Air quality

1.0 Introduction

Air pollution, for example from road transport, harms our health and wellbeing. It is estimated to have an effect equivalent to 40-50,000 deaths each year and is expected to reduce the life expectancy of everyone in the UK by 7-8 months on average, at a cost of around £16 billion per year. Air pollution also damages biodiversity, reduces crop yields and contributes to climate change.

1.1 Why is air quality important?

Despite improvements in air quality over recent decades, air pollution still has a significant effect on public health in the UK. Short-term episodes of elevated levels of air pollution are associated with immediate health effects, particularly on individuals with pre-existing heart or lung conditions. However, the biggest health burden is understood to be from long-term exposure to particulate air pollution: an annual effect in England estimated as equivalent to 25,000 deaths.

Air pollution is one of the 20 leading risk factors for disease and contributed more than 2% of the annual disability-adjusted life years (DALYs) lost in the UK in the 2010 Global Burden of Disease comparative risk assessment. This study estimated that in the UK over 360,000 disability adjusted-life-years lost were attributable to ambient (outdoor) air pollution in 2010 although this was a marked improvement from 1990 where the estimate was 996,000. However, air pollution still has a much greater impact on health than risk factors such as second-hand smoke, where only 43,000 attributable DALYs were estimated for 2010. This impact is mainly due to air pollutants, especially small particulates (PM$_{2.5}$), increasing the risk of heart and lung conditions.

Figure 1: Burden of Disease attributable to 20 leading risk factors for both sexes in 2010, expressed as a percentage of UK disability adjusted life years.

Source: Department of Health, 2014 (Based on Murray, 2013)
1.2 What is air pollution?

Air pollutants are generated by a mixture of natural and man-made (anthropogenic) components that are released into the air, often reacting with other chemicals in the air. The distribution of these pollutants will depend on the size of the molecule and weather patterns, with some pollutants being mainly deposited locally and some affecting sites in other world regions e.g. ozone. For example, in spring 2014 there were two peaks of air pollution in the East and South East of England caused by a combination of high levels of air pollution already existing in urban areas and exacerbated by Saharan dusts and easterly winds bringing pollutants from mainland Europe. These periods of poor air quality resulted in a significant increase in respiratory conditions presenting to health care services including NHS, GP in hours, GP out of hours and emergency departments\(^2\). It was estimated that the national excess consultations for wheeze or breathlessness issues was an excess of 1,200 GP in hours consultations during the first episode and 2,300 excess consultations in the second air pollution episode\(^2\).

There are many pollutants that impact health and the UK Air Quality Standards Regulations 2000\(^3\) which sets standards for:

- Particulate Matter (PM\(_{10}\) and PM\(_{2.5}\))
- Nitrogen Dioxide (NO\(_2\))
- Ozone (O\(_3\))
- Sulfur Dioxide (SO\(_2\))
- Lead
- Benzene and Benzo(a)pyrene
- Carbon Monoxide (CO)

The majority of air pollutants have declined over time in the UK, but particulates, nitrogen dioxide and ozone, are still at levels that can harm health. Ozone is not deemed to be a local pollutant, as formation takes place over some time, and may be a result of emissions from thousands of kilometres away. Ozone is not monitored in the Bedford Borough area, given its more global prevalence. Bedford Borough Council currently monitors for NO\(_2\) but not particulates such as PM\(_{10}\) and PM\(_{2.5}\). Nevertheless, the effect on health has been considered.

The Facts – Particulate Matter (PM\(_{10}\) and PM\(_{2.5}\))

What are PM\(_{10}\) and PM\(_{2.5}\)?

Particulate matter is a mixture of solid particles and liquid droplets in the air. PM\(_{10}\) are particles of material that are 10 micrometres across or smaller, PM\(_{2.5}\) are particles of material that are 2.5 micrometres across or smaller\(^5\).

Why PM\(_{10}\) and PM\(_{2.5}\)?

These have been chosen as these sizes are likely to be inhaled into the lungs. The smaller the particles the greater the potential impact because of their ability to penetrate deeper into the lung. Particulate matter affects both respiratory and cardiovascular diseases\(^5\).

Although small particulates (PM\(_{2.5}\)) have local sources, similarly to Ozone, it also has non-local sources, with some of the more significant components of the total concentration being...
outside the control of the UK. This is a key problem for local mitigation initiatives.

Figure 2: Average number of days when levels of Ozone, Particulate Matter, Nitrogen Dioxide and Sulphur Dioxide were moderate or higher at urban sites in the UK, 2010 - 2015

Sources of Particulate Matter

Particles in the air arise from a variety of natural and man-made sources and are classed as either primary or secondary sources.

Natural sources
- Sea Spray.
- Erosion of soil and rocks.

Man-made sources
- Combustion processes – both domestic combustion (wood/coal burners) and industrial (power generation).
- Transportation – primarily diesel emissions.
- Transportation – Non-exhaust emissions (attrition of road surfaces and wear and tear of tyres and brakes).
- Industrial sources – construction, waste, aggregates (mining/quarrying), agricultural.

Primary
- Released directly into the air.

Secondary
- Formed in the atmosphere by the chemical reaction of gases, first combining to form less volatile compounds which in turn condense into particles.

For PM$_{2.5}$ not all sources are local as in some weather conditions, air polluted with PM$_{2.5}$ from the continent may circulate over the UK (long range transportation) especially the East
and South East of England.

**Figure 3: The sources of Particulate Matter in 2014**

Emissions of particulate matter in the UK has been reducing for the last 40+ years. It was estimated that there was 462 Ktonnes of particulates emitted into the UK atmosphere in 1970 compared with 122 Ktonnes in 2013.

**The Facts – Nitrogen Dioxide**

Nitrogen dioxide (NO₂) is primarily a secondary pollutant produced by the oxidation of nitric oxide (NO) by ground level ozone. Nitric oxide is produced by the reaction of nitrogen and oxygen in the combustion process. The largest source of nitrogen oxides in the UK is the combustion of fossil fuels, particularly by motor transport and non-nuclear power stations.

**Figure 4: The sources of Nitrogen Dioxide in 2014**

Nitrogen dioxide is an irritant gas which has serious and, sometimes, fatal effects on health when inhaled in the very high concentrations associated with accidental exposures. Its properties as an oxidising agent can damage cell membranes and proteins. At relatively high concentrations it causes acute inflammation of the airways.

Air Quality Standards recommend a standard of 40µg/m³ as an annual average with an hourly mean of 200µg/m³ not to be exceeded more than 18 times a year (target set to be met by 31 December 2005). Nitrogen dioxide is measured continuously at the 2 active monitoring sites in Bedford town Centre and monthly at the 49 passive diffusion sites. There is strong evidence to show that NOx nationally is decreasing.

1.3 What impact does air pollution have on health?

The World Health Organisation (WHO) has coordinated several key initiatives to summarise the data on air pollution and health:

- **REVHAAP (2013)**: a review of the evidence on health aspects of air pollution, which summarises the current literature available on the short and long-term impact of various pollutants.

- **HRAPIE (2013)**: health risks of air pollution in Europe which provides recommendations for values that should be used to assess the risk associated with increasing levels of particulate matter, ozone and nitrogen dioxide. These concentration–response functions can be used to assess the cost–benefit analysis of particular interventions.

- **WHO Expert Meeting (2014)**: on methods and tools for assessing health risk of air pollution.

Additionally, the UK Committee for Medical Effects of Air Pollution (COMEAP) have identified that further study needs to be undertaken on the health effects of NO₂.

1.3.1 The Health Impacts of PM₂.₅

Fine particles of pollution (PM₂.₅) are easily inhaled deep into the lungs (Figure 4) where they may accumulate, react, be cleared or absorbed. There are several mechanisms as to how particulate pollution can impact health including oxidative stress and damage, inflammatory pathways and immunological responses. It is possible that adverse effects are seen in susceptible groups whose pre-existing lung or heart disease make them more likely to be affected by the additional low level inflammation they get from air pollution particles.

Long-term exposure to PM₂.₅ is the key air pollution contributor to excess mortality. WHO estimated that the relative risk of all-cause mortality increased by 6.2% per 10µg/m³ increase in PM₂.₅. It increases mortality for cardiovascular and respiratory diseases such as stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer. It was estimated that in 2008 PM₂.₅ was attributable to 29,000 deaths and an associated loss of population life of 340,000 life years lost. However, it has now been suggested that mortality rate could be somewhat higher than anticipated.

Short-term exposure to PM₂.₅ is also associated with small increase in hospital admissions.
for cardiovascular and respiratory conditions\(^\text{14}\). Links have been made between short-term PM\(_{2.5}\) exposure resulting in increased absence from work and school, as well as links made with reduced physical activity\(^\text{14}\).

There is currently no agreed safe level of exposure to PM\(_{2.5}\), therefore EU legislation attempts to address exposure reduction for dealing with this pollutant, with a concentration limit value 25\(\mu\)g/m\(^3\) for 2015. Overall, the UK is to reduce exposure to PM\(_{2.5}\) by 15%\(^\text{16}\). This will be challenging due to much of ambient PM\(_{2.5}\) being from non-local sources\(^\text{5}\), therefore a whole European effort is required. Nevertheless, the approach to set reduction targets moves efforts away from reducing pollutants in particular hotspots to make smaller reductions in concentrations from much larger proportions of the population, this could potentially have greater positive impact on public health.

1.3.2 Health Impact of PM\(_{10}\)

There is a different deposition pattern of fine (PM\(_{2.5}\)) and coarse (PM\(_{10}\)) particles of pollution with coarse particles having a higher deposition probability in the upper airways and bronchial tree. Larger particles in the upper airways are normally cleared rapidly through mucus and other mechanisms, as long as these methods are not affected by underlying diseases such as asthma. Therefore PM\(_{10}\) tends to have a more direct, short-term impact on people’s respiratory symptoms and health\(^\text{13}\).

Evidence suggests that PM\(_{10}\) increases the:

- Post neonatal (1-12 months) all-cause infant mortality (long-term exposure).
- Prevalence of bronchitis in children 6-12 years (long-term exposure).
- Incidence of chronic bronchitis in adults (long-term exposure).
- Incidence of asthma symptoms in children with asthma (short-term exposure)\(^\text{9}\).

Particulate air pollution (PM\(_{10}\) and PM\(_{2.5}\)) is a complex mixture of many chemical components and it is unclear which components are particularly harmful to health\(^\text{17}\). In March 2015, COMEAP\(^\text{17}\) released a statement that advises “the evidence is mixed and remains insufficient to draw reliable conclusions about which are the most health-damaging components or sources of ambient particulate matter”.

1.3.3 Health Impact of NO\(_2\)

Unlike particulates, NO\(_2\) is a gas and therefore disperses differently from traffic sources and can be inhaled deep into the lungs. Although epidemiological evidence associates exposure to NO\(_2\) with adverse effects on health, there is some discussion as to whether NO\(_2\) is just an indicator for other toxic elements of vehicle pollution\(^\text{12}\).

Nevertheless, NO\(_2\) has been linked with increased hospital admissions regarding respiratory issues, adverse birth outcomes and increased mortality\(^\text{9}\). There is also some evidence to suggest that NO\(_2\) leads to increases in the number of deaths from cardiovascular disease\(^\text{12}\) particularly when you consider short term exposure.

Long term exposure to NO\(_2\) is reported to have associations with respiratory and cardiovascular morbidity, children’s respiratory symptoms and lung function\(^\text{12}\). However, there is currently insufficient evidence to solely link NO\(_2\) to these conditions. Nevertheless, it is absolute that air pollution is causing people to become ill or exasperate existing conditions and 2008 saw 75 000 hospital admissions and 1300 deaths due to the
exacerbation of asthma in the UK\textsuperscript{18}.

In March 2015, COMEAP\textsuperscript{12} released a statement on the effects of NO\textsubscript{2} on health – “Evidence associating NO\textsubscript{2} with health effects has strengthened substantially in recent years and we now think that, on the balance of probability, NO\textsubscript{2} itself is responsible for some of the health impact found to be associated with it in epidemiological studies”.

1.4 Who is most impacted by air pollution and when?

Children, the elderly and those with pre-existing respiratory and cardiovascular disease are known to be more susceptible to health impacts of air pollution\textsuperscript{24}.

1.4.1 Health Inequalities

There is significant inequality in exposure to air pollution and related health risks: air pollution combines with other aspects of the social, economic and physical environments (Figure 5) to create a disproportionate disease burden in less affluent parts of society\textsuperscript{19}.

Figure 5: Socio-economic model of health

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(Source: Defra, 2006\textsuperscript{19})

In England, the most deprived wards tend to experience the highest concentrations of pollutants (except for SO\textsubscript{2}), although the least deprived wards also experience above average concentrations of pollutants. This distribution can mainly be explained by the higher proportion of deprived communities (and very wealthy communities) in urban areas and the levels of pollution due to road transport sources\textsuperscript{19}.

The issue is greater though when looked at on a more local level, where proximity to busy roads often results in lower rent for housing, leading to a disproportionate effect of air pollution, noise pollution and pedestrian accidents on poorer communities; also reinforcing social exclusion. Proximity to roads has also shown adverse effects on health even after adjusting for socio-economic status and noise. The precise pollutants responsible are unclear, though may be some combination of ultrafine particles, carbon monoxide, NO\textsubscript{2},
black carbon and metals that are more elevated near roads\textsuperscript{9}.

Vulnerable groups to air pollution include young children and the elderly\textsuperscript{9}. In 2006, Defra report on air quality and social deprivation in the UK and estimated that the young (0-14 years) were disproportionately affected by PM\textsubscript{10} and NO\textsubscript{2} (Figure 7), experiencing the highest cumulative concentrations as a higher proportion of this age group reside in more deprived deciles where pollutant concentrations are highest. The higher susceptibility of this age group to air pollution implies an extra compounding effect, increasing the inequalities already present. Similar has been demonstrated when regarding NO\textsubscript{2}\textsuperscript{19}.

There have been some recommendations that those with asthma should live at least 300m from major roadways, especially those with heavy truck traffic, as levels of ultrafine particulate matter decrease substantially by 300m, although this distance varies among studies\textsuperscript{19}.

### 1.4.2 Household (indoor) exposure to pollutants

For PM\textsubscript{2.5}, the particle is so small that 40-70\% of it can penetrate into indoor spaces where people are working, and provides much of the exposure to particulate matter\textsuperscript{9}.

In general, the issue of indoor air pollution has been largely overshadowed by the attention focused on air pollution outdoors related to industrial and transport emissions. There is a need for more information about levels of exposure to indoor air pollutants, as well as the risks posed by long-term exposure\textsuperscript{48}.

Active urban adults in Europe spend an average of 85-90\% of their time indoors, 7-9\% in traffic and only 2-5\% outdoors, with very vulnerable groups, such as infants and the elderly, spending nearly all their time indoors. Therefore, due to time, exposures indoors dominate overall air pollution exposures\textsuperscript{9}.

Therefore, policies that affect ambient (outdoor) PM\textsubscript{2.5} by 10µg/m\textsuperscript{3} will only reduce the urban population exposure by 5-8µg/m\textsuperscript{3}, as much of their exposure time is indoors\textsuperscript{9}. The average infiltration of PM\textsubscript{2.5} into buildings depends on location, but also decreases as new, sealed air-conditioned buildings replace older building stock. European standard EN 13779 specifies the required filter performance for good indoor air quality in non-residential buildings taking into consideration outdoor air quality.

WHO released a report stating that in 2012, 14,000 deaths in European high-income countries were attributable to indoor air pollution\textsuperscript{25}. A European Commission report advises that 2 million years of healthy life is lost annually due to indoor air pollution, otherwise described as disability-adjusted life years. The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. Originally developed by the World Health Organisation it is becoming increasingly common in the field of public health and health impact assessment.

The majority of this health impact was due to ambient (outdoor) air quality, mostly fine particulate matter, in indoor settings (Figure 6), though it is worth noting that other household dusts and mould contribute to indoor air pollution.
Wider determinants of health

Figure 6: The indoor air pollution associated burden of disease attributed to the key source of exposure in Europe annually.

(Source: European Commission, 2011)

1.4.3 National and Local Air Quality Management

The European Union (EU) air pollution legislation follows two complementary approaches:

- Controlling emissions at source.
- Setting of ambient air quality standards and long-term objectives.

The member states then must transpose the provisions of the EU Directives into their own national laws.

The Air Quality Directive and Fourth Daughter Directive (2008/50/EC) covers the following pollutants; sulphur dioxide, nitrogen oxides, particulate matter (as PM₁₀ and PM₂.₅), lead, benzene, carbon monoxide and ozone. This Directive sets 'limit values', 'target values' and 'long-term objectives' for ambient concentrations of pollutants.

Limit values are legally binding and are set for individual pollutants and comprise a concentration value, an averaging period for the concentration value, a number of exceedances allowed (per year) and a date by which it must be achieved. Some pollutants have more than one limit value.

Target values and long-term objectives are set for some pollutants and are configured in the same way as limit values. Member States must take all necessary measures, not entailing disproportionate costs, to meet the target values and long-term objectives.
The UK Air Quality Strategy has established objectives for eight key air pollutants, based on the best available medical and scientific understanding of their effects on health, as well as taking into account relevant developments in Europe and the World Health Organisation. These Air Quality Objectives are at least as stringent as the limit values of the relevant EU Directives – in some cases, more so. The most recent review of the Strategy was carried out in 2007.

National Air Quality Statistics and Indicators are reported for annual concentrations of particles and ozone and the number of days in the year when air pollution is ‘moderate or higher’. In addition, the Department of Health has identified Public Health Outcomes Framework which recognises the burden of ill-health resulting from particulate pollution as well as a whole host of other public health concerns. Specifically, the indicator is: “The fraction of annual all-cause adult mortality attributable to long-term exposure to current levels of anthropogenic particulate air pollution (human made PM2.5)”

This indicator is intended to enable appropriate prioritisation for action on air quality in local areas. The baseline data for the indicator have been calculated for each local authority in England based on modelled concentrations of fine particulate air pollution (PM2.5) in 2010. Estimates of the percentage of mortality attributable to long-term exposure to particulate air pollution in local authority areas range from around 4% in rural areas to over 8% in cities, where pollution levels are highest.

Local Authority Air Quality Management Areas are declared when the local authority review and assessment process identifies an exceedance of an Air Quality Strategy objective. The local authority must declare an ‘Air Quality Management Area’ (AQMA) and develop an Action Plan to tackle problems in the affected areas. In Bedford Borough, there is one AQMA, this covers the majority of the town centre (see Figure 7) and particularly the A6 which makes up the High Street in Bedford Town Centre. In light of proposed development within the Bedford Borough Area, it is of note that the majority of development sites are in areas of good air quality (Figure 8).
Figure 7: Bedford Borough Council's AQMA

(Source: Bedford Borough Council, 2015)
Figure 8: Map showing appointment of growth 2016-2032

(Source: Bedford Borough Council, 2015)
2. Local data

2.1 What do we know about air pollution levels in Bedford Borough?

In 2009, the Updating and Screening Assessment was undertaken for the pollutants: carbon monoxide, benzene, 1,3-butadiene, lead, sulphur dioxide and particulates PM$_{10}$. It was identified that there was no significant risk of the objectives being exceeded in the Borough with regards to exceeding the government set limits. It was identified that NO$_2$ was exceeding the stated limit at certain sites throughout the borough.

There are two types of monitoring for NO$_2$:

- **Active monitoring** is carried out by continuous automatic monitors that can measure levels of NO$_2$. There two of these monitors due to their complexity and expense. Both monitors are sited near busy roads (Figure 9).

  - Data can be collected hourly and is summarised as an annual mean or a period where a pollution exceedance has occurred. These provide information on potential hot spots or areas with at risk residents within the Bedford Borough Air Quality Management Area.

- Unlike NO$_2$ and other key local air pollutants, PM$_{2.5}$ is not included within the Local Air Quality Management Areas and there is currently no obligation on local authorities to monitor PM$_{2.5}$. There are currently no sites in Bedford Borough that monitor for PM$_{2.5}$.

*Figure 9: Map of automatic monitoring sites*

![Map of automatic monitoring sites](image)

(Source: Bedford Borough Council, 2015)

**Non-automatic monitoring** of NO2 is also carried out using diffusion tubes. Data is collected monthly. There are 46 diffusion tubes at key locations within the Bedford Borough Area (Figure 10).
2.2 Background levels of pollution in the UK

Defra provides maps of modelled background pollutant concentrations (Figure 11). In the UK, high annual NO\textsubscript{2} concentrations are mainly focused around roads, urban and industrial areas, whereas background levels of particulates are higher in the South and East of England, as these regions receive a larger contribution of particulate pollution from mainland Europe.

\textit{Figure 11: Annual mean background PM2.5, PM10 and NO2 retrospectively, 2014 (µg m\textsuperscript{-3})}

(Source: Defra, 2015\textsuperscript{28})
2.3 Air Quality in Bedford

As expected air pollution is greater near busy roads, particularly where traffic builds up. Key roads are Bedford High Street, Shakespeare Road, Prebend Street, and Ampthill Road. Although average levels of pollution are not necessarily above the threshold, health impacts are seen at levels below threshold. There are no models of PM$_{2.5}$ or PM$_{10}$ dispersion in the Bedford Borough area.

In Bedford, the annual mean objective for NO$_2$ is exceeded at a number of locations across the Borough. All but one of the exceedances are within the town centre AQMA, the site that exceeds outside the AQMA does not present relevant exposure (people living or working in the vicinity).

In 2015 monitoring showed an improvement overall in air quality, with all sites demonstrating a reduction in concentrations of NO$_2$ compared with previous years. Data collected showed that only 20% of the monitoring locations are exceeding the annual mean objective, compared to 32% in 2014.

In 2015, Lurke Street active monitoring station measured an increase in the annual mean objective and a decrease in the hourly mean objective when compared with the previous year. Contrastingly the Prebend Street monitor measured a decrease in NO$_2$ concentrations in comparison with 2014. Lurke Street monitoring station demonstrated exceedances of the annual mean objective, whereas Prebend Street has been below the limit for NO$_2$ since 2012 (Figure 12). Figure 16 demonstrates the exceedances observed at NOx tube locations from 2010-2014.

Figure 12: Trends in Annual Mean Concentration of Nitrogen Dioxide Concentrations measured at Automatic Monitoring Sites (2009 – 2014)

(Source: Bedford Borough Council, 2016)
In summary, local evidence suggests that the level of NO₂ in Bedford Borough is slowly improving overall, nevertheless, air quality and reducing NO₂ concentration levels will remain a key priority for the Borough Council.

2.4 Impact on health outcomes (Mortality and Morbidity)

In 2014, Public Health England reported on local mortality associated with long term exposure to manmade PM\(_{2.5}\). Only manmade PM\(_{2.5}\) was considered because at a local level it is considered “physically” manageable. The report estimated that in Bedford the number of premature deaths of people over 25 years in 2010 was equivalent to 73 people. From exposure to man-made activity PM\(_{2.5}\) was 73 with associate life-years loss of 802. The associate life-years loss adds up the number of years should the person die before the age of 75y, this is significant because it demonstrates that children are particularly vulnerable when compared to adults.

There are at least 12 modelling tools that combine air quality information, epidemiological derived concentration response functions and demographics to estimate air pollution related health impact. All estimate mortality impact, but only some estimate the broader health impact (morbidity) through additional cases of key diseases and disability adjusted life years.

There is uncertainty around the model inputs for morbidity, especially around the concentrations response function and the extrapolation of data from different populations.
and different systems. Therefore, the model needs to be appropriate for the context and evaluated individually, with a trade-off between technical refinement and accessibility to the user.

At present, Bedford Borough does not have specific estimates for the impact of air pollution on disease prevalence and health care utilisation. Therefore, the health impact on hospital admissions for respiratory and cardiovascular admissions needs to be based on the general estimates provided in by WHO\(^9\).

### 2.5 Health Inequalities – Susceptible Populations in Bedford Borough

There are a range of domains that can impact on the health inequalities and level of deprivation that an individual is exposed to. Environmental inequalities arise where specific communities, such as the most deprived, experience a poorer environmental quality, such as poor air quality. With air quality children (aged up to 14 years) & elderly people (over 65 years) are deemed more susceptible to the impacts of air pollution on their health and wellbeing.

Social inequalities may be exacerbated by air quality factors. For example, the most deprived areas are often located in close proximity to major transport access, such as railway stations or depots, main roads, busy junctions, airports and flight paths. These areas are seen as less desirable areas to live but are often the only areas that those on lower incomes can afford. As these areas are often at the highest risk from air pollution, residents living in the area are also at greatest risk of the negative health impacts from these pollutants.

Most of the AQMA in Bedford, and therefore the area which contains the highest levels of air pollutants, is contained within the Castle Ward area of the town. This is a mixed ward with some of the most deprived areas of the borough within the western area of the ward and the whole of the eastern area having some of the more affluent areas (figure 17). The deprived western end of the ward (471 followed by 466) is included within the AQMA due to its poor air quality. The western area occupants experience amongst the highest levels of unemployment in the Borough, high numbers of limiting lifelong illnesses, high levels of crime and overcrowding and are among the 10% most deprived areas in England\(^32\). The social mix of this area of the ward includes a relatively high proportion of ethnic minorities.

*Figure 14: Castle Ward*

(Source: Bedford Borough Council, 2015\(^{32}\))
3. Addressing Local Need: What we can do about air pollution in Bedford Borough?

3.1 Evidence around mitigation measure and effectiveness?

3.1.1 Reducing pollutants

Consistent evidence has been reported that links living near major roads and/or traffic-related air pollution to adverse effects on health\(^9\). This suggests that a positive health impact would be observed when moving away from areas with high to areas with lower air pollution and traffic\(^9\).

WHO (2013\(^9\)) summarised the evidence regarding several types of traffic-related interventions and options.
Low Emission Vehicles as an option?
In Bedford, NO\textsubscript{2} emissions from traffic is one of the largest factors that results in poor air quality. The main source of pollution from traffic is from privately owned cars moving round the Borough, particularly within the town centre. Traffic flows are also hindered due to the river and subsequent bridges which results often restrict the movement of cars through the town centre.

The Office for Low Emission Vehicles (2014\textsuperscript{43}) is a good source of information to benchmark how the government envisage a shift to low emission vehicles:
- Taxis- where appropriate reducing license fees for taxi companies who use low/ no point source emission vehicles\textsuperscript{43}
- Buses- retrofitting existing fleet vehicles to bring them up to a higher Euro standard\textsuperscript{43} and working with operators to phase out older, more polluting vehicles.
- Rapid Charger Networks – Ensuring the electric car charging network allows improve accessibility of charging borough wide and particularly within new developments\textsuperscript{43}.
- Privately Owned Vehicles – Advertise consumer incentives for purchase of electric vehicles which is a national initiative. Incorporate local incentives such as allowing bus lane use for low emission vehicles.

It was expected that the new versions of diesel cars Euro 4 and Euro 5 would see significant reductions in particulate matter emissions from traffic. Unfortunately the reductions have not been as significant as originally predicted by Government. Therefore air quality has not improved to the level as originally predicted\textsuperscript{33}. New low emission vehicles are either fully electric with no emissions at the point of use, or hybrid vehicles which have significantly reduced emissions for periods of the drive cycle and may be capable of some zero emission running. Therefore, with new low emission vehicle technology there is the potential for substantial real world cuts in emissions\textsuperscript{43}.

Low emission zones as an option?
Defra have recently concluded a consultation on their draft air quality plans that looked to improve air quality\textsuperscript{33}. This looked heavily into low emission zones or clean air zones in the large urban areas such as Birmingham, Yorkshire and Leicester. There is also limited evidence that low emission zones are effective\textsuperscript{9}.

Congestion charging zones as an option?
A study into the health benefits associated with implementing the congestion charging zone in London showed very modest impact on air pollution and public health\textsuperscript{9}. Cost and change in infrastructure would not necessarily be cost effective particularly as there may be other methods more appropriate in Bedford.

Lower traffic exposure as an option?
- Reduction in traffic speeds has been seen to improve surrounding air quality\textsuperscript{9}. This is not currently relevant in Bedford Borough area as the main issue with air pollution within the town centre is more on preventing congestion than controlling the speed. In the future this technique may be relevant to the new bypass that has been built in the Borough due to the continued housing development that is undertaken along the bypass corridor.
The construction of bypasses to relieve nearby congested streets have been shown to improve particulate matter levels by about 28% as seen by in Wales\textsuperscript{9}. Fundamentally, the bypasses saw a reduction in heavy good vehicles moving through areas of poor air quality leading to this improvement. Similar may be seen in Bedford Borough when the Western Bypass in completed in March 2016.

3.1.2 Breaking the pathway

**Use of Vegetation (Natural Environment and Green Space)**

DEFRA (2010\textsuperscript{34}) released information surrounding the impact trees can have on air pollution. Trees can have a positive impact on air quality, but if appropriate strategic considerations are not made before planting trees then there could be a negative impact on the local air quality. Vegetation can remove some gaseous pollutants by uptake or absorption and particles can physically adhere to the vegetation\textsuperscript{35}. Importantly vegetation also alters the dispersion of emissions by changing air-flow patterns, wind speed and surface roughness, enhancing turbulence and mixing of pollutants. These elements could be considered more important than the general uptake of pollution through absorption.

Trees can alter the local meteorology such as reduce air temperature which is believed to improve air quality because emissions of many pollutants/ozone forming chemicals are temperature dependent. However, if not correctly placed trees can increase the air temperature\textsuperscript{34}. Similarly, appropriate siting is required near buildings as reduced airflow on warm days and shade on cold days can increase the amount of energy used to regulate building temperature. Also, air pollution can be emitted as a result of tree maintenance, which if not managed adequately could offset any positive impacts of the trees\textsuperscript{35}.

A study undertaken by the Forestry Commission (2015\textsuperscript{35}) looked at a 10Km x 10Km mixed green space consisting of trees, grass and other vegetation, the results identified that the air quality improved to the extent that may have saved two lives and reduce hospital emissions by just two.

**Indoor Air Quality Improvements**

Although the ambient levels of PM$_{2.5}$ are monitored in outdoor air, over 90% of our exposure occurs indoors due to the large percentage of time spent there\textsuperscript{20}. Therefore, much of the health impact of PM$_{2.5}$ is due to indoor air quality demonstrating that exposure to indoor air quality must be considered.

Indoor air exposure can be independently controlled by reducing outdoor air pollution levels through emissions reduction, effective urban planning and by controlling indoor levels through filtration in building envelope and/or health ventilation systems\textsuperscript{20}. By doing this as well as combatting indoor exposure to tobacco smoke could see the reduction in burden of disease.

**Planning**

The National Planning Policy Framework Guidance on Air Quality states that Local Plans can affect air quality in a number of ways, including through what development is proposed and where, and the encouragement given to sustainable transport. Air Quality Management
Areas should be taken into account in plan making but also it is important to take into account other locations where there could be specific requirements or limitations on new development because of air quality.

Drawing on the review of air quality carried out for the local air quality management regime, the Local Plan may need to consider:
- The potential cumulative impact of a number of smaller developments on air quality as well as the effect of more substantial developments.
- The impact of point sources of air pollution (pollution that originates from one place).
- Ways in which new development would be appropriate in locations where air quality is or likely to be a concern and not give rise to unacceptable risks from pollution. This could be through, for example, identifying measures for offsetting the impact on air quality arising from new development including supporting measures in an air quality action plan or low emissions strategy where applicable.

Bedford Borough Council does not have an air quality policy for planning, each development is considered on a case by case basis.

3.1.3 Reduction of person exposure – e.g. text alerts

Air pollution warning services can either be active or passive. The UK Daily Air Quality Index (DAQI)\(^\text{37}\) is a passive system similar to a UV or pollen forecast, where levels of key pollutants (\(O_3\), \(NO_2\), \(PM_{2.5}\), \(PM_{10}\) and \(SO_2\)) are scored (0-10) and summarised into four bands (low moderate, high and very high)\(^\text{38}\). These can then be used, especially by those at risk, to adjust behaviour by potentially reducing activity outdoors or using relieving asthma inhalers more frequently (Figure 14).

Figure 14: Passive warning system for air quality levels (DAQI - Defra)
An active system uses the same information but proactively alerts registered users of forecast pollution events rather than leaving it to the responsibility of the user.

In the UK there are several systems:
- airALERT: available for Surrey, Sussex, Southampton and Sevenoaks. This system was developed and is provided by Sussex Air Quality Partnership (Sussex-air) and ERG, King's College London (http://www.airalert.info/Splash.aspx)
- airTEXT: for London, developed and operated by CERC with other partners in the airTEXT consortium (http://www.airtext.info/)
- London Air iPhone App: developed by Environmental Research Group, Kings College. (http://www.londonair.org.uk/london/asp/iPhone/)

The intention is that by providing preventative information, this empowers users to reduce exposure or increase medication to lessen or prevent the onset of symptoms, with the knock-on-effect of reducing GP visits and hospital admissions.

A review of air pollution early warning systems found that the evidence of behaviour was mixed with some indication that personal perception of poor air quality drives behaviour change more than validated data, although susceptible groups may be more aware of the official alerts.

3.2 What are our current assets and gaps?

The public health function and responsibility returned to local authority in 2012, since then there has been limited data in place to quantify the health implications of poor air quality. However, initial data is starting to be seen particularly when considering PM$_{2.5}$. This data is providing the link between mortality and air pollution.

It is important that the continued development of robust data and evidence continues in order to develop effective policies to protect the public health of individuals locally. Data such as this supports the development of effective targets within the AQMA to improve air quality levels, adding add weight to decisions taken to ensure that the targets are met with regards to air quality objectives. It would be useful to identify data that demonstrates the cost to the healthcare locally as a result of poor air quality. The costs could then potentially be offset against the changes that are required to protect public health.

The current air quality action plan will need to be refreshed so that it includes detailed quantifiable actions against which progress can be measured as well as highlighting the health benefits arising from those measures. As required by DEFRA the plan will be refreshed taking into account ongoing development within the Borough.

There are strongly competing pressures that need to be balanced to achieve regeneration and growth, while protecting people’s health against poor air quality. Redeveloping areas, such as the High Street, and bringing businesses back into empty buildings is important for economic growth which needs to be achieved alongside mitigating the potentially detrimental consequences, such as increased traffic volumes, that come with increasing the prosperity of the town centre.

Levels of air quality have not improved as predicted nationally and locally, and in some cases air quality levels have worsened. The challenges of improving air quality for the
Public awareness of air quality is increasing along with the understanding of the detrimental health effects associated with poor air quality. However, there still appears to be a lack of understanding of how an individual’s actions can have a positive impact on local air quality. This is particularly relevant due to the greatest source of air pollutants in the Borough is local private car usage, therefore behavioural changes on an individual level is required to achieve overall change.

A greater awareness of the dangers associated with poor air quality will drive individuals and agencies to change their behaviours to shape a better environment. Greater emphasis is needed to ensure air quality concerns are given equal consideration as part of the development and design process. This will encourage the synthesis of good development and a healthier environment.

3.3 Next steps: How can we address air pollution in Bedford Borough Area?

3.3.1 Lower emissions from vehicles

Consideration could be given to:
- Improving/increasing electric (rapid) charging network throughout the Borough and consider other incentives for driving low emission cars/electric cars.
- Improving the knowledge of purchasing a low emission vehicle (privately owned cars).
- Licensing incentives for Taxis who operate with low emission vehicles.
- Bedford Borough Council committing to move to low emission/fully electric fleet vehicles where appropriate.

3.3.2 Modal shift from cars to active transport

Switching journeys from cars to walking, cycling and public transport not only has a large beneficial impact on the individual’s health, but a wider benefit to the population health as there are corresponding decreases in overall air pollution levels. Mechanisms for doing this are dealt with in more detail in the Active Transport section of the JSNA.

3.3.3 Further investigation into the potential for reducing person exposure

While a lower emissions transport fleet and modal shift provide the overall long-term momentum to reduce air pollution, there are measures that may reduce personal exposure in the short-term. These include:
- Text alerts to vulnerable patient groups.
- Better use of health evidence when assessing the populations exposed in new developments.
- Further analysis of data relating to respiratory conditions such as asthma and COPD to see the level of correlation between areas of poor air quality within the Borough. This will allow more targeted measures to be identified within the action plan.
- Further understanding around the seasonal impact of air pollution and potential measures that could reduce this.
- Ensure this data is well circulated within the Council and is promoted and made
readily available to local residents, businesses and schools.

3.3.4 Air Quality Management

- Refresh the air quality action plan to include quantifiable and measurable targets, where the actions can be measured through health benefits, cost savings to the community and local agencies.
- Develop a revised Air Quality Strategy for Bedford Borough Council taking into account the new air quality evidence both nationally and locally, taking into account pollutants other than NO₂.

Links with other JSNA Chapters

The JSNA process has developed a better understanding of the key areas where air quality is complimented and compliments other departments within Bedford Borough Council. There are clear links with the following JSNA Chapters:

- Natural Environment and Green Space
- Climate Change and Adaptation
- Cardiovascular
- Respiratory Diseases: Asthma and Chronic Obstructive Pulmonary Disease
- Deprivation
- Economic Wellbeing
- Planning
- Workplace Health
- Cancer
- Active Travel
- Transport

Internal promotion is key to allow the full engagement of all necessary departments of the Council to ensure significant decision processes consider air quality issues. The links between improving air quality and the other Council JSNA chapters and associated departments need to be strengthened and developed.

4. References


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Wider determinants of health


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