# The Impact of Quarrying Activities on Air Quality and Public Health: A Case Study in Warwickshire

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**Abstract:** Poor air quality has been strongly linked with many health issues and illnesses including asthma, cancer and autoimmune diseases. This paper uses mixed-methods approach to investigate the pollution levels that school students is currently subjected to and the potential increase in air pollution if the introduction of quarrying activities is introduced and the related increase in HGVs traffic in the area. The results show that the time of the day, due to the increase in traffic, significantly reduce air quality; and the increase in quarrying activities and heavy traffic is expected to significantly increase pollution levels in the area and hence causing an increase to the risk of health issues to the local population, particularly children.

# 1. Introduction

The UK's mining and quarrying sectors are significant contributors to particulate and gas emissions, particularly $PM_{2.5}$, $PM_{10}$, and $NO_2$, which pose serious health risks to nearby communities. Air pollution from nitrogen dioxide ($NO_2$), mostly produced by diesel vehicles, has been a significant concern across the UK. Since 2010, the majority of urban areas in the UK have been recorded illegally high levels of $NO_2$. The European Court of Justice (ECJ) has acted against the UK and other nations for failing to address these air quality issues, with the UK government being forced to improve its plans following multiple legal challenges[1]. This has raised further concerns over the proposed sand and gravel quarry near Wasperton, Warwickshire due to the potential for increased $NO_2$ and particulate matters emissions from Heavy Goods Vehicle (HGV) traffic.

The quarry is located near sensitive receptors, including a pre-school and primary school situated just 700 meters away. The objective is to provide a reliable analysis of the potential environmental and health consequences of the proposed development, focusing on pollutants from quarrying activities and HGV traffic.

# 2. Methodology

## 2.1. Air Quality Data Collection

Al-Habaibeh et al. (n.d.) have monitored the real-time air quality at various locations in Barford, including a primary school and an existing quarry site, to capture realistic air pollution levels. For this experiment, Aeroqual devices are utilized, each comprising a logger and a monitoring head. A total of four devices were used, with two dedicated to monitoring $PM_{10}$ and $PM_{2.5}$ levels. To ensure a comprehensive data collection, the loggers were programmed to

[1] Carrington, D. (2020, February 3). UK taken to Europe's highest court over air pollution. The Guardian. Retrieved from https://www.theguardian.com/environment/2018/may/17/uk-taken-to-europes-highest-court-over-air-pollution

record readings at intervals of every 2 minutes. This setup allowed for the continues collection of data over a span of several days, ensuring a robust dataset for analysis.

## 2.2.Meteorological Data

Meteorological data (see figure 1) has been provided by the Barford Residents Association from the nearest station is Wellesbourne Airfield, located about 6 km from the site. The data shows prevailing wind towards Barford and Wasperton villages.

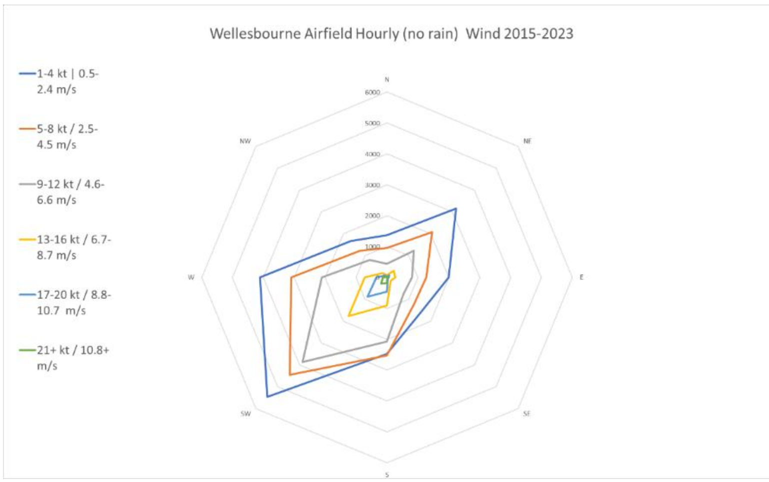



Figure 1: Wind rose diagram for Wellesbourne Airfield (2015-2023), showing prevailing wind directions (data excludes rainy periods).

## 2.3.Traffic Impact and Emission Analysis

Data from Department for Transport (DfT) has been utilised on the number of vehicles that travel past the count point (in both directions) on an average day of the year on A429 road. The

The specific dataset is accessible from the local authorities' section for Warwickshire on the DfT's Road Traffic Statistics website[2]. The dataset includes comprehensive details on vehicle counts, including cars, taxis, buses, light goods vehicles (LGVs), and various categories of heavy vehicles (HGVs).

Table 1 shows the sample data has been taken to provide an overview of traffic on a specific major road A429 in Warwickshire providing a representative snapshot of traffic conditions in the area.

Table 1: Sample data taken for Road A429

| Year | 2021 | 2022 | 2023 |
|---|---|---|---|
| Road Name | | A429 | |
| Cars and Taxis | 10812 | 11605 | 11892 |
| Buses and Coaches | 45 | 48 | 48 |

[2] https://roadtraffic.dft.gov.uk/manualcountpoints/57084

| | | | |
|---|---|---|---|
| Light Good Vehicles (LGVs) | 1812 | 2019 | 2059 |
| HGVs 4 or more rigid axles | 69 | 71 | 66 |
| All HGVs | 1031 | 1061 | 1035 |

A429 passes by Barford and Wasperton Village and it will be the main route used by lorries to transport the extracted minerals.

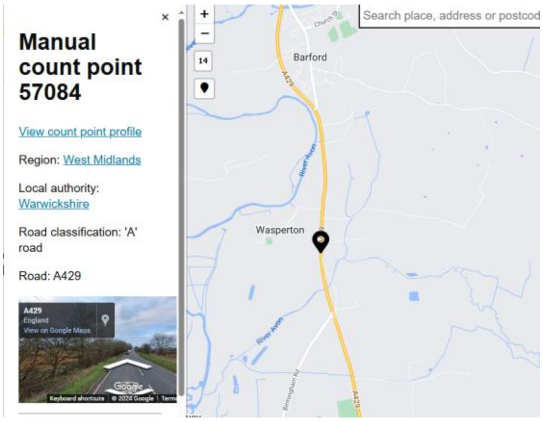



Figure 2: Location of Road A429 (Source: Road Traffic Statistics[3])

To understand the logistical impact of the proposed development, the number of lorry trips required to transport the annual production output. The site is expected to produce 200,000 tonnes of material per annum. Assuming the use of 30-tone lorries (HGVs 3 rigid axle), a sample calculation is as follows:

- Annual Trips: $\frac{200{,}000\ tonnes}{30\ tonnes\ per\ lorry} = 6{,}667\ trips$
- Daily trips: $\frac{6{,}667\ trips}{300\ days} \approx 22\ trips\ pers\ day$

To assess the potential impact of heavy goods vehicles (HGVs) on air quality, a proxy methodology was employed due to the limited availability of direct HGV emissions data. Air quality measurement equipment was attached to a car following a bus to measure its nitric oxide (NO) emissions during stop-and-start patterns similar to those expected of HGVs used in quarry operations. Nitric oxide (NO) emissions were measured using a Chemi Luminescence Detector (CLD), the industry-standard method for quantifying NO concentrations in engine exhaust. The CLD500, manufactured by Cambustion, was employed in this experiment, offering a more advanced 2-millisecond response time compared to conventional CLDs, which have response times of 1-2 seconds and are typically used to measure bag emissions where the concentration changes very slowly. The collected NO emissions data were then converted to nitrogen dioxide ($NO_2$) using conversion factors provided by DEFRA and compared to UK government air quality standards to assess potential exceedances.

[3] https://roadtraffic.dft.gov.uk/#14/52.2234/-1.6114/basemap-countpoints

As figure 3 illustrates, according to the Department for Environment Food & Rural Affairs, non-urban UK traffic in 2024 consists of approximately one-third $NO_2$ and two-thirds NO within the total $NO_x$ emissions. This data underscores the importance of monitoring and mitigating $NO_2$ emissions, particularly in areas with significant quarrying activities or heavy vehicle traffic.

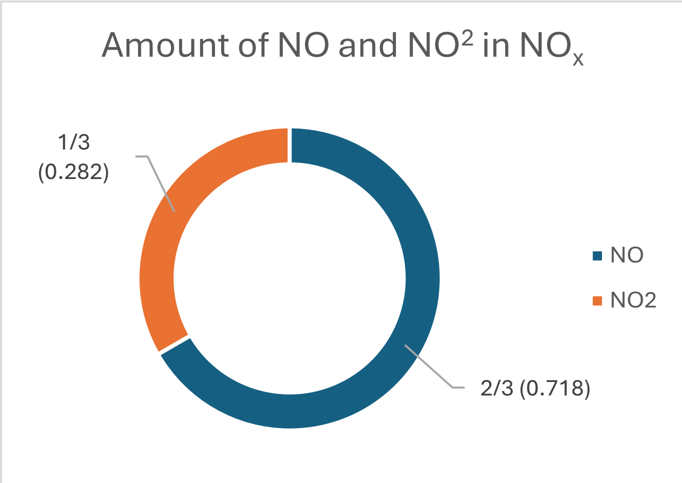
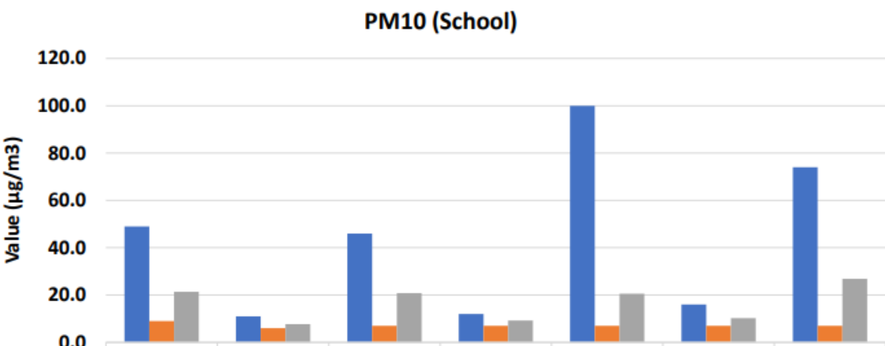



Figure 3: Amount of NO and NO2 in NOx (Source: NOx to NO2 Calculator | LAQM (defra.gov.uk))

# 3. Results and Discussion

## 3.1. NTU Air Quality Monitoring Results

Air quality readings, specifically for PM10 and PM2.5, were collected inside a school in Barford Village, with findings indicating elevated particulate matter levels during school hours compared to non-school hours (Figure 4). This increase is likely due to greater occupancy and activity during school hours.




| | School Time | Off Time | School Time | Off Time | School Time | Off Time | School Time |
|---|---|---|---|---|---|---|---|
| Max | 49.0 | 11.0 | 46.0 | 12.0 | 100.0 | 16.0 | 74.0 |
| Min | 9.0 | 6.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Average | 21.4 | 7.7 | 20.8 | 9.2 | 20.5 | 10.2 | 26.9 |

Figure 4: Data analysis for PM10 at the school at Barford village

Additionally, data recorded at a house on Barford Road, close to the proposed quarry site, mirrored the trend observed at the school. Daytime measurements were consistently higher, likely influenced by traffic. Interestingly, an unusual spike was observed on the third day, with daily averages peaking on the fourth day.

Two trials were also conducted to measure air quality near an active quarry. The first trial, which focused on short-term (1-hour) monitoring of PM10, PM2.5, and NO2 levels, showed increased particulate matter readings as the monitoring devices moved closer to the quarry (Figure 5).

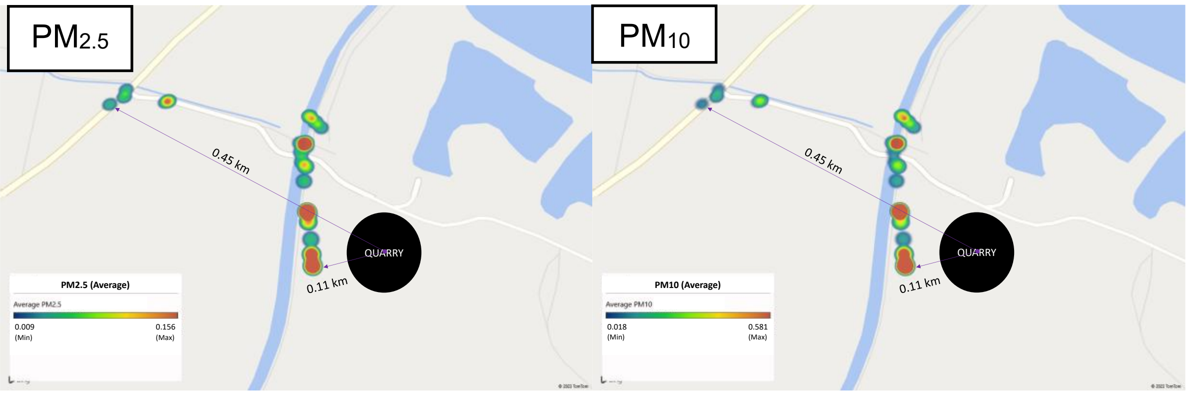



Figure 5: A map shows the location of the average PM10 and PM2.5 readings taken by devices

The second trial, lasting longer and considering variables such as wind direction, reaffirmed the presence of higher PM levels closer to the quarry. Farming activities in the vicinity also contributed to elevated PM levels, particularly in the second trial (Figure 6).


Figure 6: This map shows the fixed point in yellow circle and the path used to collect data in the last hour

Fixed-point measurements taken 0.65 km from the quarry under low wind conditions revealed relatively stable concentrations of PM10, PM2.5, and NO2. However, as mobile monitoring moved closer to the quarry, particulate matter levels increased, indicating a direct impact from the quarry's operations (Figure 7).

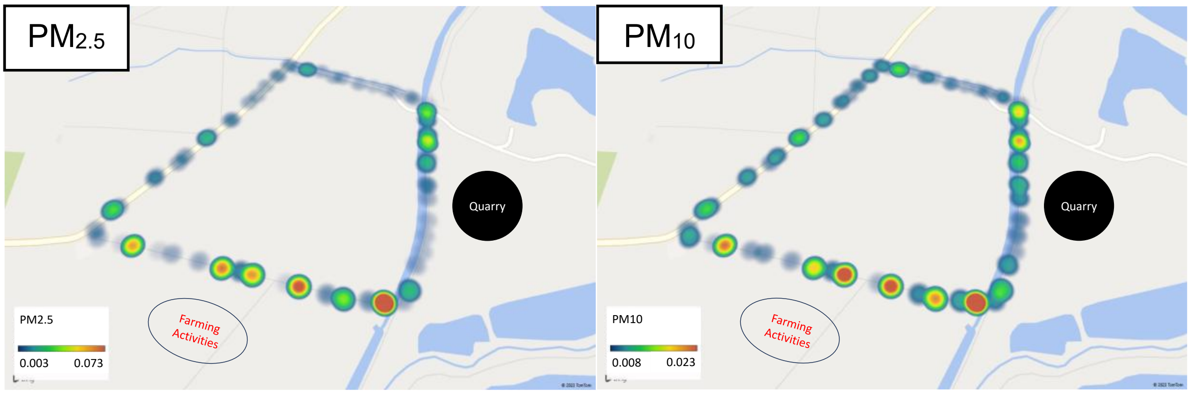



Figure 7:$PM_{10}$ and $PM_{2.5}$ colour map

## 3.2.Impacts of the HGVs

Based on the calculations earlier in the report, it is estimated to have 22 trips per day (44 trips including the return journey) over 12 hours of operation, across 300 working days per year (Monday to Saturday). However, water abstraction restrictions—such as those limiting operations when the flow of the River Avon falls below a certain threshold—might reduce the number of operational days if water needs to be pumped from the excavation pits. If standard lorries are being used, it would be necessary to complete up to 200 trips per day to fulfil the project's objectives.

Alternatively, 1.8 million tonnes are to be extracted over 15 years, equating to 120,000 tonnes per year. Assuming a maximum of 320 working days, 375 tonnes per day need to be transported. This number is doubled for infill importation, resulting in 750 tonnes per day. If 25-tonne lorries are utilized, 30 trips per day (60 trips including the return journey) will be required. If 18-tonne lorries are used, 40 trips per day (80 trips including the return journey) will be necessary.

The results from emissions of the bus clearly shows the start and stop results in spikes equate to 5,000 $\mu g/m^3$ of $NO_2$, while the average during travel is 1,000 $\mu g/m^3$.Table shows the assumptions made for different scenarios with estimated trips per hours, hourly emissions and number of daily exceedances.

Table 2: Emissions and exceedances considering different Scenarios

| Lorries tonne | Number of lorries | Trips per hour | Hourly $NO_2$ during stop and start ($\mu g/m^3$) | Number of daily exceedances (limit ×18 per year) | Hourly $NO_2$ during travel ($\mu g/m^3$) | Number of daily exceedances (limit ×18 per year) |
|---|---|---|---|---|---|---|
| 30 | 22 | 3 | 15,000 | 90 | 3,000 | 15 |
| 25 | 30 | 4 | 20,000 | 100 | 4,000 | 20 |
| 18 | 40 | 5 | 25,000 | 125 | 5,000 | 25 |
| Standard | 200 | 25 | 125,000 | 625 | 25,000 | 125 |

The numbers in table 1 are concerning after realizing that the government target for $NO_2$ is 200 $\mu g/m^3$ which can only be exceeded 18 times a year. However, the target will be exceeded at least 15 times a day which is equivalent to 180 times a year.

The limitations of using bus emissions as a proxy for HGV data are acknowledged, as HGVs typically produce higher levels of $NO_2$. Therefore, the actual air quality impacts of the proposed development would be probably greater than that estimated in this report. Further research with direct measurement of HGV emissions would be beneficial for a more comprehensive understanding.

# 4. Conclusion

This study highlights the significant environmental and public health risks associated with increased quarrying activities and HGV traffic in the Wasperton and Barford areas. The analysis reveals that the proposed quarry, alongside the rise in heavy vehicle traffic, would lead to a considerable increase in harmful pollutants such as $NO_2$, $PM_{2.5}$ and $PM_{10}$. Air quality monitoring data from local schools and residential areas already indicate elevated pollution levels during peak traffic times, particularly affecting children. The projected number of HGV per day significantly exceeds safe $NO_2$ concentration limits set by government standards, implying frequent and severe air quality exceedances. These results emphasize the need for stricter regulation and alternative transport methods to mitigate the environmental impact. Without appropriate intervention, the local population, especially schoolchildren, faces heightened exposure to air pollutants, increasing the risk of long-term health issues such as respiratory and cardiovascular diseases. This underscores the necessity for further, more precise research and comprehensive environmental impact assessments before proceeding with the quarrying project.