Short term air quality monitoring in Milton, Cambridgeshire

August 2023

Executive Summary

Air quality was monitored in Milton using new Zephyr monitoring technology during the period September 2022 to February 2023 as part of a study into air quality around primary schools. Monitoring was carried out by South Cambridgeshire District Council outside Milton Primary School, as it is recognised that children are among the most vulnerable to the impacts of air pollution. Milton Primary School was selected due to the school being near the A10. It was found that concentrations of the main pollutants, nitrogen dioxide and particulate matter, were comfortably below the national objectives for annual mean concentrations and there were no exceedances of the short-term objectives, representing good air quality. This is in line with long-term concentrations measured across the South Cambridgeshire district and reflects the rural nature of the area. Differences were seen between the school holiday periods compared to term time for nitrogen dioxide, with lower concentrations in the holidays, likely reflecting the impact of reduced school traffic.

South Cambridgeshire residents can help to improve local air quality through actions such as reducing idling of car engines and increasing walking and cycling where possible. Reducing solid fuel burning and only burning Woodsure Ready to Burn certified wood will also help to reduce particulate pollution. This report can be read alongside the yearly Air Quality Annual Status Report (ASR) and the reports from other localised studies, which are available on our website.

Glossary

Annualisation – a calculation process used to estimate an average concentration for a full year from a shorter period.

Annual mean – the average concentration across a full calendar year.

AQMA – Air Quality Management Area – an area where air pollutant concentrations exceed or are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives.

Continuous monitor/monitoring station – instruments which measure air pollution all the time and therefore can give a concentration attributed to a specific time.

Diffusion tube – small plastic tube containing a metal mesh which is coated with a chemical that absorbs nitrogen dioxide. This is exposed to the air in a fixed location for a known amount of time, usually a month, and then sent to a lab for analysis. This provides an average concentration for the time it is exposed.

Nitrogen dioxide (NO_2) – a gas predominantly formed following the burning of fossil fuels, which can cause irritation of the airways and exacerbate symptoms of other conditions.

Particulate matter ($PM_{2.5}$ and PM_{10}) – the number refers to the size of the particulates in micrometres (one millionth of a metre) – a mix of solid particles and liquid droplets of various sizes and composition, the smallest of which can get into the blood and be transported around the body.

Real-time monitoring – see also continuous monitoring – monitoring which takes place at regular intervals all the time and therefore can give a concentration attributed to a specific time.

µg/m^3 – micrograms per cubic metre, the standard units of measurement of air pollutants including nitrogen dioxide and particulate matter.

Zephyr – a type of relatively compact and lightweight air pollution sensors that measure harmful gases and particle matter in real-time.

Results of Zephyr air quality monitoring in Milton, Cambridgeshire

Introduction

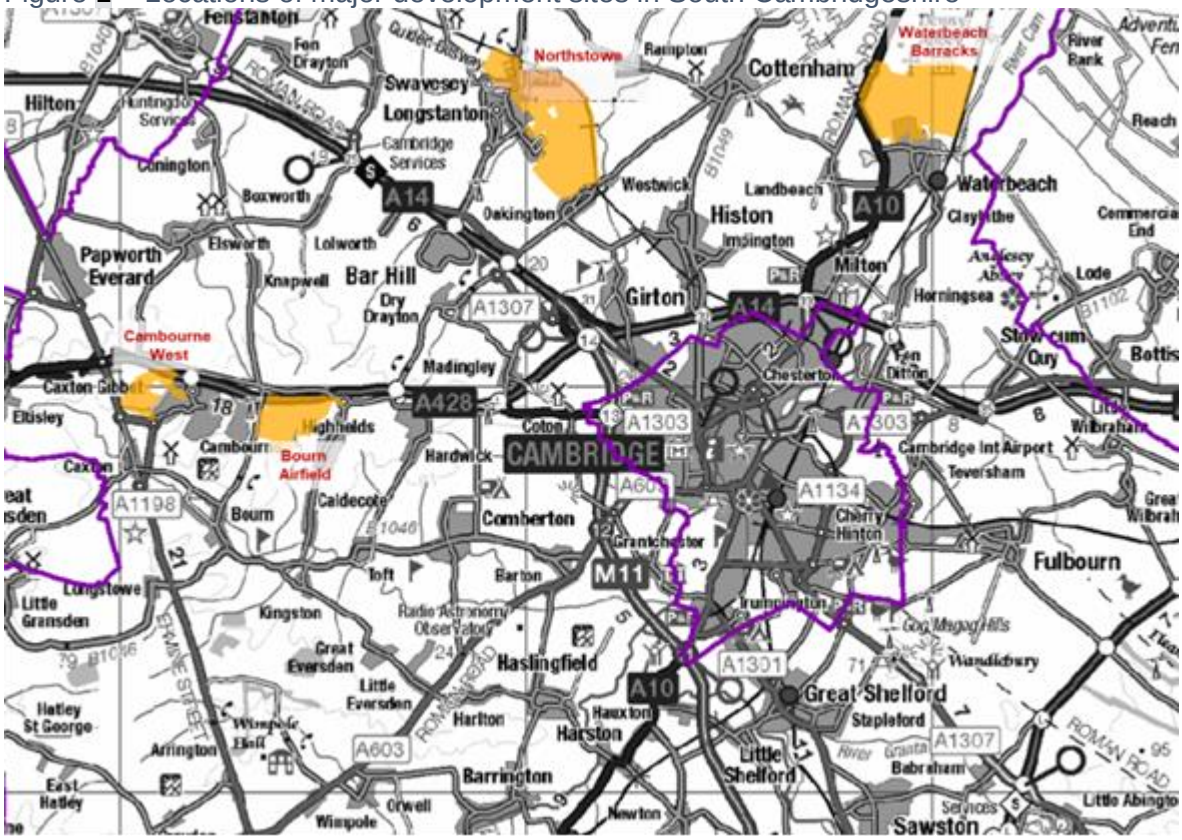
Purpose of this report

This is a report to provide the results of the short-term air quality monitoring study undertaken in Milton, Cambridgeshire, using a new style ‘Zephyr’ monitor. Monitoring was carried out during the period September 2022 and February 2023. The study was designed to be a short-term study monitoring air quality outside Milton Primary School as part of South Cambridgeshire District Council’s study into air quality around primary schools. It also serves to create additional local awareness of air quality in our area and enable people to make informed choices around how they can impact on improving air quality in their area.

Air Quality in South Cambridgeshire

South Cambridgeshire is a rural district which enjoys generally good air quality, with both short-term and long-term pollution levels below the national objectives at all monitored locations. This means we benefit from cleaner air to breathe and less pollution related health problems. The district is undergoing significant growth with major developments to keep up with the increase in demand for housing, including Northstowe (10,000 dwellings), Waterbeach Barracks (6000-10,000 dwellings), Bourn Airfield and Cambourne West, shown in Figure 1.

Figure 1 – Locations of major development sites in South Cambridgeshire



Air quality impacts in the district are mainly related to road traffic, which is likely to increase due to these areas of growth, and the major roads running through the district, including the A14 and M11/A11 corridors. Another important source of particulate matter pollution is domestic solid fuel burning, which nationally contributed 27% of the $PM_{2.5}$ emissions in 2021 according to Defra.

Air quality is an important topic as air pollution can impact our health, particularly effecting the most vulnerable, including children and those with underlying conditions such as asthma, lung conditions or heart disease. Air quality is monitored across the district using a network of diffusion tubes and continuous monitoring stations, which provide accurate air quality measurements in real-time, in addition to the new Zephyr monitors which are used for short term monitoring projects. Although the air quality in South Cambridgeshire is generally good when compared to more urban areas, there is emerging evidence that even low levels of pollutants can cause health impacts, and the World Health Organisation (WHO) have published ambitious targets for some pollutants that are lower than the national objectives.

For more information and detail on the importance of air quality and air quality in South Cambridgeshire, please refer to Appendix 1 – Air Quality Frequently Asked Questions or visit our website. Additionally, ideas on how anyone can play a role in improving local air quality can be found in Appendix 2 – How to get Involved with Local Air Quality.

The 'Zephyr' Air Quality Sensor

Zephyr monitors are compact and lightweight air pollution sensors that measure harmful gases and particles in real-time, including the main pollutants of concern (NO_2, PM_{10} and $PM_{2.5}$). They can run off internal batteries or be powered by a solar panel and can therefore be fixed in a specific location, mostly commonly a lamp post, or used as a mobile monitor. The sensors provide detailed air quality measurements in real-time to help identify pollution hotspots at a localised level, for example busy junctions. Other potential studies include investigating air quality around schools and looking into the impacts of wood burning stoves. Zephyr sensors can be used in isolation individually or deployed as a network of sensors across a wider area to build up a more detailed picture.

The data from a Zephyr sensor cannot be treated with the same confidence as that from one of our continuous monitor stations, where the data is 'ratified' after checks, however, it has been shown to provide accurate indicative measurements and is therefore appropriate for a wide range of studies, including this.

Monitoring Location

Milton was selected as part of a council study looking into air quality around schools as it is a primary school located near the A10, which is a busy main road and potential source of pollution. The major reason for investigating air quality around primary schools is that children are amongst the most vulnerable to the effects of air pollution, which was reflected by the theme of Clean Air Day in 2021 of 'protect our children's health from air pollution'. This is due to children's airways and respiratory systems being less developed than an adult's and because they breathe more rapidly than adults.

The monitor was located on a lamp post within the grounds of Milton Primary School, to be representative of the air quality at the school. It measured the main pollutants of concern, nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$), among others. The location of the Zephyr can be seen on Figure 2, with a photograph of the unit in Figure 3.

Figure 2 – Location of the Zephyr sensor in Milton

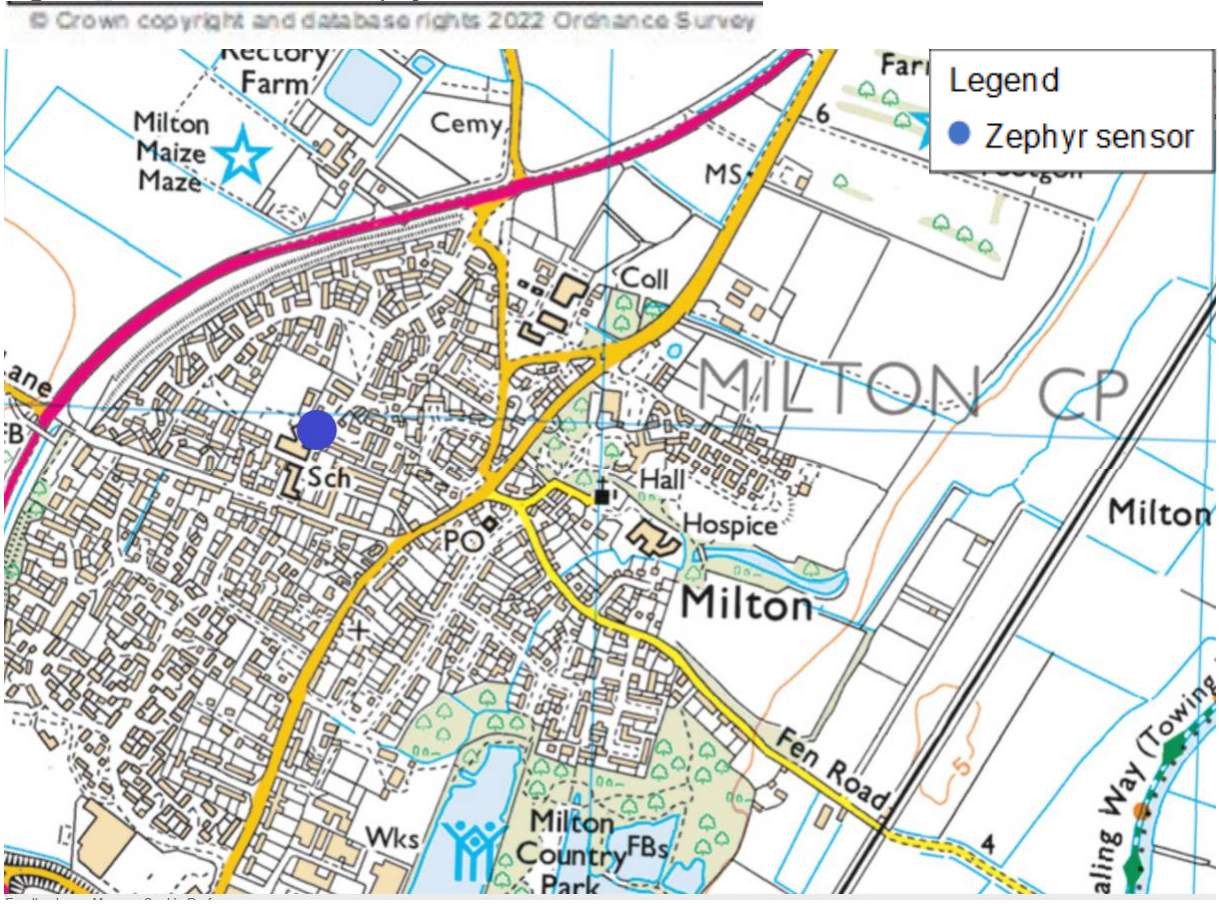


Figure 3 – Photograph of the Zephyr sensor in Milton Primary School grounds

Monitoring Data and Comparison with Objectives

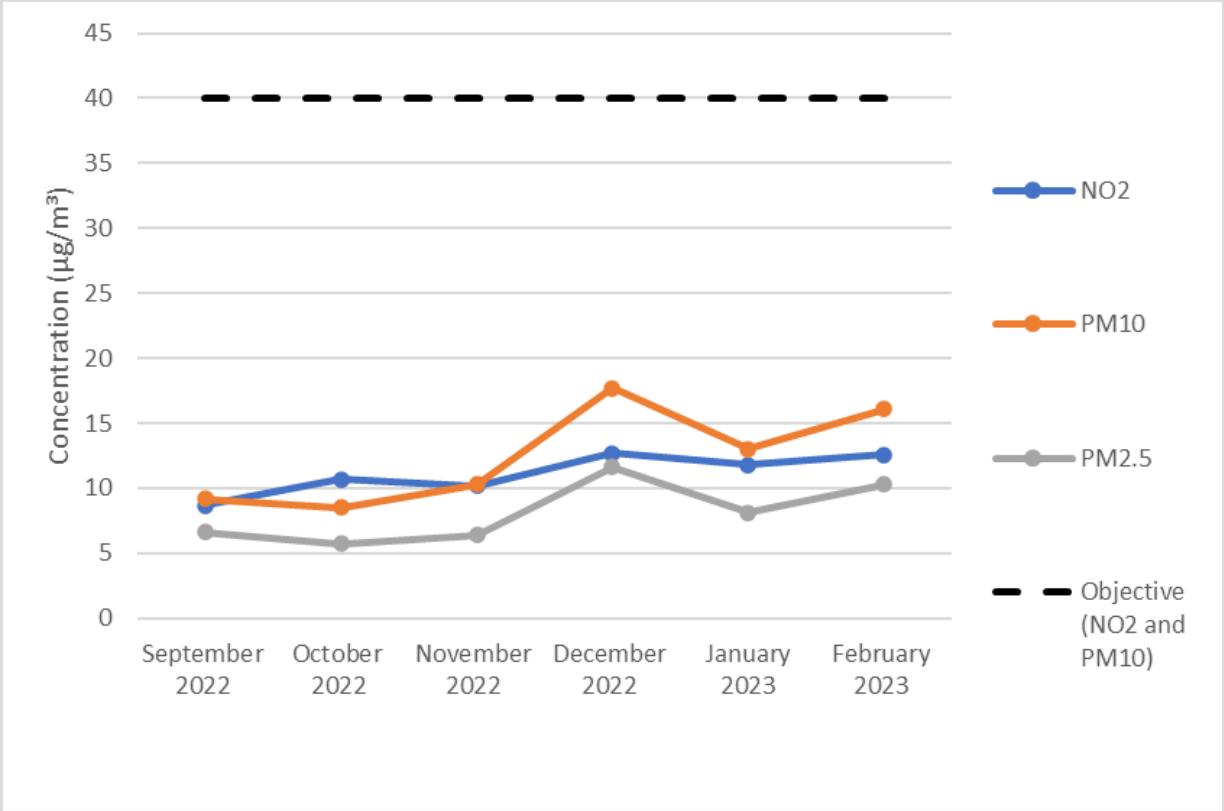
The average monthly concentrations measured in the period September 2022 to February 2023 are shown in Table 1, below, with the annual mean objective shown for information. This data is also represented in Figure 4.

Table 1 – Zephyr Air Quality data – monthly average concentrations

	Pollutant monthly average concentration / µg/m^3		
Month	NO_2	PM_{10}	$PM_{2.5}$
September 2022	8.7	9.2	6.6
October 2022	10.7	8.5	5.7
November 2022	10.2	10.3	6.4
December 2022	12.7	17.7	11.6
January 2023	11.8	13.0	8.1
February 2023	12.6	16.1	10.3
Objective (annual mean)	40	40	10*

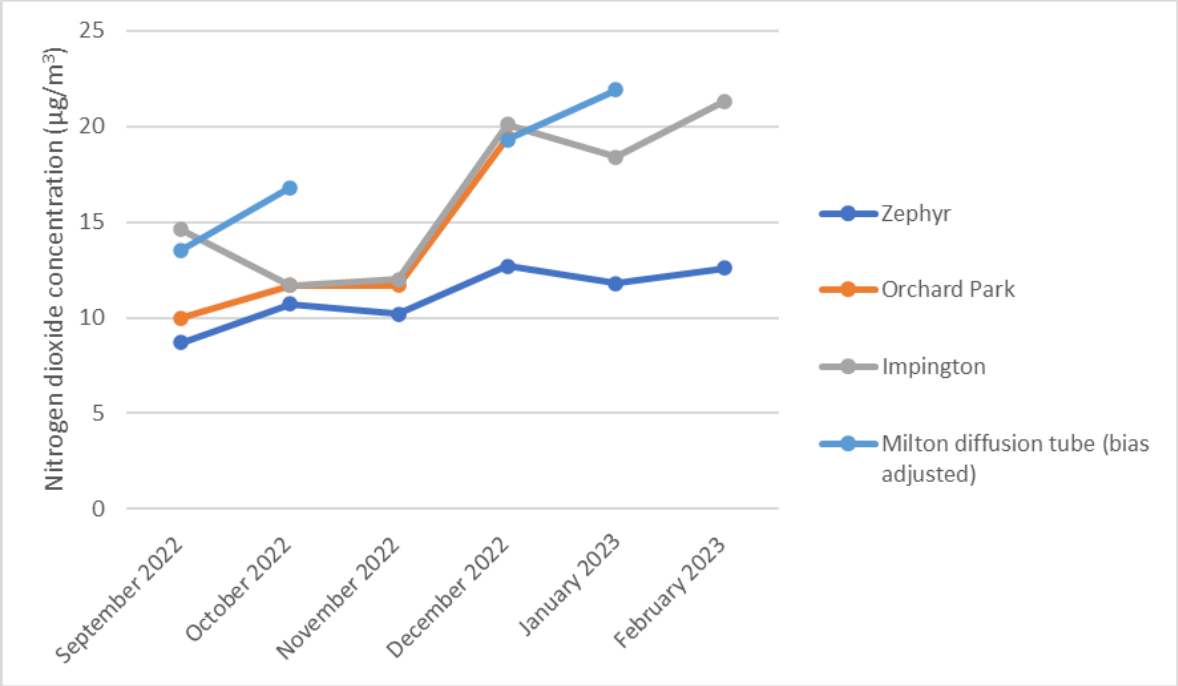
*target to be achieved by 2040

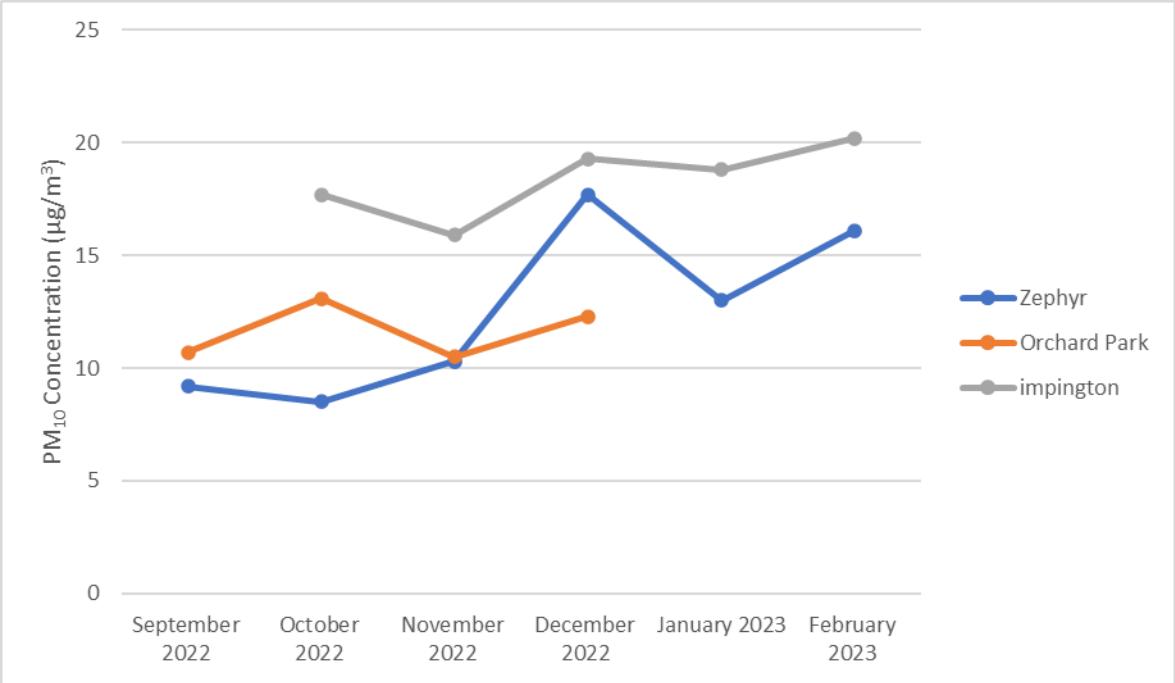
Figure 4 – Zephyr Air Quality data – monthly average concentrations and national annual mean objective



The data recorded in Milton was also compared to that recorded in the same monitoring period by the Council's automatic monitoring stations for each pollutant, as well as the nitrogen dioxide diffusion tube from Cambridge Road, Milton. As shown in Figure 5, below, the data and trends recorded by the Milton Zephyr are consistent with those seen at other monitoring locations across the district. This suggests that there can be a reasonably high degree of confidence in the data collected by the Zephyr monitor.

Figure 5 – Comparison of Milton Zephyr data to automatic monitoring sites in South Cambridgeshire for all pollutants





In addition, the average concentrations of each pollutant for the whole period September 2022 to February 2023 were calculated and then 'annualised' to give estimated annual mean concentrations to allow better comparison to the annual mean objectives. Annualisation is a calculation process used to estimate an average concentration for a full year from a shorter period, such as the approximately 6 months in this study. This is done to avoid the annual average being influenced by short-term events or seasonal changes, such as one day of high pollution like bonfire night, or pollution concentrations often being higher in the winter than the summer. The data was annualised using 2021 data from a range of continuous monitoring

background sites and is shown in Table 2, below. Full annualisation details are available in Appendix 3 – Annualisation of short-term data.

Table 2 – Zephyr Data – annualised annual mean concentrations

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Measured data average Sept 2022 – Feb 2023 –	11.1	12.5	8.1
Annualisation factor	0.83	1.07	1.08
Annualised annual mean – Milton Zephyr	9.21	13.38	8.75
Objective (annual mean)	40	40	10*

*to be achieved by 2040

As shown in Table 1 and Table 2, the long-term annual mean concentrations of the main pollutants of concern at the Milton Zephyr are significantly below the national objectives for NO_2, PM_{10} and $PM_{2.5}$, indicating good air quality. The $PM_{2.5}$ concentration is above the ambitious World Health Organisation annual guidelines, announced in September 2021 of 5µg/m^3, although it remains well below the current UK objective of 10 µg/m^3 to be achieved by 2040 as set in The Environmental Targets (Fine Particulate Matter) (England) Regulations 2022. Typically, $PM_{2.5}$ is a pollutant that is more regional than local as it can travel long distances suspended in the air. Therefore, its concentration is often more impacted by national and regional sources and less by local factors than other pollutants (such as nitrogen dioxide).

The Zephyr also allows measurements of the short-term concentrations of pollutants, which are studied through 1-hour means for NO_2 and 24-hour means for PM_{10}. These are presented and compared to the national objectives in Table 3, below. The short-term objectives are presented as hourly/daily concentrations that should not be exceeded more than a certain number of times in a year. There is currently no short-term objective for $PM_{2.5}$.

Table 3 – Zephyr Air Quality data – short-term average concentrations

Month	Number of exceedances of short-term objective	
	NO_2 1-hour mean	PM_{10} 24-hour mean
January 2022	0	0
February 2022	0	0
March 2022	0	5
April 2022	0	0
May 2022	0	0
June 2022	0	0
Objective	200 µg/m^3*	50 µg/m^3**

*Not to be exceeded more than 18 times a year
**Not to be exceeded more than 35 times per year

As shown in Table 3, there were no exceedances of the short-term objectives for NO_2 or PM_{10}.

The relevant maximum 1-hour mean concentration of NO_2 was recorded as 50.82 µg/m^3 in the evening of the 8 February 2023. This however remains well below the 200 µg/m^3 threshold.

For PM_{10} the maximum recorded 24-hour mean value was 46.17 µg/m^3 on the 25 January 2023. This was likely associated with a regional event as levels were consistently high for a few days during this period, which was matched at regional background monitors in Cambridgeshire run by DEFRA.

In addition to the overall picture outlined above, the difference between concentrations during term time and school holidays was looked at, as this can give an indication of the impact of traffic related to the school. The school holidays were: Autumn half term (24th to 28th October), the Christmas holidays and February half term (13th to 17th February). We have compared the Monday to Friday of the last full week before and first full week after the school holiday to the Monday to Friday during the school holiday period as there can be seasonal variations caused by weather and other factors that impact the levels of pollutants, especially nitrogen dioxide.

Table 4 – Comparison of pollutant concentrations between the Autumn half term and the weeks immediately before and after.

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Week before half term (17th to 21st October)	11.8	10.2	6.8
Autumn half term (24 – 28th October)	9.6	7.0	4.4
Week after half term (31st October to 4th November)	9.6	9.0	4.7

Table 5 – Comparison of pollutant concentrations between the Christmas holiday and the last full weeks of term before and after the Christmas holiday

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Week before Christmas holidays (12th to 16th December)	17.4	31.2	21.5
Christmas Holidays	6.8	5.0	2.4
Week after Christmas Holidays (9th to 13th January)	8.3	5.5	2.9

Table 6 – Comparison of pollutant concentrations between February half term and the weeks immediately before and after.

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Week before half term (6th to 10th February)	22.0	24.5	16.5
Half term (13th to 17th February)	12.7	29.5	18.9
Week after half term (20th to 24th February)	11.6	13.5	8.6

Tables 4, 5 and 6 show that in general levels of nitrogen dioxide were lower in holiday periods when compared to the surrounding weeks. On average the reduction in nitrogen dioxide concentrations during the holidays was approximately 22%. This could be a result of less traffic at the school during the holiday period as nitrogen dioxide concentrations are closely associated with vehicle exhaust emissions.

For particulate matter, both the autumn half term and the Christmas holiday showed a reduction in PM concentrations for both PM_{10} and $PM_{2.5}$. However, the February half term had higher levels of PM than the week before or after, suggesting that the reduction in traffic did not have such a significant impact. Although exhaust emissions do contribute to PM pollution, there are other sources and pollution events tend to be regional rather than localised.

Summary

The data measured by the Zephyr real-time monitor in the period September 2022 to February 2023 shows that the air quality around Milton Primary School remains good, with estimated annual mean concentrations (as well as the measured monthly averages) of the main pollutants of concern well below the national objectives. There were no exceedances of the short-term national objectives. It was found that concentrations of the pollutant nitrogen dioxide were lower during the school holidays which was likely due to reduced traffic around the school at these times. This highlights the impacts of school-run traffic and the potential air quality benefits of reduced driving. The data from the Zephyr was generally consistent with that from the rest of the monitoring sites in the district during the monitoring period, which provides confidence in the instrument. This also matches the general patterns seen across the South Cambridgeshire district of good air quality. However, due to the importance of air quality and its links to health, even at very low levels, it remains important to both monitor air quality across the district and take actions to improve air quality in our area.

Ideas on how to play a role in improving local air quality can be found in Appendix 2.

Appendix 1 – Air Quality Frequently Asked Questions

Why is air quality important?

There are a number of reasons air quality is important. In particular, polluted air is the biggest environmental threat to health in the UK. It is linked to up to 36,000 deaths per year from long-term exposure. The main impacts of poor air quality are contributing to heart and lung conditions, but air quality has also been linked to a wide range of issues. Air pollution also particularly effects the most vulnerable, including children and older people and those with existing lung and heart conditions. Air quality also strongly links to climate change, as many of the causes of the issues are the same, such as the burning of fossil fuels. This means that actions taken to improve air quality also helps prevent climate change.

How does the Council monitor air quality?

South Cambridgeshire District Council operates a monitoring network of over 30 locations across the district, made up of diffusion tubes and three continuous monitoring sites, which measure air quality accurately in real-time. This existing monitoring network allows the long-term monitoring of trends and changes in air quality across the district. Live data from the three continuous monitoring stations are available at https://scambs-airquality.ricardo-aea.com/. In addition, the Council has purchased three Zephyr air quality sensors which provide real-time measurements for the main pollutants of concern from a single monitor. These can be used for shorter-term monitoring to identify hotspots of pollution or be used in a range of targeted studies to complement our existing monitoring network. The first of these instruments was installed in Harston, with subsequent monitors installed in Swavesey, Northstowe, Histon and most recently Swavesey.

What else does the Council do around air quality?

As well as monitoring air quality, the Council acts to improve air quality through its Green to the Core focus, including an air quality strategy designed to go beyond simply meeting the national objectives, Zero Carbon Community Grants to fund community initiatives to improve sustainability, such as encouraging and enabling cycling which in turn helps air quality, and by considering air quality during the planning process[5,6]. Ideas on how anyone can play a role in improving local air quality can be found in Appendix 2 – How to get Involved with Local Air Quality.

What are the main pollutants of concern?

The main pollutants of concern are:

- Nitrogen Dioxide (NO_2) – a gas predominantly formed following the burning of fossil fuels, which can cause irritation of the airways and exacerbate symptoms of other conditions
- Particulate Matter (PM_{10} and $PM_{2.5}$), where the number refers to the size of the particulates in micrometres – a mix of solid particles and liquid droplets of various sizes and composition, the smallest of which can get into the blood and be transported around the body[7]

What are the air quality objectives?

For NO_2 and PM_{10} national objective levels have been set which must be achieved by local authorities, otherwise an Air Quality Management Area (AQMA) must be declared for the objective which is being exceeded. Objectives have been set for both long-term concentrations (measured as annual means) and short-term concentrations (hourly means for NO_2 and daily means for PM_{10}). South Cambridgeshire District Council does not currently have any AQMAs, although there has historically been an AQMA along a stretch of the A14, which was revoked in early 2022 due to sustained compliance with the relevant objectives in line with Defra guidance and the Council's constitution. The Air Quality Objectives applicable to local authorities through the Local Air Quality Management (LAQM) requirements in England are set out in Table 7. In addition, local authorities are expected to work towards reducing emissions and concentrations of $PM_{2.5}$ (particulate matter with a diameter of 2.5 µm or less), although there is currently no legal objective for local authorities.

Table 7 – Air Quality Objectives in England

Pollutant	Air Quality Objective – Concentration	Air Quality Objective – Measured as
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
Nitrogen Dioxide (NO_2)	40 µg/m^3	Annual mean
Particulate Matter (PM_{10})	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
Particulate Matter (PM_{10})	40 µg/m^3	Annual mean
Sulphur Dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
Sulphur Dioxide (SO_2)	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
Sulphur Dioxide (SO_2)	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean

If air pollution is a result of vehicles utilising the A14, how can local residents change this?

There are a number of way local residents can have an impact on air quality through everyday actions, such as those mentioned in Appendix 2 – How to get Involved with Local Air Quality. Many of these are very small changes that can add up to a big impact.

Appendix 2 – How to get Involved with Local Air Quality

Annual reports and details on air quality monitoring are available on our website, https://www.scambs.gov.uk/environment/pollution/air-pollution/local-air-quality-management/, and you can share your views via our email address, air.quality@scambs.gov.uk.

Although air quality in the South Cambridgeshire District is generally good, with concentrations below the objectives, there are actions we can all take to improve it further. Ways you can help to improve air quality in South Cambs include:

- Minimise car use wherever possible:
    - Avoid using your car for short trips (under 2 miles) - short trips are very polluting as modern engines needs to reach a very high temperature to work efficiently; on short trips it won't reach that temperature.
    - For short journeys try cycling or walking more often – this helps you stay healthy and saves you money in fuels costs.
    - For longer journeys consider public transport options.
    - Use journey-planning apps such as MyBusTrip or MotionMap for travel by bus, train, walking and cycling.
- Switch it off – don't leave your car engine idling if you are stationary e.g. waiting to pick someone up, in a traffic jam or waiting at level crossings.
- When driving, use techniques that help you use less fuel, like driving more slowly and smoothly .
    - You could use 10% less fuel by following the tips on the AA website http://www.theaa.com/motoring_advice/fuels-and-environment/drive-smart.html.
    - Like switching your engine off when stationary, this will not only reduce your emissions of air pollution but will save fuel and therefore money too!
- Consider making your next vehicle an electric vehicle.
- Join a car club or car-share regularly.
- Consider working at home where possible – the first Covid-19 lockdown showed widespread improvements in the air quality as the amount people travelled reduced.
- Use less energy at home – consider a smart meter to monitor usage and be aware of boiler standards.
- Opt for 'green energy' tariffs where available or switch to renewable sources of heating or power.
- Reduce the use of solid fuel stoves and open fires – domestic burning is now the single biggest source of particulate matter pollution in the UK (greater than traffic and industry).
    - If you are burning wood or coal ensure any fuel used meets the new standards of moisture content and emissions – more information is available at https://woodsure.co.uk/are-you-ready-to-burn/
- Make your children aware of the impact that day to day activities have on air quality.

Appendix 3 – Annualisation of short-term data

Annualisation is a calculation process used to estimate an average concentration for a full year from a shorter period, such as the 6 months in this study. Annualisation ratios are worked out as a ratio of the average concentration in a full year (annual mean (Am)) to the average in the actual monitoring period measured (period mean (Pm)), using data from background continuous sites. The average concentration from the Zephyr data during the monitoring period is then multiplied by that ratio to give an estimate of the average concentration at the Zephyr for a full year.

The data from the period January to June 2022 was annualised according to the process set out in box 7.9 of Defra's Local Air Quality Management Technical Guidance (TG16). Continuous monitoring background sites were used for the annualisation calculations. A full year from 1 March 2022 to 28 February 2023 was used for the annual mean concentrations as the monitoring covered two calendar years.

NO_2:

Background Site	Annual mean (Am)	Period mean (Pm)	Ratio (Am/Pm)
Wicken Fen	6.35	7.55	0.84
Northampton Spring Park	10.1	12.7	0.79
Norwich	9.3	10.9	0.85
Average ratio	-	-	0.83

PM_{10}:

Background Site	Annual mean (Am)	Period mean (Pm)	Ratio (Am/Pm)
Orchard Park	17.9	17.6	1.02
Norwich	13.1	11.7	1.12
Average Ratio	-	-	1.07

$PM_{2.5}$:

Background Site	Annual mean (Am)	Period mean (Pm)	Ratio (Am/Pm)
Northampton Spring Park	8.2	7.6	1.08
Norwich	8.4	7.5	1.08
Average ratio	-	-	1.08