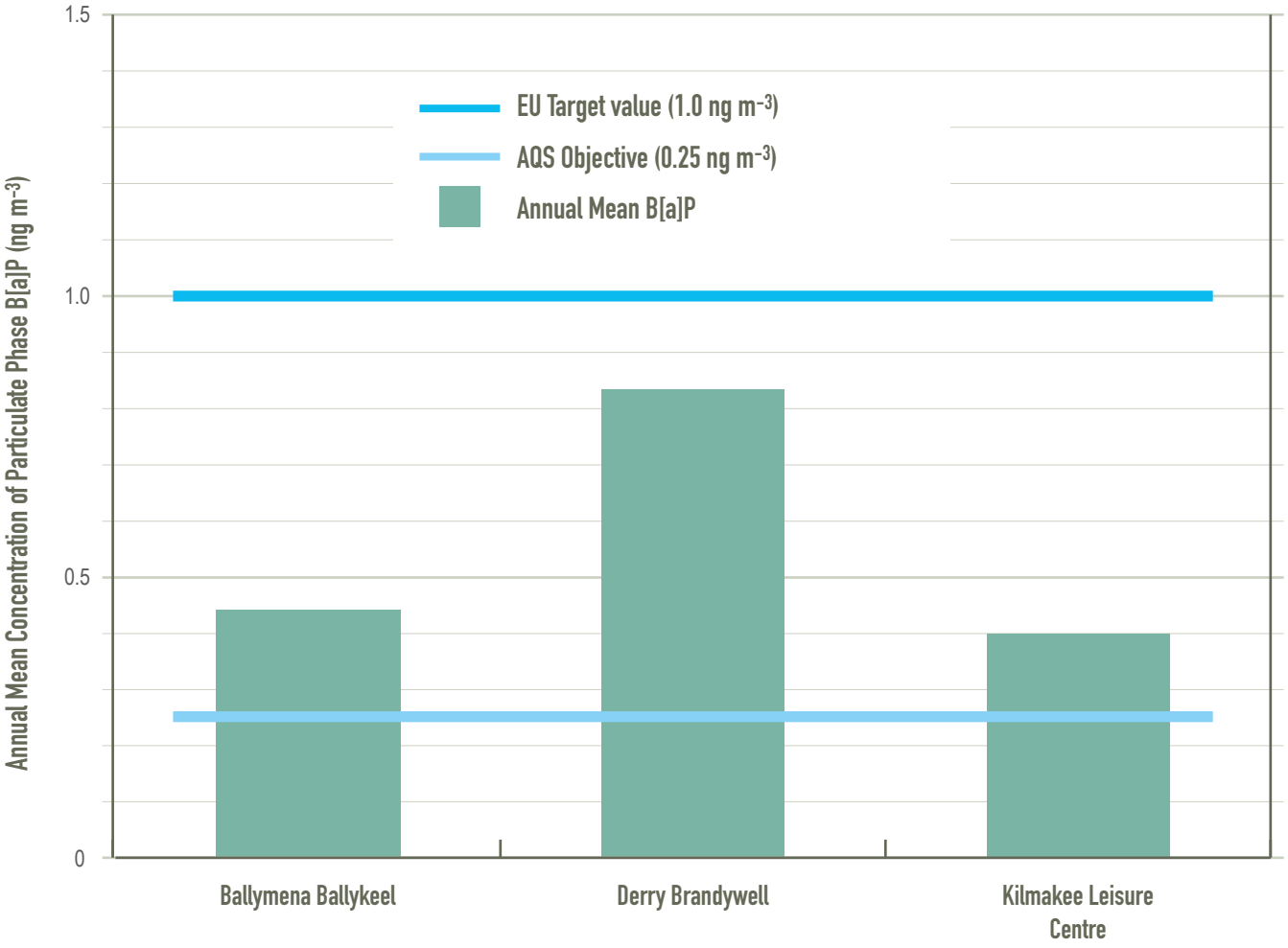


* Asterisk indicates sites with <85% data capture.
Where the valid data capture is less than 75%, the means have been "annualised" and shown as a striped bar

Polycyclic Aromatic Hydrocarbons (PAHs) were monitored at three sites in 2019; Ballymena Ballykeel, Derry 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.

Figure 4.4 shows the annual mean concentrations at these three sites for 2019. No site exceeded the EU target value of 1 ng m^{-3} for annual mean B[a]P concentration during 2019 (which was to be met by 31st Dec 2012). 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.

Figure 4.4: Annual Mean Concentrations of Benzo[a]pyrene for 2019



Summary

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

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

Of the three sites that measured $PM_{2.5}$, all met the EU Stage 1 (25 µg m^{-3}) and EU Stage 2 (20 µg m^{-3}) limit values for $PM_{2.5}$.

Four monitoring sites did not meet the AQS objective for annual mean for nitrogen dioxide in 2019; Belfast Stockman's Lane, Newry Canal Street, Downpatrick Roadside, and Limavady Dungiven. All are traffic-related sites. One site, 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 and/or measured 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.

No site exceeded the EU target value for benzo[a] pyrene. However, all three sites where this pollutant is monitored continue to exceed the more stringent AQS objective.

Facing towards Warrenpoint. Taken at Cranfield beach

5. Air Quality Changes Over Time

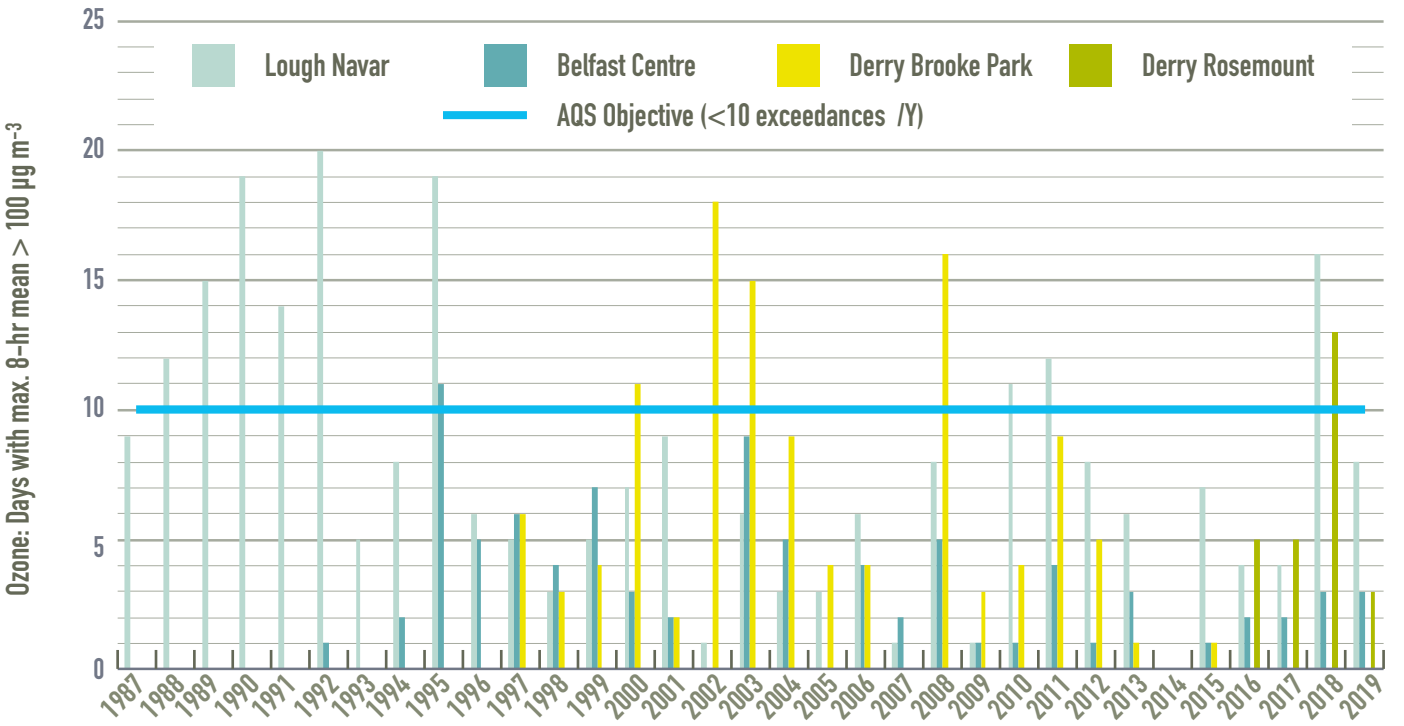
This section looks at trends in ozone (O_3) over the past 30 years in Northern Ireland, and the impact of reductions in nitrogen oxides on ozone levels.

Ozone is a harmful gas causing irritation to the eyes nose and throat, and inflammation of the airways and lungs. Long-term exposure to high levels of ozone can exacerbate symptoms for those with respiratory health conditions, such as asthma. As ozone is a powerful oxidant it can also cause damage to vegetation, affecting crop yields.

Ozone is classed as a 'secondary' pollutant as it is primarily formed by chemical reactions involving NO_x and volatile organic compounds (VOCs), in the presence of sunlight. NO_x can also be a sink for ozone. In urban areas, where levels of NO_x may be highly elevated, ozone can be rapidly scavenged via reaction with emitted NO. As such, a reduction in NO emissions can result in an increase in local ozone concentrations, as there is less NO available to destroy ozone. The complex non-linear relationship between ozone, NOx and VOCs makes control strategies for ozone challenging. Additionally, ozone can remain in the troposphere for several days and be transported over long distances. This means that much of the ozone measured in one particular area may have been generated elsewhere. As such it is more difficult to reduce concentrations by local action.

Figure 5.1 shows the number of ozone exceedances at four sites in Northern Ireland, since continuous measurements began. As ozone is a secondary pollutant its formation depends substantially on weather conditions. High ozone episodes typically occur during hot and sunny weather conditions, as a result, ozone levels fluctuate from year to year and exceedances of the AQS objective occur in some years but not others. For example, there were no ozone exceedances at any site in 2014.

Figure 5.1: Ozone - Days with Maximum 8-Hour Mean > 100 µg m^{-3} from 1987 – 2019

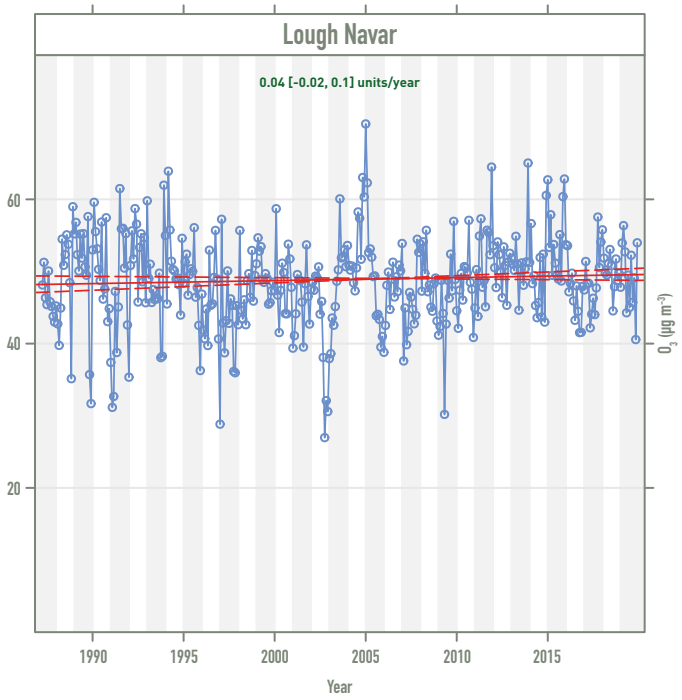


City centre of Belfast Northern Ireland

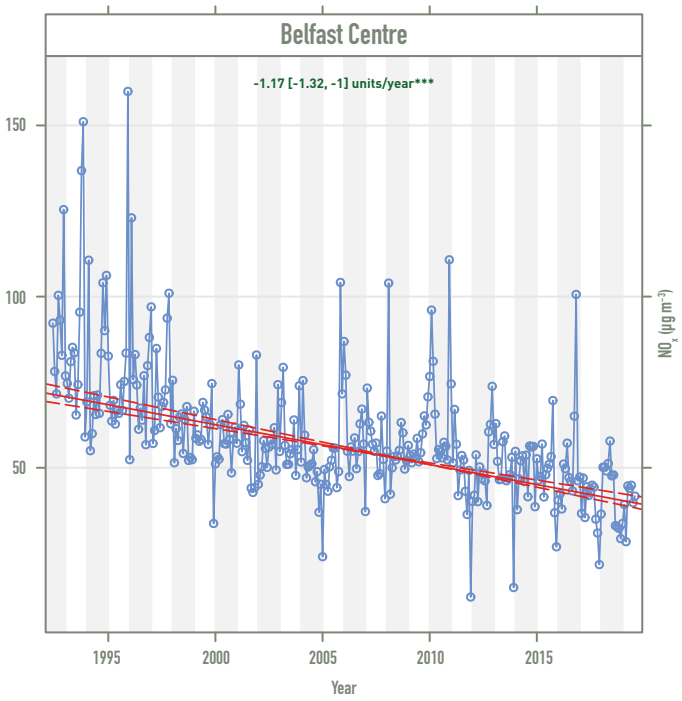
There is evidence that background concentrations of O_3 in the northern hemisphere have increased due to the contribution from global human activities. To understand long-term changes in O_3 in Northern Ireland, trend analysis has been performed at two long-running monitoring sites: the rural Lough Navar site and the urban centre site in Belfast.

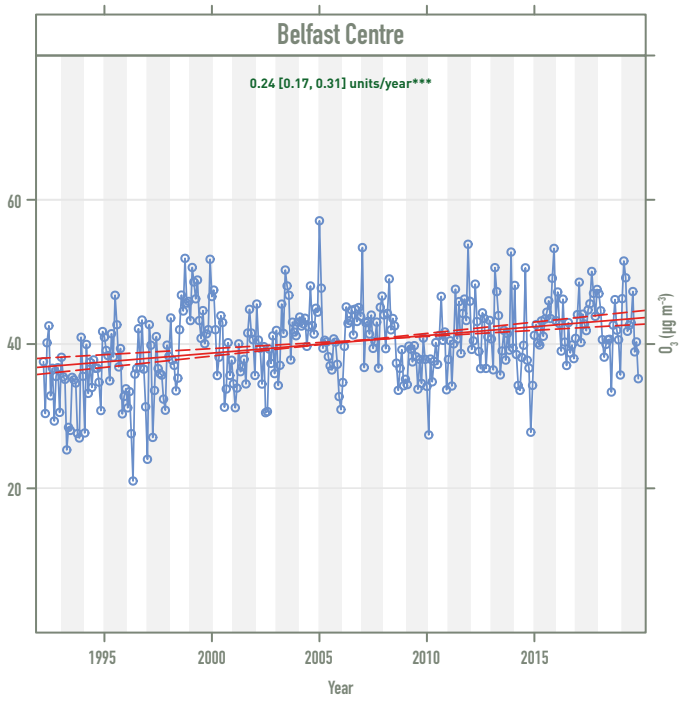
The trend analysis has been carried out using Openair: a free, open-source software package of tools for analysis of air pollution data. Openair was developed by King's College London with the University of Leeds. For more information on this package please see http://www.openair-project.org/. Here, 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 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, where appropriate. When this option is used Openair also fills any gaps in the dataset by a linear interpolation method; therefore, the datasets shown in these plots appear uninterrupted, though this is not necessarily the case. The trend is shown as a solid red line, with its 95% confidence intervals as dotted red lines. The trend is given at the top of each 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. Openair Theil-Sen trend graphs for Lough Navar and Belfast Centre are presented in Figure 5.2.

Figure 5.2: Top figure: de-seasonalised trend plot for O_3 measured at Lough Navar from 1987 to 2019 Bottom figure: de-seasonalised trend plots for O_3 and NO_x at Belfast Centre from 1992 to 2019



At Lough Navar no significant trend is observed in measured O_3 from 1980 to 2019. On the other hand, Belfast Centre has seen an increase in O_3 of 0.24 µg m^{-3} per year between 1992 and 2019, significant at the 0.001 level. The reason for this is likely to be related to the implementation of emission controls to reduce NO_x in urban areas. The trend in NO_x measured at Belfast Centre from 1992-2019 show a significant decreasing trend of 1.17 µg m^{-3} per year, over this period. Reductions in NO_x in urban areas can actually lead to an increase in O_3, as there is limited NO available to react and scavenge ozone. Thus, further O_3 exceedances in Belfast Centre remain possible in the future.



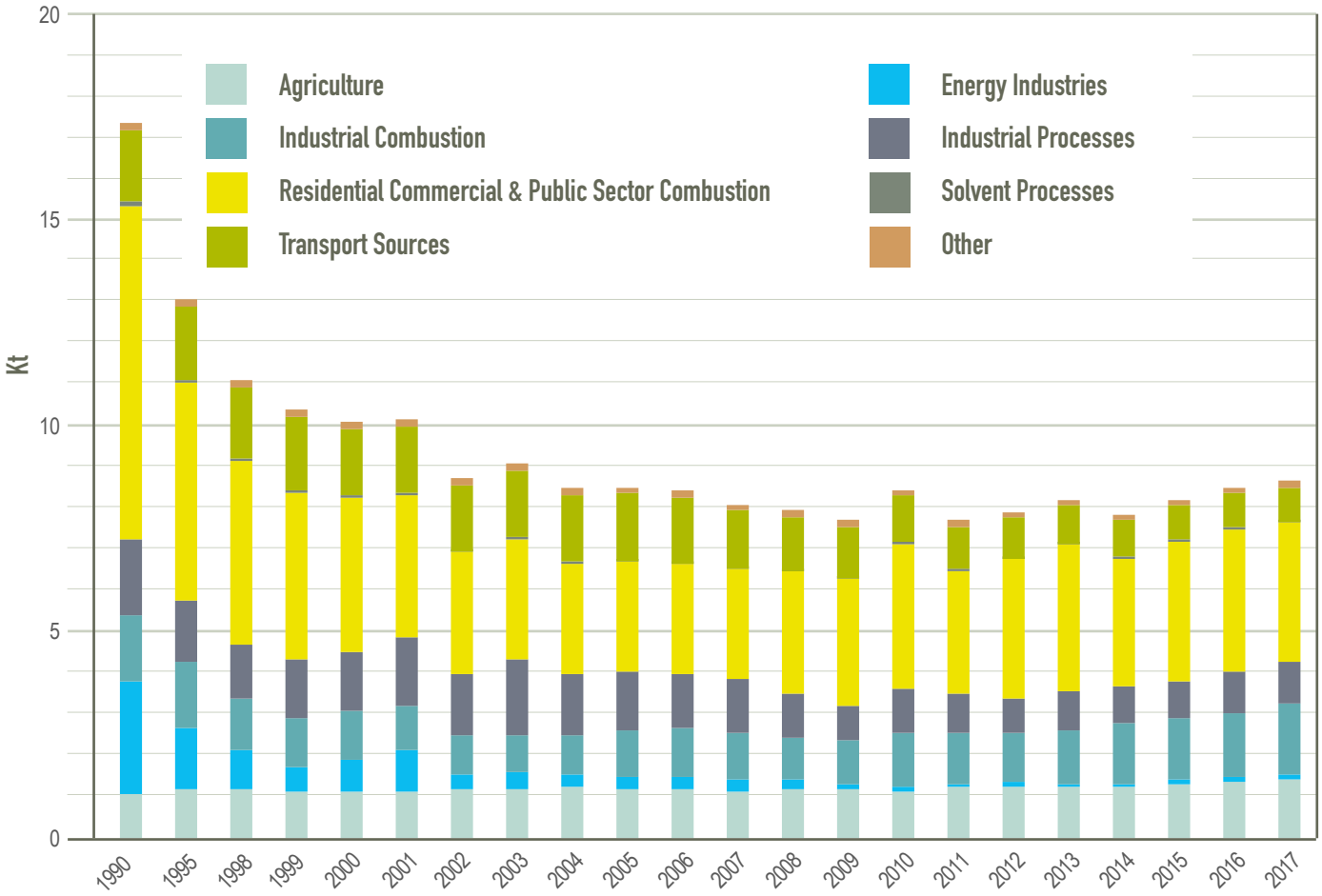


6. Particulate Matter in Northern Ireland

Particulate matter (PM) varies in size and is made up of many different compounds and substances. In terms of the impact on health the very small particles are of particular importance, and in the UK, there are Air Quality Strategy objectives in place for PM_{10} (particles that are less than 10 micrometres in diameter) and $PM_{2.5}$ (less than 2.5 micrometres)[4]. PM can travel long distances, so emissions in one region can impact another downwind. As such, transboundary transport of PM and its precursors from the continent and further afield, can influence measured PM levels.

This section highlights the sources of particulate matter in Northern Ireland, their impact on health, and outlines some of the actions undertaken to reduce PM.

Figure 6.1: Estimated emissions of PM_{10} in Northern Ireland from different sectors from 1990 to 2017



[4] Full definitions as defined in ISO 7708:1995: PM_{10} - Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at 10 µm aerodynamic diameter. $PM_{2.5}$ - Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at 2.5 µm aerodynamic diameter.

Sources of Particulate Matter in Northern Ireland

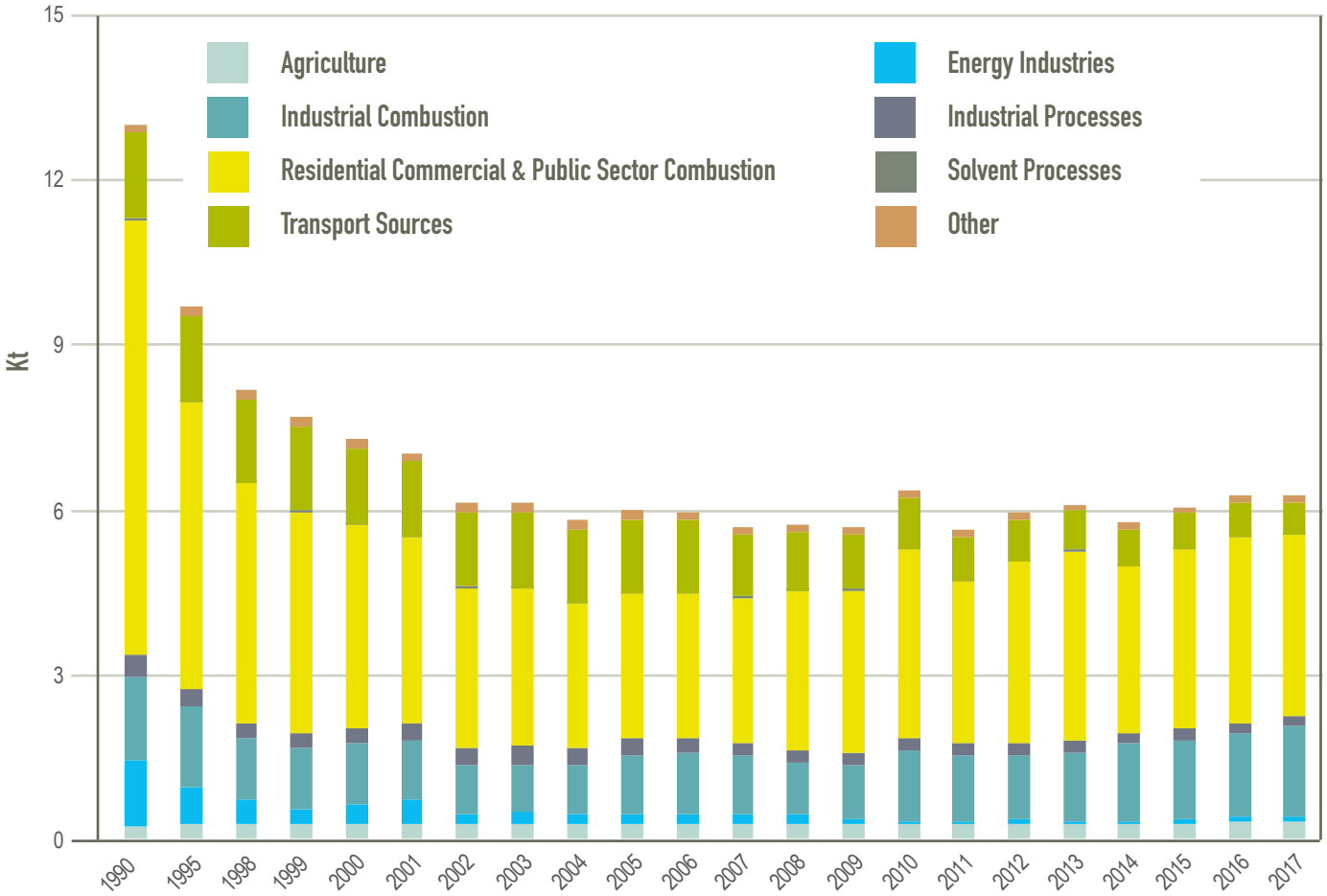
Primary PM is emitted directly into the atmosphere from natural and man-made sources. Secondary PM is formed in the atmosphere, from chemical reactions of precursors, such as sulphur dioxide, ammonia, and nitrogen oxides.

The main sources of PM emissions in Northern Ireland are:

- Residential, Commercial & Public Sector Combustion
- Industrial Combustion
- Agriculture
- Industrial Processes
- Transport

Figure 6.1 and Figure 6.2 show emissions of PM_{10} and $PM_{2.5}$, respectively, in Northern Ireland from 1990 to 2017 (the most recent year of emission estimates at the time of this report), as estimated from the National Atmospheric Emissions Inventory (NAEI)[5]. The figures show that total estimated emissions of PM have reduced since 1990. In 2017, total PM_{10} emissions were estimated to be 8.7 kilotonnes (kt) and total $PM_{2.5}$ emissions, 6.3 kt. This represents a decrease of 50% for PM_{10} and 52% for $PM_{2.5}$, from 1990 emission estimates.

Figure 6.2: Estimated emissions of $PM_{2.5}$ in Northern Ireland from different sectors from 1990 to 2017



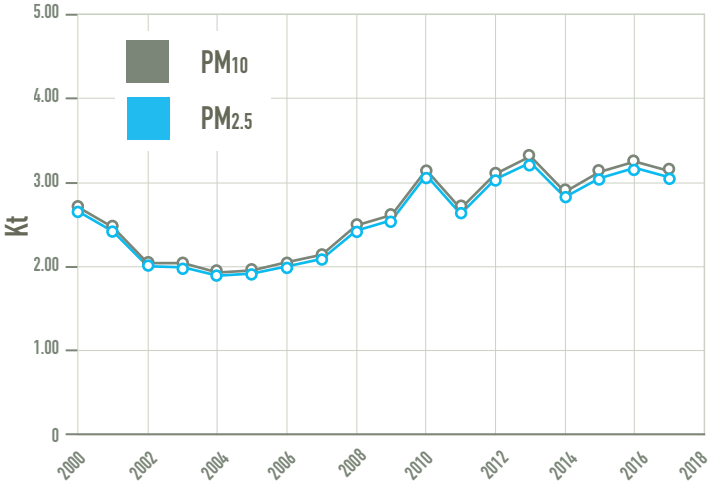
[5] https://naei.beis.gov.uk/

The largest contributor to PM_{10} and $PM_{2.5}$ emissions in Northern Ireland is combustion, which includes residential, commercial and public sector combustion, and industrial combustion. Together these two sectors accounted for 58% and 79% of the total PM_{10} and $PM_{2.5}$ emissions, respectively, in Northern Ireland in 2017. Within the residential, commercial and public sector combustion, the largest contributor to PM emission is from domestic combustion. Figure 6.3 shows that estimated emissions of PM_{10} and $PM_{2.5}$ from domestic combustion have increased since 2002, which is likely to be the result of an increase in use of solid fuel burning over this period.

Agriculture and industrial processes are also large contributors to PM in Northern Ireland, particularly for PM_{10} where the two sectors contribute 17% and 12% of total PM_{10} emissions, respectively.

In 2017, 10% of the total PM_{10} emissions and 9% of the total $PM_{2.5}$ emission in Northern Ireland came from the transport sector (which includes all forms of transport). For road traffic, exhaust emissions have declined over time as a result of the introduction of tighter vehicle emission controls, however non-exhaust emissions (brake and tyre wear, road surface wear, and resuspension of road dust) have increased, due to an increase in the number of vehicles on the road[6].

Figure 6.3: Estimated emissions of PM_{10} and $PM_{2.5}$ in Northern Ireland, from domestic combustion, 2000 to 2017

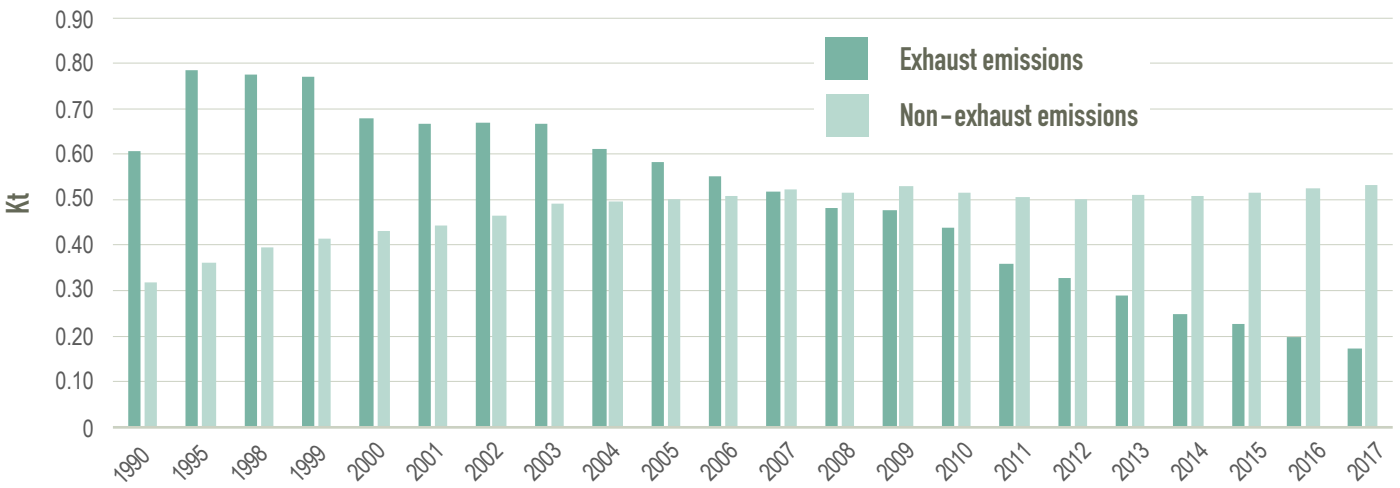


The change in estimated PM_{10} emissions from 1990 to 2017, for exhaust and non-exhaust sources, is shown in Figure 6.4.

Smaller contributions to PM emissions in Northern Ireland come from solvent processes, energy industries and other sources.

In addition to local emissions, long-range transport of pollutants is also a source of particulate matter in Northern Ireland. Easterly wind flows can result in transboundary transport of PM, and its precursors, from continent Europe, elevating levels in Northern Ireland.

Figure 6.4: Estimated road transport emissions of PM_{10} in Northern Ireland, from exhaust and non-exhaust sources, from 1990 to 2017



[6] https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2004151035_DA_Air_Pollutant_Inventories_1990-2017_Issue_1.2.pdf

Maps of Background PM

Measurements from air quality monitoring sites in Northern Ireland have been combined with pollutant emissions estimates from the UK's National Atmospheric Emissions Inventory to produce detailed modelled maps – at 1 km resolution – of average background pollutant concentrations across Northern Ireland for 2019.

Figure 6.5 shows modelled annual mean PM_{10} concentrations for 2019. Highest concentrations occur in the Lagan Valley, in the area around Belfast and Dunmurry. The size of the area with PM_{10} levels above 14 µg m^{-3} can vary from year to year (see previous annual reports).

Annual mean background concentrations throughout the region, however, are well below the AQS objective, and PM_{10} levels overall are reduced compared with maps from previous years.

Figure 6.6 shows modelled annual mean $PM_{2.5}$ concentrations for 2019. Most of rural Northern Ireland has annual mean background concentrations below 6 µg m^{-3}. The highest levels are observed in Belfast where the annual mean background concentrations can be above 9 µg m^{-3}. Isolated hotspots of elevated $PM_{2.5}$ can also be observed in other areas, such as Derry. However, annual mean $PM_{2.5}$ concentrations throughout Northern Ireland are well below the EU Stage 2 limit value of 20 µg m^{-3}.

Figure 6.5: Estimated annual mean background PM_{10} concentrations for 2019

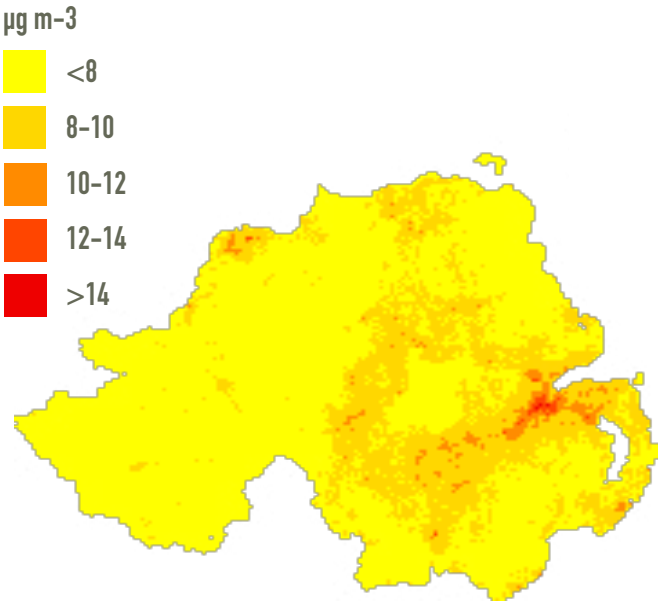
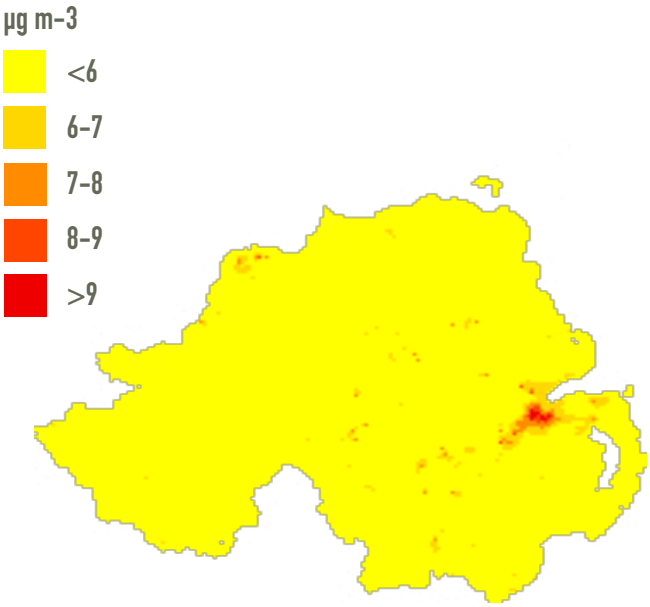


Figure 6.6: Estimated annual mean background $PM_{2.5}$ concentrations for 2019



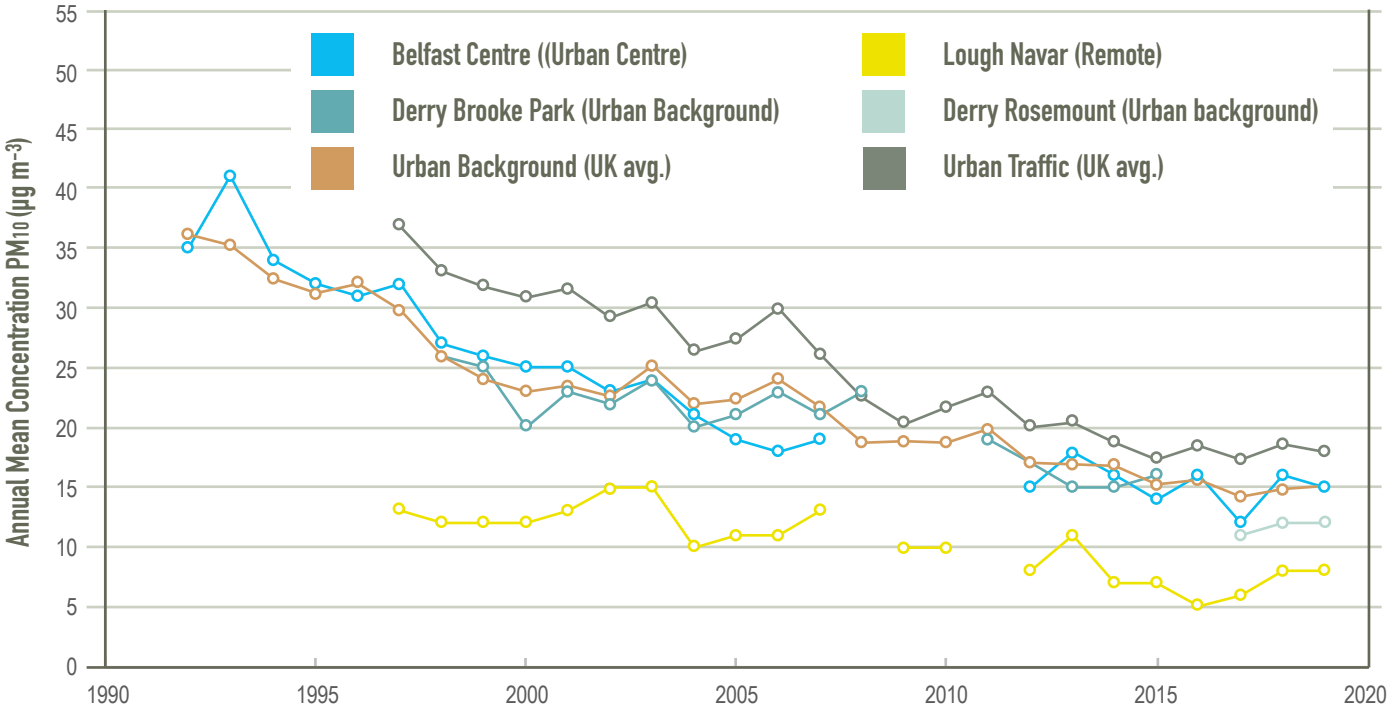
PM_{10} levels overall are reduced compared with maps from previous years.

Trends in PM

An analysis of PM trends shows that background levels of PM_{10} on average, across the UK, have decreased since 1992, however, since 2015, levels have largely remained constant[7]. This general trend can also be seen at individual sites in Northern Ireland, as shown in Figure 6.7. Annual mean concentrations of PM_{10} at Belfast Centre and Derry Brooke Park are comparable to the mean UK concentrations at urban background sites.

As shown in Figure 6.8, between 2009 and 2015, $PM_{2.5}$ concentrations in Northern Ireland decreased over time ($PM_{2.5}$ monitoring in Northern Ireland did not start until 2009) and remained relatively constant from 2015 to 2019, following a similar pattern to the UK average.

Figure 6.7: Annual mean PM_{10} concentrations at Belfast Centre, Lough Navar, Derry Brooke Park, and Derry Rosemount from 1992 to 2019. Note: Derry Rosemount replaced Derry Brooke Park in early 2016. Also shown are the annual mean concentrations of PM_{10} averaged over all urban background and urban traffic sites across the UK for the same period (UK data sourced from https://www.gov.uk/government/publications/air-quality-statistics/concentrations-of-particulate-matter-pm10-and-pm25).



[7] https://www.gov.uk/government/publications/air-quality-statistics/concentrations-of-particulate-matter-pm10-and-pm25

Figure 6.8: Annual mean $PM_{2.5}$ concentrations at Belfast Centre, Derry Brooke Park, and Derry Rosemount from 2009 to 2019. Also shown are the annual mean concentrations of $PM_{2.5}$ averaged over all urban background and urban traffic sites across the UK for the same period (https://www.gov.uk/government/publications/air-quality-statistics/concentrations-of-particulate-matter-pm10-and-pm25)

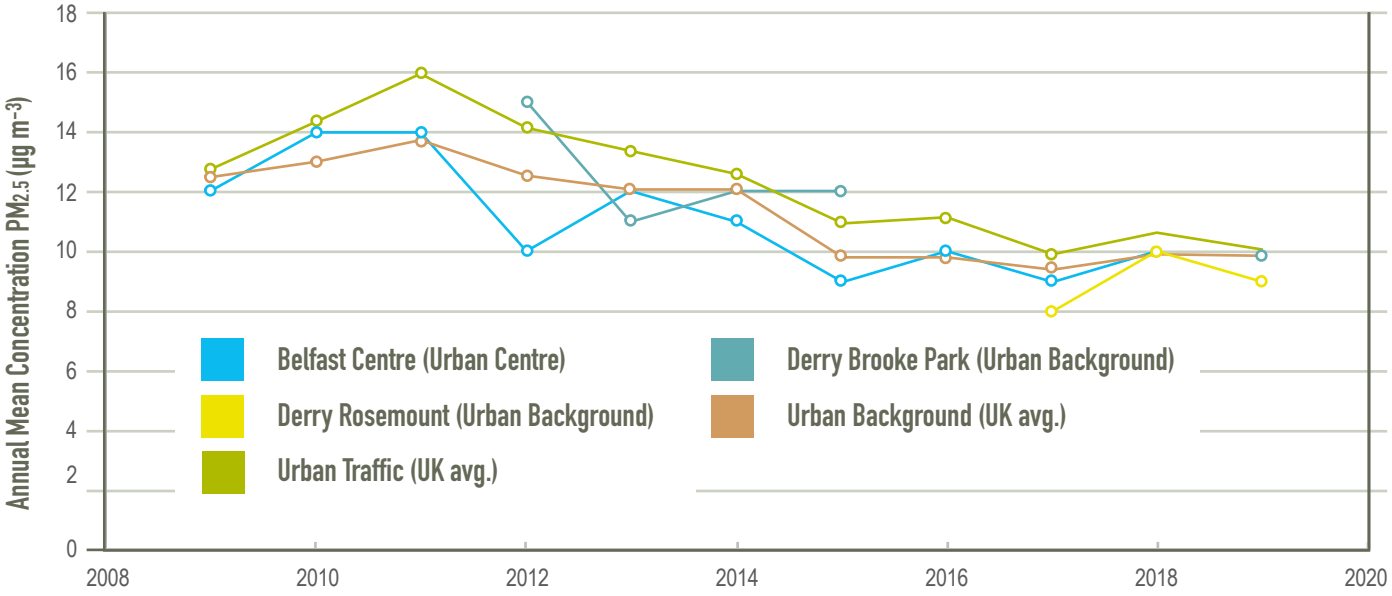
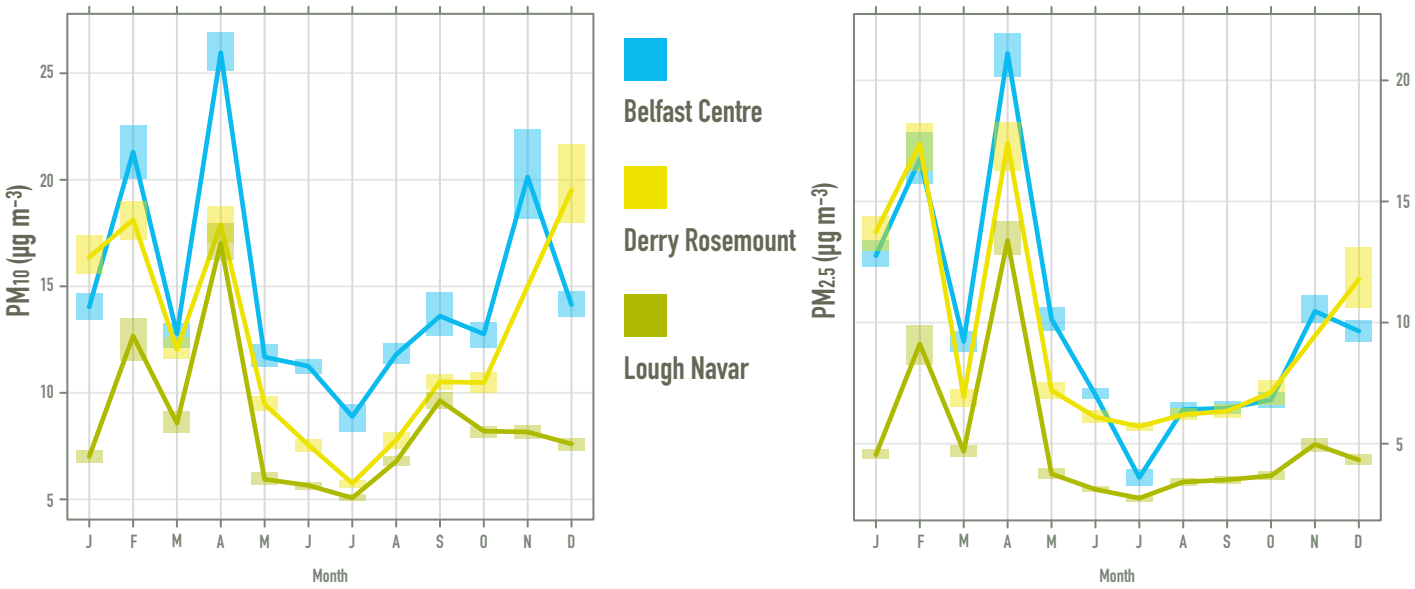


Figure 6.9 shows monthly mean PM_{10} and $PM_{2.5}$ concentrations for 2019 for three monitoring sites in Northern Ireland. PM_{10} and $PM_{2.5}$ concentrations are typically highest in the winter and spring months. As discussed in Section 6.1, a large source of PM emissions in Northern Ireland is from residential combustion, which is greatest during the colder months. Additionally, PM from agriculture emissions often peaks in the springtime.

Figure 6.9: Monthly mean PM_{10} and $PM_{2.5}$ concentrations at Belfast Centre, Derry Rosemount and Lough Navar, for 2019. Shaded areas represent the 95% confidence interval in the mean



Health Impacts

When inhaled, particulate matter can get into the respiratory tract, and in the case of fine particulate matter may penetrate deep into the lungs and into the bloodstream. Many studies have shown a link between exposure to particulate matter and adverse health impacts, such as respiratory and cardiovascular disease. The elderly, pregnant women, children, and those with underlying health conditions are particularly vulnerable.

One of the biggest impacts of particulate pollution on human health is from long-term exposure to $PM_{2.5}$ which may reduce life-expectancy. A report by the Committee on the Medical Effects of Air Pollutants provide a best estimate of the risk factor of $PM_{2.5}$ as a 6% increase in all-cause mortality per 10 µg m^{-3} increase in ambient $PM_{2.5}$ concentration[8], however, this estimate is likely to include effects from other pollutants too, such as NO_2[9].

Actions on Reducing Particulate Matter

In addition to the legislations and policies in place to regulate and improve ambient air as outlined in Section 3, additional actions which include measures to reduce particulate matter are given below:

Smoke Control Areas (SCAs): SCAs were introduced under the Clean Air Order (1981), which enables district councils to declare all or parts of their district as Smoke Control Areas. Within SCAs only authorised fuels or exempted appliances are permitted for home use. Authorised fuels are those that have been thoroughly tested to ensure that they burn within minimal smoke. Exempted appliances can be used in SCAs to burn other fuels as they have been tested to demonstrate low smoke emissions. Lists of authorised fuels and exempted appliances can be found on DAERA's website at https://www.daera-ni.gov.uk/articles/air-pollution. Your district council can also provide you with advice if you are unsure if you live in a Smoke Control Area.

Ecodesign stoves: By 1st January 2022 regulations in the UK will require all new solid fuel stoves to meet Ecodesign requirements for emissions and efficiency. The Ecodesign directive will apply to all areas, whether or not they are a smoke control area.

Ammonia: Through the reaction with nitrogen and sulphur oxides ammonia can contribute to the formation of secondary particulate matter. Thus, reducing ammonia emissions can also help in the reduction of PM. DAERA is working with stakeholders to develop an ammonia strategy to propose recommendations for mitigating ammonia emissions. Further information on ammonia reduction in Northern Ireland can be found in Section 7 of this report.

Active travel and sustainable transport: Promoting active transport can help in reducing traffic emissions. The Northern Ireland Direct website - https://www.nidirect.gov.uk/information-and-services/travel-transport-and-roads/active-travel-and-sustainable-transport - provides important information on active travel and sustainable transport, including walking, cycling, public transport, and advice on greener driving. Additionally, the Active School Travel in Northern Ireland programme, run by the charity Sustrans, aims to increase the number of children who travel actively (walk, cycle or scoot) to school. The programme, jointly funded by the Department for Infrastructure and the Public Health Agency, is currently working with over 400 schools across Northern Ireland.

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/304641/COMEAP_mortality_effects_of_long_term_exposure.pdf

[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734813/COMEAP_PM_2.5_statement.pdf

7. Measures, Initiatives and Reports

This section highlights some of the measures and initiatives taking place in Northern Ireland, which are expected to deliver improvements in air quality.

MyNI Campaign: MyNI is a government communications platform which uses social media to engage citizens and influence positive behavioural change through joined up digital communications. It aims to join up digital communications from Departments and other trusted public sector bodies, to help drive calls-to-action that will motivate and enable citizens to change their behaviour. MyNI has delivered a series of mini campaigns on a range of environmental issues over the last couple of years that have demonstrated very high levels of engagement and tangible results.

MyNI ran a successful mini campaign in November and December 2019, promoting and encouraging users to respond to the NI Environment Strategy discussion document. That campaign also integrated messages and calls-to-action under air quality, cycling, public transport and health.

Plans are under way to co-design future MyNI campaign activity with external partners in 2020 that will integrate more messages and calls-to-action that aim to contribute towards tackling air quality and air pollution issues

You can follow MyNI activity on MyNI Facebook or MyNI Twitter or MyNI Instagram These channels are also supported by the MyNI website at https://www.myni.life/.

Ammonia Reduction: Northern Ireland is a relatively high contributor to ammonia emissions. In 2017, Northern Ireland accounted for 12% of the UK's total ammonia emissions[10] despite having only 3% of the UK's population and 6% of the UK's land mass. The agriculture sector is responsible for the majority of ammonia emissions in Northern Ireland, in 2017 agriculture accounted for 96% of the ammonia emissions. Ammonia emissions in Northern Ireland peaked in the late 1990s and by 2010, ammonia emissions were 17% less than they had been in 1998. From 2010 to 2017 agricultural ammonia emissions increased by 20% due to a trend of increasing livestock numbers, greater use of indoor housing systems, and insufficient uptake of ammonia reduction measures. Although a slight decrease of 1% was registered in 2018, sustained and tangible reductions in ammonia are required to protect nature, to meet Northern Ireland's legal obligations, and to ensure a sustainable agri-food sector. DAERA is developing an ammonia strategy to achieve the sustained and tangible reductions in ammonia emissions which will facilitate a flourishing environment and a sustainable and prosperous farming sector while facilitating the sustainable development of a prosperous agri-food sector. A consultation document is expected to be published in 2020.

By 2010, ammonia emissions were 17% less than they had been in 1998.

[10]Air Pollutant Inventories for England, Scotland, Wales, and Northern Ireland: 1990-2017. Available at https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2004151035_DA_Air_Pollutant_Inventories_1990-2017_Issue_1.2.pdf

Belfast's Rapid Transport ('Glider')

Environment Strategy for Northern Ireland: DAERA is currently developing an Environment Strategy which aims to improve the quality of the environment in Northern Ireland and enable people to avail of the health benefits from engaging with their environment. In the first instance, DAERA has engaged with stakeholders to produce the Environment Strategy for Northern Ireland Public Discussion Document. Under the theme of Environmental Quality, the Public Discussion Document covers air quality, in particular focussing on NO_2, PM_{10} and ammonia. DAERA launched the discussion period on 18th Sep 2019 and invited the public to express their views on the Discussion Document (and 11 questions posed within it). The discussion period was initially planned for 14 weeks but was extended to 20 weeks (closed 5th Feb 2020) due to: large volume of responses received, the General Election and requests from stakeholders). A summary report will be issued once the responses are analysed. The Strategy will be published for formal public consultation once it receives Executive approval.

Belfast Rapid Transport ('Glider'): To encourage people to use alternative travel methods, the Department for Infrastructure developed Belfast Rapid Transport (BRT) and launched the new Glider service, operated by Translink in September 2018. This first phase links East Belfast, West Belfast and the Titanic Quarter via the city centre and has proven very attractive with passenger growth exceeding its target by 26% within the first 52 weeks of operation. This equated to an additional 2m journeys above initial projections. This patronage demonstrates a significant modal shift from the private car to public transport with positive air quality benefits. Each 'Glider', having capacity for up to 105 people, is powered by hybrid diesel/electric engines achieving a 10% to 40% improvement in fuel efficiency when compared with other Metro buses (dependent on vehicle type) and a 90% improvement in emissions (reduction in NO_x and particulate matter emissions). Phase 2 of the BRT network, to cover North and South Belfast and connect Queens University and the City Hospital, is included in the Belfast Region City Deal with the Minister determined to ensure maximum environmental and air quality benefits from any future extension.

Clean Air Strategies: The Clean Air Strategy, published in January 2019 by the UK Department for Environment, Food and Rural Affairs (Defra), sets out a number of objectives to improve air quality across the UK. Section 9.5 of the Clean Air Strategy covers air pollution in Northern Ireland. Additionally, DAERA has been working on developing a draft Clean Air Strategy for Northern Ireland Discussion Document. This work has involved close collaboration with other departments. The draft Discussion Document is being finalised in advance of it being issued to a public consultation to seek views on a wide range of matters.

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.

Download a free app for iPhone and Android at https://www.airqualityni.co.uk/stay-informed, keeping you updated about air pollution in Northern Ireland. The app provides:

- Easy access to the latest pollution levels from the monitoring sites
- Colour-coded map showing the pollution forecasts
- Approved health advice based on the pollution levels
- Subscribe to free alerts when moderate, high and very high pollution is forecast.

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

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

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