20 mph Phase 1 - Air Quality Monitoring Report – Executive Summary

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Transport for Wales

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Executive summary

The 20 mph Task Force Group report, published in 2020, set out the key performance indicators which should be monitored as part of 20 mph Phase 1, including “*Air quality remaining [the] same (at the least)*”. [[1]](#footnote-2) In 2021, TfW commissioned Jacobs to develop an air quality assessment methodology to assess changes in air pollution (if any) resulting from the implementation of the 20 mph default speed limit. The methodology proposed the use of air quality sensors to measure the impact in three separate Phase 1 areas.

Air quality sensors were deployed at locations in Cardiff, Severnside (Magor) and Abergavenny, to monitor differences in concentrations of nitrogen dioxide (NO2), particulate matter less than 10 µm in diameter (PM10) and particulate matter less than 2.5 µm in diameter (PM2.5). Pairs of sensors were located on the same stretch of road, one ‘inside’ and one ‘outside’ of the introduced 20 mph speed limit, in an attempt to measure its influence on air quality.

In order to improve the accuracy of the results obtained, prior to installation and periodically over the duration of the monitoring, the sensors used were calibrated against a more accurate reference station forming part of the Air Quality Wales Network at Bridgend.

Data was obtained and analysed from May 2022 through to April 2024. Whilst concentrations of PM10 and PM2.5 were measured, it was found that road traffic emissions on adjacent roads contributed very little to the measured PM10 and PM2.5 concentrations at each pair of sensors. As such, the assessment has focussed on the pollutant NO2, which, as shown by the monitoring undertaken, is strongly influenced by road traffic exhaust emissions, especially at the roadside.

In addition to the air quality monitoring, traffic volume and speed was also monitored at a nearby location within the 20 mph speed limit area in Cardiff and Magor and at nearby locations both inside and outside the 20mph speed limit area in Abergavenny. Where possible, the traffic data were compared to the air quality data to assess whether any observed differences in measured NO2 concentrations could reasonably be attributed to differences in vehicle speed following the introduction of the 20 mph limit.

Additional supplementary analysis has also been undertaken to consider:

* Wider trends in air quality within Wales over similar timescales.
* The impact of regional air pollution episodes on concentrations measured by the air quality sensors.
* The impact of a period of nearby construction and traffic management on measured NO2 concentrations adjacent to one of the sensors in Cardiff.
* The impact of a new raised pedestrian crossing on measured NO2 concentrations adjacent to one of the sensors in Cardiff.
* The impact of partial temporary closures of the M48 (and resulting increased traffic congestion on local roads) on measured NO2 concentrations at one of the sensors in Magor.
* The impact of speed enforcement activities within the 20 mph speed limit area in Magor on measured NO2 concentrations.

Summary of Results

A summary of average measured NO2 concentrations at the sensors inside and outside each of the 20 mph speed limit areas (and the resulting difference) is presented in Table ES‑1, along with the estimated average measurement error of the sensors. The results obtained in each area are discussed further in the sub-sections below and in the full technical report. In summary:

* All measured concentrations of NO2 were within the level of the relevant annual mean Air Quality Objective / Limit Value. Furthermore, these measurements were made at the roadside, meaning NO2 concentrations at the nearest residential properties, which are set further back, would likely be much lower. This is because NO2 concentrations typically decrease rapidly with increasing distance from a road due to the increased dispersion and dilution of road traffic emissions.
* The differences in measured NO2 concentrations between the sensors inside the 20 mph speed limit area relative to those outside the area were mainly small relative to the annual mean NO2 Air Quality Objective / Limit Value. The differences were also within the range of average measurement error, apart from in Magor.
* At Cardiff Outside Location 2 and Magor, measured NO2 concentrations inside the 20 mph speed limit were lower than those outside the 20 mph speed limit, with the largest difference being at Magor. Potential reasons for these differences are discussed in the relevant sub-sections below.
* At Cardiff Outside Location 1 and Abergavenny, measured NO2 concentrations inside the 20 mph speed limit were slightly higher than those outside the 20mph speed limit, but well within the range of measurement error. Again, potential reasons for these differences are discussed in the relevant sub-sections below.

Table ES‑1. Summary NO2 concentration data within each area

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| --- | --- | --- | --- | --- |
| Area | Average Measured NO2 Concentration Inside 20mph Speed limit  (µg/m3) | Average Measured NO2 Concentration Outside 20mph Speed limit  (µg/m3) | Difference Between Inside and Outside 20mph Speed limit  (µg/m3) | Average NO2 Concentration Measurement Error  (µg/m3) |
| Cardiff (using Outside Location 1) | 21.0 | 20.6 | +0.4 | 3.6 – 3.8 |
| Cardiff (using Outside Location 2) | 21.7 | 23.3 | -1.6 | 1.4 – 4.3 |
| Magor (Severnside) | 20.2 | 25.8 | -5.6 | 2.6 - 5.1 |
| Abergavenny | 15.0 | 14.5 | +0.5 | 1.6 - 2.7 |

Cardiff

Monitoring was undertaken in Cardiff between May 2022 and March 2024. However, the sensor outside the 20 mph speed limit had to be moved (from Outside Location 1 to Outside Location 2) following the construction of a raised pedestrian crossing adjacent to the sensor. This crossing was thought likely to cause frequent deceleration and acceleration events and hence increased road traffic emissions. Construction activities and related traffic management were present in this area from late November 2022 to early January 2023, the impact of which can clearly be seen in the measurement data. The measurement data obtained during this ‘construction’ period were therefore excluded from the analysis. The remainder of the monitoring data obtained indicates:

* **Outside Location 1** (before the construction of the crossing) - There was a small difference between the NO2 concentrations monitored inside and outside the 20 mph speed limit with an average difference of 0.4 µg/m3 higher inside the 20 mph speed limit area. As well as being small in comparison to the annual mean NO2 Air Quality Objective / Limit Value (40 µg/m3), this difference is well within the average measurement error of the sensors.
* **Outside Location 2** (post construction of the crossing) - The sensor outside the 20 mph speed limit recorded an average NO2 concentration 1.6 µg/m3 higher than the sensor inside the 20 mph speed limit, a small difference in comparison to the annual mean NO2 Air Quality Objective / Limit Value (40 µg/m3), and within the average measurement error of the sensors for the majority of the time. Outside Location 2 is much closer to the 20 mph speed limit than Outside Location 1 and it is thought that the acceleration of vehicles leaving the 20 mph speed limit as they pass the sensor is potentially a reason for the higher concentrations measured at Outside Location 2.

The construction of the raised pedestrian crossing and associated footway works adjacent to Outside Location 1 resulted in a considerable increase in measured NO2 concentrations at this location as a result of emissions from construction plant and equipment and associated traffic management (including temporary traffic lights which resulted in increased congestion and acceleration). This inadvertent finding provides additional confidence that the assessment approach used was able to detect changes in exhaust emissions as and when they occurred.

Magor (Severnside)

Monitoring was undertaken inside and outside the 20 mph speed limit in Magor between July 2022 and April 2024. The outside location at Magor has consistently monitored higher concentrations of NO2 compared to the sensor inside the 20 mph speed limit. This difference is greater than the average measurement error of the sensors for the majority of the time.

As traffic volumes adjacent to each sensor are the same, it is thought likely that the higher NO2 concentrations outside of the 20 mph speed limit can be explained by a combination of:

* Vehicles potentially still accelerating away from a roundabout to the west as they pass the sensor outside of the 20 mph speed limit, resulting in increased engine load and exhaust emissions.
* The proximity of trees and vegetation to the sensor outside the 20 mph speed limit resulting in a more enclosed environment, meaning pollutants cannot disperse as readily compared to the area adjacent to the sensor within the 20 mph speed limit.

Observed mean speeds (of approximately 30 mph) near to the sensor within the 20 mph speed limit indicate that the measured difference in NO2 concentrations between the sensors is not as a result of vehicles within the 20 mph speed limit area travelling at 20mph, although it may be that vehicles adjacent to the sensor outside the 20 mph speed limit area are travelling faster than those adjacent to the sensor inside the 20 mph speed limit.

A number of short periods of speed enforcement were undertaken in this area during the monitoring period. Information from the speed enforcement period has been used in an attempt to understand potential impacts on NO2 concentrations should vehicles travel at mean speeds closer to 20 mph. However, it is considered that the overall duration of speed enforcement (and resulting quantity of monitoring data collected during periods of enforcement) is insufficient to draw firm conclusions as to the potential impact of lower average vehicle speeds on NO2 concentrations.

Large differences in NO2 concentrations between the sensors were recorded when there were traffic issues as a result of temporary closures of the M48 Severn Bridge. During this time, over late December 2022 to early January 2023, the sensor outside the 20 mph speed limit area recorded much higher NO2 concentrations compared to the sensor inside the 20 mph speed limit area which is potentially associated with greater levels of congestion at the roundabout to the west and along approaches to the roundabout. Meteorological conditions during this period were also potentially favourable for the grounding of nearby industrial stack emissions, however without activity data and more detailed analysis beyond the scope of this study, this cannot be confirmed. The monitoring results obtained during this period were removed from the analysis, but again demonstrate that the monitoring approach employed was able to detect changes in road traffic emissions as and when they occurred.

Abergavenny

Air quality monitoring has not been undertaken for as long in Abergavenny (March 2023 – April 2024) due to difficulties installing the sensors in this area. Since monitoring began, the sensors both inside and outside the 20 mph speed limit area have recorded similar NO2 concentrations, albeit with the sensor inside the 20 mph speed limit recording slightly higher concentrations. This difference is well within the average measurement error of the sensors. It is possible that the difference between the sensors is a result of the location of Nevill Hall Hospital which is between the two sensors. Traffic passing the sensor inside the 20 mph speed limit will not always continue to pass the sensor outside of the 20 mph speed limit, if it is travelling to and from the hospital. There is evidence within the traffic flow data to suggest this is the case. This finding again shows that the monitoring approach employed was able to detect differences in road traffic emissions between the sensors, but in this case because of differences in traffic volumes.

Conclusions

There is good evidence in all three study areas that measured NO2 concentrations are strongly influenced by traffic conditions on the adjacent road (as expected). It is also clear that the assessment approach is able to identify differences in NO2 concentrations and therefore road traffic exhaust emissions. This was particularly evident in Cardiff during traffic management to facilitate construction works, in Magor during periods when there were closures on the M48 and in Abergavenny due to differences in traffic volumes.

Measured concentrations of PM10 and PM2.5 were shown to be much less heavily influenced by road traffic emissions as sources of these pollutants are more regional in nature, including emissions from industrial sources, domestic wood burning or sea salt over the wider region. The focus of this assessment has therefore been on measured concentrations of NO2.

At all monitoring locations there were differences in measured NO2 concentrations inside the 20 mph speed limit area compared to outside the 20 mph speed limit area, however these differences:

* Were typically small relative to the annual mean NO2 Air Quality Objective / Limit Value (and typically within the average measurement error of the sensors).
* Indicate that NO2 concentrations inside the 20 mph speed limit were similar to (or in the case of Magor, lower than) those outside the 20 mph speed limit.
* Are not simply a result of vehicles travelling at 20 mph within the 20 mph speed limit areas, as vehicles are travelling in excess of 20 mph within all three of the monitoring areas.
* Can potentially be explained by other factors which influence road traffic emissions more than slight changes in vehicle speed (such as increased acceleration or differences in traffic volume).

1. <https://www.gov.wales/20mph-task-force-group-report> [↑](#footnote-ref-2)