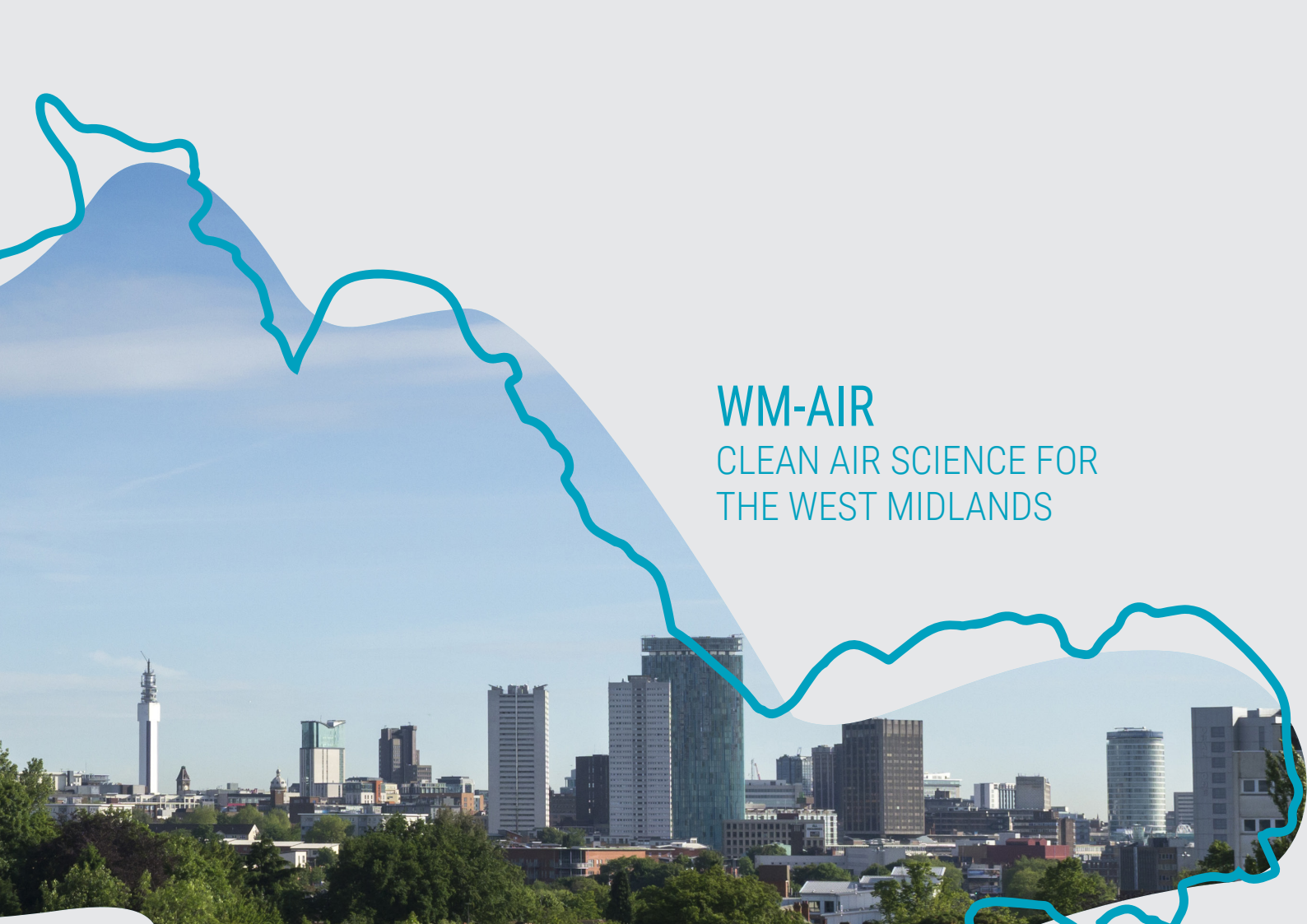
UNIVERSITY OF BIRMINGHAM

Natural Environment Research Council

WM-AIR
IMPACT REPORT

March 2025



WM-Air Impact Report

March 2025

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Executive Summary

WM-Air enabled regional partners, ranging from local authorities to SMEs, to access state-of-the-science research expertise to improve policy and actions for clean air, providing environmental, societal and economic benefits for the people of the West Midlands and beyond. Co-designed with stakeholders and supported by NERC funding from 2019-2024, WM-Air has worked collaboratively with over 100 organisations and end-users of research to deliver 45 impact projects which have informed, influenced and improved local and regional actions for clean air. WM-Air impact has been delivered through over 160 engagement events, producing over 200 reports and other outputs, 16 regional policy briefings and guidance notes, leveraging and influencing over £40m of investments, and delivering GVA benefit estimated to reach £34m by 2028. Media reach is estimated at >650m from over 150 stories, interviews and reports.

The project has trained and developed a regional air quality Community of Practice, now supported through legacy funding via the WMCA, produced 46 scientific journal articles and supported 25 student (PhD, MSc, BSc) projects. Ranging from implementation of the first regional Clean Air Framework with the WMCA; development of new products with start-up businesses; projects with all regional local authorities and a range of other bodies; public exhibitions, citizen panels and a "sounding out pollution" artwork, the project has delivered Clean Air Science for the West Midlands, and an exemplar for regional impact from NERC environmental science.

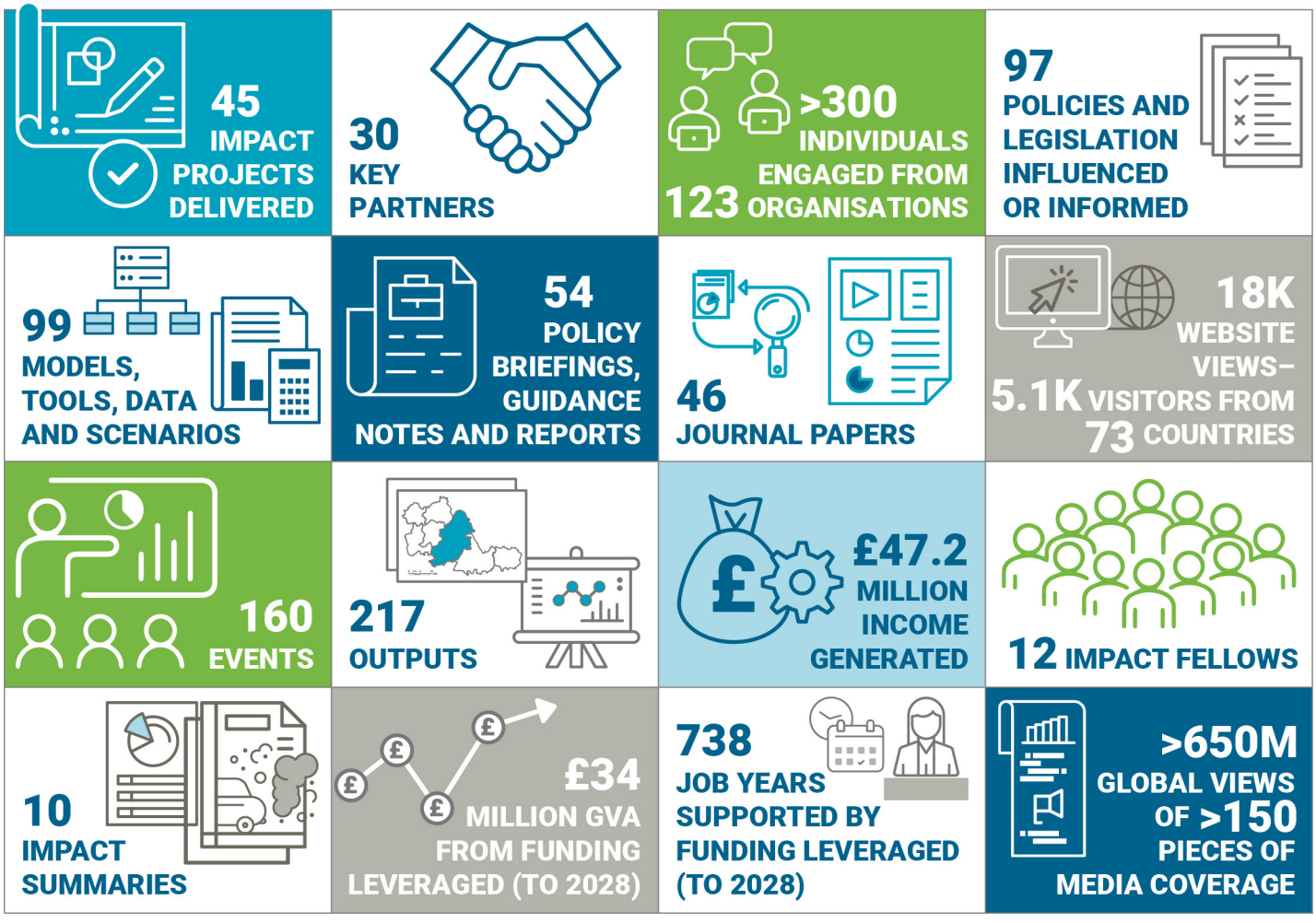


Figure 1: WM-Air in numbers

Impact Highlights:

- Supporting the development of the **first West Midlands Air Quality Framework**, now formally adopted by the West Midlands Combined Authority (WMCA) to enable, drive and coordinate future air quality policy actions across all Local Authorities (2.8m inhabitants), and which has led to further £1.5m central government and £370k regional funding.
- Working with local authorities and the Clean Air Justice Network to provide a methodology to assess the **health and healthcare economic benefits** from clean air policy interventions, supporting change through business case development, with the new methodology adopted by other local authorities and healthcare providers elsewhere.
- Enabling Birmingham City Council (BCC) to **quantify impacts of the new Birmingham Clean Air Zone**, of Low Traffic Neighbourhood initiatives, and of Covid-19 on NO_2 levels, whilst **supporting air quality education** and engagement projects for all Schools in Birmingham.
- Working with the Commonwealth Games Organising Committee to make **air quality a key environmental focus of the 2022 Games** (held in Birmingham); providing daily operational capability during the games, and minimising (and then assessing) the impact of the Games' travel policy on air quality.
- Supporting University Hospitals Birmingham (UHB) NHS Foundation Trust to understand their air quality environment and impacts from NHS activities, leading to pilot interventions to reduce air pollution. **Developing guidance for monitoring air quality at NHS sites**, evaluated with Sandwell and West Birmingham trusts, shared nationally.
- Delivering the **first Climate Risk and Vulnerability Assessment (CRVA)** for BCC, leading directly to Birmingham receiving A-list city status for climate action by the Carbon Disclosure Project for the first time. Subsequently extended to the whole of the West Midlands, and assessment of transport infrastructure risk and vulnerability.
- Undertaking **air quality and emissions analyses** for Birmingham Country Football Association (BCFA) as part of their 'Save Today, Play Tomorrow' initiative for grassroots football. Following a number of sustainability awards, the work was expanded nationally.
- Applying WM-Air air quality tools and modelling capabilities to a **portfolio of impact projects** across the region. Examples including quantifying the air quality co-benefit from growth of the Electric Vehicle (EV) fleet for different policy options; investigating the impact of railway emissions with the Rail Safety & Standards Board; modelling air quality across the region in support of local and regional status reports; and supporting Transport for the West Midlands (TfWM) rapid transit route prioritisation decisions.
- Providing evidenced advice for the use of Green Infrastructure in urban environments, and best practice guidance for local authorities, planners and practitioners including an **AQ Design Charter**, briefing notes and CPD events.
- Input to **national policy** development, including working with UK-100 promoting clean air/net zero policy co-benefits, evidence provision in support of design of the national 2021 Environment Act targets, air quality target development in Wales, and the 2022 and 2024 Chief Medical Officer's reports.

WM-Air has supported **public understanding and engagement** ranging from lesson plan materials for Schools to a major exhibition "The Air We Breathe" at The Exchange public venue in Birmingham City Centre; over 150 media pieces with reach estimated at over 650m, public and interest group talks and events ranging from Clean Air Day to Sustainability West Midlands, and a collaboration with sonic artist Robert Jarvis to produce air quality-driven musical compositions featured in outlets ranging from Mixmag to Glastonbury.

The legacy of WM-Air includes bringing to maturity a West Midlands Clean Air **Community of Practice** (CoP) through technical and networking events (now adopted by WMCA), and wider outcome dissemination through the UKRI Clean Air SPF. Examples of amplifying and **follow-on funding** include WM-Adapt (£2m, supporting regional climate adaptation decision making); the Wellcome Trust WM-Net Zero (£2m, identifying climate and air quality co-benefits); EPSRC Clean Energy & Equitable Transport Solutions (CLEETS) network (£5m, expanding WM-Air modelling work into new regions and overseas), UKRI Indoor Habitability during the Transition to Net Zero Housing (INHABIT) Hub (£5.5m, addressing housing retrofit challenges), and EU Climate Resilient Development Pathways in Metropolitan Regions of Europe (CARMINE), expanding WM-Air legacy overseas.

1. Introduction

WM-Air: Clean Air Science for the West Midlands (wm-air.org.uk) is a UK Research and Innovation (UKRI) initiative funded under the Regional Impact from Science of the Environment (RISE) programme. It applies the latest research science to deliver regional impact–in societal, economic and policy terms–in support of improved air quality and health across the West Midlands. WM-Air is led by the University of Birmingham and delivered through a portfolio of projects with external partners ranging from the West Midlands Combined Authority (WMCA), Transport for West Midlands (TfWM), local authorities, the NHS, private sector organisations, consultancies, charities and SMEs.

The University of Birmingham has internationally leading research expertise and critical mass in clean air science, ranging from quantifying sources of air pollutants, measurement of their health effects and predicting their future abundance, to provision of air pollution science advice to UK government, the EU and WHO, assessing the economic case for environmental policy, and environmental law and governance. WM-Air was established to integrate these strengths with the interests and needs of partner organisations to deliver impact – in pollution, economic and policy terms. Delivering cleaner air directly benefits the region's inhabitants and economy, reducing pollution-driven health inequalities, and enabling synergies with climate/net zero policies.

In 2018, the WM-Air team was awarded £4m investment from Natural Environmental Research Council (NERC) plus £1m from University of Birmingham, to initiate this programme of work across the West Midlands, supporting regional decision making and delivering (then) Industrial Strategy aspirations. In essence, this funding provided the resources to enable partner organisations to draw down expertise in co-designed projects to understand current air pollution drivers and to predict future air pollution impacts, including health and economic aspects, of potential policy options and interventions. Programme design combined a focus upon building capability and co-delivery, with the development of operational tools and methodologies.

This report outlines the array of work undertaken by WM-Air during 2019-2024, exploring the approaches taken, engagement activities, outputs, outcomes and ultimately, the impact the programme has had on the region and beyond.

> **"The culmination of the WM-Air input to the initial air quality options paper was transformational to the course of regional policy and strategy on air quality. The overall outcome will be to improve the health of 2.9m residents... The reality is, that very little of this would have been possible/ achieved without the support from WM-Air. The work on air quality has been accelerated significantly because of the investment of time and resources from the programme."**
>
> *Jackie Homan, Head of Environment, WMCA*

1.1 Context: Air Quality Challenges in the West Midlands

Air pollution has substantial impacts upon public and environmental health, and imposes direct and indirect economic costs upon city-regions, public and private sector organisations. Across the UK, the mortality burden from outdoor air pollution amounts to between 29,000 and 43,000 premature deaths each year, with economic costs of over £20bn.[1]

Birmingham is the UK's second city with just over one million inhabitants, while 2.9 million people live in the seven constituent local authorities that make up the WMCA (which came into being in mid-2016, chaired by the first Mayor of the West Midlands from 2017, and second Mayor from 2024) and 5.75 million in the wider West Midlands conurbation (Fig

1 *Every Breath We Take: The lifelong impact of air pollution*, Royal College of Physicians report, 23 Feb 2016.

2). The region has some of the worst AQ in the UK after London, with the greatest population-wide health impacts arising from particulate matter (PM, specifically $PM_{2.5}$) and nitrogen dioxide (NO_2); up to 2300 premature deaths occur per year due to PM exposure alone,[2] with an annual economic cost in the WMCA presently estimated at £0.8bn.[3]

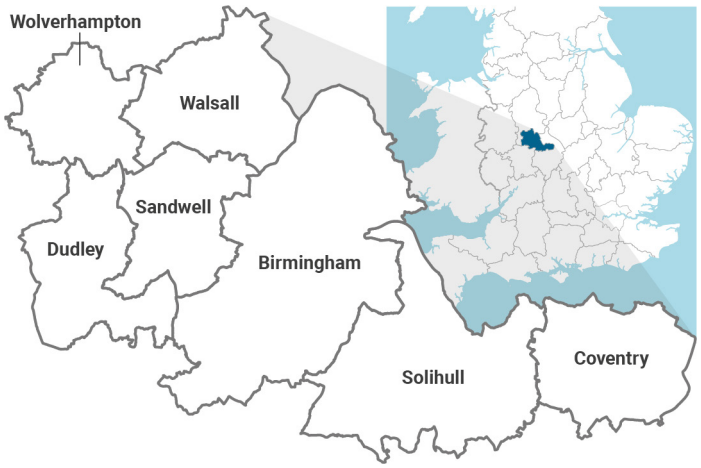


Fig 2: West Midlands Conurbation (WMCA constituents) and location within England

Scientific understanding demonstrates that reductions in both $PM_{2.5}$ and NO_2 are necessary to achieve public health goals. Air pollution impacts upon business productivity through sickness and loss of working days, introducing direct costs, and through reduced regional environmental quality and perceived disamenity, hindering inward investment and economic growth. This substantial regional 'air quality penalty' excludes health costs imposed on the NHS outside of the working population, and developing understanding of impacts of poor air quality on cognitive function.

1.2 The WM-Air Opportunity

WM-Air addressed strategic gaps in the application of clean air science to support policy development and investment decisions on the part of local and regional authorities, private sector bodies and other actors. In essence, regional actors struggled to determine (i) how effective given interventions might be – *e.g.* would it address the two key regional pressures of compliance with legal limit values for NO_2, and of reduced mortality burden from air pollution, which is driven substantially by $PM_{2.5}$? (ii) which options might provide the best health, economic benefit? (iii) what would happen anyway (e.g. as the vehicle fleet evolves, electric vehicle use grows), and (iv) what the integrated air quality, public health, and economic benefits, costs and knock-on effects for different intervention options would be.

The formation of the WMCA in 2016 brought an integrated approach to regional policy development with a focus on growth, transport investment and the environment.[4] This created a unique and timely opportunity to bring together the University of Birmingham's environmental science expertise to support regional air quality policy, address priorities in the Second Devolution Deal for the West Midlands,[5] and was essential to deliver the Clean Growth challenge from the 2017 UK Industrial Strategy,[6] and subsequent policies including the Environment Act[7], and more recent measures such as the 2025 Environment Plan[8] and the Modern Industrial Strategy.[9]

NERC's Regional Impact from Science of the Environment (RISE) programme was *"dedicated to bringing research organisations together with business, policy bodies and other actors contributing to economic development specific to their locations, to deliver significant regional impact form NERC environmental science"*, and provided an opportunity to build on University expertise, exploit the opportunities brought about by the WMCA formation and ultimately address air quality challenges across the region.

WM-Air therefore endeavoured to address these needs using placed-based approaches, exploiting a timely opportunity to apply NERC-derived environment science during a period of major regional integration in the West Midlands, and of significant political interest in air pollution. As such, WM-Air embedded science expertise into the regional air quality policy cycle to address gaps in public and private sector knowledge and capability, identified through a co-design process at proposal stage.

2 As determined by WM-Air's AQ-LAT
3 HM Treasury, "Air Quality: Economic Analysis" Green Book, 2015.
4 The West Midlands Combined Authority: Strategic Economic Plan: Making our mark: The West Midlands, the best region in the UK to do business, WMCA 2017
5 A second devolution deal to promote growth, WMCA, 2017
6 UK Industrial Strategy White Paper, 2017
7 Environment Act 2021
8 25 Year Environment Plan–GOV.UK
9 Invest 2035: the UK's modern industrial strategy–GOV.UK

1.3 Project Objectives

Mission Statement

WM-Air: '*Clean Air Science for the West Midlands*' is a NERC-funded initiative, led by the University of Birmingham, working in collaboration with over 20 cross sector partners, to apply environmental science expertise to support the improvement of air quality, and associated health, environmental and economic benefits, across the West Midlands.

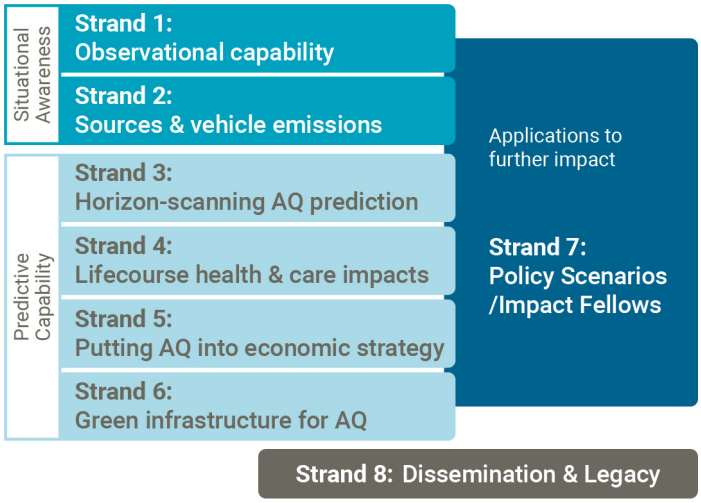


Fig 3: Overarching themes and work strands for WM-Air

The overall aim of WM-Air was to enable our stakeholders to reduce the impacts of air pollution upon human health and economic growth in the West Midlands, translating environmental science to support regional decision making. The project provided the capability to understand current air pollution drivers and to predict future air pollution impacts, including health and economic aspects, of potential policy options and interventions. Programme design combined a focus upon building capability and co-delivery, with the development of operational tools and methodologies which could be applied beyond the duration of the RISE funding and were exportable, maximising wider legacy.

WM-Air comprised three broad themes (Fig 3):

i. improve understanding of the region's air pollution challenges by providing new measurements and quantifying pollution sources by sector, including measurement of real-world on-road vehicle emissions ('**Situational Awareness**')

ii. provide new capability to support clean air measures and policy, including modelling future air quality levels and potential intervention scenarios, evaluating the air quality-driven health and economic benefits and impacts of such predictions, and providing guidance on the use of green infrastructure (urban vegetation) to improve air quality ('**Predictive Capability**')

iii. apply this new understanding and capability to a portfolio of projects in support of partner need, such as around major interventions (e.g. Clean Air Zones), infrastructure developments (e.g. Commonwealth Games) and other developments on scales from regional to local ('**Application**')

The original WM-Air Key Performance Indicators (KPIs) and Key Success Measured (KSMs) are outlined in Annex 1 and referenced throughout this report.

2. Project Overview

Between 2019 and 2024, WM-Air worked collaboratively with external partners to deliver impact for the benefit of the region. WM-Air activities were co-created, arising from discussions with external partners or in response to a direct request, whilst others developed from assessing where there were gaps in knowledge or requirements, or a need for new capabilities, tools or models.

A high-level summary of WM-Air 'inputs to impact' (2019-2024) is shown in Fig 4, outlining the relationships between the **key inputs**, **activities** and **approaches** (discussed in this section), and the overall results (discussed in Section 3) – covering the **outputs** (i.e. products), **outcomes** (i.e. results of the activities and/or ways in which the outputs were used) and **impact delivered**[10] (i.e. the benefits derived from use of the outputs and outcomes).

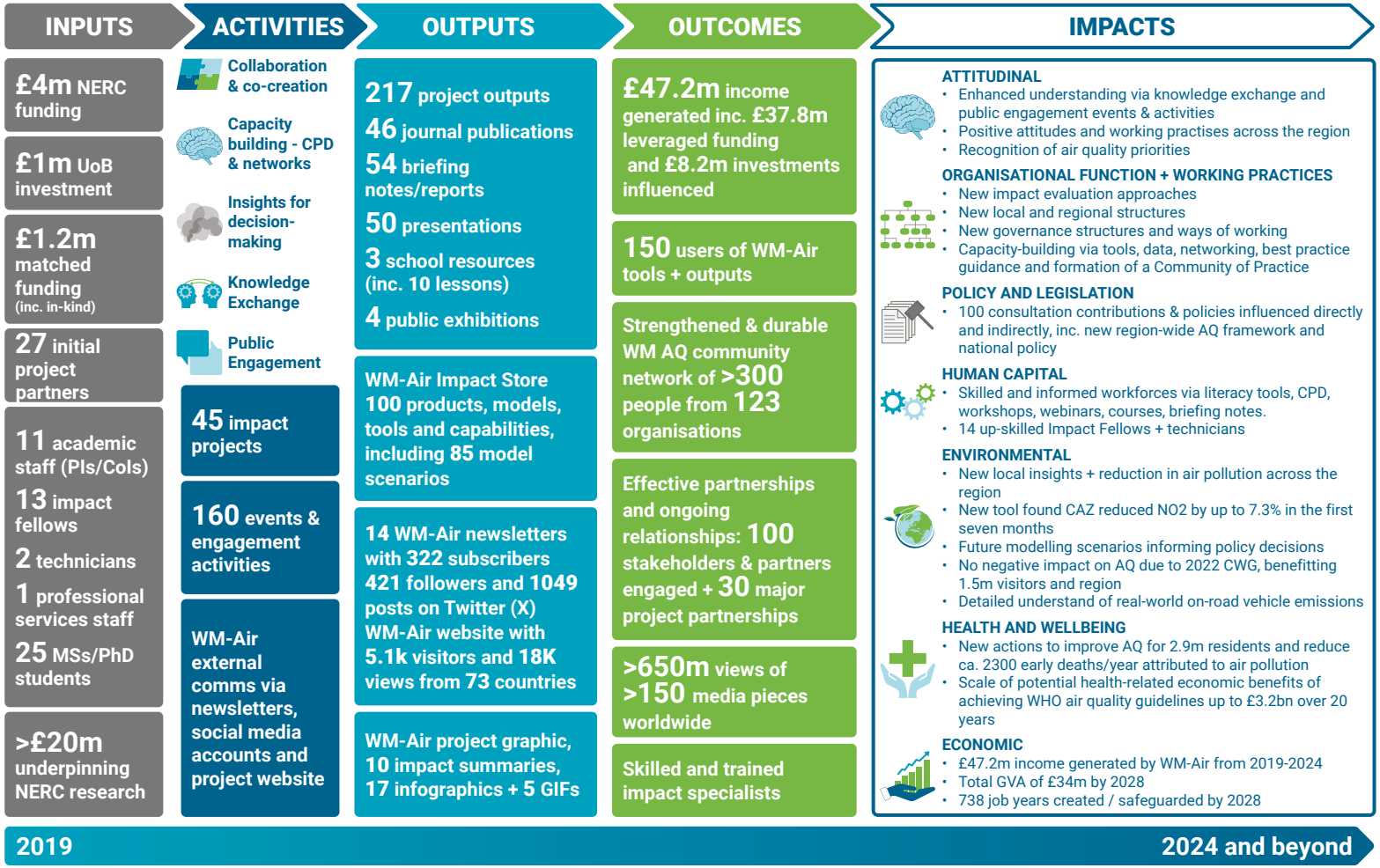


Figure 4: Selected WM-Air inputs, activities, outputs, outcomes and impacts

Figure 4 notes:

1. Outcomes (to end 2024) are reported quantitatively where known, to show the scale and magnitude of outcomes. However, data shown are a conservative estimate.
2. Impact provides a high-level summary of short-term impacts (i.e. those achieved to end 2024). The majority of WM-Air impact is 'attitudinal' or 'organisational function/practice', so providing the foundation needed to deliver transformational change over longer timescales (to 2030 and beyond), via 'policy & legislation' and beyond to tangible change in 'environmental', 'health and wellbeing' and 'economic' impact. 'Human Capital' impacts reflect WM-Air's influence on the project team and beyond through benefits delivered via training, guidance, CPD and sharing of impact approaches, delivery and evidencing resources.
3. Quantified impacts are shown where data are available, and impacts can be proportionately attributed to WM-Air activities and outcomes. Some impact types are best expressed qualitatively due to challenges of attribution. This is achieved via testimonials and surveys.
4. Whilst WM-Air formally ended in December 2024, longer-term benefit will accumulate into the future, especially changes to air quality itself, the West Midlands economy, and the health and wellbeing of its population and visitors. WM-Air activities and outputs have laid the foundations for this to happen.

10 Note, it is anticipated that further impact will accumulate beyond 2024.

2.1 The WM-Air Approach

WM-Air addressed gaps in public and private sector knowledge and capability identified through a co-design process with external partners, alongside a cohort of 12 WM-Air 'Impact Fellows', maximising impact by formalising aspects of WM-Air into transferrable operational tools, enabling their application more widely, and as an ongoing legacy beyond the programme duration (See Annex 2 for Organisation and Governance). The initial project foci and structures were co-designed with end users through a series of stakeholder workshops prior to submission of the WM-Air proposal.

WM-Air comprised of eight strands of work (Fig 3), each of which was co-led by a research PI and external stakeholder/end user, to ensure effective translation to user interests:

- Strand 1 – Observations: Augmenting Nitrogen Dioxide (NO_2) and Particulate Matter ($PM_{2.5}$) observation capacity, quantifying their sources, and evaluating the impacts of air quality interventions, including the COVID lockdowns and Birmingham Clean Air Zones.
- Strand 2 – Traffic Emissions: Updating emission inventories and integrating real-world emissions information into regional policy.
- Strand 3 – Air Quality Modelling: Provide capability to predict WM air quality, and exploring the impact of policy changes and intervention scenarios co-developed with/for stakeholders.
- Strand 4 – Health: Assessing health and healthcare economic impacts on a lifecourse basis from present and predicted future air quality levels, supporting the business case for change.
- Strand 5 – Economics: Integrating air quality and economic impacts in support of investment decisions
- Strand 6 – Urban Design and Green Infrastructure (UDGI): Using design, planning and green infrastructure effectively to reduce emissions and exposure to air pollution.
- Strand 7 – Applications: Applying WM-Air tools and understanding in support of user need: Policy and practice; Healthcare settings; Sport sustainability (e.g. Commonwealth Games, Football, Cricket); Knowledge Exchange, education and training.
- Strand 8 – Legacy: Dissemination and sustainability of project outputs, tools and knowledge.

The WM-Air team worked closely with external partners in a variety of ways, with the most common of which are summarised in Table 1. These categories were developed from analysis of project activities, case studies and partner feedback. Specific examples are discussed in Section 3.

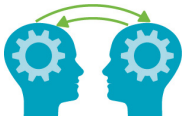
	**Collaboration & Co-creation:** development of activities, tools and their application to specific user priorities through joint exploration.
	**Knowledge Exchange:** two-way sharing of the latest academic research findings and capabilities, industry working practices and local and regional policies via 1:1 meetings, briefing notes, reports, presentations and events.
	**Capacity Building:** increasing organisational capacity via training, CPD, upskilling and network formation
	**Insights for Decision-Making:** A key WM-Air aim was to improve situational awareness via air quality measurement, emission assessment, source apportionment, air quality modelling, and insight tools – suitable for use beyond the project.
	**Public Engagement:** engaging and involving the public in clean air science in order to enhance knowledge and understanding, drive policy, and initiate attitudinal and behaviour change.

Table 1: WM-Air's main ways of working

2.1.1 Collaborative Projects

Over the 6-year period, WM-Air worked with external partners to deliver more than **88 distinct pieces of work** leading to a total of **45 impact projects** (Annex 3). These co-developed projects differed in size and duration, with some involving multiple strands over years, and others a single Impact Fellow for a period of a few weeks. The collaborative work involved **1:1 meetings, reports and presentation** of results to project partners, with some developing into **academic journal papers** and/or **published briefing notes**. The impact of these projects are discussed in Section 3. There were also **25 PhD, MSc, undergraduate and summer student projects** associated with WM-Air (Annex 4)

The **WM-Air Project Development Mechanism** (Annex 5) was developed to assist members of the WM-Air team and external partners in developing and proposing impact projects, to ensure their outcomes were evidenced and measurable, and to allow for Impact Fellow time and resources to be allocated.

Developing **additional collaborative funding proposals** also formed part of WM-Air Activities. Most of the WM-Air projects were conducted within the WM-Air's available resources, but there were several spin-off projects which secured additional funding (Annex 6). Section 3 explores leveraged funding in more detail, as well as the specific outputs, outcomes and impacts generated form these collaborative projects.

2.1.2 Stakeholder Engagement and Knowledge Exchange

Stakeholder engagement was an important WM-Air activity, with over **160 events** held (Annex 7). Significant **WM-Air-led engagement events** (*KPI 8.3*) include **three Community of Practice events** for the regional air quality community (on Clean Air Nights and Clean Air Days) and **six Annual Meetings** – with a **total of more than 600 delegates attending** (fig 5). These events were an opportunity for our stakeholder community to hear updates from the project (i.e. latest tools, capabilities and applications) and find out about the latest in scientific understanding and developments, but also a valuable opportunity for informal networking and discussions around air quality actions and activities across the region. The value and implication of these engagements cannot be fully quantified, but from feedback from our partners and wider networks it is clear that this is one of the most important developments that has stemmed from WM-Air, with 100% of delegates surveyed (~10% of attendees) rating them 'very good' or 'excellent', stating that they were 'likely' or 'very likely' to recommend them to colleagues and that the events were likely to make a difference to how they approach their role or air quality management challenges. Contextual comments noted delegates gained new contacts because of attending the events and/or that the events resulted in new engagement, insights, collaborations or activities (discussed further in Section 3.4).

"I would like to thank colleagues in the WM-Air team for providing us with a number of platforms through which we can talk about our work to improve the region's air quality. These include Clean Air Night, where I was able to talk to a range of regional stakeholders about our ambitious plans, and support for a visit from the Secretary of State for Defra (Therese Coffey) in February 2023."

Andy Street, Mayor of the West Midlands

"WM-AIR events have been an essential lifeline for LA AQ officers to meet, catch up and share all sorts of information on interesting local and regional projects and updates."

"Got to stand in the same room as Andy Street, and hearing his enthusiasm for AQ initiatives was really encouraging"

"Developed new links, made new contacts, strengthened existing contacts, helped inform work programme and priority setting."

"Networking opened up opportunities with others to advance an air quality project we are looking to run."

Anonymous feedback from event delegates

Recognising the value of bringing the regional air quality community together, the WMCA will be continuing to hold annual air quality events to support the WM-Air legacy (Section 5.)

Figure 5: WM-Air Annual Meetings and Community of Practice events involved a) presentations and discussions (including invited speakers such as Mayor Andy Street) and b) networking

"Networking is one of the best parts of the WM-Air function, as it facilitates cross-silo relationships within Local Authorities but also greatly strengthens University relationships with Local Authorities."

Sophie Morris, Public Health Specialist- Air Quality and Climate Change, Sandwell Council

"I do believe the WM-Air networking events have filled a void for those wishing to know and do more on air quality, who have struggled to reach across professional work areas and to seek out like minded colleagues. The WM-Air team have therefore provided a much-needed coordinator role, improve local knowledge sharing and liaison."

Amanda Clover, Solihull Council

"The various stakeholder meetings, CAD [Clean Air Day] events and WM-Air annual meetings have allowed the WM-Air team to showcase working to date, preliminary results/outputs (with 'health warnings' where appropriate) and provided short briefing papers for participant use and onward discussion on topical matters relevant to the geographical area and applied in use for relevant stakeholders".

Mark Wolstencroft, Operations Manager Environmental Protection, BCC

On several occasions WM-Air also hosted visits from **key regional and national figures** including Adam Tranter (WM Walking and Cycling Commissioner), Professor Chris Whitty (Chief Medical Advisor) -resulting in input into subsequent CMO reports – and Therese Coffee (former Secretary of State for Environment, Food and Rural Affairs), Andy Street (former West Midlands Mayor) and Cllr Ian Courts (WMCA Environment Lead). Many of these visits involved a trip to the UKRI-funded Birmingham Air Quality Supersite (BAQS) following clean air discussions (fig 6 overleaf).

Figure 6: BAQS tours: a) Andy Street, Cllr Ian Courts and Therese Coffee with members of WM-Air in Feb 2023, b) WMCA councillors and TfWM officers in January 2020, and c) WM-Air leads with Cllr Waseem Zaffar (BCC "Environment" portfolio and Clean Air Justice Network lead) at COP26

"Air quality has been centralised across the local authority in terms of a key input to all policy. I feel that the partnership with the UoB on such a large and well recognised project as the WM-Air has helped to embed this further – the visit to the city by Professor Sir Chris Whitty further helped to cement this link and is still remembered."

Mark Wolstencroft, Operations Manager Environmental Protection, BCC

Informal meetings (online and in-person) were also regularly held with stakeholders in order to explore and co-develop projects and/or tools, for fact-finding purposes, and knowledge-exchange discussions. There are 370 documented activities across the team, but this is likely to be an underestimate (i.e. may not include all meetings). Regular and *ad hoc* email exchanges and videoconferences with our project partners also supplemented these meetings.

In addition, WM-Air has provided input into **working groups** and **technical groups** to support the community and foster more effective partnerships for tackling air quality issues:

- West Midlands Air Quality Framework Implementation Group
- West Midlands Environmental Protection Group
- Coventry and Warwickshire Air Quality Alliance
- Sandwell Air Quality Action Plan 2020-2025 Steering Group
- Solihull Air Quality Technical Officers Group
- Birmingham Clean Air Justice Network
- NHS Sustainability Group

"The University of Birmingham's WM-Air team are a new and integral member of the Solihull air quality technical officers group, bringing a unique scientific and academic perspective that will enhance our abilities to effectively utilise the latest technologies and evidence base for improving air quality across the borough. In addition to assisting us by reviewing and shaping this strategy, we will explore potential opportunities for joint working on a range of projects and initiatives. Their advice and particular understanding of air quality is an important element to ensuring that our efforts and use of resources are best placed and properly informed."

Solihull's Air Quality Strategy 2024-2028

WM-Air team members attended and presented at **more than 100 externally-hosted meetings, workshop, conferences and events**, engaging, communicating and networking with the wider-community and establishing new partners, and promoting and showcasing the work of WM-Air (fig 7).

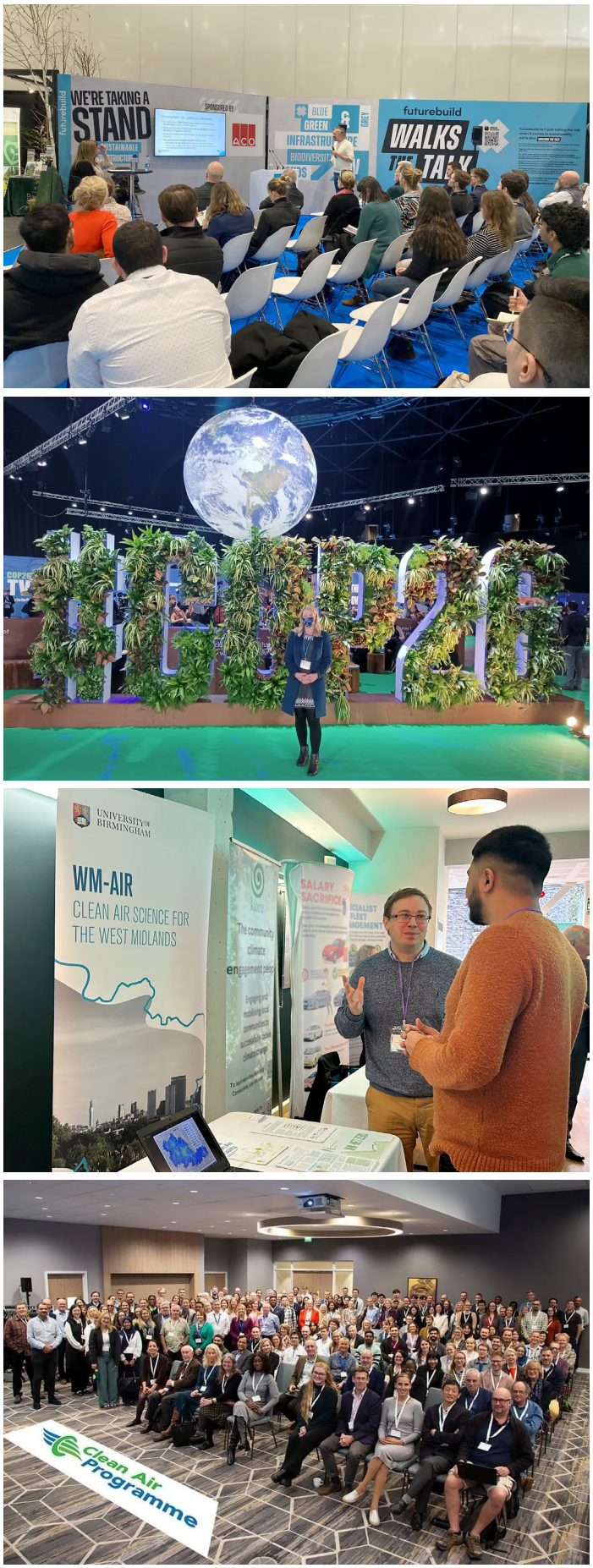


Figure 7: WM-Air engagement at a) FutureBuild (2024), b) COP26 (2021), c) Sustainability West Midlands AGM (2023), d) Clean Air Conference (2024)

2.1.3 Capacity-Building

A number of **training events**, **masterclasses**, **CPD** and **Knowledge Exchange sessions** were led by members of the WM-Air team for a variety of stakeholders (both within and outside of the West Midlands). Examples include 9 sessions with **local authority-elected members, WMCA councillors and TfWM officers** in order to improve understanding and evidence scope for regional policy (an essential precursor to regional political support for the WM Air Quality Framework); tailored workshops with stakeholders exploring WM-Air tools and capabilities (e.g. 2 sessions for the TfWM Data Insights Team exploring emissions data and capabilities); and sector-specific sessions including a RTPI seminar for the regional planning sector on 30th Feb 2021, with over 60 participants – this training session and feedback informed the WM-Air Urban Design for Air Quality Charter (which has received >3,000 social media impressions); a climate walk for BCC officers; and a public health masterclass to 76 delegates on 10th November 2020 exploring inclusive growth and economic recovery at a regional level and training for the UK100 climate leadership academy of elected members (30 delegated, 16 September 2020.)

"The WM-Air team has hosted WMCA councillors and TfWM officers (30 January 2020, 26 January 2022, 25 January 2023) to present West Midlands air quality issues and the work of WM-Air. Representatives from the University of Birmingham have also given presentations to WMCA's Transport Delivery Overview and Scrutiny Committee (22 January 2024) and the Committee's sub-group ("Member Engagement Group") which considers air quality issues (Air Quality, Congestion and Environmental Impact MEG) (21 September 2020, 23 November 2020, 22 March 2021, 28 November 2023, 30 January 2024)."

Mike Waters, Director of Policy, Strategy and Innovation, TfWM

"I wanted to thank you for your help with air quality. I now have a paper, being written by our officers, coming to overview and scrutiny [committee] of transport, environment and economy in April 24 with regard to our current air quality policy and what we need to improve the measuring of air quality in North Yorkshire. We can then work out how to improve the quality. We have the additional challenge of farming related emissions. Our CO_2 emissions from farming are 1/3rd of our carbon footprint. I wanted you to know that your presentation at UK 100 has made a difference in North Yorkshire at least, although I am sure it carries much further afield."

Paul Haslam, North Yorkshire Councillor serving Bilton and Nidd Gorge, North Yorkshire Council Climate Change Champion – attendee on Climate Academy Course with UK100 on 9/1/2023

2.1.4 Communication and Public Engagement

Stakeholder networks were also regularly engaged via quarterly **newsletters**, the WM-Air **website** (wm-air.org.uk) and **social media**, including the WM-Air Twitter page (@WMAir_UoB) and the WM-Air LinkedIn Group.

Although not part of the original RISE call objectives, WM-Air also took part in **public engagement events** throughout the course of the project (more on public engagement outputs in Section 3.2.5). Events included a UoB-funded collaborative 'Clean Air for All' event with **University Hospitals Birmingham**, which initiated the project collaboration with UHB and was supported at Board level. Awareness-building activities at sporting events were also conducted, including via deployment of a mobile air quality unit (part of the NERC-funded UK-AQST capital grant) at **Edgbaston Cricket's 'Go Green' Game** (the first Sustainability Match Day on 3rd September, 2023) for public display to the 25,000 spectators and to assess to impact of a public-transport-only approach, which saw fans arrived on free shuttle buses from New Street station and on National Express West Midlands services). The instruments were also displayed at the **CWG athletics stadium** on 4th-6th August with an estimated 190,000 people visiting one site over those 3 days (fig 8). 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. Air quality monitoring was also mentioned in the official souvenir programme, asking people to 'spot a sensor'.[11] Significant international media discussion around air quality at the Games arose 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.)[12]

Figure 8: Engagement activity at a) Edgbaston Cricket Club (2023) and Alexander Stadium, CWG (2022)

11 Birmingham 2022 Commonwealth Games Official Souvenir Programme (hard-copy version only–available on request)
12 https://www.bbc.co.uk/newsround/58730694

"There has been regular interaction and curiosity from our workforce, volunteers and spectators during the field work at Alexander Stadium and University of Birmingham venues for the Games. This has certainly raised awareness of the WM-Air project, local air quality conditions and prompted questions about other local air quality schemes, such as the city Clean Air Zone (CAZ)."

Ian Reid, CEO of the Birmingham 2022 Commonwealth Games Organising Committee (OC)

2.1.5 Measurements, Tools and Model Development

Situational awareness and predictive capabilities were enhanced by the development and implementation of new measurements, models, tools and datasets for application across the West Midlands, allowing new insights for decision-making (outlined in detail in Section 3):

- New "low cost" (or small form factor) air quality sensors were developed and deployed across the region to augment existing air quality monitoring capabilities, enhanced by source apportionment analysis to explore sources of PM.
- Instruments (e.g. EDAR) and new techniques (e.g. Traffic Ear sensor) were applied to explore real-world vehicle emissions
- New models (e.g. ADMS-Urban, CMAQ regional model) were produced to improve predictive capabilities and explore hypothetical policy scenarios in terms of air pollution, health and economic impacts.
- New tools were developed to explore the impact of policy scenarios on air pollution, including enhanced tools for estimating the health and economic impacts (e.g. AQ-LAT)
- New machine learning tools to evaluate the impacts of air quality interventions (e.g. AQ-PET)
- GIS decision-support tools were co-developed with partners to address stakeholder needs (e.g. BCC CRVA, WMCA CRVA)

2.1.6 Secondments

The value of embedding staff within partner organisations was recognised from the outset:

- A WM-Air Impact Fellow was seconded to the **Birmingham 2022 Commonwealth Games (CWG)** Organising Committee for a period of 33 months (April 2020 – Dec 2022) at 0.4FTE in order to embed WM-Air capabilities into CWG sustainability practices.

"Through my role as an Impact Fellow on the WM-Air project I was seconded to work with both the Commonwealth Games Organising Committee and the West Midlands Combined authority. These secondments were a brilliant experience and allowed me, together with the research strands, to respond to requests from across both organisations and deliver the outputs needed to make an impact. In addition, the relationships and connections I made have continued to support my work well beyond the secondment."

Quote from Joe Acton (WM-Air secondee)

- There were also two (match-funded, part-time) policy placements into **WMCA** during the period 2020-2021. This work directly contributed to the development of a new West Midlands Air Quality Framework (Section 3.4.3).

"...we began to work with the WM-Air Team, particularly through the Impact Fellow (Joe Acton) funded through the WM-Air programme (and part matched by the WMCA). The work that Joe undertook with us, supported by extended members of the WM-Air Team, was transformational in getting air quality pushed up the WMCA policy agenda."

Jackie Homan, Head of Environment, WMCA

- A **Birmingham City Council (BCC)** officer was also seconded onto WM-Air for 50% of their time from the beginning of WM-Air, as both UoB and BCC recognised the value of having an Officer embedded within the WM-Air project for both knowledge exchange and to enable the co-creation and embedding of tools and capabilities within BCC. This secondment resulted in the development and adoption of a Climate Risk and Vulnerability Assessment (CRVA) tool (Section 3.2.3), which in turn led to Birmingham achieving A-list status for climate action by the Carbon Disclosure Project.

"This role provided a really important link between the research team and the city. I was able to act as a conduit, enabling the research team to more readily connect with key city officers; and being able to bring city requests or suggestions, to the research team. This resulted in accelerated policy responses within the city and helping raise the whole issue of air quality, higher up the political agenda. A secondment is a brilliant arrangement and should be built into future NERC funding calls. The city developed a Climate Risk and Vulnerability Assessment (CRVA) via a close collaboration with the WM-Air team; this made air quality more relevant and immediate to many more decision makers. This was an excellent outcome. This was then extended to the whole WM-region, making it the first in the UK, to achieve this. On a personal note, hugely enjoyable and valuable professional development. I'd like to thank the team for the opportunity."

Nick Grayson (secondee), Green City Manager, Birmingham City Council

- There was also a **NIHR School of Public Health Research-funded transdisciplinary placement** with **University Hospitals Birmingham** which focused on assessing public health impacts of the Birmingham Clean Air Zone.

Specific WM-Air tools/capabilities, outputs, impact case studies, additional income generated, and other activities mentioned above are discussed further in Section 3.

2.2 Key Inputs

These are the essential inputs contributing to the WM-Air project.

2.2.1 Funding

The monetary input into WM-Air consisted of:

- NERC RISE funding–£4m (£5m FEC; 80% funded – standard UKRI approach)
- UoB support–£1m

WM-Air was also supported by £1.2m matched funding (including in-kind resource) from stakeholders, and built on underpinning NERC funded research at Birmingham (prior to grant award) of at least £20m.

2.2.2 Human Capital

The WM-Air project team consisted of a total of 27 staff members: 2 research technicians, 12 Early Career Researchers ('Impact Fellows') plus 1 P/T secondee from BCC, 11 academic PI/Co-Is and 1 Project Manager. Section 3 provides an overview of career develop and destination pathways for the team within the timeframe of WM-Air. In addition, 25 PhD, MSc and undergraduate summer student projects were associated with WM-Air (Annex 4 – list of student projects) The team was supported by several core professional services staff from University of Birmingham (i.e. communications, marketing, design, finance, legal).

2.2.3 External Partners

During the inception of WM-Air through the development of the proposal to the RISE scheme, 27 stakeholders were identified as core partners. This number increased significantly over the course of the project – these stakeholders can be seen in the expanded logo-cloud in fig. 18 in Section 3.3.1.

3. Benefit Realisation and KPIs

3.1 Evaluation Approach

In order to track and store engagement activities, outputs and impact evidence, a WM-Air **Impact Store** and **Engagement and Impact Tracker** were developed (Annex 8.)[13] The Impact Store allowed outputs, evidence, documents etc to be collated, whilst the Engagement and Impact Tracker enabled written and dated descriptions of the work conducted by the team, including meetings and events, model scenarios, new partners, impact case studies, media activities and policy consultations to be logged. This Tracker also linked through to the WM-Air Impact Store.

In addition to the WM-Air Impact Store, a WM-Air **Impact Evaluation** protocol (Annex 9) was also developed. The intention was for this to be used – in conjunction with the WM-Air Project Proposal Form (Annex 5), where possible – to allow for outcome evidence to be captured and impact evaluated.

It was also important that WM-Air activities aligned with our original objectives/KPIs (Annex 1) as well as Key Success Measures (KSMs, Annex 1), and that this was documented within the Impact Tracker, on Impact Evaluation forms and referenced throughout this report.

Feedback and evidence from project partners and wider stakeholders was sought via **surveys** and **testimonial letters** in order to evaluate both impact projects and engagement activities. Annex 10 contains the survey templates, and Annex 11 the testimonial email request and general guidance document that was sent to project partners – all letters were written independently by stakeholders without further direction from the WM-Air team. The resulting information provided narrative details and evidence for how partners have used WM-Air outputs, and the impact of our collaborations, knowledge exchange and engagement activities.[14]

By collating the information collected by these evaluation tools and methods, 45 impact case studies, consisting of 88 sub-projects, were documented (Annex 3). Ten of these were developed into Key Impact Summaries. This overall evidence base is used to inform the outputs, outcomes and impacts discussed in this report.

3.2 Outputs Delivered

Outputs describe the tangible products that were produced by WM-Air.

3.2.1 Written Outputs

A variety of written outputs were created by WM-Air in order to communicate with stakeholders and convey information. The team produced over **200 overall written outputs** (Annex 12):

- **38 reports** for project partners. Significant examples of this include the Air Quality Options paper (which led to the development and adoption of the WM Air Quality Framework – see Section 3.4) and BCC Covid report evaluating the impact of lockdowns on air quality regionally and beyond.
- **16** policy briefing notes and guidance notes (*KPI 8.2*) to communicate new scientific knowledge, regional applications of new policies and best-practice advice. Some of these briefings accompanied engagement events, for example 'New air quality targets and interim goals for fine particulate matter ($PM_{2.5}$), and the implications for the West Midlands region' briefing note launched on Clean Air Day (15th June 2023) and accompanied by a stakeholder event, bringing together 60 local and regional stakeholders and fostering networking and exchange of knowledge. Briefing notes were shared through Defra's Air Quality Hub for dissemination nationally.

13 These were developed from the SWEEP Impact Store and revised to fit WM-Air activities

14 It should be noted that there was no dedicated Impact Manager or support staff for evaluation activities within WM-Air resources, therefore the Project Manger took on coordination of this with support from the wider team, and with guidance and advice from other RISE projects.

"The WM-Air briefing notes are particularly helpful in succinctly making the case for continued investment in active travel and modal shift; by highlighting where maximum impact can be gained to improve air quality and deliver sustainability, we are building a deeper understanding and awareness of the sources of air pollution and the actions we can take to improve it which will directly translate into the next iteration of the Brum Breathes Clean Air Strategy, promoting modal shift towards cleaner, healthier forms of travel."

Stephen Arnold, Head of Clean Air Zone, BCC

"WM-Air briefing notes are extremely useful for summarising key facts and influencing us as policy makers."

Sally James, BCC

- **50 presentations** from WM-Air Annual Meetings and stakeholder events are available on the WM-Air website, enabling delegates to re-visit material.

"Since research findings and all presentations can be viewed on the WM-Air website this is proving to be a lasting and valuable learning legacy from the project. The council can readily view the free to access knowledge and training material and use it repeatedly to help and support staff as a source of ongoing reliable advice and guidance."

Amanda Clover MCIEH CenvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council

- **43 local, regional and national consultation responses** (Annex 13) – informed by WM-Air tools modelling and capabilities – including, for example, the UK Clean Air Strategy consultation, DEFRA Call for evidence on future $PM_{2.5}$ concentrations, Environment Act consultation, the Birmingham Clean Air Zone consultation, and West Midlands Three Year Air Quality Action Plan consultation.
- **46 international peer-reviewed scientific journal papers directly attributed to WM-Air to-date** which both underpin impact and communicate new findings to academic audiences.
- 10 impact summaries which provide a succinct overview of the impact of major collaborative projects.
- Over **25 PhD**, **MSc** and **undergraduate summer student project outputs** associated with WM-Air.

3.2.2 Newly Created Products

A total of ninety-nine **new products, tools, models, model scenarios, capabilities and datasets** were developed by WM-Air. The outcomes and impacts delivered from these products are discussed in more detail in Sections 3.3 and 3.4.

- AltaSensePM sensors (*KPI 1.1*): One of the early aims of WM-Air was to provide **increased observational capability** for air quality in the West Midlands. Particulate Matter (PM) was a key target for the project, given the increasing importance of monitoring traffic non-exhaust emissions as new Euro class vehicles and Evs penetrate the fleet. Building on prior commercial success in the development of Internet of Things (IoT) sensors for meteorological applications in transport and working in collaboration with a UoB operating division (Altasense), a technology transfer project was completed to apply IoT sensing principles to PM measurement. The result was a self-contained, low-cost, ambient air PM sensor which could be produced for less than £200[15] (Fig 9) and therefore had the potential to be deployed in numbers to underpin dense networks across urban areas. Working with the relevant local authorities, two operational networks of 45 sensors – both AltaSensePM and commercial EarthSense Zephyrs – were deployed across the West Midlands in Birmingham (27 Zephyrs and 6 Altasense sensors) and Coventry (12 Altasense sensors) and for specific events such as B2022 CWGs (*KPI 7.1, KSM 1-2, 7*).[16]

15 The innovative nature of the AltasensePM sensor also caught the attention of **Siemens Mobility Ltd**, who were keen to implement the sensor into their larger product offering. Similarly, although originally designed for outdoor use, the application of the sensor in an indoor environment was also explored by **Unilever**. Although these early trials were largely successful, technical difficulties moving from the early prototype proved challenging and difficult to overcome.

16 A key development during the early phase of WM-Air was the award of additional funding from EPSRC when Birmingham received support to develop an urban observatory across the city. Air Quality was a key target of the observatory resulting in the procurement of range of commercial sensors which were deployed as nested networks across the city, allowing for unprecedented intercomparisons of sensors and unprecedented spatial insights on air quality.

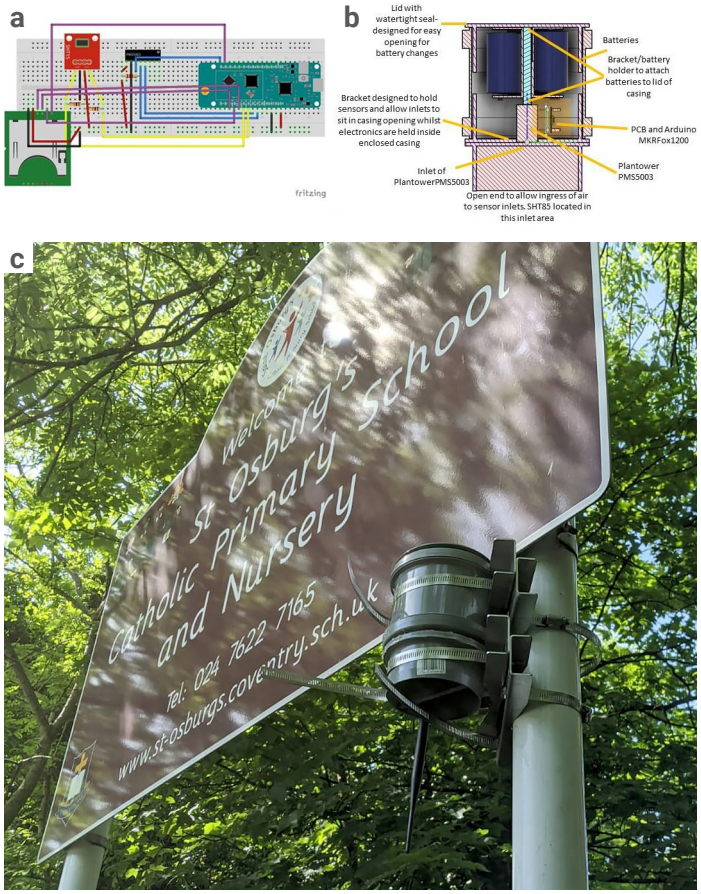


Figure 9: a) Fritzing diagram of the breadboard-based prototype for the AltasensePM. b) A diagram of the custom casing. c) An AltasensePM device deployed outside a school

> **"WM-Air research and guidance has helped steer monitoring practices... The research has identified the importance of a well-resourced monitoring programme for the management of air quality, in particular for $PM_{2.5}$."**
>
> *Amanda Clover MCIEH CenvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council*

- **New source apportionment results (*KPI 1.2*)**: New insights into the sources of fine particulate matter ($PM_{2.5}$) across the region were provided by WM-Air, through PM sampling followed by offline laboratory chemical analysis and the application of positive matrix factorisation approaches to identify the PM sources actually present, without reference to (dependence upon) potentially uncertain emissions data or air quality modelling. The results, which highlighted the several-fold increase in wood burning-related $PM_{2.5}$ in the region over past 15 years, have been published in the peer-reviewed literature and used as the basis of multiple dissemination/engagement events, feeding into the WM Air Quality Framework development. Beyond WM-Air, this work is currently being supplemented with ongoing measurement of the spatial distribution of woodsmoke around Birmingham using a vehicle-mounted aethalometer to explore relations with population demographic inequalities, and with ongoing analysis of aircraft sampling around Birmingham achieved through a deployment of the NERC Facility for Airborne Atmospheric Measurement (FAAM) aircraft, to estimate the contributions of national, regional and local sources.
- **Vehicle Telematics map for the West Midlands (*KPI 2.2*)**: WM-Air has created the largest ever inventory for road transport emissions based upon speed/time data from telematics data captured from more than 10,000 connected vehicles per hour across the West Midlands (3-7% of the fleet, depending on time and location). The inventory allows for spatio-temporal understanding of pollution hotspots within the West Midlands. The WM-Air team developed an innovative approach for converting vehicle telematics data into various urban mobility and transport characteristics, generating a wide array of parameters, including vehicle speed, acceleration, real-world emissions, and driving behaviour characteristics, with exceptional spatial and temporal resolutions. Although the method was constructed using West Midlands data, it can be translated and applied to other urban environments in the UK and around the world.
- **Real-world on-road traffic emissions dataset (*KPI 2.1. KPI 2.2; KSM 3*)**: An Emissions Detection And Reporting (EDAR) remote sensing system was deployed at two West Midlands locations (Sandwell, June 2022, and Birmingham, October 2022) for two periods of two weeks. The EDAR system instantaneously measures the emission rates gases and particles from individual passing vehicles in order to gain new insights into real-world road emissions. The emissions of over 94,000 (unique) vehicles were measured and the resulting data allow various public and private organisations to assess the role of their fleet emissions on overall emissions within the WM region. The EDAR measurements were conducted through a close collaboration between WM-Air and Birmingham and Sandwell councils, to leverage their respective expertise and resources to design and implement effective monitoring campaigns. Impacts are expected beyond the timeframe of WM-Air.
- **'Traffic Ear' product development**: WM-Air partnered with Sandwell MBC in supporting a UK Innovation Grant project (£100k), led by a small private

enterprise 'Innovation Factory'. Sandwell was used as the test bed – alongside the EDAR deployment – for the development of the **"Traffic Ear" sensor**, a ground-breaking sensor which used AI to link vehicle engine noise with associated tailpipe emission concentrations. Traffic Ear offers a non-intrusive solution for monitoring traffic noise, providing invaluable insights via noise maps for urban planners and policymakers in their efforts to address noise pollution and enhance the quality of urban life. Using telematics data and fleet composition, the first traffic noise map of West Midlands were developed. The product has been presented at WM-Air Annual meetings and to Transport for Scotland.

"Being part of this product research and development provided us with a unique insight into an area of work normally outside the scope of our day-to-day activities, as we were able to interrogate and discuss the potential future commercial viability of this product."

Sophie Morris – Public Health Specialist (Air Quality and Climate Change), Sandwell Council

Elizabeth Stephens – Air Quality Team Manager, Sandwell Council

"The research you conducted on vehicle emissions was particularly significant in enhancing our understanding of air quality, environmental monitoring. The findings not only challenged our existing approach but also guided us in implementing more effective policies and procedures. For instance, after our discussions in the WM-Air event in early Oct 2022 we introduced new algorithm to capture noise and vehicle emissions that have already shown a measurable impact. Since the adoption of these changes, we have seen an improvement into our system."

Anwar Almojarkesh, CEO, Innovation Factory

- New Air Quality Modelling capabilities for the West Midlands, including **85 local and regional model scenarios** – see Annex 14 for full list (*KPI 3.1-3.3, KPI 7.2, KSM 4 + 7*):

1. **ADMS-Urban Air quality model for the West Midlands (Local model)**: A novel high-resolution (street-scale, 10m) local air quality model was developed for the West Midlands (fig 10). A new air pollutant emission inventory was generated for baseline and future years from the best available datasets (in partnership with BCC, TfWM, TfWM). This allowed for 70 local policy scenarios to be modelled (e.g. Business-As-Usual (BAU), Net Zero, traffic-reduction, speed reduction, changes in fleet, Low Traffic Neighbourhoods (LTNs), Covid lockdown, Commonwealth Games (CWG), Clean Air Zone (CAZ), woodburning, railway emissions, cycling ["wheeling"] to enable health impact and economic calculations of potential policy options and anticipated future change.

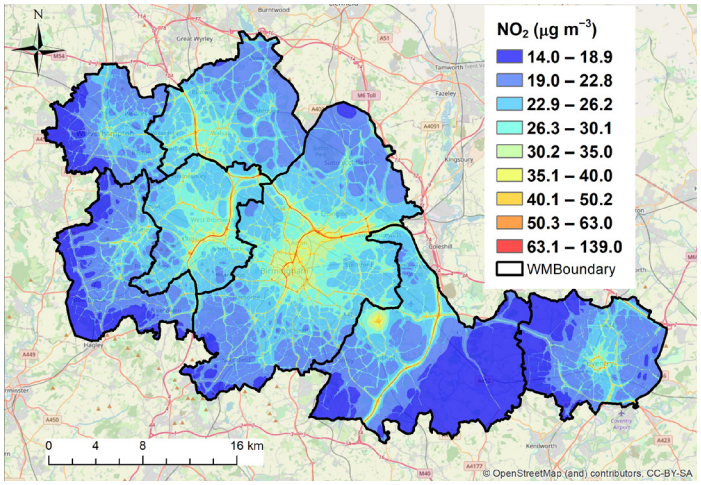


Figure 10: Modelled annual average NO_2 concentrations (business as usual scenario)

2. **CMAQ regional model**: A chemistry-transport model was developed for the West Midlands at the national and regional scale, allowing assessment of national, or region-only, policies upon air quality, and reproduction of longer-lived pollutant species and their formation (such as ozone, secondary aerosol particles). 15 hypothetical scenarios exploring, for example, reductions in woodburning, reduction in agricultural emissions, reductions in road transport emissions, 2030 emissions scenarios, Net Zero strategy scenarios and climate change scenarios were explored using the CMAQ model tool (and published in the peer-reviewed literature).

"They have developed free to access to air pollution modelling and provided interpretation on both regional and local levels of air pollution in the West Midlands."

Amanda Clover MCIEH CenvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council

- **Air Quality-Lifecourse Assessment Tool (AQ-LAT)** is a new downloadable, excel-based tool (fig 11) that can estimate health and economic impacts of air pollution (*KPI 4.1-4.2, KPI 7.3-7.4; KSM 6*). It was developed and refined using feedback from stakeholders via workshops and surveys. AQ-LAT produced the first health impact of air quality assessment for the WMCA area which have been used in policy, infographics and communications toolkits. The tool is intended to be used by policymakers and other regional stakeholders to see likely impacts of different scenarios (e.g. meeting WHO guidelines, 2030 Net Zero targets, and vehicle electrification) vs 'business-as-usual' scenarios, and hence to support the evidence case and business case development for clean air policy options.

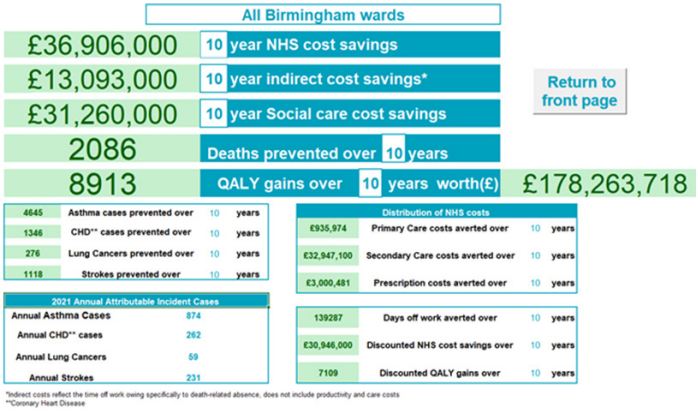


Figure 11: AQLAT output dashboard (screenshot)

- **'Defra+' damage cost tool (*KPI 5.1*)**: WM-Air have developed a protocol to expand Defra's AQ Damage Costs tool, looking at incorporating other economic costs which are currently neglected (for example, employment performance, cognitive function) which are not currently considered in "damage cost" estimates used in e.g. HMT Green Book methodologies, and testing this within the WM. A corresponding systematic literature review paper is being prepared. Outcomes and impact expected beyond the timeframe of WM-Air.
- **Air Quality-Policy Evaluation Tool (AQ-PET) (*KPI 5.2*)**: A new methodology – initially developed in the NERC APHH programme – was used to explore the impact of Covid-19 lockdowns on air quality in the West Midlands, and subsequently applied for evaluating the Birmingham CAZ. AQ-PET allows for the effect of meteorology (weather) through machine-learning de-weathering approaches, and applies a synthetic control approach to construct a hypothetical future business-as-usual or no-change dataset for the pollutant of interest, allowing the actual impact of the policy measure enacted to be isolated and quantified. This was accompanied by a briefing note, blogs, peer-reviewed journal paper and a launch press release. Ongoing development will provide a web-based version of the tool.
- Three **Climate Risk and Vulnerability Assessment (CRVA) Tools** were developed in collaboration with external partners (*KPI 6.1-6.3, KPI 7.5*):

1. **Birmingham CRVA**: The Birmingham CRVA built on a number of initial climate resilience activities with BCC colleague undertaken as part of an EPSRC Fellowship awarded to Ferranti, and internal EPSRC Impact Award funding. These included Climate Walks around the city centre, and presenting at/attending many standing meetings in different policy areas such as planning/urban forestry/net zero – to raise awareness of the issues, build consensus at BCC, and demonstrate where climate resilience aligned and improved existing policy areas (e.g. levelling up/environmental justice). This led to climate resilience being mandated in decision-making at BCC, via its addition to the corporate Risk Register. The work ultimately work brought together several important agendas within the Council including urban forestry, air quality, environmental justice, and climate resilience by developing a CRVA that can be used now, and in the future, by BCC (i.e. beyond WM-Air input/support). The resulting CRVA map pulls together different environmental, physical, and socio-economic data layers to understand how climate risk and vulnerability varies across the city. It combines information on flood risk, access to green space, overheating risk, air pollution, and vulnerability indicators such as the Indices of Multiple Deprivation and Excess Years Life Lost to create a combined score for climate risk and vulnerability. The development of the CRVA and its integration into city processes took part in several stages over several years and involved weekly end user meetings with BCC. A methodology guidance document accompanied the tool.
2. **West Midlands Built-environment/Community CRVA** (fig 12): WM-Air worked with WMCA to expand the CRVA mapping tool to the WMCA area, utilising improved data layers for socio-economic vulnerability and population density. This work also incorporated four adaptation-specific West Midlands "Greener Together"

Citizens' Panel to help shape the research outputs and WMCA adaptation policy, and producing accompanying visual materials that communicate the findings of CRVA tools and how to use them. A methodology guidance document was also developed.

3. **West Midland's Transport-specific CRVA**: Working with WMCA and Transport for West Midlands (TfWM), WM-Air developed a further, transport-specific CRVA that includes the key assets that span the West Midlands' transport network. (The Transport CRVA will likely be available in an interactive format in early 2025.) The CRVA transport map gives different areas of the West Midlands a score based on the presence of seven different climate-related hazards, including flood risk, high surface temperature, landslips, tree hazards and wind damage. These hazards impact the transport system, resulting in a variety of challenges, such as disruption and delays, increased maintenance and repair costs, injury to transport users and staff, and unsafe infrastructure. The map also gives a centralised focus for discussions within local authorities and external stakeholders about areas such as cascading impacts across different network types. Its results offer valuable information to support strategic decisions on transport planning and insight into the effects of climate change on a region.

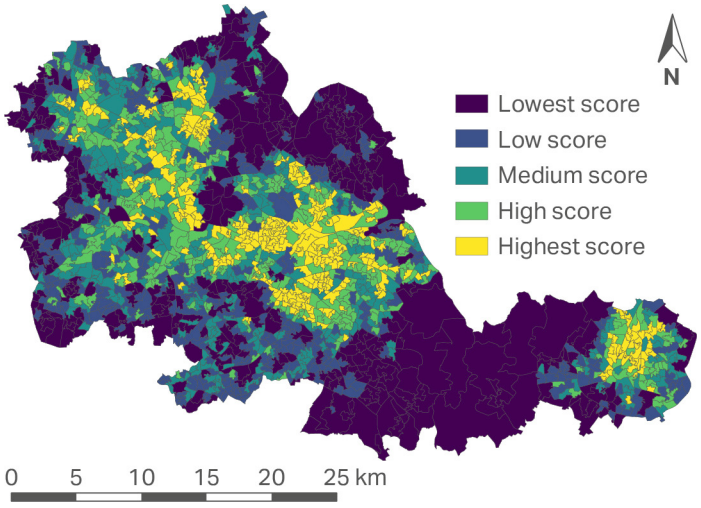


Figure 12: CRVA map of the West Midlands

"WM-Air has worked collaboratively with us at the WMCA to co-design a region-wide Climate Risk and Vulnerability Assessment (CRVA) mapping tool that is relevant and fit for purpose... A collaborative and flexible approach to cross sector working has facilitated the smooth handover of project outputs and will enable WMCA staff to replicate the model in future data updates."

Bethany Haskins-Vaheesan, Climate Adaptation Project Officer, WMCA

4. **A bespoke WM-Air Impact Store and Tracker** (Annex 8) was developed as a project management aid and for monitoring activities, tracking progress, evaluating impact and storing evidence. There were also a number of WM-Air impact resources to support gathering or developing impact evidence, including project proformas, impact summary templates, guidance documents for obtaining testimonials.

3.2.1 Media and Communication

Stakeholder networks were engaged via **14 newsletters** which were emailed out to **322 subscribers**. The WM-Air **website** (wm-air.org.uk) was created and populated with key information, resources, tools, briefings, impact summaries and news and activities throughout the course of the WM-Air project (KPI 8.1). It has received **18k views, 5.1k visitors from 73 countries**[17] and is supported until 2030. The WM-Air Twitter page (@WMAir_UoB) has a **following of over 420 and over 1000 tweets** over the 6-year period.

Members of the WM-Air team were also involved in traditional media activities, including press releases, interviews and news articles linked to publications and activities. In total, there were **>650m views** of **>150 media pieces** linked to WM-Air work (Annex 15 – Full list of media activities linked to WM-Air.) Examples of high-profile media activities include 65 news pieces on the CAZ analysis by AQ-PET tool, a series of air pollution articles in Birmingham Mail[18], Sounding Out Pollution (SOP) coverage in MixMag

17 From 15th March 2021 only and 8 months missing in 2023.

18 https://www.birminghammail.co.uk/news/midlands-news/scandal-silent-killer-cuts-short-27998018
https://www.birminghammail.co.uk/news/news-opinion/what-found-measured-air-pollution-27994664
https://www.birminghammail.co.uk/news/midlands-news/pollution-destroying-health-how-safe-28009910
https://www.birminghammail.co.uk/news/midlands-news/revealed-exact-time-youre-most-28016065
https://www.birminghammail.co.uk/news/midlands-news/5-things-you-can-improve-28026674

(amongst others), results from the AQ-LAT exploring the regional impact assessment of air quality in the West Midlands (with over 13m views) and coverage of our PM source apportionment analysis by the BBC and others (reaching a global audience of >560m) (fig 13).

Figure 13: a) BBC Midlands Today reporting on the significance of domestic woodburning across the West Midlands, including interviews with WM-Air team members; b) 5 News interviewing WM-Air Co-I on the launch of the Birmingham Clean Air Zone and c) BBC interviewing the WM-Air PI about Clean Air Zones

Seventeen air quality and health infographics and five GIFs (linked to a guidance note on the use of low-cost sensors) were created for communicating key metrics and information to public and social media audiences, partners and stakeholders – the infographics, which were informed by AQ-LAT output, are currently being used by WMCA as part of their community engagement and behaviour change campaigns. WMCA are also using AQ-LAT output as part of communications toolkits for local authorities, schools and NHS trusts to create a consistent message around air pollution in the West Midlands. An **overall project 'graphic'** summarising the activities, outputs, outcomes and impacts resulting from WM-Air in a clear and easy-to-digest manner was also developed (fig 14 overleaf).

3.2.2 Public Engagement and Outreach Products

In addition to products developed for industry partners, there were a number of **public engagement outputs** developed by WM-Air (the attitudinal impact of these activities are explored in Section 3.4.1):

- Support, scientific expertise and active involvement in the **University of Birmingham 'The Air We Breathe' (TAWB)** public exhibition (fig 15) and programme at **The Exchange** (central Birmingham civic exhibition space), which was visited by >6500 people (with a high proportion of visitors in younger age groups and 15% under 16.) The public programme included a range of events delivered by WM-Air team for different audiences from children to adults, with different educational backgrounds/ knowledge.) The assets produced include physical exhibitions and videos, including a movie exploring scanning electron microscope (SEM) images of particles, and a film showing modelled NO_2 over the course of 24-hours. Feedback shows a high level of satisfaction by different audiences (3% sampled), particularly the interactive exhibition and the creative activities brought to them through expert engagers (more detail in Section 3.4).

Fig 14: WM-Air project summary graphic

"Fantastic storytelling and lovely art activity. It's our second visit to The Exchange and we love it! Thank you, Joe (13) Henry (10)"

"Really interesting space. Great exhibition and credit to all the staff for their welcome, knowledge and enthusiasm."

Sample anonymous feedback from exhibition visitors and public programme participants

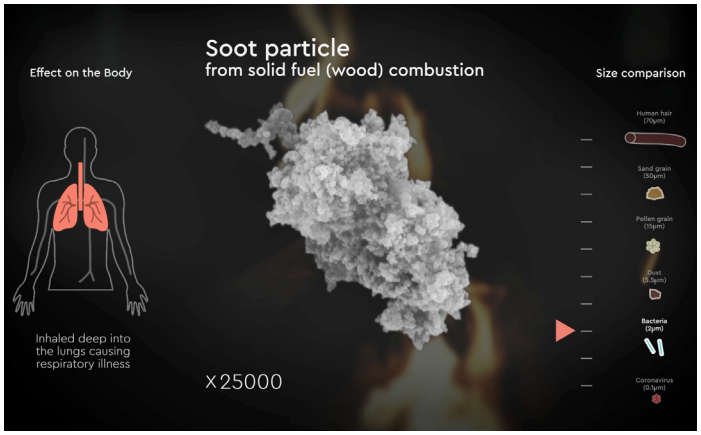


Figure 15: a) Photos of TAWB exhibition and b) screenshot of the SEM film

The TAWB assets were also used by WM-Air and partners beyond the exhibition. For example, **WMCA** used these assets and WM-Air infographics to raise awareness of air pollution at **21 community events** to support residents in improving their knowledge and actions they can take to reduce pollution and exposure. Other visitors to the exhibition included the Mayor of the West Midlands Andy Street, and the Government Chief Medical Officer, Prof Christ Whitty.

"WM-Air allowed us to borrow their exhibition equipment, which includes infographics and pollution boxes to demonstrate a visual representation of pollution emitted by vehicles."

Katie Jepson, Environment Behaviour Change Project Officer, West Midlands Combined Authority.

- NERC 'Growing Roots' funding was also obtained for **'Sounding Out Pollution: Can you hear what's in the air?' (SOP)** public engagement project. WM-Air worked with an independent sound artist to use sound compositions to communicate variations in air quality. The project produced three distinct audio-visual pieces that were composed using a variety of different instruments and styles, in order to stimulate curiosity and improve understanding of how to manage exposure to poor air quality and reduce emissions. The work was displayed at exhibitions (TAWB) and online, and gained a range of media traction (including an article in MixMag) with >100k views from >16 countries – it was even featured in the **Sound Canopy for Science Future exhibition at Glastonbury** (there were several thousand visitors to Science Futures during the festival, fig 16 overleaf).

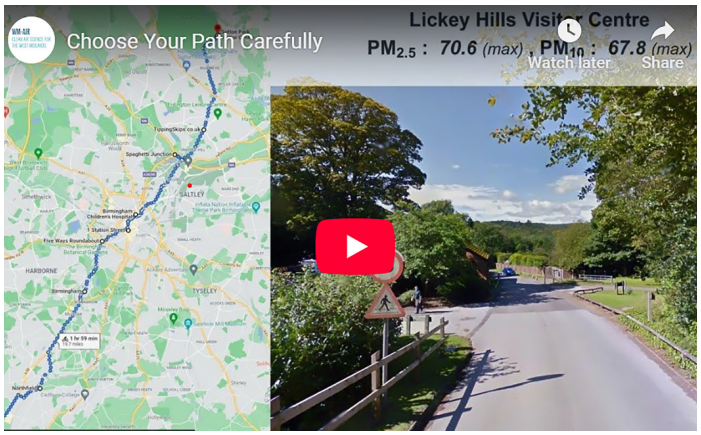


Fig 16: a) One of the three SOP videos on YouTube, b) COP at The Air We Breathe exhibition and c) SOP featuring as part of the Sound Canopy in the Science Futures zone at Glastonbury

"I found it easier to follow the ideas via sound patterns than by a graph or other visual means."

"This was a very good example of a didactic sonification: the mapping is relatively simple (certainly in the first sonification) but the idea here is not as much an artistic expression but more an explanatory sonification. Combined with the explanation below, I think the sonification is really useful."

Selection of anonymous feedback about the audio-visual method

- Two 'images of innovation' contributions were included in the **COP26 'UK Universities' Climate Innovation Showcase'**, including 'Where is the Cleanest Air?' and 'Measuring the Air We Breathe'. Members of WM-Air also attended and contributed to panel sessions at COP26.
- WM-Air contributed to the Clean Air theme (Fig 17) of the '**Our Changing Planet**' exhibition at ThinkTank museum in Birmingham in 2021, which focused on an audience of 11-19 years old.

Fig 17: Clean Air exhibition at ThinkTank museum

- Members of WM-Air contributed to a **UoB-commissioned film on air quality** to communicate the work of WM-Air within the West Midlands during the run-up to the Birmingham 2022 Commonwealth Games (650 views).
- WM-Air provided input into a regional **air quality animation developed by the WMCA**. The aim of the animation is to provide easily digestible content on air quality for public audiences and is included in a new regional air quality website (launched Jan 2025).

"WM-Air team have reviewed and provided amendments to the draft script and provided their logo to include within the animation to show their expert support."

Katie Jepson, Environment Behaviour Change Project Officer, West Midlands Combined Authority.

3.2.3 Educational and Training Resources

WM-Air developed curriculum-linked **air quality school resources** which included 10 stand-alone lessons:

- Introduction to Air Pollution: Resources for Schools (KS3+4)
- Additional Activity for Introduction to Air Pollution: Geographic Information Systems (GIS)

These have been downloaded by >300 teachers from 40+ institutions. WM-Air also provided support for BCC's school AQ programme in all 500 schools across the city, including providing an **'introduction to air pollution' presentation** for primary schools, for a package of resources to accompany the BCC School AQ programme.

WM-Air contributed to a number of WMCA's behavioural change activities, including the development of **literacy courses** on **Climate Change**, **Adaptation** (in prep) and **Air Quality** for local authority officers and elected officials across the West Midlands. For example, the regions first Air Quality literacy course was developed to increase knowledge and awareness of air quality (i.e. moving away from thinking air pollution is purely a transport issue) and has been certified by the CPD Certification Scheme for learners to use their hours towards their continued professional development. The WM-Air Team provided expert advice and technical support on the creation of the course, providing statistics (e.g. from AQ-LAT tool), infographics, feedback and input into the content. The course launched on Clean Air Day 2024 and to date, **37 officers** across all local authorities have passed the course. The aspiration is for 100 officers and elected officials to have passed the course in a year. The Climate Change literacy course – developed by WMCA in 2022 as part of CWG legacy – has seen **90,000+ people** in the UK achieve a Carbon Literacy certificate, demonstrating the potential reach for the subsequent literacy courses. Members of the team participated in Citizen's Panel events, providing expert input to discussions around environmental priorities.

"The awareness amongst political leads across the region, on the importance of tackling poor air quality, has been significantly increased and an 'air quality literacy' training programme has been developed (with the support of the WM-Air Team) to develop air quality knowledge for politicians and officers. We are securing CPD accreditation for this course currently"

Jackie Homan, Head of Environment, WMCA

3.1 Outcomes

Outcomes are an intermediary (usually short or medium-term) stage between delivery of the activity/ outputs, and the impact accruing. This section describes the results of WM-Air activities and the ways in which WM-Air outputs/products have been used (i.e. adopted, adapted, applied, trialled or tested.)

3.1.1 Strengthened WM AQ Network, New Partnerships and Stakeholders

During the inception of WM-Air for the RISE proposal, 27 stakeholders were identified as core partners. An initial Stakeholder Analysis was conducted at the start of the project in order to help identify other potential stakeholders and partners (Annex 16 – stakeholder mapping).

During WM-Air, this number has increased to become a (global) network of more than **300 stakeholders from over 120 individual companies**, of which **30 are classed as key partnerships** (i.e. linked directly to impact case studies, projects and tool development.) The partners we have engagement with – via project partnerships, through engagement events (fig 18), through exploratory meetings or via online resources – can be seen in fig 19 (overleaf).

Figure 18: Delegates attending the final WM-Air annual meeting

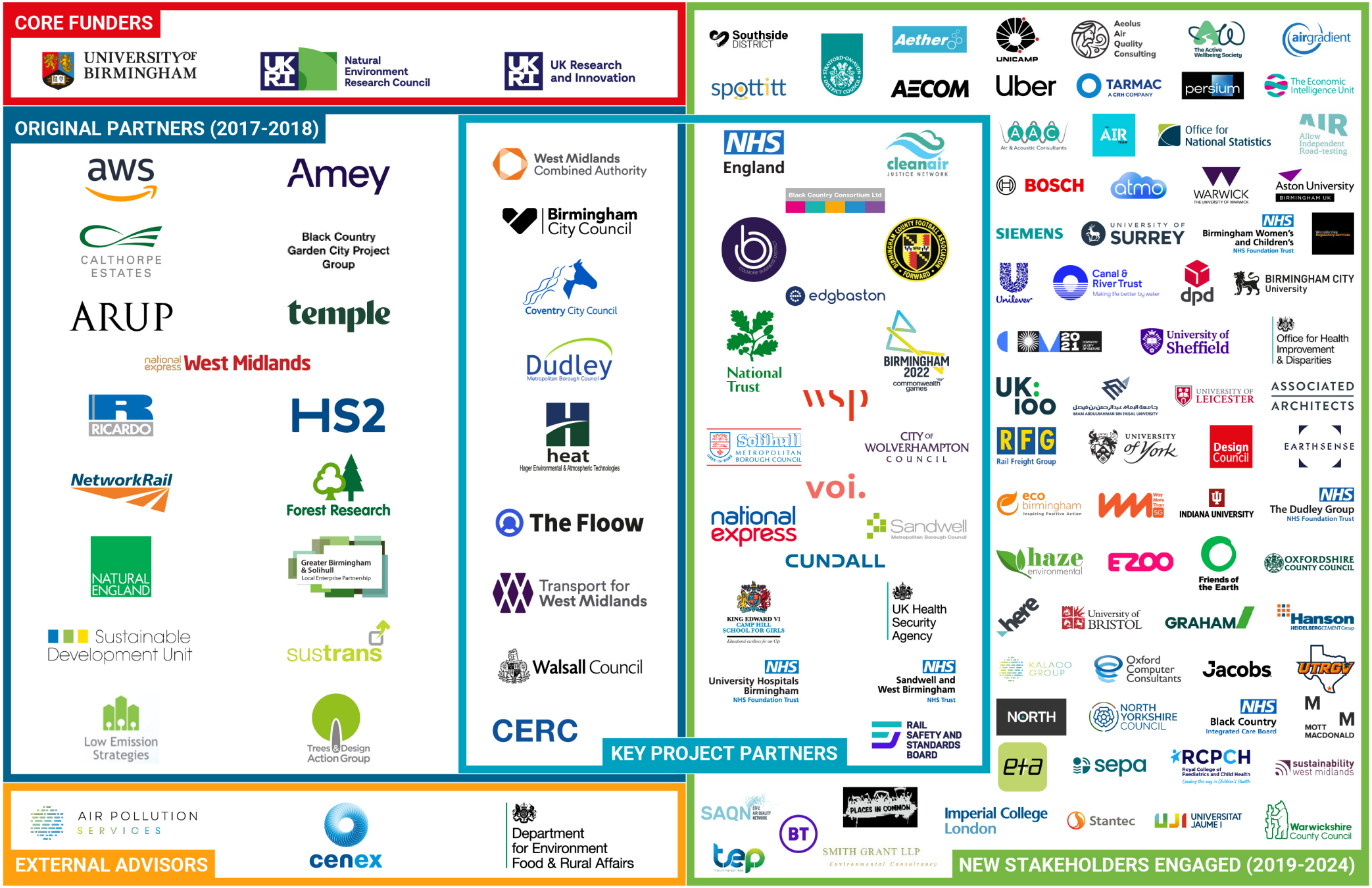


Fig 19: Map of partners and stakeholders engaged over the lifetime of WM-Air

This represents a **4.5-fold increase in terms of organisations engaged, and an 11-fold increase in terms of individuals within the overall network**.[19] Overall, 13% of the total network are from academic institutions, 39% from the private sector/consultancies, 14% from the public sector/publicly-owned, and 16% from Governmental organisations, and 17% from charities/not-for-profits/community groups. Focussing solely on our key partners, one-third are from local and regional authorities or governmental bodies. Many of these new stakeholders and partners have been obtained via WM-Air and external events, through PR and communication activities and online resources, but also via word of mouth and through our existing relationships with original end user partners.

WM-Air has helped to support and strengthen the West Midlands air quality community and foster a more effective partnership between regional and local authorities, private and public bodies and community groups for tackling air quality issues.

"WM-Air has played a key role in increasing our air quality knowledge and has succeeded in bringing together a wide variety of stakeholders from across the West Midlands and further afield. In doing so, they have allowed learning and partnership working to evolve and flourish and demonstrated the importance of taking a comprehensive and evidence-based approach to tackling poor air quality."

Elizabeth Stephens – Air Quality Team Manager, Sandwell MBC

"The research activity and experience gained has been shared through regional partners, technical specialists and interest/campaign groups. Specifically, the group has endeavoured to engage and closely liaise with constituent councils within the West Midlands Combined Authority (WMCA) of which Solihull Council is one."

Amanda Clover MCIEH CenvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council

"Before the start of the WM-Air project there was little interaction between TfWM and local authorities on air quality issues. The "bringing together" of officers in meetings, workshops and work on WM-Air has established much greater partnership working in this field. There is now regular contact between TfWM and air quality officers and dialogue when local authorities are developing air quality strategies and air quality annual status reports, for example TfWM input into Coventry City Council's annual status reports tables of measures to reduce NO_2 emissions."

Mike Waters, Director of Policy, Strategy and Innovation, TfWM

"Gained new contacts in air quality consultancies and met with familiar contacts from other organizations. Useful discussions for future collaborations"

"My attendance will inform policy development and collaborative activity."

"Excellent networking opportunity, helped build new links and strengthen existing ones (I am new in post)"

"Developed new links, made new contacts, strengthened existing contacts, helped inform work programme and priority setting"

"Got to stand in the same room as Andy Street, and hearing his enthusiasm for AQ initiatives was really encouraging."

"Spoke with someone from National Express and new staff at UKHSA and met a couple of new staff who are now working at Birmingham City Council who I want to work more closely with in the future."

A selection of anonymous feedback from Annual Meetings and Community of Practice events

3.1.2 Leveraged Funding and Investments Influenced

Annex 6 summarises the income influenced, leveraged funding and matched funding generated by WM-Air, **totalling £47.2m**. This consists of:

19 This is expected to be an underestimate as, despite best efforts, it is unlikely fully capture all engagements with individual project team members that did not develop, nor does it capture indirect engagements via national policy citations and media reach.

- **£37.8m leveraged funding** (where working with WM-Air has helped an organisation – not limited to project partners – secure new or additional funding. This also includes funding income to UoB which was leveraged by WM-Air.)
- **£8.2m investments influenced** (other forms of investment where the WM-Air sphere of influence has been strong, but where spend cannot be considered to have been exclusively leveraged by WM-Air)
- **£1.2m matched funding** (includes cash/in-kind contribution from project partners, as evidenced by contracts or letters of support.)

Much of this funding has allowed for partnerships to strengthen within the course of WM-Air, and/or continue beyond the timeframe of the NERC RISE-funding. For example, funded activities involving WM-Air and the WMCA – some of which are on-going – include:

- **Impact Fellow Secondments–£21.3k (2019-2022)**: funding received from WMCA for two Impact Fellow secondments (2021-2022)
- **UKRI COIO funding–£207k (2023-2024)**: Expansion of CRVA work to the West Midlands
- **Defra Funding–£918K (2023-2025)**: The WM-Air team provided advice and support for WMCA's Environment Team for a successful bid for Defra funding of a new air quality sensor network.

"In March 2023 the WMCA was awarded £918k from the Defra air quality fund. This funding was undoubtedly partly secured through the work of the WM-Air team, particularly through the Impact Fellow (Joe Acton) funded through the WM-Air programme (and part matched by the WMCA)."

Elle Winning, Air Quality Lead, West Midlands Combined Authority

"The work of the WM-Air Team has helped us to understand the sources of this air pollution and has provided a vital evidence base that we have been able to use to secure significant grant support – a total of just under £1.5m from Defra and DLUHC."

Andy Street, Major of the West Midlands

Funding has also been awarded to allow *specific* elements of WM-Air to be continued and expanded, both within and beyond the timeframe of WM-Air, such as expansion of WM-Air activities within and outside of the West Midlands, funded research activities, development of further tools, capabilities and modelling, impact and knowledge exchange activities and supported various engagement activities. Annex 6 provides an overview of these funded activities.

Examples of major grants that will continue and expand specific elements of WM-Air beyond the timeframe include (legacy is expanded on in Section 5):

1. **WM-Net Zero – £2m (2023-2026, Wellcome trust)**: Exploring the air quality co-benefits/ disbenefits of net zero policy in the West Midlands – builds directly on WM-Air legacy (identical regional footprint) and stakeholders
2. **WM-Adapt–£2m (2024-2027, NERC)**: NERC-funded WM-Adapt will build on partnerships developed during the project, and take forward the CRVA work to maximise adaptation to climate change across the region.
3. **CARMINE–€12m (2023-2026, EU)** – 'Climate Resilient Development Pathways in Metropolitan Regions of Europe': EU-Horizon funded project focused on delivering climate-resilient development pathways in metropolitan regions of Europe.
4. **INHABIT–£5.5m (2025-2030, UKRI)** – 'Indoor HABItability during the Transition to Net Zero Housing Hub' – The INHABIT Hub aims to produce scientific evidence and policy-relevant solutions to realise the health co-benefits of the UK's net zero transition in housing.

3.1.3 End User Applications of Tools and Capabilities

WM-Air's monitoring and modelling capabilities, tools, data, outputs and analyses have been used by stakeholders or fed into specific stakeholder activities.

Air Quality Measurements

WM-Air undertook specific **air quality monitoring** in response to requests from Local Authorities and partners. For example, the team worked with

stakeholders (**CWG, WMCA, BCC, CCC, Edgbaston Cricket, UHB NHS, Canal and River Trust**) to deploy low-costs sensors at specific locations for a range of real-world applications.

This included **CWG locations** to explore local air quality, at **Edgbaston cricket stadium** to assess the impact of their 'Go Green Games', within and around the **Birmingham CAZ**[20] (*KSM 1*), along the **canals** in order to explore PM exposure compared to taking equivalent journeys through the city, and at locations of air quality improvement schemes in Coventry (such as highway improvements, infrastructure changes and new cycle routes, *KSM 2*). These trial deployments gained visibility, especially in Coventry, where the work featured regularly in their Annual Status Reports to Defra. Indeed, in line with the rest of WM-Air, interest was shown right across the West Midlands and beyond (e.g. Warwickshire) with support voiced by the West Midlands Environmental Protection Group, West Midlands Combined Authority and the Coventry & Warwickshire Air Quality Alliance. The learnings from these networks were ultimately used to develop a guidance note on **procuring and deploying low-cost and commercial AQ sensing networks for local authorities**, which has been viewed >150 times and reached >7500 people on social media. Wider exposure was obtained by the publication of an abbreviated version in the (private/commercial) air quality procurement guide, which was sent to >10,000 recipients. Such guidance is helping other local authorities – including Solihull Council – to improve their monitoring capabilities.

"The data will also prove valuable to colleagues in our Environmental Protection Team carrying out our functions under Local Air Quality Management. The existence of the sensors means that we may be able to use future data in reference to planning applications and addressing issues of development in areas of high PM pollution, planning officers in development management and planning are also supportive of any information we can get from the sensors."

Steven Dewar, Environmental Protection Officer, Coventry City Council

"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 of the Birmingham 2022 Commonwealth Games Organising Committee (OC)

"Evidence from research at the University of Birmingham's (UoB) WM-Air team has enabled Solihull to enhance our knowledge and understanding of the monitoring, investigation and management of air quality."

Amanda Clover MCIEH CenvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council

Measurement campaigns were conducted at the Queen Elizabeth Hospital Birmingham (QEHB) and Birmingham Heartlands Hospital (BHH) for **University Hospitals Birmingham NHS Trust (UHB)** in order to explore local air quality. The data – along with the Clean Air Hospital Framework evaluation activity – was used by UHB to explore and implement interventions to reduce air pollution, therefore influencing decision-making at Board-level and improving the use of public funds for operational investment (including the recruitment of a dedicated Sustainability Officer as recommended by WM-Air.) Subsequently the effectiveness of the implemented air pollution interventions – such as actions to improve air quality near the main entrance – were also measured by WM-Air (paper under review). Learnings from the UHB monitoring was used to develop a **standardised guidance note on ambient air quality monitoring for healthcare settings**, which has been viewed >130 times and was posted out to **41 WM HNS Trusts** (the guidance was also shared in **Wales** via the Welsh Clean Air Champion.) Other Trusts that have since used this guidance and learnings from the UHB work include **Sandwell and West Birmingham (SWB) NHS Trust, University Hospital Coventry & Warwickshire (UHCW)**, who wanted to implement actions for improving air quality and approached WM-Air for advice on AQ

20 Cowell, N., Chapman, L., Bloss, W., Baldo, C., & Zhong, J (In Press). What can we learn from nested IoT low-cost sensor networks for air quality? A case study of $PM_{2.5}$ in Birmingham, UK. *Meteorological Applications*

monitoring and mitigation, and **Birmingham Women and Children's NHS Foundation Trust (BWC)** to support the procurement of sensors for assessing air pollutant concentrations in ambulance bays.

Quantification of the major **sources of $PM_{2.5}$** via source apportionment analysis provided new insights across the region. These published results indicate that the dominant source of $PM_{2.5}$ include biomass burning (25%), resuspended dust and traffic emissions (22%), and secondary aerosols (25%). Results also show that biomass burning contribution to PM in Birmingham has increased over ~15 years (present day for example, 2.4 μg m^{-3} compared to the 2007-2008 value of 0.23 μg m^{-3}). The work suggests local and regional policies could substantially reduce $PM_{2.5}$, significantly decreasing mortality and life-years lost due to air pollution. The BBC reported on this work, highlighting that woodburning is a major source of $PM_{2.5}$ across the region in a Midlands Today Special Report which reached 363m people globally via >20 news pieces. The work has also been presented to >100 stakeholders at WM-Air events, directly to Local Authority officers through the West Midlands Environmental Protection Officers Group (WMEPG) and via a workshop on wood burning organised by Smallwoods (sector organisation). Such events generate awareness of the significant impact of biomass burning and enable policy to be influenced. For example, **regional policy** via the AQ Framework; **targeted local policies** to reduce woodsmoke – i.e. via smoke control areas in Sandwell – and traffic-related $PM_{2.5}$ emissions – including promoting electric vehicles, public transportation, and road dust management; **educational campaigns** and materials to raise awareness about the impact of woodburning and traffic emissions on air quality and health; and **advocacy** for regional and local emission reduction targets to address secondary aerosols influenced by industrial and agricultural activities.

"Modelled regional air pollution data and source apportionment data from the WM-Air team strengthened our arguments for implementing the Smoke Control Area, as it highlighted the significant contribution of particulate matter created from biomass burning across the West Midlands."

Sophie Morris – Public Health Specialist (Air Quality and Climate Change), Sandwell Council

Elizabeth Stephens – Air Quality Team Manager, Sandwell Council

Transport Emissions

The **telematics dataset** gained interest from **Transport for West Midlands** (TfWM) who attended two technical sessions in 2023 exploring the methodology, datasets, and potential applications of urban mobility and road transport insights. Subsequently, the datasets for 2016 and 2018 were shared with TfWM to integrate into their models, analyses, and policy formulations. This collaboration between the WM-Air team and TfWM signifies a partnership aimed at leveraging cutting-edge research to inform and enhance transportation planning, infrastructure development, and policy-making processes in the West Midlands region.

Air Quality Modelling and Policy Scenarios

Local and Regional business-as-usual (BAU) modelling outputs, plus total of **85 modelling scenarios** (Annex 14), were produced by WM-Air for a range of projects across the West Midlands (*KSM 8*). (Details on policy and practice influence are given in section 3.4). Examples of modelling work produced for Local and Regional Authority partners include:

- **WMCA**: modelling to inform the Air Quality Framework, to support sensor deployment as part of the Defra-funded air quality project, to explore the potential for "stretch" air quality targets for the region, Net Zero scenarios, and Covid lockdown scenarios.
- **Black Country**: Black Country AQ modelling for the State of the Sub-region reports
- **TfWM**: Traffic-reduction scenarios (for Future Rapid Transit Route prioritisation, also working with Mott Macdonald Plc), Air Quality and Health scenarios (for Local Transport Plan to 2036), impacts of lowering motorway speed limits on M5 and M6, and bus fleet electrification
- **Birmingham** (*KSM 4*): Initial baseline modelling and scenarios for the Clean Air Zone (CAZ) and subsequent explorations of remaining non-compliance areas within CAZ and areas of exceedances outside CAZ (also utilising low-cost sensors and telematics – including analysis of AQ data during local bus strikes – to provide insights into sources and potential policy changes to alleviate exceedances). Exploration of the impact of Low-Traffic Neighbourhoods (LTNs) in Kings Heath and Moseley. Investigation into the impacts of Covid-19 Lockdown in 2020 on nitrogen dioxide – this methodology was also applied in

partnership with Birmingham City Council (BCC) to assess likely 2020 and 2021 air quality compliance with legal limits, informing decisions on Clean Air Zone implementation timeline. Traffic reduction modelling scenarios were also conducted to demonstrate the scope for traffic change to address air quality. Air quality prediction for Castle Vale in Birmingham for 2021 BAU and 2030 BAU scenarios, linked to understanding air quality co-benefits from a low emission homes trail. Modelling output was used for the development of Colmore BID (Business Improvement District) future development plan, the **Colmore BID & Retail BID 'Going Green Programme' Masterplan**. Provision of an 'evidence base' that underpins the advice BCC are giving to schools around the issue of AQ in their localities, and to inform BCC deployment of Airly sensors in schools. Ongoing work includes input into a Birmingham Healthy Streets Index, which requires Birmingham air quality data (supplied by WM-Air modelling), tree data and noise data.

- **Solihull**: The provision of Business-As-Usual (BAU) air quality modelling outputs fulfilled a direct need to model pollutants that had not previously been spatially represented, enabling Solihull to understand pollutant make up across the region, and was used in their Annual Status Reports (ASRs) – to justify (to Defra) their stance on the assessment of $PM_{2.5}$ within the borough – and to inform their new Clean Air Strategy. The WM-Air team has since embarked on an additional verification exercise to help diagnose and understand a modelled pollution hotspot in Solihull near a specific industrial site.

> **"The council has included a good $PM_{2.5}$ section... The council also commissioned* an additional study relating to $PM_{2.5}$ across the council area. This is encouraging to see."**
>
> *Defra feedback on Solihull's ASR (2023)*
>
> **Provided by WM-Air*

- **Coventry**: "BAU" modelling for application to housing developments, exploring the Foleshill/NE Coventry transport link roads and impacts of interventions to reduce traffic, and for the River Sherborne Cultural Programme in Coventry.
- Air pollution exceedances investigations were also conducted in **Dudley**, **Sandwell** and **Wolverhampton**.

Modelling was also undertaken for a number of specific or hypothetical policy intervention measures/activities across the region, including:

- **CWG**: Air quality predictions for 2022 Commonwealth Games venues.
- **NHS Trust sites**: output supplied for hospital sites for UHB, Sandwell and West Birmingham (SWB) and University Hospital Coventry & Warwickshire (UHCW) Trusts, to support AQ intervention work.
- **Railway emissions**: Improved representation of rail diesel emissions on local air quality for RSSB (Rail Safety and Standards Board).
- **Voi e-scooters/WM-cycles ('wheeling')**: Exploring the impacts of cycle and e-scooter hire on air quality emissions avoided.
- **Transport decarbonisation (TfWM, WMCA)**: quantifying the air quality co-benefit from growth of the Electric Vehicle (EV) fleet under different scenarios and linking this to resulting changes in air quality inequality across wards, compared through e.g. IMD scores. Future traffic activity, changing fleet composition (Euro classes), and the electrification of public transport.
- **2030 Net Zero scenarios (TfWM, WMCA)**: Exploring the impacts of Net Zero policies (2030 NECD Scenario, 2030 Net Zero Scenario, 2030 Electric Vehicle Scenario and a BAU Scenario) on air quality and attainment of 2021 WHO air quality guidelines. Policy Briefing "Co-benefits of decarbonisation policies on future ambient air quality and health" produced.
- **Regional emissions reduction scenarios (WMCA)**: (1) PM woodburning (85% reduction); (2) NH_3 Agriculture (30% reduction); (3) Road Transport (30% reduction); (4) NH_3 Agriculture + Road Transport (30 + 30% reduction) (paper in prep). WMCA regional responses to Defra AQ targets.
- **MAQS-Health (CERC)**: In collaboration with Cambridge Environmental Research Consultants Ltd (CERC), the regional-to-local coupling air quality modelling system was tested and validated for the West Midlands case study. WM-Air model development is promoted to CERC's international client base. The baseline WM-Air model configuration and evaluation datasets

have been used by CERC on the government advisory Atmospheric Dispersion Liaison Committee (ADMLC) project to 'review methods used to assess the performance of atmospheric dispersion models'.

Ongoing work includes providing modelling output for exploring air pollution around **nurseries and early years providers** in the West Midlands for UCL for health-related study; providing air quality modelling output to **UKHSA** for exploring the impacts on health; and using modelling to explore the impact of the proposed **8 Hills/Forest for the Nation (FFTN)** area to the South of Birmingham for a proof-of-concept study with National Trust aiming to improve the quality of, and access to, green spaces (full proposal in prep).

Air quality maps produced by WM-Air were used in the Chief Medical Officer's annual report on air pollution in 2022 and annual report on health in cities in 2024, and have been used to inform local to national policy responses (e.g. exploring estimated future $PM_{2.5}$ levels across the West Midlands to inform responses to the DEFRA target-setting consultation) and for knowledge exchange with local and regional authorities, and the public (e.g. the Air We Breathe and Sounding Out Pollution). Air quality model outputs are key input data for the AQ-LAT and CRVA tools.

Health and Health Economics

AQ-LAT (tool to allow end users to estimate health and healthcare economic impacts of future air quality scenarios) has been downloaded by **>150 people**. The WM-Air team worked with Las to develop AQ-LAT in order to help local and regional policymakers and councillors understanding the geographies of (air quality) health burdens (*KSM 6*). AQ-LAT is being used to inform local and regional policies, for example, air quality action plans, Local Plans (which contain planning policies and processes for urban planning), and transport strategies, which are required to align with health.

AQ-LAT output was used to produce a Health Impacts of Air Pollution briefing note for Birmingham and a presentation for **Coventry City Council**. BCC included this output as part of an air quality community grant scheme, and it was also provided to the **Clean Air Justice Network** to shape their activities. **Walsall Council** have also collaborated to produce an updated version of AQ-LAT using local air quality measurements. The outputs were used by the **WMCA** to support first West Midlands AQ Framework and related communications activities. AQ-LAT is being expanded to Oxfordshire as part of additional commissioned funding, with discussions in advanced stages about application to Stoke-on-Trent, and exploration of consultancy opportunities using publicly available datasets for other areas outside WM region. A web-based version of the tool, requested from end-user feedback, is under development.

"The development of the AQ-LAT and its use in assessing negative costs of air quality impacts of planning development is another useful tool used in our discussions and consultation with planning colleagues."

Steven Dewar, Environmental Protection Officer, Coventry City Council

"Dr Suzanne Bartington and Dr James Hall's new Air Quality Lifecourse Assessment Tool (AQ-LAT), supported by the wider WM-Air team, enables local authorities to assess the potential health and economic impacts of air quality policy choices. This tool is included within WMCA's air quality policy agenda and will also be used in Sandwell as we update our Air Quality Action Plan. The tool will help us to gain buy-in from senior management and elected members by clarifying the co-benefits to health and the economy from cleaner air."

Sophie Morris – Public Health Specialist (Air Quality and Climate Change) and Elizabeth Stephens – Air Quality Team Manager, Sandwell MBC

"WM-Air's AQ Life Course Assessment Tool is an example of where the knowledge and skills of the WM-Air Team have been translated into an actionable tool for ward-level insight into the health impacts of different AQ scenarios over time."

Stephen Arnold, Head of CAZ, BCC

Policy Evaluation

AQ-PET was originally developed to explore the true impact of COVID lockdowns on air quality in

the West Midlands, and has since been applied by WM-Air for a number of applications. This included analysing the **true impact of Birmingham's Clean Air Zone (CAZ)**, finding that CAZ reduced NO_2 by up to 7.3% in the first seven months – this resulted in substantial regional and national media coverage in >65 news articles resulting in >64m views. AQ-PET was also applied to explore the impact of B2022 CWG and London Ultra Low Emission Zone (ULEZ) on air quality. Workshops and training have been held for 40+ participants and an updated version of AQ-PET is under development, with national interest from Defra.

"Deliverables which have helped Birmingham City Council include… the benefit arising from the CAZ when the weather component was disaggregated from the model. The work around the modelling of the CAZ benefit was very helpful in helping to local authority to message during the early months of the CAZ and to answer questions around the benefit arising from the CAZ especially when there was the confounding position of the earlier lockdowns."

Mark Wolstencroft, Operations Manager Environmental Protection, Birmingham City Council

"Researchers in the WM-Air team have also analysed the early data on the NO_2 changes seen over the first 3 months of implementation of the CAZ. This provisional analysis – using data from automatic monitoring stations – applied a machine learning weather normalisation approach to correct for meteorological factors, and an augmented synthetic control methodology to isolate the impact of the CAZ policy. The intention of the CAZ was to reduce NO_2 emissions, and analysis indicates reductions in average NO_2 concentration ... at sites within the CAZ with no clear evidence of displacement effects, although the monitoring network is limited. Analysis found no significant impact attributable to the CAZ on local $PM_{2.5}$ concentrations within the CAZ."

Case study on CAZ in CMO report by Chris Baggott, Claire Humphries, Mary Orhewere, Humera Sultan, Justin Varne, BCC

Urban Design and Green Infrastructure Tools

A major outcome of the **Birmingham CRVA** is that **BCC received its first A-grade by CDP for transparency and bold climate action** (*KSM 9*). Until 2023, BCC had only received a B-grade, and this was part due to lack of understanding of climate risk vulnerabilities. The public-facing CRVA developed with WM-Air is included in BCC's CDP submission in 2023. BCC is now working to integrate the CRVA in their geospatial platform for council staff (at a 100m resolution, as opposed to the Ward and LSOA results shown on the public-facing platform).

The Birmingham CRVA tool is now "changing policy, procedure, and understanding of climate resilience and adaptation within the City Planning and design team at Birmingham City Council"

Simon Needle TechArborA. Strategic lead – Urban Forestry & Nature, BCC

The Birmingham CRVA gained interest from **WMCA**, and resulted in the development of **West Midlands Community and Transport-focused CRVAs** made possible via additional UKRI COIO-funding. These initiatives will increase resilience to climate change by mapping the climate vulnerability of communities and transport infrastructure, and by engaging citizens to optimise project outcomes and improve awareness of climate risk. This has been supported by several conference presentations in 2024.[21] UoB and BCC have also been awarded UKRI funding to expand this work in the West Midlands via WM-Adapt (2024-2027), and EU Horizon funding to take this work forward 8 as part of an international project to develop Climate-Resilient Development Pathways in Metropolitan Regions of Europe (CARMINE, 2024-2028).

Wider Applications

WM-Air capabilities have been used for a number of **Sports Sustainability** applications (*KSM 7*): For example, WM-Air worked in partnership with **Birmingham County Football Association (BCFA)** as part of their 'Save Today, Play Tomorrow' initiative to assess local air quality and air pollutant emissions from grassroots football travel in order to better understand links between football activities, air quality and health, and to support sustainable

21 Futurebuild 2024; First International SEE Conference on Net Zero Solutions and Circular Economy; GISRUK 2024; BIFoR Conference 2024; Transit Data 2024; Green Cities Symposium; UN (November 2024.)

transport policy actions. WM-Air quantified **local air quality for football locations**, and **estimated air pollutant emissions related to football activities** by utilising football-related travel data and **real-world vehicle air pollution emissions factors (Efs) developed by WM-Air's emissions strand**. The findings from this project demonstrated that approximately half of all registered grounds in the County are in locations which exceed WHO health-based air quality guidelines for annual $PM_{2.5}$ concentrations, and that football travel contributed to 20% of the average participants overall annual travel emissions. Following this initial work, further work was commissioned to explore the **air quality for all national football venues**.

"Over the last couple of years, the WM-Air team has provided us with science-based data and analysis which has played a crucial role in informing our decision making at a local level, but ultimately positioning ourselves as a credible, academic research led governing body. It is not by coincidence that our programme is successfully changing behaviours in the grassroots game across the region, this has been born out of the initial study and research completed by the team that provided us with a solid starting point and a means to engage clubs in positive climate action."

Richard Lindsay, Sustainability & Insights Manager, Birmingham County Football Association

The Birmingham Commonwealth Games (B2022 CWG) provided an opportunity to improve the way air pollution was considered within sustainability activities for large events. Modelling scenarios and daily air quality predictions ensured any potential pollution episodes were incorporated into delivery of, for example, endurance events in near-real-time. By providing support on air quality to the Organising Committee, WM-Air ensured that air quality was a key environmental focus of the Games and that any negative impacts of the event delivery/travel were minimised.

"Our athlete liaison teams in Games Family Services shared the daily air quality report, provided by the research team, and these were "very well received" by coaches and athletes. Atmospheric conditions are directly related to athlete performance, especially for distance or longer duration events, and sports performance specialists will consider this in preparation for an event. This daily report also supported information for the OC Medical team from a public health perspective and complimented the UK I support."

Ian Reid, CEO of the Birmingham 2022 Commonwealth Games Organising Committee (OC)

WM-Air was also involved in a **Defra-funded project with WMCA** supporting a new air quality sensor network (utilising WM-Air modelled maps to strategically to allocate sensors to improve air quality in areas with the highest pollutant concentrations); investigating pollutant 'hotspots' across the region (including targeted-monitoring to help identify relevant mitigation measures); providing quarterly commentary on air pollutant data from UoB's Birmingham Air Quality Supersite (BAQS) (data analysis is key in guiding action to help improve air quality within the West Midlands); provision of modelled datasets for the new WM air quality platform (to present the regional picture of air pollution to the public in an understandable and accessible way), and providing technical expertise on WMCA newly developed air quality literacy both for local authority officers and elected officials (helping push air pollution up the political agenda.) Additional funding from WMCA also enabled WM-Air to research and model a range of future scenarios in order to assess the realistic scope and impact of potential future regional "stretch" air quality targets, including with relation to inequalities.

Educational air quality resources developed by WM-Air have been downloaded by >300 teachers at 40 institutions, and have specifically been used by BCC as part of their **schools programme** to install air quality sensors and raise awareness, and by **Sandwell Council**, also inspiring the creation of their **'Aunty Duck' KS2 programme**. WM-Air's school work is being included as a case study on how/where Birmingham is supporting schools with resources and materials to help embed sustainability in the curriculum as part of a UoB COP30 case

study, and may also be included on DfE's proposed *Sustainability Support for Education* resources.

"The air quality education resources the WM-Air team created for schools is a great asset for secondary schools in Sandwell. This is a comprehensive package of resources that ties in with Key Stage 3 and 4 curriculum requirements. Promotion to local schools of these resources continues by our team and a link to the resources provided on Sandwell's air quality website page. The WM-Air schools' information pack inspired the production of air quality education resources for our Key Stage 2 air quality programme "Auntie Duck", aimed at increasing air quality awareness and promoting positive behaviour change."

Sophie Morris – Public Health Specialist (Air Quality and Climate Change) and Elizabeth Stephens – Air Quality Team Manager, Sandwell MBC

"WM-Air's schools' AQ resources will be utilised in the roll-out of phase 2 of the Council's Schools' AQ Monitoring Programme which will see an AQ sensor installed on the façade of every school in Birmingham over the next 12 months, building a vast network of data alongside provision of support to schools in encouraging safe and active travel and wider sustainability activities in their curricula."

Stephen Arnold, Head of CAZ, BCC

In additional to the modelling work, WM-Air conducted a qualitative analysis of **Low-Traffic Neighbourhood consultation responses for BCC** – before and after two LTNs were implemented – in order to explore the expectations and lived experiences of people within LTNs in Birmingham, finding that there are a range of diverse views and perspectives, that initiatives may undermine community cohesion and can disadvantage different groups of people . This work was quoted in press coverage. A mixed-methods analysis was also undertaken, finding that the Birmingham LTNs resulted in an increase in active travel and a (modest) reduction in air pollution after implementation, underlining the importance of comprehensive baseline data, long-term community engagement, and integration with broader urban planning initiatives to enhance their success.

3.1.4 Awards and Recognition

There were a number of **awards and recognition** associated with WM-Air including:

- The Urban Observatory (including WM-Air sensors) was nominated for THE Research Project of the Year (STEM) in November 2019.
- Suzanne Bartington was appointed Regional Clean Air Champion for the Midlands to North of England in 2021 and for the UK in 2022.
- WM-Air overall won the 2024 University of Birmingham Impact Award for 'Outstanding Impact on the Environment'.
- The CRVA mapping work was shortlisted for a regional Chartered Institution of Highways and Transportation award in Sustainability, and a national Chartered Institution of Highways and Transportation Research Award, where it was Commended by the judging panel. It also received special Recognition Award at the SEE Redefining Sustainability Conference 2024, Dubai.
- WM-Air air quality modelling was nominated for HPCWire Award for 'Best HPC Response to Societal Plight'.
- BCFA's Save Today, Play tomorrow' initiative – which WM-Air fed into in order to explore air quality co-benefits – has won 6 awards to-date, including the Kings Award for Enterprise.

3.2 Impact Delivered

Impacts describe the benefits or changes derived from WM-Air activities and use of WM-Air outputs and outcomes. Following REF, WM-Air defines impact as '*an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia*'. This includes impacts on activities, attitudes, perceptions, awareness, understanding, behaviours, capacity, opportunity, performance, policy, practice, or process, and on organisations, audiences, beneficiaries, communities, constituencies, or individuals.[22] For WM-Air this primarily covers the West Midlands area, but may also extend beyond to the wider-region, national or international perspectives.

22 SWEEP Impact Report

A ‘Pathway to Impact’ was developed to summarise how the WM-Air project achieved impact (Fig 20).

WHAT WE DO	WHO WITH	HOW THEY FEEL	WHAT THEY LEARN AND GAIN	WHAT THEY DO DIFFERENTLY	WHAT DIFFERENCE DOES THIS MAKE?
The key activities that are delivered	**Who is engaged and involved**	**How do they react to the activities, what is it that helped them engage positively**	**What knowledge, skills, capacity or attitude changes**	**What behaviours, policies or practices change**	**What is better for people of commuities**
Integration of clean air science into real-world applications across the West Midlands	Local and Regional Authorities (e.g. WMCA, TfWM, Black Country Consortium, BCC, CCC, Wolves, Walsall, Dudley, Sandwell, Solihull) Healthcare sectors (e.g. UKHSA, NHS England, UHB Trust, SWB Trust, UHCW Trust) Sporting associations (e.g. CWG, BCFA, Edgbaston Cricket) Civil Society (e.g. general public, media, schools/HE) Private Sector (e.g. The Floow, HEAT, Cundall, WSP, CERC, HS2, National Express, RSSB, Network Rail, Air Gradient, Mott Macdonald, Tyelsey Energy Park, Cenex, Bosch, Voi, Colmore BID, EarthSense) Charities/NFPs (e.g. Sutrans, NT, Canals and Rivers Trust, Clean Air Justice Network, IAWM/ SWM)	Supported Heard Informed Involved Confident	New tools and resources (e.g. AQ-LAT, AQ modelling, CRVA, AQ measurements, source apportionment) New skills, knoweldge and understanding (e.g. via training/CPD, briefing notes, public engagement) Increased capacity (e.g. network building, secondments, jobs created, new investments) Support to implement new policy/practice/activites (via co-development / design) to benefit the region Increased confidence and better opportunities	Research-informed decisions and actions taken to improve air quality (e.g. decisions based on modelling scenarios, air quality integrated into sustainability strategies, regional policy implementation, tool used in planning decisions, new stretched AQ targets) Operational practices optimised (e.g. new governance structure for framework, integration of new tools, outputs and guidance notes) People change their attitude and behaviours due to public engagement, education and awareness campaigns (e.g. more active travel and public transport, EV uptake, better burning practices etc) Access + utilise appropriate support, resources, tools and experties Co-creation/co-development with researchers (e.g. via secondments, 1:1 meetings) Better engagement with academics, industry and wider AQ networks (e.g. via community of practice events, meetings + events) Collaboration across regional local authorities to coordinate WM air quality policies (e.g. WM AQ Framework)	Improved health + wellbeing across the region (e.g. reduced mortality and morbidity due to lower emissions, reduced exposure, behaviour change) Cleaner air across the region and compliance with legal AQ values (e.g. lower emissons due to informed policy interventions) Less health inequalities linked to air quality More robust and aligned policy framework for the region Better informed and skilled population and workforce Economic growth (e.g. via jobs created, investments influenced, improved efficiencies) Better and more efficient policy and practice

Figure 20: The WM-Air Pathway to Impact vision

For the purposes of this report, in the following section we have highlighted examples for seven key impact themes – **Attitudinal**, **Organisational Function/Practice**, **Policy and Legislation**, **Human Capital**, **Environmental**, **Health and Wellbeing**, and **Economic**.

Some impacts occur in the **short-to-medium term** and have already been realised – particularly **attitudinal**, **practice**, **policy** and **human capital**. However, other impacts will continue to develop – particularly to the **environment**, **health and wellbeing**, and **economy** – and will occur in the years and decades beyond the life of the initial WM-Air funding, for example, as policy changes manifest. Where possible, we have included modelled projections of these impacts to capture where the work of WM-Air will have longer term impacts. We have taken a conservative approach to the impacts presented in this section, and their attribution to WM-Air. While the project is likely to have had a beneficial influence on all aspects of clean air strategies across the West Midlands, at least indirectly, due to our involvement with all local and regional authorities, we have only included work that we are certain can be attributed to the WM-Air activities, and only impacts realised to date.

Details of all projects leading to the impact described in this section can be found in Annex 3, and summaries of key impact case studies can be found here. Aggregate impacts of the entire WM-Air project are captured in (earlier) fig 4.

3.2.1 Attitudinal

Attitudinal impacts were evident across all WM-Air projects and engagement activities, with stakeholder shifts in **awareness**, **perceptions** and **understanding** of air pollution and related issues. Attitudinal shifts are the first step in the impact pathway/change theory leading to subsequent changes in practice and policy.

General Shifts in Attitudes

Overall feedback sought from external stakeholders via an Impact Evaluation Survey (Annex 10) was very positive, indicating that:

- 83% completely agree that engaging and collaborating with WM-Air has resulted in them learning something new (with the remining agreeing somewhat).
- 83% completely agree that their involvement with WM-Air has resulted in them developing useful relationships with others (with the remining agreeing somewhat).
- 58% completely agree that engaging with WM-Air has made them think differently about air pollution and health (with the remining agreeing somewhat).
- 92% completely agree that engaging with WM-Air has brought fresh perspectives/innovative solutions to air quality issues (with the remining agreeing somewhat).
- 58% completely agree that their organisation has taken action as a result of having engaged with the WM-Air project.
- 75% completely agree that their organisation will take action as a result of having engaged with the WM-Air project (with the remining % unsure, or neutral).
- 50% agree that senior management in their organisation have changed their thinking as a result of the WM-Air project (with the remining % unsure, or neutral).
- 50% agree that senior management in their organisation have changed the way they are doing things as a result of the WM-Air project (with the remining % unsure, or neutral).
- 92% completely agree that their organisation will continue to collaborate with the University of Birmingham on air quality and health.

Stakeholders and Partners

WM-Air enhanced the understanding of air quality issues, in general and specific to the West Midlands, for stakeholders and partners via **knowledge exchange events and activities**, as described in Section 2. These events have reinvigorated the community and resulted in positive attitudes and working practices across the region.

"After the disconnect we experienced throughout the COVID lockdowns and increased remote working the WM-Air face to face meetings and events enabled our WMEPG members to reconnect with each other and network with new and existing contacts. This has inspired us with the latest ideas, exchanging successes (and failures) and providing us with new motivation. This is impossible to measure and quantify suffice to say that we have always felt energised and positive from each event, and we are incredibly grateful."

Steven Dewar, Environmental Protection Officer, Coventry City Council

Feedback from events indicate learnings and influences that shift the day-to-day activities of delegates, from use of tools to greater awareness of new scientific understanding.

"Greater awareness of amount of particulate pollution relates to different sources and how much control we can have over those sources"

"It has given me further new perspectives on how to tackle air quality challenges and embed it into our work."

"Greater focus on $PM_{2.5}$ as part of day-to-day deliberations"

"Opportunities have arisen for use of existing air quality sensor stock within the West Midlands, as well as seeking advice from expertise on our project idea."

"Ability to use research presented at the event to demonstrate scientific evidence that supports the air quality measures that we want to introduce or are in the process of introducing."

"AQ-LAT and AQ-PET talks identified tools that we can use to help add additional details to our project."

"Encourages my enthusiasm and motivation working with colleagues who care passionately about improving air quality, always a positive and beneficial experience and time well spent! Thanks! "

"Further collaboration within WMCA to ensure greater partnership between TfWM and the Environment team to work together"

"Enables to me to discuss the latest information and argue the case for clean air interventions."

"By gaining a greater understanding of the latest research findings, I can shape the next iteration of the Brum Breathes Clean Air Strategy accordingly, alongside relevant policy decision making"

"It is excellent to be equipped with the latest research on air quality in the region, I am a nerd at heart but do not have the time to be keeping up to date with reading the latest research – so having it presented to you in an engaging way is super valuable. This gives me more confidence when making decisions – because I have a better understanding of the regional picture."

A selection of anonymous feedback from Annual Meetings and Community of Practice events

WM-Air also held several focused briefing sessions, for example with **West Midlands Councillors**, exploring the impact of air quality on public health, the issue of $PM_{2.5}$ air pollution in the West Midlands, the use of green infrastructure, and the impact of reducing motorway speed limits and electrification of the West Midlands bus fleet. These resulted in greater understanding of the issues and built a consensus of support for subsequent policy measures (e.g. the WM Clean Air Framework).

"These have all generated significant interest, understanding and support of councillors on sustainable urban transport strategy and how it can improve air quality."

Mike Waters, Director of Policy, Strategy and Innovation, TfWM

There has been a **shift in local and regional priorities** away from primarily focusing on transport as the main source of air pollution (specifically NO_2 from exhaust emissions and policies such as clean air zones), to $PM_{2.5}$ and domestic combustion (woodburning) – reflecting the key determinants of poo health. There is improved recognition of the significant inequalities that exist in terms of air quality exposure and resulting health and well-

being implications across the region, which are being addressed in new policies (see Section 3.4.3). These changing attitudes have been driven by WM-Air tools and insights, such as modelling and source apportionment results, as well as through knowledge exchange, partnership work, event presentations and briefing notes, and have ultimately impacted policies and practices across the region.

"Birmingham City Council's on-going collaboration with WM-Air has been key to addressing the challenges it faces in improving the air quality for our city …we are building a deeper understanding and awareness of the sources of air pollution and the actions we can take to improve it which will directly translate into the next iteration of the Brum Breathes Clean Air Strategy."

Steve Arnold, Head of CAZ, BCC

"[The co-developed options paper] highlighted:

- **The importance of tackling particulates as part of our work on air quality, especially $PM_{2.5}$.**
- **That poor air quality was still a transport issue, but that we would need to start to look beyond that and begin tackling domestic and industrial combustion.**
- **That there are significant health and well-being impacts in the region from poor air quality (supported through data in the AQ-LAT tool, developed as part of the WM-Air work).**
- **That there is significant inequality of exposure to poor air quality in the region (identified in the WM-Air modelling) and that this will be important to address in our air quality work"**

Jackie Homan, Head of Environment, WMCA

"WM-Air engagement and exposure to its research findings has made me think differently about pollution and health. It has bolstered my ambition to act and also given me confidence to tackle those more difficult issues and actions. By producing much needed technical guidance, I have felt supported in my air quality activities. WM-Air has changed my perception and how I interface with others. While it is not possible to quantify or evidence these improved perspectives, within a council framework (and a tendency for silo working) this cross-party appreciation of others work areas and challenges has made a real and significant difference in how I work with colleagues."

Amanda Clover, Solihull Council

"Engaging with WM-Air has made me think differently about air pollution and health through an increased scientific approach."

Steve Dever, Coventry City Council

Public Awareness and Attitudes

- **The Air We Breathe (TAWB) exhibition** visitors were asked to state something they would do differently after visiting TAWB, with 1300 making a pledge – 43% of these stated they would make changes to their choice of transportation, either to walk or cycle for local journeys, use public transport instead of driving, or reducing use of diesel vehicles.

"Great event, our children and adults learned so much and had fun. Thank you"

"We have learnt a lot these few minutes. Thank you and the kids had fun. Joseph."

Sample of anonymous feedback from TAWB exhibition of public programme attendees

- For the **Sounding Out Pollution (SOP)** public engagement activity, 24 audience feedback surveys were completed, with 83% stating that the compositions successfully communicated where and when they might encounter less exposure to air pollution, with 62.5% stating that the exhibition had inspired them to consider actions to reduce

their own emissions and/or their exposure to air pollution. The three SOP videos have been viewed 1,110 times on YouTube.

"The sound compositions communicate the 'ominous' nature of poor air quality very well. Really impactful."

"Really thought provoking!"

"The 2nd video ('Pick Your Moment') directly made me think about when is the best time to go out for my daily run. This was reinforced by the 3rd video. The messaging for the first 'Location Matters' video seems more obvious although the last slide is pretty powerful. All can be summed up as Avoid The Traffic!!!"

"The directness and perceived simplicity of the mapping of the sounds to the data are really effective and communicating. I particularly like the particular sounds of the particulates"

Selection of anonymous feedback

- Feedback concerning the **WM-Air educational resources** captured their use for building awareness in schools and the community, both within the West Midlands and further afield.

"I want to organise an awareness campaign in public schools and highschools."

"Planning to use it in sustainable development initiatives in school as part of whole school projects and for teaching of how to use GIS"

"This was understandable information I could share with participants on our walks and cycling around Birmingham."

Anonymous feedback from users of Educational Resources

- The WM-Air Team supported the WMCA's work convening the **Greener Together Citizens' Panel** (this comprises 30 people who, statistically, 'represent' the West Midlands) discussions. One of these was focused on Air Quality, which resulted not only on improved awareness of issues for the citizen panel members, but in the production of a set of 'guiding principles' for policymakers when developing air quality projects. Another was focused on Climate Adaptation to help shape research outputs and next policy steps for the WMCA (linked to the WMCA CRVA).
- WM-Air provided input into regional **behaviour change campaigns**: One of the key outcomes of the (Defra-funded) behaviour change and engagement campaign is to support the understanding that poor air quality is an issue, and appreciation of what can be done to reduce exposure. WM-Air provided input and support including: 7 in-depth behaviour change campaigns (completing in March 2025); 21 community outreach/engagement events (completing in March 2025); a communications toolkit and assets developed to support local authorities with consistent messaging about air quality.

"The research WM-Air has conducted to date has shaped the behaviour change trials and communication materials we've created for the Defra Air Quality Project."

Katie Jepson, Environment Behaviour Change Project Officer, West Midlands Combined Authority.

WM-Air worked in partnership with **Sandwell Metropolitan Borough Council** and local citizens on a LGA-funded climate innovation project to develop a 'Leaving No-one Behind' Climate Champion toolkit, building upon the successful model of Sandwell's award winning COVID Champions programme. A cohort of ~120 Community Climate Champions were created, consisting of community members from schools, faith centres, NHS staff, Council staff, Councillors and other members of the public. The Champion group received a bespoke training programme, comprising of a workshop series focusing on communicating different aspects of climate change behaviours, and material with key goals and actions for the wider public to take with a timeline. Academic evaluation led by WM-Air used qualitative and quantitation data obtained before and after the training programme in order to measure changes in attitude towards climate change, lessons learned and behavioural shifts. Sandwell are now modelling a community research champion programme on the work.

- It is difficult to quantify the precise attitudinal impact, but awareness-building engagement activities at **sporting events** – CWG B2022 and Edgbaston Cricket's Go Green Game – influenced

thousands of spectators, athletes, families, and workers (plus many millions more via air quality engagement through baton relay which visited 72 nations and territories globally).

- **Online communication** via the WM-Air website (18k views, 5.1k visitors from 73 countries) and social media (420 followers) will also have played a role in influencing the public via promotion of outputs and communication/awareness building, but beyond statistics such as followers and post views, it is difficult to determine the precise shifts in attitudes linked to this platform. Similarly, there were >650m views of >150 media pieces linked to WM-Air, but difficult to quantify the precise attitudinal impact. Awareness-building media input included a series of WM-Air articles and videos for the Birmingham Mail on air quality in Birmingham which received ca. 830k views.[23]

3.2.2 Operational Function and Working Practices

WM-Air influenced the operational functions of our external partners via improved capacity and productivity brought about by utilising outputs, creating jobs, and working collaboratively to secure income and change working practices. Overall, 50% of surveyed external partners stated that impact on operational function had already been realised; whilst 50% stated was impact not yet realised, but under development with potential for longer-term impact.

Business cases/investments influenced

The total investments influenced or leveraged (£47.2m) is captured in Section 3.3.2. A major example of influencing business cases and investments is through our work with WMCA, particularly though the **£1m Defra funding**, and subsequently the **£500k capital grant committed by DLUHC** to expand the West Midlands air quality sensor network, and the further **£370k committed by WMCA** to support the implementation of the Framework, showing the national and regional support for ongoing, integrated clean air activities.

> **"The Defra funding has also been boosted by additional money coming from DLUHC (£500k) to expand the low-cost sensor network further. An additional £370k has been committed, by the WMCA, following the approval of the final Air Quality Framework and Implementation Plan at the November 2023 WMCA Board."**
>
> *Jackie Homan, Head of Environment, WMCA*

Specific examples of investments include (Annex 6 – full list of income generated):

- **UKRI Creating Opportunities, Improving Outcome (COIO) funding (£207k)** was obtained for the expansion of the CRVA to the West Midlands.
- **DfT-funded (£600k) projects** 'Towards a digital twin for urban transport and Towards a mobility digital twin', to incorporate the AQ data into a national urban transport platform, and to explore the potential for digital twin demonstrators based on AQ data.
- **NERC SPF- funded (£500k) TRANSITION** Clean Air Network to optimising air quality and health benefits associated with a low-emission transport and mobility revolution in the UK and to address emerging indoor/outdoor air quality challenges across UK surface transport.
- Various **Research England-funded (>£100k)** activities to expand the impact work of the WM-Air team, including 'An in-depth analysis of the efficacy of the Clean Air Zone (CAZ) on air quality', 'Evaluating the effectiveness of London Low Emission Zone (LEZ) and Ultra Low Emission Zone (ULEZ): evidence from Machine learning and Econometrics', and 'Sustainable Urban Planning To Mitigate Overheating (SUPMO)'
- Net Zero Innovation Partnership with Sandwell Metropolitan Council: WM-Air worker in Partnership with Sandwell Metropolitan Borough Council and local citizens on an **LGA-funded (£30k)** climate innovation project to develop a 'Leaving No-one Behind' Climate Champion toolkit, building upon the successful model of Sandwell's award winning COVID Champions programme.

23 https://www.birminghammail.co.uk/news/midlands-news/scandal-silent-killer-cuts-short-27998018
https://www.birminghammail.co.uk/news/news-opinion/what-found-measured-air-pollution-27994664
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https://www.birminghammail.co.uk/news/midlands-news/revealed-exact-time-youre-most-28016065
https://www.birminghammail.co.uk/news/midlands-news/5-things-you-can-improve-28026674

- Funding for **placements and secondments** valued at ca. £30k were also leveraged (with £50k in-kind), including a transdisciplinary placement with UHB NHS which focused on assessing public health impacts of the Birmingham Clean Air Zone, and secondments with WMCA to support the development of the air quality framework.

A large amount of funding (>£10m) has also been directly leveraged to continue and expand on the work initiated by WM-Air – these projects are discussed in the Legacy Section (5).

Jobs created/safeguarded

WM-Air directly influenced the creation of **17.5 FTE jobs** (i.e. via initial or additional funding, or WM-Air recommendations). This figure reflects jobs created through WM-Air itself and at partner institutions, and is estimated to represent ca. **75 job years** over the 6 years of the programme.

- University of Birmingham – 12 WM-Air technicians/ Impact Fellows and a project manager employed as part of WM-Air, and 1 P/T secondment from BCC to WM-Air
- WMCA – 1 air quality project lead linked to the Defra-funding; 1 P/T secondments from WM-Air and 1 F/T secondment from WSP linked to the WM AQ Framework.
- Solihull – 1 new air quality officer (influenced by WM-Air)
- UHB – 1 new sustainability officer (influenced by WM-Air)
- CWG – 1 P/T secondment from WM-Air

WM-Air also led to the creation of 25 PhD, MSc projects and summer studentships/internships.

*Note – Regional economic accounts modelling was commissioned to support WM-Air's evaluation of impacts, and is reported in **Section 3.4.7 – Economic Impacts**. This economic evaluation provides an additional estimation of Gross Value Added (GVA) and jobs created due to WM-Air's leveraged funding and investments influenced.*

"Development of the WM-Air networking programme and its earlier sessions coincided with Solihull's identifying a need for a more strategic (and regional) approach to air quality. Senior management subsequently supported the realignment of posts and a dedicated air quality role (Senior Development Officer – Air Quality) has now been created. The new post combines the technical aspects of air pollution monitoring, assessment and reporting with a more strategic approach, and has opened up new technical support work for policies and procedures. This is a positive change towards a more integrated council function. The new technical role sits side by side with its Public Health Counterpart (Senior Public Health Specialist (Healthy Places)) and this is a much-improved way of working closely across disciplines. Officers who take up both of these roles have been WM-Air attendees from early in the WM-Air programme and their journey to partnership working has been helped tremendously by WM-Air support."

Amanda clover, Solihull Council

"As a result of the work and funding, three roles were created from Sept 2021 up until now: Joe Acton (WM-Air Impact Fellow) joined the Environment Team on a 5 month secondment; Alex Jones (Air Quality Consultant at WSP) joined the WMCA Environment Team on a 1 year secondment; and, Elle Winning is the current Air Quality Project Lead in the WMCA Environment Team leading the delivery of the Defra and DLUHC-funded projects."

Jackie Homan, Head of Environment, WMCA

New local and regional operational structures and practices

- **New ways of working within Local Authorities**: Local Authorities have adopted news ways of working to tackle air pollution and exploit co-benefits by collaborating across departments and teams – such as environmental protection, public health, planning, climate – many of which traditionally worked in a somewhat disconnected manner.

"Fundamental to development and delivery of the updated Brum Breathes Clean Air Strategy is the need to take a multi-agency, cross-cutting approach that recognises the policy benefits of improving air quality to be gained by other teams such as Net Zero, Planning, Future Parks, and Environmental Protection; through our close working with the University, we are taking a structured, collaborative and supportive approach to improving air quality that will result in much wider benefits across broader policy areas. I look forward to continued collaboration with the WM-Air and WM-Net Zero Teams to deliver positive change for Birmingham."

Stephen Arnold, Head of CAZ, BCC

"Working with academia, WM-Air, and UoB we can build an evidence base to justify to senior politicians, cabinet members, senior managers and directors, this evidence base is the justification for new ways of working."

Steve Dewer, Coventry Council

"My involvement with WM-Air has improved my contact with other teams and officers, even within my own council and attending events in tandem with said officers has meant we have gained a greater 'shared' knowledge and understanding which should not be underestimated. I now work very closely with Public Health colleagues on every aspect of AQ work."

Amanda Clover, Solihull Council

- **Improved relationships between local authorities**: WM-Air has helped to broker better working relationships across the region, primarily via engagement and networking events, partnership activities such as developing regional air quality policy and supporting local air pollution actions.

"It makes a huge difference knowing what our neighbouring LAs (and the wider region) are up to in terms of AQ, but more than that, it's the ability to ask colleagues directly at an event about the latest progress on a particular project. The added bonus is we have both WM-Air and WMCA experts to hand, invaluable."

Anonymous feedback at WM-Air Event

Collaborating with WM-Air has strengthened the Authority's position in the region."

Sally James, BCC

"Officer involvement in WM-Air projects has helped Solihull achieve closer working with neighbouring authorities and further its standing within the West Midlands.

WM-Air have held numerous seminars, workshops and events that have allowed and facilitated important cross working arrangements, and they have enabled closer working between other regional facilitators and organisations like the WMCA, to help (for example) facilitate and enable economy of scale investment and equipment deployment."

Amanda Clover MCIEH CEnvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council

- **New regional governance structures**: Closer working between the local and regional authorities has developed due to the establishment of a region-wide air quality framework and implementation group (the Regional Framework is discussed in Section 3.4.3) and subsequent investment. Prior to this, the 7 local authorities worked very much in silo, and air quality was mainly considered a transport issue, covered by TfWM. The work of WMCA working in collaboration with WM-Air to develop an air quality framework has led to new governance structures, led by WMCA with support from the local authorities and overseen by a framework implementation group. The WM-Air Team will continue to play a significant governance/guidance role in this going forward, as members of the Framework Steering

Group and through ongoing activities such as the Defra-funded Air Quality project which has enabled WMCA and regional partners including UoB and the seven constituent local authorities to take a collective approach to tackling air pollution within the region.

"Up until June 2021, work on air quality in the region was covered by the 7 constituent local authorities that make up the WMCA (Birmingham, Coventry, Dudley, Sandwell, Solihull, Walsall and Wolverhampton) and Transport for West Midlands (TfWM). The work undertaken had mainly focused on delivery of Air Quality Action Plans (as required by Defra) and reduction of emissions from transport."

Jackie Homan, Head of Environment, WMCA

- **Positive academic-public partnerships**: Air quality has been centralised across many local authorities in terms of a key input to all policy – the support of WM-Air has enabled local authorities to embed and solidify this further.

"The big learning point was just how much benefit can be brought by a strong public–private partnership that the WM-Air project evoked. I feel this is in some ways a confirmation bias in that I expected the WM-Air project to deliver tangible outputs that could help the partnership to apply knowledge in a productive way; the real eye opener however was just how far that could be developed and that is a credit to the development and delivery of the programme through the leadership team. So, the 'thinking differently' is really about the benefit that can be leveraged from such relationships; in the form of the combined total eclipsing the sum of the parts so to speak."

Mark Wolstencroft, Operations Manager Environmental Protection, BCC

Capacity-building

- **Knowledge exchange and networking at events and workshops** allowed for the sharing of best practice and networking to strengthen the air quality community.

"Knowledge sharing across professional sectors via project workshops and events allowed sharing good and new practices."

Sam Chapman, The Floow

- **Use of guidance notes by practitioners to inform best-practice**: The experience of setting up a high density network of low-cost sensors across the region provided the team with a unique opportunity to develop best practice guidance on the procurement and deployment of low-cost sensors for air quality. The resource has been accessed >150 times (with >5000 impressions on LinkedIn and >2500 views on Twitter). Wider exposure was then obtained by the publication of an abbreviated version in the commercial air quality procurement guide (> 1,500 copies were printed and distributed to recipients in local authorities across the UK, and the digital version of the Procurement Guide was sent to a further 9,000 recipients.) The aim of this best-practice guidance note is to improve understanding of low-cost sensors and appropriate procurement/deployment via low-cost sensor guidance. This has also unlocked government funding (totalling £600k) for two projects with the Department for Transport to develop best practice in terms of data curation to underpin the proposed national digital twin. Air quality, in particular, low traffic neighbourhoods, were developed as use cases.
- **Use of tools and briefing notes in air quality assessments**: WM-Air model output has been used to inform Cundall's methodology for air quality assessments in the West Midlands for pilot case studies, and Haze Environmental's air quality assessment reports for planning.

"These outputs from the regional dispersion modelling have been of great benefit to inform exposure assessments for Cundall Air Quality assessments in the region. Cundall have been able to reference this data, having agreed the text to be used in our reports, to credit the research team at the University. Cundall have been able to apply the data in our geographical information system (GIS) mapping and generate figures to display the data"

Jenny Carrington, Associate Air Quality Consultant, Cundall Johnston & Partners LLP

['First Steps in Air Quality for Built Environment Practitioners' and 'Urban design for air quality' briefing notes] "helped with my air quality assessment reports for planning."

Chloe Fellows, Haze Environmental (Consultant)

- **Impact of tools on local and regional decision-making**: Without the CRVA development, BCC and WMCA would not have the realised capacity to scrutinise climate risk in more detail in all aspects of critical decision-making, particularly planning. For example, the Birmingham CRVA is featured in BCC's Green Infrastructure planning document, 'The Green Infrastructure Master Plan for Birmingham', which is the blueprint to create the biophilic relationship between nature and the city underpinning the BCC City of Nature Plan.

"The CRVA work is now feeding into the development of the Local Nature Recover Strategy, being utilised through socialisation of the Birmingham Urban Forest Master Plan 2021-2041 to inform work with local communities in understanding local climate impacts and the need for trees and urban greening and as an evidence base to support the integration of new planning policy (as part of the Local Development Plan Review) such as the Urban Greening Factor."

Simon Needle, BCC

The WMCA CRVA has also informed numerous actions in the WMCA Internal Climate Adaptation Plan 2024, and will feed into local Nature Recovery priorities, internal functions, and programmes such as Net Zero Neighbourhoods, in order focus adaptation actions and advocacy.

"WMCA colleagues who have had no prior awareness of the geographic spread of climate hazards and social vulnerability across the region will now use the CRVA to identify where their respective assets and projects fall into areas of concern. Items that teams across the WMCA intend to overlay CRVA data with include: WMCA's operational and strategic assets; The WMCA Cultural Infrastructure map; Adult education facilities and providers; WMCA's net zero neighbourhoods; Local nature recovery priorities. These upcoming uses of the CRVA outputs will enable WMCA teams to identify which places fall within an area of concern and therefore warrant focused adaptation action and advocacy relative to their policy area."

Bethany Haskins-Vaheesan, Climate Adaptation Project Officer, WMCA

Prior to the CRVA work, TfWM did not have the evidence base needed to identify transport network vulnerabilities to climate hazards–the transport-focused CRVA now brings nuances to their understanding of climate vulnerability with the inclusion of criticality weightings for specified transport networks and nodes. This means that TfWM and transport partners not only have a greater understanding of where climate hazards might fall across the network but also which of the most critical infrastructure is most at risk from each hazard type.

"Without the NERC funding and WM-Air's willingness to meet with transport colleagues regularly to co-develop and interrogate the model, we would not have a starting point that is owned and understood by transport colleagues who, until this project, had little awareness of how climate adaptation might be prioritised on our networks."

Bethany Haskins-Vaheesan, Climate Adaptation Project Officer, WMCA

- **Use of new data for better understanding of local air quality issues**: For example, a number of air quality activities at Solihull (actioned in their Air Quality Action Plan) were influenced either been directly or have been supported by WM-Air, such as

the interpretation and dissemination of modelling findings, to support Solihull's deployment of the WMCA low cost sensor network (previously Solihull had limited monitoring capabilities) and additional investigations on modelled hotspots.

"The research has contributed to both local and regional recognition of the air quality issues (for NO_2 and $PM_{2.5}$), within the borough and across the West Midlands and provided extensive spatial modelling and mapping. The WM-Air team have ensured they provide continued support to Solihull Council's air quality ambitions throughout the research project and have endeavoured to help better understand the nature and extent of air quality hotspots."

Amanda Clover MCIEH CEnvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council

Coventry City Council used insights from WM-Air monitoring and modelling in discussions around planning applications, informing housing developments and exploring the impacts of traffic interventions along Foleshill Road.

"The planning design guidance for has been useful in assessing planning applications and explaining design requirements to planners and urban design, architects. Helping to raise awareness of air quality and design approaches for new builds including large scale residential, 16 storey apartments, 500+ dwelling housing sites.... The existence of the sensors means that we may be able to use future data in reference to planning applications and addressing issues of development in areas of high PM pollution."

Steve Dewer, Environmental Protection Officer, Coventry City Council

- **Input into specific programmes of work**: WM-Air provided modelling, expertise and guidance for the air quality, urban heat and green infrastructure aspects of the **Colmore BID & Retail BID 'Going Green Programme' Masterplan**. This masterplan has the ambition to visibly manifest green infrastructure across spaces in both BIDs to impact on carbon reduction, improve air quality and above all create engaging series of pieces that will attract workers, visitors and shoppers back to the central part of Birmingham. WM-Air provided modelling input for developing the River Sherbourne as part of **Coventry's Cultural Programme** – the WM-Air model was used to explore the air quality around the High Streets Heritage Action Zone (a national demonstrator project), focused on the Palmer Lane site within the Coventry Ring Road. This allowed the local pre-development air quality to be assessed, as there is currently a lack of air quality measurement sites in the vicinity of the development.
- **Influence and insights for sport sustainability measures**: WM-Air was involved in a number of sport sustainability projects in order to encourage the incorporation of air pollution as a co-benefit of climate/carbon reduction measures: **B2022 CWG** provided an opportunity to influence the way air pollution was considered within sustainability activities for large events. By providing support on air quality to the Organising Committee, WM-Air ensured that air quality was a key environmental focus of the Games and subsequent analysis highlighted that any negative impacts of the event on air pollution were indeed minimised. The team also supported **BCFA's** 'Save today, play tomorrow' initiative – initially a carbon-focused initiative–by using air quality and emissions data to explore the impact of football-related travel on air pollution, and explored how measures may have a positive impact. Subsequently, WM-Air were invited to monitor the impact of **Edgbaston Cricket's** 'Go Green Game' – their first Sustainability Match Day on 3rd September, 2023–to assess to impact of a public-transport-only approach on air quality (analysis currently in prep.)

"We wanted to explore how hosting a major sporting event impacts local air quality – and how local air quality can impact a sporting event. In a first for the Commonwealth Games, and together with the University of Birmingham through its WM-Air air quality improvement programme, we set out to capture the daily state of play air quality-wise and to share this information with medical teams and athletes to help with their preparations. Air quality was measured through instruments at a permanent site close to an Athletes Village and hockey venue, an array of air quality measurement devices at the Alexander Stadium and stationary devices at the Alexander Stadium and Edgbaston Cricket Ground."

Quote from CWG Sustainability Report

- **The use of monitoring and evaluation to inform healthcare air pollution interventions**: The NHS Long Term Plan recognises the need for NHS services to take action to mitigate air pollutant emissions, including those arising from site activities and patient, visitor and staff travel. However, undertaking air quality monitoring and implementing targeted air-pollution interventions can present organisational, financial, and logistical challenges. In 2020, WM-Air was invited to submit an NO_2 case study around the Queen Elizabeth hospital, which was submitted to the NHS Net Zero Call for Evidence 2020. Subsequently, WM-Air assessed the feasibility of small form monitoring (diffusion tubes and sensors) for evaluating local air quality interventions in healthcare settings, via an assessment of a localised traffic management scheme aiming to reduce local air pollutant concentrations at QEHB. Working with UHB NHS Trust, WM-Air conducted a package of activities including evaluating UHB's Clean Air Hospital Framework, AQ monitoring (sensors and diffusion tubes) and analysis using the Health Outcomes of Travel Tool (HOTT). This work package provided a range of intervention recommendations (via a briefing paper and journal paper), some of which were approved and adopted by UHB Board Members and subsequently included in the UHB Green Plan and implemented by UHB. This included a recommendation for a Sustainability Officer who was appointed, improved cycle parking and changes to bus drop-off route around entrance a hotspot. They also promoted alternative travel modes including partnership with National Express facilitated a modal shift away from single-car occupancy, leading to a substantial reduction in single-car journeys to our sites and contributing to improved air quality, and improvements to on-site cycling facilities (e.g. secure bike storage trust wide and locker rooms, and shower facilities) to create an environment that encourages staff to cycle to work, which has also contribute to a noticeable decline in the use of personal vehicles at UHB sites. Following on from this work, WM-Air NHS monitoring guidance was distributed to all WM NHS Trusts, which resulted in follow-on partnership work with SWB Trust and UHCW Trust (for their own Green Plans).

"The data and guidance provided by WM-Air have been instrumental in informing our strategies and shaping our policies to encourage active travel."

Mrs. Kawun Williams, Head of Sustainability – Strategic Developments, Sustainability & Property (SDSP), UHB NHS Trust

- **New impact evaluation approaches**: The Wellcome Trust WM-Net Zero project is now utilising WM-Air tools, guidance and proformas. There are also plans to disseminate these resources more broadly within the university.

3.2.3 Policy and Legislation

Policies and legislation were influenced both at the local and regional level, but with some reach to national and international levels. To date, nearly 100 policies, pieces of legislation and regulations have been influenced directly and indirectly via consultation responses, through citations of WM-Air publications and briefings, and via collaboration or direct expert input into development (Annex 13).

Overall, 33% of surveyed external partners stated that policy impact had already been realised, whilst 50% stated impact was under development with potential for longer-term impact.

Influencing Regional Policy and Legislation

Regional Air Quality Policy (*KSM 5 + 8*): The first West Midlands-wide Air Quality Framework was co-created by WM-Air and the WMCA to improve air quality for the 2.9m residents. Prior to this, action

to improve air quality was delivered by the seven constituent local authorities that make up the WMCA (Birmingham, Coventry, Dudley, Sandwell, Solihull, Walsall and Wolverhampton) and Transport for West Midlands (TfWM), in a fragmented manner, with the work mainly focused on delivery of Air Quality Action Plans (as required by Defra) and reduction of emissions from transport – with an emphasis of NO_2 compliance, rather than health, and limited consideration of $PM_{2.5}$.

In 2021, building on dialogue involving WM-Air project, WMCA began developing an AQ framework, with WM-Air (via a co-funded Impact Fellow policy placement) developing the initial '**options paper**' to identify activities complementary to existing local and regional air quality strategies, scope opportunity/return for the region, bring together an evidence base and a propose range of options for a future air quality strategy (including input from WM-Air tools and models). WM-Air worked with stakeholders at WMCA, TfWM and LAs to identify effective potential actions to improve AQ and health, and areas not covered by prior local AQ strategies; provided expert commentary and a series of briefings to groups of elected members/officials to develop understanding and political/ technical buy-in; brought together an evidence base to support a future AQ strategy which established the health impacts of poor AQ in the West Midlands; quantified the health/ healthcare economic benefits of AQ measures under consideration; and explored issues impacting AQ which were neglected in current strategies (including place-based environmental inequality across the region). Following-on from consideration of the Options Paper by the WMCA Board (11 Feb 2022), a fully-costed **Air Quality Framework** and **Implementation Plan** was developed, through collaboration with WSP (environmental consultancy) working closely with WM-Air for input, advice, guidance and support for the appraisal of the 145 identified options. The AQ framework was approved in Nov 2023 and Defra-funding (£1m) was obtained to supporting the implementation of initial actions. The Framework positions the region to deliver science-informed air quality policies, specifically focusing upon $PM_{2.5}$, and links the science understanding provided through WM-Air with policy shifts arising from the 2021 national Environment Act. This work has been accepted for publication as a *WHO Strategic Action for Urban Health* case study (in prep).

WM-Air team are currently funded by WMCA (**£24.7k, 2023-2025**) to explore the possibility of adopting a '**stretch target**' for regional air quality improvements that would see reductions in pollutants ahead of those identified (set) by UK government.

> **"The reality is, that very little of this would have been possible/achieved without the support from WM-Air. The work on air quality has been accelerated significantly because of the investment of time and resources from the programme. The Impact Fellow role has been of critical importance in the development of the air quality work, providing trusted support and input to the development of policy and strategy."**
>
> *Jackie Homan, Head of Environment, WMCA*

Regional Transport Policy

A **Briefing Paper** on the impact of COVID-19 lockdowns on air quality was provided to BCC, TfWM and WMCA for advice and guidance purposes, and is cited in **WMCA Transport Delivery** Committee Report (June 2020).

WM-Air has provided input – via modelling scenarios–into the development of the new **West Midlands Local Transport Plan 5** (LTP), for development of area strategies and identification of priority corridors for new rapid transit lines to 2036. Work provided information on which areas of the West Midlands are more sensitive to transport sources of air pollution: where population exposure is highest, and where transport is the highest polluter. This will assist in the development of programmes of transport schemes and measures to improve air quality, alongside identifying the impact on air quality from reductions in transport carbon emissions, supporting promotion of sustainable travel use in the West Midlands. The WM-Air work supported the identification of priority corridors and longer-term proposals for new rapid transit lines (November 2022–January 2023). This was an important part of the development of the consultation draft "**Big Move**" strategy chapters of the draft LTP which are being refined for publication in 2025.

"Mott MacDonald consultants performed multi-criteria analysis on behalf of TfWM. The multicriteria analysis included an assessment of whether potential rapid transit routes would serve areas of poor air quality. Data supplied by WM-Air was of great use to support this aspect of the assessment. If WM-Air data had not been used, a much cruder assessment of whether potential rapid transit routes served a local authority Air Quality Management Area would have been used."

Mike Waters, Director of Policy, Strategy and Innovation, TfWM

"Overall, the WM-Air Project has brought together local and regional efforts to improve transport-related air quality. It has provided a greater understanding of air quality issues faced by the transport sector and, for example, through mapping of NO_2 and $PM_{2.5}$ levels, has helped embed air quality strategy into the thinking of transport strategy."

Mike Waters, Director of Policy, Strategy and Innovation, TfWM

The WM-Air Urban Design Charter outlined the role of green infrastructure in improving public health outcomes related to lower exposure to air pollutants. Presentations by the WM-Air Team on the role of green infrastructure were provided to WMCA councillors: WMCA's Transport Delivery Overview and Scrutiny Committee TDOSC (22 January 2024) and the Committee's sub-group ("Member Engagement Group") which considers air quality issues (Air Quality, Congestion and Environmental Impact MEG), resulting in incorporation of the 'Reduce, Extend' Protect' principle into the draft **West Midlands LTP**.

"The presentation to TDOSC on 22 January 2024 led to the Committee making the following resolutions:

(1) The committee Welcomed a presentation by WM-Air, University of Birmingham.

(2) It was recommended that TfWM officers developing West Midlands Local Transport Plan (i) Incorporate, in relevant sections of the Plan the "reduce, extend, protect" principle, to support the role of green infrastructure in urban transport design for air quality; (ii) Review the draft "Green Transport Revolution" Big Move Chapter to ensure it effectively encompasses the role of green infrastructure in supporting climate resilience in the West Midlands."

Mike Waters, Director of Policy, Strategy and Innovation, TfWM

Regional Planning Policy

The WM AQ Framework integrates work on planning and the natural environment, including working towards a consistent "best practice" planning document that local authorities can use in their own planning guidance. WMCA are the responsible authority for the region's Local Nature Recovery Strategy, and the Framework provides some clear actions/delivery priorities as that work is rolled out.

Furthermore, the WM CRVAs are holistic decision-support tools, allowing climate risk to be scrutinised in more detail in critical decision-making for planning, enabling WMCA teams to identify which warrant focused adaptation action and advocacy relative to their policy area. WMCA submitted its first adaptation report submission as part of the Government's Fourth Round of Adaptation Reporting Power (ARP4). The CRVA is referenced in current, planned, and potential planning related actions, including:

- Greater inclusion of climate resilience in WMCA's upcoming design charter update, with reference to the WM-CRVA (planned).
- Integration of climate risk considerations and climate adaptation policy into emerging high streets programme and other policy developments (potential).

- Incorporation of WM-CRVA into Energy Capital's emerging Local Area Energy Planning Processes (planned).
- Interrogate the transport WM-CRVA for risks to TfWM's assets, schemes, and services (current and potential).

The CRVA will also feed into local Nature Recovery priorities, and programmes such as Net Zero Neighbourhoods, in order focus adaptation actions and advocacy.

Other **regional policy citations and influence include**:

- Black Country State of the Sub Region 2022 Report: The report focused on the 'indicators' in the Black Country Performance Management Framework, which enable an understanding of whether the Black Country is making real progress against its ambitions. WM-Air provided a detailed map of baseline air quality across the Black Country region.
- WMCA Health of the Region 2020 report cites WM-Air Briefing Note 'Air Quality in the West Midlands: Impacts of Covid-19 Restrictions, March-May 2020' and inputs from WM-Air team (ongoing work with the WMCA's Health and Wellbeing Team, as the 'State of the Region's Health' report is refreshed.)
- WMCA Regional Air Quality Review and Action Plan 2019: Includes WM-Air in various places and acknowledges our input/membership of the Steering Group.

WM-Air **regional policy consultation responses** – which were informed by WM-Air expertise, tools, modelling and capabilities – include:

- WMCA climate action/zero carbon green paper 2020
- West Midlands Three Year Air Quality Action Plan 2020
- WMCA Natural Capital Plan 2021
- Draft Black Country Plan 2039 (Regulation 18) Consultation 2021
- Energy Capital Research Consultation 2024–West Midlands Regional Energy Strategy

Influencing Local Policy and Legislation

Future and hypothetical modelling scenarios and WM-Air tools were used to inform policy decisions, particularly transport, net zero and planning with individual Local Authorities; a number of policy actions have resulted:

Solihull Council

> **"Alongside practical and technical support WM-Air have assisted us with the provision of research evidence to help develop our policies and procedures for managing air quality. UoB WM-Air researchers have therefore contributed to the overhauling of strategic policies and helped to develop content for reports, action plans and procedures.**
>
> *Amanda Clover MCIEH CEnvH MIOA, Senior Development Officer (Air Quality) – Enforcement, Monitoring and Compliance, Solihull Metropolitan Borough Council*

- WM-Air support is noted in Solihull Council departmental briefings, in council committee meeting proceedings[24] (public and broadcast) and as part of the background to the roll out in Solihull of a new WMCA low-cost sensor network.
- WM-Air have supported work on Solihull's new Air Quality Strategy (2024-2028), Consultation Report (2024) and Action Plan (in prep).
- In preparation for Solihull's Annual Status Report (ASR), WM-Air Modelling outputs featured in Solihull ASR 2022, 2023, and 2024. WM-Air are referenced throughout the ASRs with regard to our supportive role.

> **"SMBC's New Air Quality Strategy has been informed by briefing notes, in particular those relating to $PM_{2.5}$ findings. The related Action Plan has drawn on various briefing elements and has helped formulate and prioritise work areas and focus. Our Annual Status (ASR) report has been aided by discussions included in briefing note and our Local Plan and associated planning policies (Supplementary Planning Documents, SPDs) have sought to drawn on and align with those related topics also, where appropriate."**
>
> *Mandy Clover, Solihull MBC*

24 See Economic Development, Managed Growth and Skills Scrutiny Board- 17th July 2024 and CPH Climate Change & Planning Decision Session–29th July 2024

- Following liaison with WM-Air team, Solihull has deployed additional monitoring in an area where modelling indicates further verification/ investigation is required.
- Further NO_2/$PM_{2.5}$ verification monitoring has been carried out, facilitated by the provision of equipment from the University of Birmingham (via deployment of an air quality monitoring van).
- WM-Air GI guidance notes used as input into decision-making processed and by planners working with HS2.
- WM-Air provided a **consultation response (inc. model output)** for Solihull's AQ Strategy consultation (2023)

The findings of the University of Birmingham's green infrastructure (GI) research has become known internally and has now been submitted (by planning agents/developers/ consultants)–e.g. GI strand working with the team at HS2. Given the WM-Air team are University of Birmingham based, this has added a confidence and reassurance to decision makers that messaging has been unbiased, that facts and figures are trusted and can be rigorously defended."

Amanda Clover, Solihull council

Sandwell Council

- WM-Air featured in Sandwell's ASR 2022, 2023, 2024
- WM-Air provided a **consultation response** for Sandwell Smoke Control Area consultation (2022)
- WM-Air provided Sandwell with a detailed ward-based estimation of the distribution of attributable health burden of air pollution, as well as distribution and scale of potential benefits of potential policies to reduce air pollution.

Coventry City Council

- WM-Air case studies and briefing notes were used frequently in discussions with planners and developers at Coventry, in particular, the planning design guidance for has been useful in assessing planning applications and explaining design requirements to planners and urban design, architects. [25]
- Modelling provided insights into housing developments and exploring the Foleshill Road/ North East Coventry transport links and impacts of interventions to reduce traffic.
- WM-Air's support and partnership is referenced in Coventry's ASR 2022-2023, 2021 and 2020.
- WM-Air provided a **consultation response** for Coventry Council's AQ Supplementary Planning Document (2018).
- AQ-LAT output provided for Coventry to meet direct end-user request.

"The development of the AQ-LAT and its use in assessing negative costs of air quality impacts of planning development is another useful tool used in our discussions and consultation with planning colleagues."

Steve Dewer, Environmental Protection Officer, Coventry City Council

Birmingham City Council

- CAZ: Initial modelling of the Clean Air Zone (CAZ) in Birmingham and subsequent explorations of remaining non-compliance areas within CAZ and areas of exceedances outside CAZ. The AQ-PET methodology was applied in partnership with BCC to assess likely 2020 and 2021 air quality compliance with legal limits, with a report informing decisions on Clean Air Zone implementation.
- LTNs: BCC's Emergency Transport Plan accelerated the introduction of a number of Low Traffic Neighbourhoods (LTNs). WM-Air evaluated the air quality benefits of the largest of these, to help inform the scheme review and future LTN implementation.
- The CRVA is now included within planning documents at Birmingham City Council to promote climate positive development, including the East Birmingham Green Infrastructure Masterplan (approved 29/2/24).

25 See https://planandregulatory.coventry.gov.uk/planning/index.html?fa=getApplication&id=243316 and https://acp.planninginspectorate.gov.uk/ViewCase.aspx?caseid=3299161

"The collaboration with Birmingham University has led to the development of a method of measuring the impact of Climate Change, which is a ground breaking piece of research. This research has now been incorporated into Birmingham City policy as part of its Journey to Net Zero. It was part of BCC achieving an A Grade from CDP."

Stephen Jones, Lead Data Engineer – Geospatial, BCC

- WM-Air's support and partnership is referenced in Birmingham's ASR 2023, 2022, 2021, 2020

"The evidence of impact on health of poor air quality provided by WM-Air has been instrumental in shaping Birmingham's Clean Air Strategy and will be fundamental to identifying key areas of focus in the next iteration of the Strategy, and has shaped the thinking of local authority officers in Transport, Public Health, Planning and Housing."

Sally James, BCC

"The work done to date around $PM_{2.5}$ will be utilised to help inform the next iteration of our Clean Air Strategy. The existing relationships will be maintained such that BCC will continue to work with the UoB on future projects (small and large) and share data and insights to hopefully assist the UoB on future work strands that can build on what was delivered through the WM-Air programme and be used to help answer future air quality related questions and inform existing or emerging policy."

Mark Wolstencroft, Operations Manager Environmental Protection, BCC

WM-Air provided responses for **several BCC consultations**–which were informed by WM-Air expertise, tools, modelling and capabilities – including:

- Consultation on the Birmingham Clean Air Zone 2018
- BCC Health & Social Care Overview & Scrutiny Cttee report 2019
- BCC Clean Air Strategy 2019 consultation
- BCC transport white paper 2020
- Digbeth High Street Public Realm 2020
- BCC AQ Action Plan 2020
- Consultation For Birmingham Healthy City Planning Toolkit 2021
- BCC traffic management plan consultation 2021
- BCC Birmingham Health and Wellbeing Board Strategy 2021: Creating a Bolder, Healthier City
- BCC Our Future City 2023
- Birmingham City Centre Movement and Access Strategy Consultation 2024

The work of WM-Air was referenced in **Walsall Council's** ASR 2023

WM-Air has provided advisory and expert input via membership of **Local and Regional Committees**:

- University Hospitals Birmingham NHS Foundation Trust for the Sustainable Development Management Plan (STMP): Provision of public health and technical air quality advice to University Hospitals Birmingham NHS Foundation Trust for the Sustainable Development Management Plan (STMP), outlining plans to improve prevention and the wider determinants of health in the communities they serve. STMP adopted by UHB Board in autumn 2019.
- Association of Directors of Public Health West Midlands regional Air Quality Policy Position Statement (to support national ADPH Policy Position on Outdoor Air Quality)–Expert public health and air quality science input. Statement launched at West Midlands Public Health Excellence Conference Air Quality Workshop
- Birmingham Urban Forestry Master Plan: Membership of a guidance committee.

Influencing National Policy and Legislation

Beyond the West Midlands, WM-Air were involved as contributors or via specific citations of WM-Air outputs/documents in national policy and official reports.

Both the **2022 Chief Medical Officer's (CMO) Annual Report on Air Pollution** and the **2024 CMO Annual Report on Health in Cities** included **WM-Air air quality modelling outputs** in chapters exploring health in cities in England and work to reduce air

pollution, respectively. A **case study on Birmingham written by BCC** colleagues in the 2022 CMO report featured their partnership with WM-Air, citing work on monitoring, modelling, real-world on-road vehicle emissions, health impact assessment, support for engagement with local schools, evidence and reports on the CAZ, the effects of COVID-19, World Health Organization air quality guidelines briefing, work exploring areas of exceedances, low-traffic neighbourhoods, the Commonwealth Games, design charter for air quality, and WM-Air tools for assessing the benefit of green infrastructure and the effects of policy decisions air quality and health at a ward level.

For the Parliamentary Office of Science & Technology (POST), both the **UK-POST Indoor Air Quality** and **UK-POST Urban outdoor air quality** briefings included contributions from members of/drawing upon WM-Air and citations from GI4AQ, 'Quantifying the impact of clean air policy interventions for air quality management', and 'Real-World Contribution of Electrification and Replacement Scenarios to the Fleet Emissions in West Midland Boroughs, UK'

WM-Air Green Infrastructure and Urban Design outputs and diagrams–including the GI4AQ publication and 'First Steps in Urban Air Quality for Built Environment Practitioners briefing–has been cited in the following documents:

- Policy Exchange's 'Nature and the City Policies to enhance access to nature in cities'
- Greater London Authority, Mayor of London 'Using Green Infrastructure to Protect People from Air Pollution'
- HS2 (Arup): Interchange Station Design & Access Statement For information in support of the Schedule 17 and Section 23 planning submissions for Interchange Station and carparks
- Grantham Institute Briefing Note: Integrating green and blue spaces into our cities: Making it happen

The CRVA Methodology was referenced as part of the Government's Call for Evidence on Heat resilience and sustainable cooling, as an example of working with local authorities to quantify climate risk to support decision-making in urban planning and design. WM-Air provided input into the London Climate Resilience Review on the potential/benefits of using the CRVA approach for London in terms of collaborative and informative decision-making, and providing existing WM-Air guidance on Urban Design for Air Quality. The Transport CRVA will feature as a case study in a forthcoming UN report by the Transport Trends and Economics working group exploring the assessment of impacts and adaptation for inland transport.

The Royal Society report on the effects of net-zero policies and climate change on air quality contained contributions from members of/drew upon WM-Air. **COMEAP's** Interim assessment for Synthesis and Integration of Epidemiological and Toxicological Evidence (SETE) for long-term exposure to $PM_{2.5}$ and COVID-19 included evidence from WM-Air work on the abrupt but smaller than expected changes in surface air quality attributable to COVID-19 lockdowns.

WM-Air work on assessing the impact of Birmingham's Clean Air Zone was included in **Bright Blue ThinkTank's report**, 'Up in the air? Delivering cleaner air in a socially just way', whilst early WM-Air work exploring the real-world assessment of vehicle air pollutant emissions subsets was citated in the **Institute of Development Studies' report** on 'Emission Reductions and Health Impacts of LEVs'

> **['New Air Quality Targets and Interim Goals for Fine Particulate Matter – $PM_{2.5}$: Implications for the West Midlands' briefing was] "used as part of research to assess local authorities' approach to more stringent air quality targets than UK legislative standards."**
>
> *Anonymous feedback from Senior Air Quality Advisor at National Highways*

WM-Air work was regularly included in **UKRI regional factsheets** which were circulated to government officials:

- UKRI regional factsheet 2021 (Q2): BAQS
- UKRI regional factsheet 2021 (Q3): WM Clean Air Champion and GI4AQ
- UKRI regional factsheet 2022 (Q1): WM AQ Framework
- UKRI regional factsheet 2022 (Q3): CWG AQ report
- UKRI regional factsheet 2023 (Q2): Community of practice event + AQ targets briefing
- UKRI regional factsheet 2023 (Q4): CRVA

Policy consultation contributions: 23 national (and outside WM) policies were influenced directly via WM-Air responses to consultations (Annex 13)–informed by WM-Air tools modelling and capabilities:

- UK Clean Air Strategy Consultation 2018
- NICE indoor air quality at home quality standard 2019
- GLA Guide 2019 – Using GI to protect people from air pollution – produced directly in consultation with WM-Air
- NO_2 case study at the Queen Elizabeth II Hospital was submitted to the NHS Net Zero Call for Evidence 2020
- Improving access to greenspace: A new review for 2020, Public Health England
- House of Commons' Environment, Food & Rural Affairs Committee Inquiry on Air Quality 2020
- DEFRA Call for evidence on future $PM_{2.5}$ concentrations 2020
- Consultation on the Draft Policy Statement on Environmental Principles 2021
- OEP Draft Strategy and Enforcement Policy 2022
- NICE indoor air quality at home quality standard 2022
- Government consultation on a national Cyber-Physical Infrastructure 2022
- National Highways as a potential AQ partner 2022
- Revision of LAQM 2022
- Environment Act Consultation 2022
- Draft AQ Strategy 2023
- New EAC inquiry–outdoor and indoor air quality targets 2023
- Government's Call for Evidence on Heat resilience and sustainable cooling 2023
- Major conditions strategy 2023
- PAS 4023 Air Quality Monitors 2023
- Urban Green Spaces–EFRA Inquiry 2023
- London Climate Resilience Review 2023
- EAC Inquiry on Climate Change and Security 2024
- Wychavon Draft Design Codes 2024
- MHCLG questions on co-benefits of climate adaptation 2024

Advisory, Expert Input or Membership of National Committees: WM-Air members have provided expert input via membership of various national-level committee memberships and reviews, including:

- Committee on the Medical Effects of Air Pollutants (COMEAP)
- Clean Air Advisory Panel for Wales
- Environment & Natural Resources Scotland Science Advisory Board
- Expert input into Meteorological Data reviews/ needs for UK APAS
- CAF Air Quality evaluation: Clean Air Fund undertook a strategic evaluation of the work of one of their grantees, Asthma and Lung UK, with input from WM-Air.

Influencing International Policy and Legislation

Although the focus of WM-Air was primarily regional impact, there were associated international impact via citations of WM-Air outputs (table 2 overleaf).

Document	WM-Air citation
UN Climate Technology Progress Report 2023	GI4AQ publication
WHO's Measures to reduce risks for children's health from combined exposure to multiple chemicals in indoor air in public settings for children	GI4AQ
World Resources Institute's Better Forests, Better Cities	GI4AQ
Identifying Key Areas in the City of Phoenix for Infiltration and Retention Using Low Impact Development: Final Report	GI4AQ
IZA Institute of Labor Economics: Green Infrastructure and Air Pollution: Evidence from Highways Connecting Two Megacities in China	GI4AQ
European Parliaments Committee: AMENDMENTS 1–231–Draft report Implementation of the Ambient Air Quality Directives: Directive 2004/107/EC and Directive 2008/50/EC	Abrupt but smaller than expected changes in surface air quality attributable to COVID-19 lockdowns
Inter-American Development Bank Working Paper Series No IDB-WP-1270: Quantifying COVID-19's Silver Lining: Avoided Deaths from Air Quality Improvements in Bogotá	Abrupt but smaller than expected changes in surface air quality attributable to COVID-19 lockdowns
IPCC: AR6 Climate Change 2021 The Physical Science Basis	Abrupt but smaller than expected changes in surface air quality attributable to COVID-19 lockdowns
WHO Urban planning, design and management approaches to building resilience – an evidence review: first report on protecting environments and health by building urban resilience	Temporary urbanisms as policy alternatives to enhance health and well-being in the post-pandemic city
Irish Environmental Protection Agency Regional-to-local scale air quality modelling of the Republic of Ireland Report	Using task farming to optimise a street-scale resolution air quality model of the West Midlands (UK)
International Council of Clean Transport Air quality and health impacts of heavy-duty vehicles in G20 economies	Real-world assessment of vehicle air pollutant emissions subset by vehicle type, fuel and EURO class: new findings from the recent UK EDAR field campaigns, and implications for emissions restricted zones

Table 2: Examples of WM-Air citations in Official International Documents and Policy

3.2.4 Human Capital

WM-Air has had a positive impact on the careers and professional development of both the project team and individuals at partner institutions, ultimately leading to a more skilled and knowledgeable workforce.

Professional Development of Stakeholders

WM-Air has resulted in more skilled and informed individuals via their involvement in knowledge exchange activities, engagement events (fig. 21), training workshops, webinars, networking, communication activities, literacy courses and via briefing notes. These activities have contributed to the professional development of our stakeholders– from local authority officers through to the elected

members – leading to increased knowledge and awareness of air quality, and a greater understanding of how to better integrate air quality into decisions making and strategies. Testimonials emphasising the influence WM-Air has had on individuals from partner institutions can be seen throughout this report and were stated in all feedback surveys and testimonials.

Figure 21: Photos from 2022 WM-Air Annual Meeting

"[Briefing Notes] improved subject knowledge and awareness to influence the planning and methodology of air quality projects that we would like to run within TfWM."

Anonymous feedback from a TfWM Traffic and Network Management Officer

"I feel I have a reasonable grasp on the health outcomes arising from air pollution and recognise that this understanding evolved during the WM-Air timeframe from both contact with WM-Air colleagues and widening knowledge nationally and internationally."

Mark Wolstencroft, Operations Manager Environmental Protection, BCC

"My new learning has been around $PM_{2.5}$. Sources and impact on the internal environment caused by log burners"

Shaun Walker, Service Lead in Environmental Crime, Wolverhampton city Council

"Provided more detail into particulate matter not previously known."

Sam Chapman, The Floow

"Increased confidence and capacity within the team. The regular sessions hosted by WM-Air have shared recent scientific evidence and advancement, which has helped to improve my understanding of air quality as a whole but also steps that can be taken to combat it."

Sophie Morris, Public Health Specialist- Air Quality and Climate Change, Sandwell Council

"Officers working in the field of air quality brief senior managers and cabinet members on air quality matters. WM-Air Briefing notes and guidance documents have provided officers with additional support to frame and update decision makers whilst also advising (and addressing) 'myth busting'.

This aspect of WM-Air support has been particularly important and has allowed technical work to be correctly framed in the context of other council functions. As an example, senior managers are better informed on the nature and extent of local and regional air quality and how this might impact on, or be impacted by new development, and transport decisions."

Amanda Clover, Solihull Council

Professional Development of the WM-Air Team

WM-Air has produced skilled and trained Impact Specialists. WM-Air's strategy was to recruit a smaller number of Impact Fellows on longer-term contracts, and support them to engage across multiple projects, since it was recognised that

recruiting researchers with the appropriate skills required for stakeholder engagement and real-world applications would be challenging. As such, it was important to nurture our ECRs throughout the project, ensuring they had training opportunities and first-hand experiences to drive forward the work of WM-Air. By working closely with external partners, the Impact fellows developed effective impact skills and built close relationships with stakeholders, which has ultimately contributed to the success of WM-Air. As a result, they have either moved on to related positions at other academic institutions, or been promoted, gained permanent positions or retained for ongoing impact projects, contributing to development of in-demand skills and hence supporting future (public) benefit. Annex 17 summarises the post-WM-Air destinations of WM-Air technicians, ECRs and the Project Manager – these are primarily faculty or future "impact fellow" posts modelled on WM-Air/RISE, with a net shift in focus from research to impact.

"WM-Air has provided me great opportunities to develop a state-of-the-art high resolution air quality model for the West Midlands, and to apply modelling scenarios to deliver impacts (such as exhibitions, policy documents, and impact case studies) for and with a variety of stakeholders from government, industry and health sectors. All these experiences have facilitated me with strong modelling expertise and knowledge exchange skills, which have greatly helped me to secure a permanent academic position."

Jian Zhong, WM-Air Impact Fellow

"The impact-based nature of the project was completely new experience for me. Given the need to maximise the impact of the project, our analytical tools were co-developed with policymakers and third sector groups. As a consequence, I had to develop an understanding of principles of codesign, the local authority landscape, and build a strong system of contacts within local authority and public health teams. This amazing opportunity for learning and development has enabled me to go on to lead research design and co-investigator status on a series of subsequent follow-on projects aimed at further developing environmental and health tools within policymaker communities."

James Hall, WM-Air Impact Fellow

"As an early career researcher, being a part of a project that was developed around stakeholder engagement and creating impact has shaped how I approach my own research projects. The skills learned from collaborating with stakeholders opened new opportunities for my career, and even enabled me to complete PhD part-time ."

Nicole Cowell, WM-Air Technician

"Working with BCC and WMCA throughout WM-Air was an extremely positive experience. All the colleagues I engaged with were very supportive; going above and beyond to advise me, advocate the work we co-developed, and address or help resolve any challenges encountered. This benefitted my career development, as listening to the public sector perspective first-hand throughout enabled me to focus deliverables on meeting the needs of these project partners and ultimately, to benefit citizens across Birmingham and the West Midlands."

Sarah Greenham, Impact Fellow

3.2.5 Environmental

The key impacts of WM-Air on local and regional air quality will become evident in the medium to long term, reflecting the timescale for change. Additional air quality monitoring provided for new locations has improved situational awareness, whilst new tools and capabilities, such as air quality models, have enabled insights into to policies such as CAZ (Birmingham) and specific interventions (Coventry), as well as for specific events and activities. This has allowed some immediate, localised impacts to be realised via collaborative projects.

Overall, 33% of surveyed external partners stated that environmental impact had already been realised, whilst 58% stated that impact was under development with potential for longer-term impact.

New insights and awareness

New findings from source apportionment analysis of collected filter samples indicate that the dominant source of $PM_{2.5}$ include biomass burning (25%), resuspended dust and traffic emissions (22%), and secondary aerosols (25%). Results also show that biomass burning contribution to PM in Birmingham has increased over ~15 years (2.4 µg m^{-3} compared to 2007-2008 value of 0.23 µg m^{-3}). The work suggests local and regional policies could reduce $PM_{2.5}$ by over 50%, significantly decreasing mortality and life-years lost due to air pollution.

Short-term, localised or event-specific impacts on air quality

- **B2022 CWG** brought thousands of athletes and 1.5 million spectators to venues in Birmingham and across the West Midlands, which had the potential to impact local air pollutants. Detailed analysis of ambient air quality measurements by University of Birmingham's WM-Air project showed that the Games had little impact on background NO_2 concentrations in Birmingham, and no significant impact on background $PM_{2.5}$ concentrations. Actions taken by the Organising Committee to limit carbon emissions associated with the Games – such as sustainable transport approaches–most likely delivered co-benefits for local air quality.

"The WM-Air research is a central part of Birmingham 2022's Sustainability Strategy, notably within the carbon management pillar. The project findings will be incorporated into the Sustainability Functional Area post-Games report. WM-Air research will show the effect the Commonwealth Games has had on air quality in the city area. Provisional measurements made during the Games period showed good local air quality, which is a positive result for Birmingham 2022 and for future Games to keep monitoring."

Ian Reid, CEO of the Birmingham 2022 Commonwealth Games Organising Committee (OC)

- The 'Save today, Play Tomorrow' initiative WM-Air supported has seen **BCFA** progress their football travel & transport work by partnering with Liftshare, a digital platform predominantly used in the corporate world, to create the first of its kind grassroots football "Liftshare community" for their members. Participants register though a safe & secure digital app and engage in car-sharing to/ from football, validating & recording all journeys and the subsequent savings made. To-date, 850 people have signed up to the programme and active users who have avoided 141,557 miles, reduced emissions by 31.21tco2e and saved £41,073 in fuel costs.

"When we initially set about creating our sustainability programme for football, air quality was not something we had considered, however following the excellent work completed by WM-Air in detailing the venues in at risk areas and providing the evidence/ data that supports this we have now focused heavily on travel & transport and trying to shift the behaviours of over c.125,000 people across the West Midlands involved in grassroots football to consider how they travel and finding alternative more sustainable solutions"

Richard Lindsay, Sustainability & Insights Manager, Birmingham County Football Association

- **UHB reductions in air pollution due to interventions**: The WM-Air study assessing the impact of clean air interventions at UHB found air pollution reduced from 24-34 µg m^{-3} in 2021 to

21.5-25.5 µg m^{-3} in 2023 for NO_2 across the site, with a significant reduction at the entrance where traffic intervention measured were introduced at the patient drop off area (provisional data–a journal paper outlining the UHB case study is currently under review with a peer-reviewed journal).

- WM-Air evaluated the causal effectiveness of the **Birmingham Clean Air Zone (CAZ)** on air pollution using the AQ-PET, finding that the CAZ reduced NO_2 levels by up to 7.3% during the first seven months of operation, that the biggest reductions were at busy roadside locations within the CAZ ,and that the CAZ also had a beneficial "spillover" effect at the edges, with people leaving vehicles at home.

Medium-term/wider-scale impact on air quality

Air pollution levels have decreased across the West Midlands over the timeframe of WM-Air (Fig 22). Whilst this is not solely due to WM-Air activities, WM-Air has contributed to much of the regional air quality management strategies and interventions that will continue these reductions.

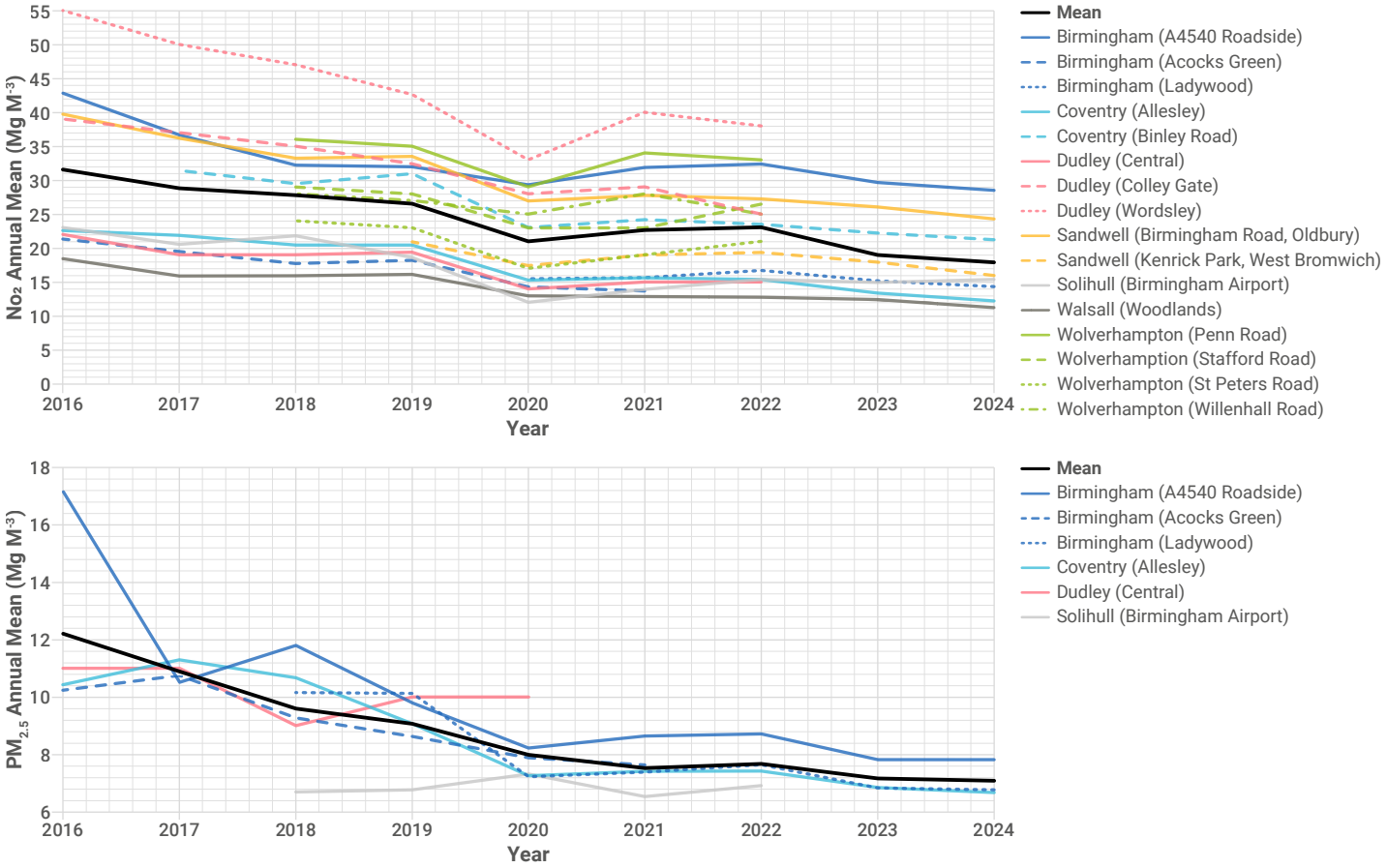

Figure 22: Annual changes in a) NO_2 and b) $PM_{2.5}$ since 2016 for monitoring stations across the West Midlands (where available – data obtained from ASRs, Defra air quality data portal or local authority data portal. Note variability in data availability over the time period–mean provided for illustrative purposes only)

Potential future/longer term impacts on air quality

New air quality modelling has allowed for future policy scenarios to be explored, providing insight into what is possible due to the policies and practises that have already been influenced.

Figure 23 shows air quality over the West Midlands for 2021 and for a 2030 "business as usual" (BAU) scenario. The simulations show a fall in NO_2 concentrations of up to 28 µg m^{-3} (or 37 %), and smaller reductions in $PM_{2.5}$ concentrations predicted between 2021 and 2030 BAU scenarios of about 1 µg m^{-3} (or equivalent to 8 %). The BAU scenario captures policy changes supported by WM-Air work and was used to contrast with (more aggressive) Net Zero policy scenarios.

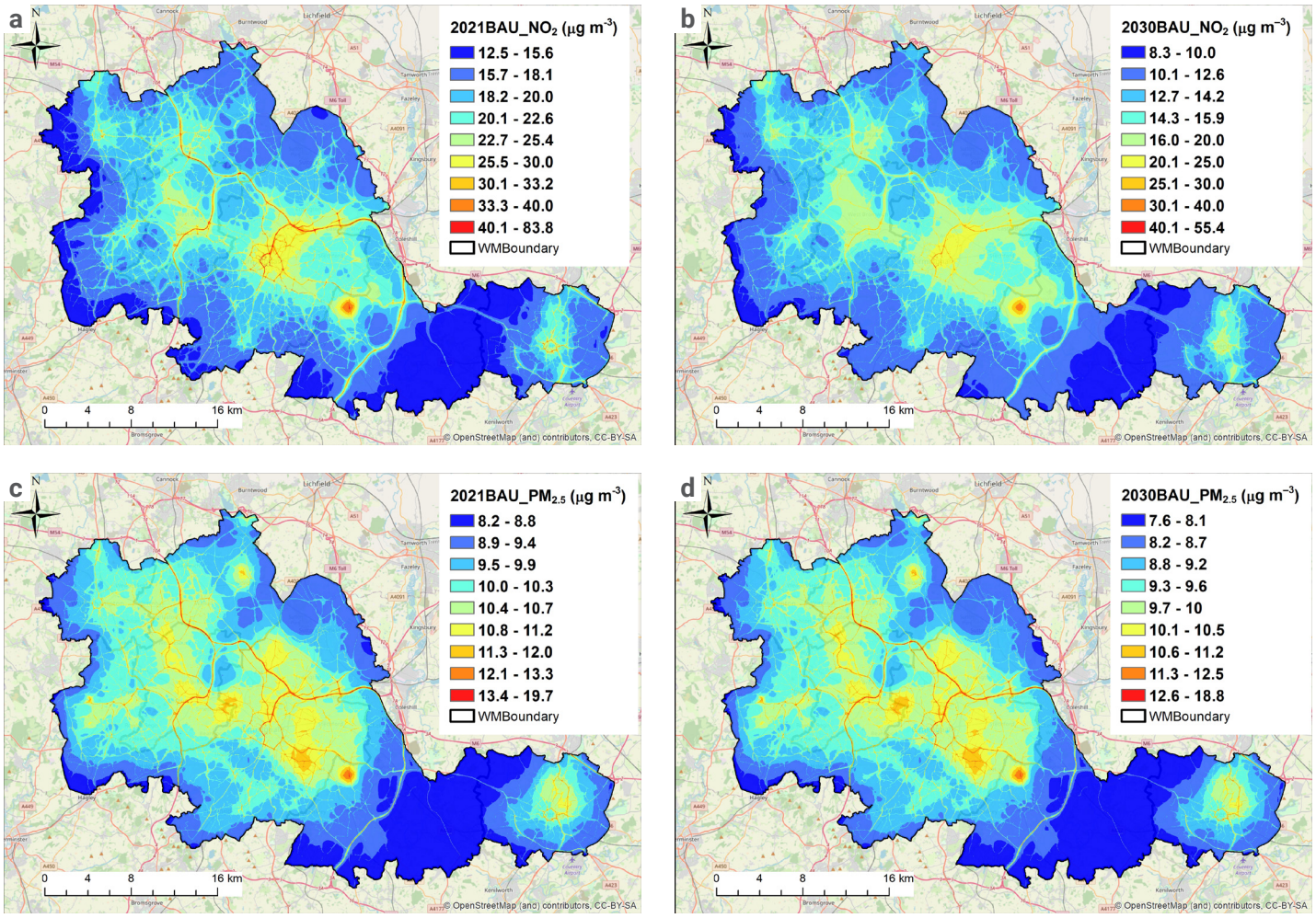

Figure 23: Air quality maps of annual mean concentrations of NO_2 (a NO_2 for 2021, b NO_2 for 2030 BAU) and $PM_{2.5}$ (c $PM_{2.5}$ for 2021, d $PM_{2.5}$ for 2030 BAU) (in µg m^{-3}) at 10 m × 10 m resolution for 2021 and 2030 BAU scenarios. BAU represents the business-as-usual scenario.

3.2.6 Health and Wellbeing

Impacts on health and wellbeing, from improved air quality, will be realised throughout the lifecourse of the exposed populations (indeed, the AQ-LAT approach is to assess whole lifespan impacts). This is reflected in the expert survey results, with 17% of external partners noting that health and wellbeing impact had already been realised, whilst 67% stated impact was under development with potential for longer-term impact. We assess these changes below.

Potential future/long-term impacts on health and wellbeing

WM-Air AQ-LAT insights provide information about the current state of the impact of air pollution on health, as well as exploring the future impact of interventions. Published work using the AQ-LAT indicates that each year air pollution may cause:

- up to 2300 early deaths[26]
- 4,200 asthma diagnoses
- 1,400 coronary heart disease (CHD) diagnoses
- 300 lung cancer diagnoses
- 1,000 stroke cases

Local and regional policies–influenced by WM-Air, such as the new Air Quality Framework and Local Policies–support the implementation of new actions to improve air quality and ultimately improve health outcomes for 2.9m residents. The AQ-LAT approach has estimated the benefits of reducing $PM_{2.5}$ and NO_2 concentrations to within WHO Air Quality Guidelines, including:

- the prevention of up to 12,000 deaths, 50,000 asthma, 15,000 CHD, 2,400 lung cancer, and 10,000 stroke diagnoses.
- reduced healthcare and social care demand
- improved productivity

26 Before WM-Air, this was estimated to be 750 deaths/year

Outputs from AQ-LAT policy scenarios estimate:

- health-related economic benefit of £5m over the coming ten years related to electrification of the bus fleet (paper in prep);
- assessment of impacts of various scenarios– reduced emissions arising from the Air Quality Framework, Clean Air Strategy and Net Zero Strategy – indicates that reduced domestic combustion would have greatest impact in reducing regional mortality by 1000 over 10 years (paper in prep). This is the focus of measures within the WM Air Quality Framework.

WM-Air explored the health-economic impact of the Birmingham Clean Air Zone. Unpublished health impact assessment for Birmingham clean air zone over 5-years[27] predicts:

- 37 asthma and 1 lung cancer case prevented
- 4 deaths averted
- 12 Quality Adjusted Life Years (QALYs) gained
- £30,000 NHS cost savings
- £1.7M benefit from life years gained

"The findings of WM-Air's research will have impact in the longer term on the health and well-being of the Birmingham population, as it is being used to shape policy and practice at the Council"

Sally James, BCC

3.2.7 Economic

Economic impacts can be felt in the near-term (i.e. funding influenced) and also in the longer-term (e.g. health-related economic and productivity benefits). Overall, 25% of surveyed external partners stated that economic impact had already been achieved; whilst 58% stated impact was under development with potential for longer-term impact.

Economic impacts achieved

WM-Air has directly leveraged £37.8m funding, influenced investments worth £8.2m and generated matched funding of £1.2m, resulting in **£47.2m funding *that is known to have been influenced* or leveraged *directly* by WM-Air from 2019-2024** (See 3.3.2; Annex 6). When this figure is compared to the initial WM-Air funding of £5m, this represents an **investment gain of £36.7m** and a **return-on-investment (ROI)[28] of 734%** (or 7.34 times the initial investment.)

It is highly likely that this is an underestimate, particularly the investments influenced, as we have only included grants and investments that we can confidently say are linked to WM-Air activities. It is not possible to discern all indirectly-linked investments that have been influenced by our activities with any certainly – for example, income that may have been generated as a result of information harnessed (such as from online resources and journal papers) by stakeholders beyond the WM-Air network.

Potential economic benefits

In order to explore the economic impacts associated with further investment/funding that has been drawn due to WM-Air activities, an independent, external economic analysis was commissioned. This utilised a regional broad impact model with a small number of underlying assumptions to estimate the impact of the additional drawn-in funding on two variables– **Gross Value Added (GVA)** and **employment (job years created)** – through to 2028. The methodology was adopted from that developed for SWEEP[29]. (The analysis does not, however, reflect the wider economic impact of WM-Air activities themselves.) Full details of the approach, assumptions/caveats and findings can be found in Annex 18.

WM-Air's matched, leveraged and investments influenced were modelled to 2028:

- **Leveraged funding**: Based on the scale of leveraged funding captured by the WM-Air programme team it is estimated that this may *directly* support ca. 314 job years over the period 2019-2028, peaking 2023, and may have supported

27 Estimates assume continued 3µg m3 reduction in NO_2 each year

28 ROI ((Final value–Initial cost)/Initial cost x 100) is a useful metric for evaluating an investment's performance and identifying its financial returns. A higher ROI indicates a greater benefit earned from the investment. ROI can be positive (profit) or negative (loss).

29 https://sweep.ac.uk/wp-content/uploads/2023/02/full-SWEEP-impact-report.pdf

a *total* of ca. 587 job years in the wider economy[30] (beyond those jobs directly supported through the associated drawn-in funding). This is equivalent to a *direct* GVA impact of £21.4m, or £27.3m in *total* GVA impact.

- **Investments influenced**: Based on the scale of investments influenced it is estimated that this may *directly* support ca. 80 job years over the period 2019-2028, peaking in 20/21, and may have supported a *total* of ca. 149 job years in the wider economy. This is equivalent to a *direct* GVA impact of £5.4m, or £6.9m in *total* GVA impact.
- **Matched funding** (not including in-kind) was not set out separately; instead, the impacts have been encapsulated in the total combined impact.
- **Combined Impact**: Overall, the income generated by WM-Air activities resulted in a *total* (encompassing direct, indirect and induced impacts) projected **GVA of £34m by 2028 (£27m in *direct* GVA)**. The evaluation also found that this would result in **738 job years created/safeguarded by 2028** (in addition to the ca. **55 job years** known to have been created directly by WM-Air funding). According to this analysis, there was a build-up of impacts which peaked in 2022, supporting ca. 127 jobs and ca. £5.9m GVA in that year.

> **"The economy will be influenced over time by the outputs of WM-Air's research and tool development, through the associated improvements to health and well-being of Birmingham's population from improved traffic flow, and modal shift to more cycling and active travel"**
>
> *Sally James, BCC*

Potential health-economic benefits

AQ-LAT can also provide an insight into **healthcare costs**, with the scale of potential health-related economic benefits of achieving WHO air quality guidelines assessed to be up to **£3.2bn over 20 years** for the West Midlands.

3.3 Evaluation of Impact

This section focuses on evaluating specifically how WM-Air aligns with and contributes to achieving the objectives defined in the NERC RISE Programme's Announcement of Opportunity (AO).

Objective 1: Bring considerable NERC investment in excellent research within the participating research organisation(s) together with strengths in businesses, policy bodies and other stakeholders particular to their location(s)

How successful was the programme in progressing existing, and supporting the development of new collaborations and partnerships that are inclusive of the full range of relevant stakeholders, and what key lessons have been learned?

WM-Air has engaged 300 new stakeholders from 123 new organisations over the 6 years, ranging from local government to charities to private sector companies – from an initial base of 27 partners. Working together, this has created 45 impact projects from 88 individual pieces of work and have engaged an active air quality community across the West Midlands–through events, partnerships, online resources, outputs and communication activities – that will continue beyond the timeframe of WM-Air.

The importance of networking and fostering the community via events and engagement activities should not be underestimated as the cumulative impact is large – this is clear from feedback and testimonials, although the longer-term impact of such activities (beyond the attitudinal and human capital impacts) is difficult to quantify. The development of this community – including working with elected officials and media in support of policy change (the WM AQ Framework) – would not have been possible without the RISE funding over a 5+ year period.

Objective 2: Conduct a coherent programme of high impact, focused, co-designed and co-delivered research translation and innovation activities.

What lessons have been learned about the approaches used by the projects that made them particularly successful or unsuccessful in achieving the co-design and co-delivery of the planned activities?

The most successful partnership and projects developed from a direct request from an external stakeholder, or from the assessment of where there was a clear (real, not idealised) need for an

30 Given the breadth of locations for organisations who have interacted with WM-Air then this impact is likely to have occurred across the UK, although a good proportion may have occurred within the West Midlands

additional tool/insight or guidance. Examples of this include the (co)development of the CRVA tools, the AQ-LAT model, the WM AQ Framework, and development of briefing and guidance notes that have subsequently been used to inform policy and new activities.

Where partnerships did not develop or were discontinued, this was usually due to a lack of motivation from the external stakeholder or changing priorities at the external organisation (e.g. HS2), changing staff (noted as a managed risk – e.g. National Express) or restructuring (e.g. NHS England), or simply that we could not provide the insights or support required for the particular request (e.g. development of the University Station).

During the lifetime of WM-Air, both anticipated and unexpected challenges arose. Foremost amongst these was the Covid pandemic and working restrictions, which led to some difficulties such as building rapport via online meetings, changing local and regional priorities, and conduct of ongoing measurement work (Local authorities supported this by designating relevant WM-Air staff formal key worker status to enable their work to continue). This also led to opportunity, to exploit the "natural experiment" of lockdown by exploring the impact on air quality, which allowed us to improve predictions of future traffic control and confidence in the benefit/response of policy changes. There were also specific requests for AQ guidance and information by local authorities due to COVID-19 (e.g. guidance regarding indoor AQ, outdoor burning), and interest from partners for digital air quality and health training materials and online workshops. Birmingham City Council – a key partner – was issued a Section 114 notice in September 2023, related to their prevailing economic position. As a result, there were staff changes, reduced capacity for environmental officers to prioritise WM-Air events and difficulties engaging – however there was also an appreciation for WM-Air input and support for air quality activities, for example via briefing papers and WMCA-led activities, which maintained momentum around this agenda.

External drivers of project shifts included the evolving national policy framework (development of updated air quality targets within the Environment Act, 2021) and publication of updated (for the first time since 2006) WHO Global Air Quality Guidelines (2021). In the case of the former, WM-Air provided technical input to the groups developing the target approach, and then supported WMCA and LAs in understanding their likely position vs the new objectives; in the case of the latter, the AQ-LAT approach was used to quantify, for the region, benefits in attaining WHO levels and to capitalise on the profile afforded in development of regional response.

The WM-Air focus (and capabilities – notably modelling and measurement) addresses the West Midlands area. While local and regional governments in this domain comprise the vast majority of WM-Air partnership work, we have been approached by other local authorities beyond the West Midlands region (e.g. Oxfordshire, Worcestershire, Warwickshire, Gloucestershire). There is opportunity to broaden the WM-Air work and impact to this wider geography, should funding – including administrative boundaries–permit. While public engagement was explicitly excluded from the RISE remit by NERC, the team have successfully managed to incorporate a range of funded activities to engage public audiences with the work of WM-Air and build awareness of clean air science, therefore increasing our diversity of stakeholders and impact/effectiveness of policy work.

To what extent have projects been successful (or are on route to being successful post-funding) in achieving impact (intended or unintended) from the planned activities?

As highlighted in the Executive Summary and throughout the report, key impact achieved by WM-Air includes:

- Supporting the development of the first West Midlands Air Quality Framework to enable, drive and coordinate future air quality policy actions across all Local Authorities (2.8m inhabitants), and leading to a further £1.5m central government and £370k regional funding.
- Working with local authorities and the Clean Air Justice Network to estimate benefits arising from policy interventions, providing the health and healthcare economic case for action.
- Enabling Birmingham City Council (BCC) to evaluate the new Birmingham Clean Air Zone, Low Traffic Neighbourhood initiatives, understand the impact of Covid-19 on NO_2 levels, and supporting their schools air quality education and engagement projects.
- Working with the Commonwealth Games Organising Committee to make air quality a key

environmental focus of the 2022 Games, provide daily operational capability during the games, and assessing the overall impact of the Games' travel policy on background air quality.

- Supporting University Hospitals Birmingham (UHB) NHS Foundation Trust to understand their air quality environment and impacts from NHS activity, leading to pilot interventions to reduce air pollution. Guidance for monitoring air quality at NHS sites, evaluated with Sandwell and West Birmingham trusts.
- Delivering the first Climate Risk and Vulnerability Assessment (CRVA) for BCC, leading to Birmingham being graded A-list city status for climate action by the Carbon Disclosure Project for the first time. Subsequently extended to the whole of the West Midlands.
- Undertaking air quality and emissions analyses for Birmingham Country Football Association (BCFA) as part of their 'Save Today, Play Tomorrow' initiative. Following a number of sustainability awards, the work was expanded nationally.
- Applying WM-Air air quality tools and modelling capabilities to partnership projects across the region. Examples including quantifying the air quality co-benefit from growth of the Electric Vehicle (EV) fleet under different scenarios and wider decarbonization hubs; investigating the impact of railway emissions with RSSB; modelling air quality across the region for local and regional status reports; and supporting TfWM's rapid transit route prioritisation work.
- Green Infrastructure advice and guidance for local authorities, planners and practitioners including an AQ Design Charter, Trees and AQ briefing, low-cost sensor guidance, and CPD events.
- National policy development, including working with UK-100 promoting clean air/net zero policy co-benefits, evidence provision in support of design of the 2021 Environment Act targets for air quality nationally, target development in Wales, the 2022 and 2024 Chief Medical Officer's reports, and Parliamentary Office of Science & Technology note on Outdoor Urban Air Quality.

Objective 3: Leverage benefits and contributions from other sources of funds relevant to the ambition of the proposal.

What benefits and contributions have been leveraged across the programme?

£47.2 additional income has been leveraged or influenced by WM-Air (to-date) This includes funding from Defra to support the initial implementation of the West Midlands AQ Framework, and from WMCA itself to support further work exploring the potential for implementing a stretched air quality target for the regions. Additional funding was also obtained from the UKRI COIO programme to support the expansion of the CRVA to the West Midlands Region.

Research-include from UKRI, EU, Wellcome Trust was also obtained to expand working relationships with external partners to 2030, including WM-Adapt, WM-Net Zero, INHABIT, CLEETS and CARMINE projects. Details of these benefits and income are provided in Section 5.

What lessons have been learned about maximising the potential for leveraging benefits and contributions that have been instrumental in the success of the programme?

WM-Air endeavoured to use real world challenges to drive the research agenda forward and co-create funding applications with practitioners to ensure research outputs delivered information needed to support decision making. The nature of our key partners – local government – was such that cash input was challenging, while in kind input through time, data, access etc less so. Collaboration to draw down additional resource was pursued successfully in some instances where there was a real key strategic requirement (e.g. Framework, CRVAs), which also maximised buy-in. There were, however, occasional difficulties getting funding applications through local authorities on time. In some instances, WM-Air declined requests which were essentially for environmental consultancy services at lower rates, with minimal NERC environmental science input. Data access/data sharing for health data (from the NHS) and associated ethical review also proved time consuming (although this was as anticipated/ allowed for in the project timeline).

Objective 4: Creating durable collaborations between the academic and non-academic participants.

What actions have been taken to ensure the durability of the collaborations post-funding, and what is the evidence that these are likely to be successful in providing continued support for the development of the next generation of environmentally informed planners, practitioners and professionals?

Relationships have been sustained and nurtured thought follow-on funding in the form of WM-NZ, WM-Adapt, CLEETS, INHABIT, the WM AQ framework (formally embedded in WMCA governance) and ongoing work. The WMCA will continuing to support the west midlands air quality community developed by WM-Air via an annual regional clean air conference, the first of which will be held in summer 2025.

WM-Air has fostered skilled and trained Impact Specialists who have either moved on to related positions at other academic institutions, or been promoted, gained permanent positions or retained for ongoing impact projects, contributing to development of in-demand skills and hence supporting future (public) benefit. Annex 17 summarises the post-WM-Air destinations of WM-Air technicians, ECRs and the Project Manage, which are primarily faculty or future "impact fellow" posts modelled on WM-Air/RISE, with a net shift from research to impact. Training, CPD, networking and knowledge exchange activities have also supported the development of colleagues at external institutions.

To what extent and how have the projects improved the standing and reputation of the regional expertise in its ability to translate environmental science into innovation, and stimulate economic growth?

Relationships between external stakeholders and UoB was enhanced significantly by the WM-Air project, evidenced through testimonials and feedback, and continued involvement in ongoing projects (e.g. WMCA Framework, Defra project, WM-NZ, WM-Adapt etc). External recognition is reflected in invited contributions to CMO reports, POST guidance, meeting presentation invitations (e.g. Institute for Air Quality Management; UKHSA, DEFRA, UK100, UKRI Clean Air SPF (National Conference held at the University of Birmingham, 2/3 Oct 2024), Chartered Institute for Environmental Health; Futurebuild). The funding leveraged, as well as the projected GVA and jobs created/safeguarded, also provides strong evidence for impact on economic growth within the region as a result of WM-Air.

4. Lessons Learned

There were many lessons learned from the WM-Air project, both due to the nature of the project with a focus on generating impact rather than traditional research outputs, through anticipated challenges and unforeseen circumstances.

- The length of the programme, and flexibility offered by the RISE opportunity to allocate resource to opportunity, was highly beneficial in developing relationships with stakeholders and end-users and increasing their awareness of the potential offered by RISE/WM-Air.
- It is self-evident, but to be successfully integrated into policy creation, scientific outputs should be designed with the needs of policy makers in mind rather than purely focused on novel research. This was a strength of an impact focused programme such as RISE, and WM-Air, where all activity focussed on relevance and end-user value, rather than seeking to "retro fit" research outputs not designed from the outset in this manner.
- Air quality research and policy is shaped by a large network of stakeholders across the region. Regularly engaging with stakeholders during the development of both the Options Paper and Framework was essential for ensuring a diverse range of perspectives were incorporated into the Framework. In parallel, media profile – while carefully (and deliberately) approached from a perspective of expert, informed comment, not one of policy recommendation – contributed to the project's influence.
- Involvement of end users/stakeholders in the design stages of projects and capacity-building tools (e.g. CRVA, AQ-LAT) significantly increased their value, uptake and impact.
- The WM-Air staffing approach (of maintaining a coherent group of staff assigned to consecutive projects, rather than seeking to staff each project independently) was successful in maximising integration, cross-project benefits and providing career continuity for the staff concerned. We did not find it straightforward to recruit individuals with impact skills – especially communication skills – as distinct from science ability, so this was of importance. Nonetheless, close connection between policy makers and academic researchers provided a foundation of evidence and data for policy and delivered real world impact from research.
- WM-Air explicitly sought institutional engagement beyond individual contacts, with a formal, but light touch, partnership agreement in each case (supported by legal advice from the University). The former approach was of benefit through personnel changes; the latter was not drawn upon but provided confidence in governance and risk management should difficulties have arisen.
- Aspects of integration within large and diffuse partner bodies provided some challenge, in part due to outsourcing approaches – for example, around access to air quality monitoring locations "managed" by a private sector contractor, and between transport, air quality and environmental health teams.

"The project, as well as observing vehicle emissions, also unexpectedly allowed review of mobility change due to the covid pandemic providing views upon societal shifts and its impacts to air quality and transport."

Sam Chapman, The Floow

- Following the Section 114 notice at Birmingham City Council, there were staff changes and reduced capacity for officers to attend WM-Air events – however there was also an appreciation for WM-Air input and support for air quality activities, for example via briefing papers and WMCA-led activities, due to shift in foci at BCC to their financial challenges.

"I am conscious that quite a few senior managers have moved on during the lifetime of the programme such that those who remain may be somewhat increasingly distanced in terms of relationships than those who were present during the commencement of the WM-Air programme. Plus, the primary focus of the LA is no longer the CAZ, but the financial challenges faced by the Council."

Mark Wolstencroft, Operations Manager Environmental Protection, BCC

What worked well and what did not?

- WM-Air occurred at the right time in the right place to support and leverage the full development of the WMCA; regional role for air quality explicit in the second devolution deal (devo-2) of 2017; senior political sponsorship (Mayor Andy Street); strong officer leadership.
- Project focus (air quality) leveraged, and benefitted, high profile around this issue nationally and beyond – arising from clean air challenges (Client Earth court action, Defra roadside NO_2 plans and mandates for Clean Air Zones including Birmingham, Ella Kissi Debra inquest, Environment Act, WHO air quality guidelines).
- Substantial (5 year, plus 12 month no-cost extension) programme duration essential to maximise value of relationships with partners and end users, and their appreciation of the WM-Air offer.
- Dedicated Impact Fellow approach (i.e. focus of ECR work, not 'in addition' to research) essential and successful, but hard to recruit to compared with traditional "science research" postdoctoral positions. The key skills gap identified was around communication with stakeholders/users, and ability to orient activity to their interests.
- WM-Air benefitted from shared experience with the other RISE programmes – SWEEP, iCASP, CAMELIA – and strong engagement with NERC via the PEG (in contrast to most grants).
- WM-Air enjoyed the strongest engagement with public sector bodies and consultancies, with fewer projects across the private sector/SMEs (beyond technology development). In some cases, caution was exercised over being seen to endorse a particular product.
- The approach to limiting engagement with campaigning groups was undoubtedly correct, maintaining the standing and independence of the WM-Air team to represent the best science. Initially uncertain over approach to public engagement (vs RISE AO constraints); then able to leverage significant University investment.
- All RISE programmes developed bespoke approaches to capturing impact. This may represent a missed opportunity for efficiency, and best practice.
- In common with many activities, WM-Air experienced challenges due to local authority resourcing, specifically relating to Birmingham City Council's position following Section 114 declaration in final stages of programme.

5. Perspective on Long-Term impacts and Legacy

"My hope would be that we continue to collaborate, as significant regional partners, on improving air quality across the West Midlands, for the benefit people and communities that live here. I cannot stress enough that we would never have reached this point without the support from the WM-Air Team, and I would like to extend my thanks to them for all the work that they have put in to reaching this point."

Jackie Homan, Head of Environment, WMCA

WM-Air implications for future research and wider societal benefits

Policy and Practice: WM-Air has transformed the regional approach to Air Quality across the West Midlands, upskilling regional capacity and enabling integration to a position where the regional has the strongest approach and critical mass to Clean Air beyond London, and is developing ambition – beyond legislative obligations – which will be leading nationally. In policy terms, this has been reflected in the WM Air Quality Framework and is enabling discussions, live at the time of writing, regarding approaches to environmental policy and resourcing regionally under single settlement discussions with Defra/HMT.

People, Skills, and Engagement: Creating of a Clean Air Community of Practice, now adopted by the WMCA, has allowed practitioners to share best practice internally and externally. WM-Air approaches have been showcased through sector and national events. Public engagement – ranging from exhibitions to lesson plans – while not a focus of WM-Air, has wide societal benefit and supported policy ambition amongst elected officials, amplified through provision of an independent and trusted (expert insight, not policy comment) media strategy and presence.

Environment and Health: WM-Air has delivered measured for cleaner air which will deliver increasing benefit beyond the project duration (for decades, given the timescale of e.g. planning decisions and vehicle fleet change). These in term will improve health, and reduce air quality mediated environmental health inequality, across the region, benefitting 2.9m people across the West Midlands.

Ongoing partnership work

WM-Air continues to work closely with WMCA in support of implementation of the West Midlands Air Quality Framework:

1. Formal governance through membership of the Framework Implementation Advisory Group (three meetings held to-date).
2. Contributing to follow-on activities funded by Defra (March 2023 – March 2025), including deployment of the UoB Mobile AQ Supersite to investigate pollution hotspots, use of BAQS for sensor validation and comparison; quarterly commentary to explore AQ data from BAQS – i.e. local vs regional vs imported sources, patterns in data etc; model scenarios for use on AQ website – specific scenarios; audit of available monitoring and sensor networks across the WM; input into website content. Major outputs of this project include a comms toolkit and assets for local authorities, new West Midlands Air Quality website and data platform and a regional network of air quality sensors, providing lasting WM-Ait legacy for the region.
3. A WMCA-funded project (July 2024 – March 2025) exploring options for future regional "stretch" air quality targets by modelling a range of future scenarios in order to assess the realistic scope and impact of potential future regional "stretch" air quality targets, including with relation to inequalities.

Other work includes ongoing identification of PM sources (following the published WM-Air Source Apportionment analysis); sampling of PM around Birmingham to identify hotspots areas – urban vs rural, recreational burning vs fuel poverty – and to refine uncertainties in National Atmospheric Emissions Inventory predictions. Analysis of FAAM-aircraft measurements to estimate the contribution of regional and local sources (ECR-led). An updated version of the AQ-LAT webtool is being developed based on end-user feedback, moving away from a

downloadable excel-based tool. AQ-LAT and AQ-PET have recently (Nov 2024) been presented to Defra and UKHSA colleagues, with follow-up conversations planned in early 2025 to ascertain how these tools might be utilised nationally.

"The existing relationships will be maintained such that BCC will continue to work with the UoB on future projects (small and large) and share data and insights to hopefully assist the UoB on future work strands that can build on what was delivered through the WM-Air programme and be used to help answer future air quality related questions and inform existing or emerging policy."

Mark Wolstencroft, Operations Manager Environmental Protection, BCC

"The Uni is a centre of AQ excellence in the Region, so it is difficult to envisage a future without close collaboration"

Shaun walker, Wolverhampton

"The whole WM-Air team have been an extremely well-regarded professional academic/research team, who have provided essential support and advice. They filled a void left when the West Midlands Low Emissions Towns and Cities Programme (WM LETCP) became less active and have been a really valuable and much appreciated resource for Solihull Council.

The team have listened carefully to what help and support Local Authorities have needed and tried hard to deliver on those wishes. "

Amanda Clover, Senior Development Officer – Public Protection (Air Quality), Solihull Council

Stakeholder Engagement

The WM-Air team continue to present WM-Air's achievement and legacy to academics and external stakeholders, including Clean Air Day and Night (with some of these linked to WM-Net Zero), and through an annual regional clean air conference (commencing summer 2025). A final WM-Air Showcase event will also be held in October 2025 to celebrate the achievements of the project since 2019, to bring together the community once more and to thank everyone for being an integral part of its success. There will continue to be wider outcome dissemination of WM-Air work the AQ Hub.

New Partnership Projects

The WM-Air project has led to a series of joint publications and follow-on funding awards which is enabling ongoing relationships with partners and stakeholders. For example, a number of the WM-Air team are involved in legacy projects which will take aspects of the WM-Air project forwards:

- **WM-Net Zero – £2m (2023-2026)** involving 9 of WM-Air's stakeholders and 10 members WM-Air team: Exploring the air quality co-benefits/ disbenefits of net zero policy in the West Midlands–builds directly on WM-Air legacy (identical regional footprint), existing stakeholders, and WM-Air tools. For example, applying AQ modelling tool for Net Zero policies, and expanding the AQ-LAT tool to develop a Climate Life-course Assessment Toolkit (CLIMATE-LAT) tool to provide a systems evaluation of non-communicable disease (NCD) and mental health impacts by climate policies (e.g. transport, energy and housing), going beyond air quality-mediated health impacts, and incorporating multiple exposure pathways (e.g. indoor air pollution, noise pollution, heat effects, road traffic impacts, physical activity, green space, as well as ambient air pollution.)

"WM-Air meetings and conferences have been hugely beneficial in improving our connections to the other West Midlands local authorities, staff at WMCA, as well as other public and private stakeholder organisations. It has also resulted in positive and productive work partnerships with the University of Birmingham, with a variety of work-streams that came about through the connections with WM-Air. One such example is the Wellcome Trust funded WM-Net Zero project, in which Sandwell is a co-investigator, this project investigates air pollution in relation to decarbonisation within the context of health."

Sophie Morris – Public Health Specialist (Air Quality and Climate Change) and Elizabeth Stephens – Air Quality Team Manager, Sandwell MBC

- **WM-Adapt–£2m (2024-2027)** involving 2 of WM-Air's stakeholders and 5 members of the WM-Air team: UKRI-funded WM-Adapt will extend regional work from WM-Air and WM-Net Zero to a climate change adaptation capacity.
- **CLEETS–5.3m (2023-2028)** – Clean Energy and Equitable Transportation Solutions' Global Centre involving WM-Air stakeholders and 2 members of the WM-Air academic team: Evidence base for decision making for transport decarbonizations.
- **INHABIT–£5.5m (2025-2030)** – 'Indoor HABItability during the Transition to Net Zero Housing Hub'–The INHABIT Hub aims to produce scientific evidence and policy-relevant solutions to realise the health co-benefits of the UK's net zero transition in housing. It involves 6 of WM-Air stakeholders and 7 members of WM-Air academic team.
- **CARMINE–€12m (2023-2026)** – 'Climate Resilient Development Pathways in Metropolitan Regions of Europe'- involving 1 of WM-Air's stakeholders and 3 members of the WM-Air team: EU-Horizon funded project focused on delivering climate-resilient development pathways in metropolitan regions of Europe.
- **WMCA: DEFRA Air Quality project** (£900k) and **WMCA-funding for stretched targets work** (£25k) – both involving 4 members of WM-Air.

6. Annexes*

*Annexes can be requested by emailing wmair@contacts.bham.ac.uk

Annex list

Annex 1: Original Key Performance Indicators (KPIs) and Key Success Measures (KSMs)

Annex 2a: Organisation and Governance

Annex 2b: Biannual Meetings

Annex 3a: Impact Case Studies

Annex 3b: Impact Case Study graphical summaries

Annex 4: PhDs, Masters, undergraduate and summer student projects associated with WM-Air

Annex 5: WM-Air Proposal template

Annex 6: Additional income generated

Annex 7: Engagement and Events

Annex 8: WM-Air Impact Tracker template

Annex 9: WM-Air evaluation template

Annex 10a: Survey templates

Annex 10b: Survey results

Annex 11a: Testimonial letter request email and guidance

Annex 11b: Testimonial letters

Annex 12: WM-Air outputs

Annex 13: Consultations, Policy and Legislation

Annex 14: Model scenarios

Annex 15: Media Activities

Annex 16a: Initial stakeholder mapping

Annex 16b: WM-Air Partners and Stakeholder list

Annex 17: Next Destinations for WM-Air staff

Annex 18: Economic evaluation