Improving Air Quality for 1.5m visitors to the Birmingham 2022 Commonwealth Games

No negative impact on air quality due to B2022, benefitting **1.5m visitors** and **2.9m WM residents**

New analyses verified that CWG impact on background air quality was **minimal**

Daily air quality predictions incorporated into operational activities

Awareness of Clean Air raised via public engagement at athletics stadium

Effective collaboration – via Impact Fellow secondment

Practice - air quality considered in CWG sustainability strategy for the first time

Operational - daily air quality predictions incorporated into delivery

Environmental - CWG impact on background air quality was minimal

The Birmingham 2022 Commonwealth Games (B2022 CWG) brought thousands of athletes, support teams and 1.5 million spectators to the region in summer 2022, providing a unique opportunity to apply the WM-Air expertise and capabilities for a Global, high-profile event. By providing support on air quality to the CWG Organising Committee (CWG-OG), WM-Air ensured that air quality was a key environmental focus of the Games and that any negative impacts of the event were minimised. This helped to establish the B2022 CWG as a best-in-class example of application of science in support of sustainability and clean air legacy, among comparable events.

Background - why does this work matter?

The 2022 CWGs were held in Birmingham, 28th July to 8th August 2022, bringing thousands of athletes and 1.5 million spectators to venues in Birmingham and across the West Midlands. As traffic is a major source of air pollution, changes in activity associated with this short-term influx of people to the region had the potential to impact air quality in the West Midlands. It was therefore imperative that actions to minimise this were incorporated into the planning of B2022.

Method – what did we do?

WM-Air provided support on air quality to the CWG-OC via an Impact Fellow secondment and a package of activities including advice and guidance, modelling, measurements and engagement. Working closely with the Organising Committee, the partnership became *"central to understanding"* (Ian Reid, Chief Executive B2022) how hosting a major sporting event impacts local air quality. As such, WM-Air ensured

that air quality was a key environmental focus of the Games alongside carbon (maximising air quality-climate co-benefits).

What tools/outputs were developed?

- High-resolution air quality modelling - informed by Games period traffic modelling from TfWM - was provided by the WM-Air team. This allowed air quality at Games venues to be estimated.

- Air quality measurements were used to produce daily air quality briefings for the CWG Associations, and Health and Games Family Services teams throughout the Games period, providing operational support to endurance event planning.
- Detailed analysis of ambient air quality measurements by WM-Air was conducted using a new methodology to separate policy impact from natural variability.

Outcomes, Impacts and Benefits delivered

WM-Air was central to the development of a sustainability strategy **and transport approaches that optimised air quality-climate (carbon) co-benefits**. This helped to establish B2022 CWG as a best-in-class example of application of science in support of sustainability and clean air legacy, among comparable events.

Guidance and technical expertise was provided for air quality monitoring around key Games locations in the two years leading up to and throughout the Games period, including installing "low-cost" air pollution sensors (at Alexander Stadium and Edgbaston Stadium), advising on their placement and subsequent data interpretation. A NERC-funded mobile air quality monitoring supersite was also located at the Alexander Stadium collecting air pollution data before, during and after the Games, for the period 19th July – 10th August. This provided additional local data to supplement the background air quality monitoring in the city and at the Birmingham Air Quality Supersite (BAQS).
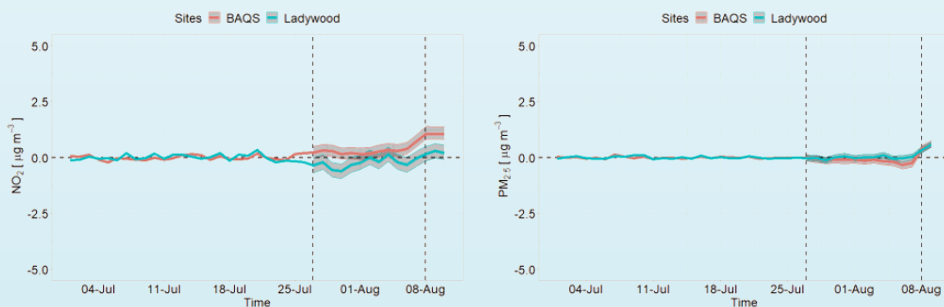
Deviation of de-weathered NO_2 (left) and $PM_{2.5}$ (right concentrations from a synthetic control (horizontal dotted line) at BAQS and Ladywood measurement stations.

Atmospheric conditions directly impact athlete performance, especially for distance or longer duration events. As such, near real-time measurements were analysed together with modelled data and **daily air quality updates were provided to the Organising Committee and sports performance specialists in order to inform their daily plans**. These were also disseminated to coaches and athletes via athlete liaison teams in Games Family Services, and "*supported information for the OC Medical team from a public health perspective and complimented the UK HSA support.*" (Ian Reid, Chief Executive B2022).

Air pollution measurement data was also used to explore the overall impact B2022 had on background air quality levels. Indeed, detailed analysis of ambient air quality measurements by WM-Air was conducted using a new methodology to separate policy impact from natural variability. **Results showed that the Games had little impact on background nitrogen dioxide (NO_2) concentrations in Birmingham, and no significant impact on background fine particulate matter ($PM_{2.5}$) concentrations.** This is likely due to actions taken by the B2022 CWG-OC to limit emissions associated with the Games, such as the public-transport-only approach (650,000 spectator journeys were counted on shuttle buses over the competition days).

On-site air quality measurements made at Alexander Stadium using the mobile air quality monitoring supersite showed that whilst the Games had little impact on background NO_2 and $PM_{2.5}$ concentrations in Birmingham, **localised**

"I am extremely grateful to The University of Birmingham's WM-Air Project team for the extensive work measuring air quality levels at key venues in the two years leading up to and throughout the Games period. This is the first time a dedicated air quality research project has been conducted at a Commonwealth Games."

Ian Reid, Chief Executive B2022

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COMMONWEALTH GAMES
AIR QUALITY UPDATE FOR ALEXANDER STADIUM

PREPARED ON: 27th July 2022
General Weather Conditions from Met Office, AQI from DEFRA

PARAMETER	FORECAST FOR 28/07/22
Air Pollution (Air Quality Index)	3 (Low)
Weather Conditions	Cloudy
Average temperature (peak)	17 (22) °C
Average wet bulb temperature (peak)	13 (15) °C
Relative Humidity	62%
Wind	7.6 mph
Rainfall	Dry

POTENTIAL IMPACTS: Local air quality is good and will not impact performance. Mild temperatures provide good conditions and may favour quicker performances for endurance events.

Summary of provisional air quality at Edgbaston 12:00 26/07/22 – 12:00 27/07/22

PARAMETER	24h mean concentration	24h peak concentration	Typical summer concentration*
Nitrogen dioxide (NO_2)	13 µg m⁻³	33 µg m⁻³ (07:00)	10.4 µg m⁻³ (daytime average)
Ozone (O_3)	46 µg m⁻³	81 µg m⁻³ (12:00)	-
Particulate matter ($PM_{2.5}$)	5.4 µg m⁻³	9.0 µg m⁻³ (07:00)	5.9 µg m⁻³ (daytime average)

*based on WM-Air modelling

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COMMONWEALTH GAMES
AIR QUALITY UPDATE FOR BIRMINGHAM

PREPARED ON: 8th August 2022
General Weather Conditions from Met Office, AQI from DEFRA

PARAMETER	FORECAST FOR 09/08/22
Air Pollution (Air Quality Index)	3 (Low)
Weather Conditions	Sunny
Average temperature (peak)	21 (27) °C
Average wet bulb temperature (peak)	14 (16) °C
Relative Humidity	53%
Wind	4.7 mph
Rainfall	Dry

POTENTIAL IMPACTS: Local air quality is good and will not impact performance. Mild temperatures provide good conditions and may favour quicker performances for endurance events.
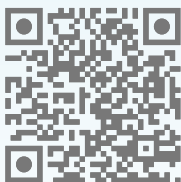
high concentrations of PM$_{2.5}$ were recorded in fan zones at times. These concentrations were driven by the emission of particulates from cooking sources. A paper presenting these findings and their relevance for other large cultural events is currently under preparation.

Air pollution awareness was enhanced via **engagement with spectators, athletes, families, B2022 workforce and volunteers at the Alexander Stadium** on the 4th - 6th August, with an estimated 190,000 people on site over those 3 days. Members of WM-Air accompanied a new mobile air quality supersite during the main athletics programme, engaging members of the public about the air pollution measurements that were being made by the mobile monitoring station, the work of the WM-Air project, general air quality issues and local interventions, such as the Birmingham Clean Air Zone, public transport, active travel and health. The mobile supersite was also branded with logos and QR codes to direct people to find out more about WM-Air activities. Air quality monitoring was also mentioned in the official souvenir programme, asking people to 'spot a sensor'. There was also international media discussion around air quality at the Games due to the inclusion of an air quality sensor within the Queens Baton Relay "baton", which visited 72 nations and territories of the Commonwealth. A member of the WM-Air team provided academic consultancy to ensure science alignment and raise the international public profile of NERC air quality science.

WM-Air also contributed to a Carbon Literacy Training Course developed by CWG in conjunction with the West Midlands Combined Authority (WMCA). The (initially) Climate-focused course was expanded to include air quality resources - an introduction to air quality and air quality-carbon co-benefits - as part of modules 2 and 3. To-date, 90,000 + people in the UK have achieved their Carbon Literacy certificate.

The post Games sustainability report includes a summary of some of the WM-Air activities (p.28).

Looking to the Future/Legacy

WM-Air worked with the B2022 CWG-OC to help shape legacy – to maximise the scope for the Games to become a catalyst to inspire behavioural change (notably, through the public-transport-only approach) and provide a lasting air quality impact in Birmingham and the West Midlands, as well as to provide a best-practice example of how to consider and account for the air quality implications of future Commonwealth Games, and indeed other large events.

Underpinning Science

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- Modelling output and presentation provided by WM-Air.
- Hodgson, J.R, Chapman, L., Pope, F.D. (2021) The Diamond League athletic series: does the air quality sparkle? Int J Biometeorol, 65(8):1427-1442.
- Bousiotis, D., Singh, A., Haugen, M., Beddows, D. C. S., Diez, S., Murphy, K. L., Edwards, P. M., Boies, A., Harrison, R. M., and Pope, F. D. (2021). Assessing the sources of particles at an urban background site using both regulatory instruments and low-cost sensors – a comparative study, Atmos. Meas. Tech., 14, 4139–4155.
- Shi, Z., Liu, B., Cheng, K., Elliott, R.J.R., Cole, M.A., Bryson, J.R., 2022. Quantifying the impact of Clean Air Policy: For air quality management. Working paper.
- Report assessing the impact of the 2022 Commonwealth Games on background air quality across Birmingham.
- (Journal papers in preparation related to this report: 'The impact of hospitality on air quality at a major sporting event' and 'The impact of the Birmingham 2022 Commonwealth Games on regional air quality')