

I. Cover Page

Project Title

Building Sensor and Community Partnership Networks for Air Quality in Madison, Wisconsin

Applicant Organization: City of Madison

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DUNS number: 076147909

Set-Aside: No set-aside

Brief Description of the Applicant Organization: The City of Madison is a local government entity serving the nearly 270,000 residents of Wisconsin's second largest and fastest growing city. Our Mission is to provide the highest quality service for the common good of our residents and visitors, with a commitment to fairness, justice, and equal outcomes for all. Our Sustainability and Resilience program focuses on advancing environmental sustainability, climate resilience, and environmental justice.

Project Partner(s)

Foundation for Black Women's Wellness. Primary Contact: Alia Stevenson, astevenson@ffbww.org

Latino Health Council. Primary Contact: Dr. Patricia Téllez-Girón, patricia.tellez-giron@fammed.wisc.edu

The Hmong Institute: Primary Contact: Peng Her, peng.her@thehmonginstitute.org

University of Wisconsin at Madison. Primary Contact: Tim Bertram, timothy.bertram@wisc.edu

Public Health Madison and Dane County. Primary Contact: Jeffrey Lafferty, jlafferty@publichealthmdc.com

Project Location: Madison, Wisconsin. Zip codes: 53593, 53703, 53704, 53705, 53706, 53713, 53714, 53715, 53716, 53717, 53718, 53719, 53726, 53792

Air Pollutant Scope:

In this project, we focus on high spatial and temporal measurements of size resolved particulate matter concentrations (i.e. PM₁, PM_{2.5}, and PM₁₀).

Budget Summary:

EPA Funding Request	Total Project Cost
\$429,746	\$429,746

Project Period: November 2022 - October 2025

Short Project Description: The City of Madison will lead a collaborative project to install a city-wide network of air quality sensors to provide real-time, ground-level, publicly accessible information on particulate matter pollution at the neighborhood scale. The team will engage the Madison community through multiple avenues to raise awareness about the connections between air quality and health, with a focus on BIPOC communities, and ensure that community input is reflected in the design and deliverables of the project. Using data from the network, we will characterize the spatial distribution of PM pollution across the city, identify neighborhoods experiencing the greatest levels of PM air pollution, and work with the community to determine next steps for improving air quality and protecting the health of residents.

II. Workplan

Section 1 – Project Summary and Approach

A. Overall Project

This project aims to install air quality sensors throughout the City of Madison to identify areas experiencing particulate matter (PM) air pollution and support greater awareness, education, and action to address air quality and health disparities. EPA funding would be used to 1) create a city-wide network of air quality sensors to provide up-to-date and publicly accessible information, informed by city residents and organizations, 2) engage the Madison community through multiple avenues to raise awareness about the connections between air quality and health, with a focus on BIPOC communities, 3) identify areas experiencing the greatest levels of PM air pollution, and 4) begin community outreach, education, and engagement efforts to collaboratively determine community needs and next steps for improving air quality and protecting the health of residents.

This project will help EPA achieve Objective 4.1, “Improve Air Quality and Reduce Localized Pollution and Health Impacts” outlined in the draft FY 2022-2026 EPA Strategic Plan.

POLLUTANT SCOPE

In this project, we focus on high spatial and temporal measurements of size resolved particulate matter concentrations (i.e. PM₁, PM_{2.5}, and PM₁₀). PM measurements are made in real-time and reported to a publicly assessable database for direct access by city residents and community partners. Our focus on PM as a key metric for air pollution is driven by: 1) well-established connections between outdoor exposure to PM and adverse respiratory health effects,^{1,2} 2) strong in-city variability in particle concentrations that have the potential to lead to significant health disparities,³ and 3) availability of a robust and quantitative sensing platform (QuantAQ MODULAR-PM) for real-time measurements of PM₁, PM_{2.5}, and PM₁₀.

LEADERSHIP TEAM

- **City of Madison (the City):** Dr. Jessica Price, City of Madison Mayor’s Office - Project Manager
- **Public Health Madison and Dane County (PHMDC):** Jeffery Lafferty, Public Health Madison and Dane County - Environmental Epidemiologist
- **University of Wisconsin – Madison (UW-Madison):** Dr. Tim Bertram, Departments of Chemistry and Atmospheric and Oceanic Sciences; Dr. Tracey Holloway - Department Atmospheric and Ocean Sciences and Nelson Institute for Environmental Studies
- **Foundation for Black Women’s Wellness (FFBWW)*:** Alia Stevenson, Chief Programs Officer
- **Latino Health Council (LHC)*:** Dr. Patricia Téllez-Girón, MD, Chair of Latino Health Council
- **The Hmong Institute*:** Peng Her, CEO

* These three non-profit community organizations are the community partners in this project.

PROPOSED ACTIVITIES

Task 1. Project Management and Reporting: The Project Manager, in collaboration with the Leadership Team, will finalize a project work plan and execute contracts for subawards to project partners; produce quarterly reports detailing activities, deliverables and milestone, as outlined in (Section 4c); plan and execute all Leadership Team meetings, coordinate project activities, and track progress; and coordinate activities by City staff to fulfill the obligations of this grant. All members of the Leadership Team will participate in regular team meetings.

Task 2. Engage Community in Project & Sensor Network Design: The Leadership Team will plan and execute a series of community engagement activities aimed at 1) informing Madison residents about the creation of the city-wide air quality sensor network, 2) raising awareness about the connections between air quality and health, 3) gathering information from residents to inform the design of the air quality sensor network (Task 3), and 4) learning the best ways to inform and collaborate with community members once air quality data from the sensor network is available and areas of greatest concern have been identified (Task 4).

City of Madison (the City) will create a web page for this project on its website where the public can access information about project aims, progress, and outputs. The website will be updated during the project and beyond.

The City will hold 3-5 Open House events to achieve aims 1-4 described above by reaching a broad spectrum of the community. Community partners – Foundation for Black Women’s Wellness (FFBWW), Latino Health Council (LHC), and the Hmong Institute – will provide guidance on the best design for each Open House’s audience, location, and content to ensure they achieve the aims described above. Community partners will also promote the Open Houses through their own communication channels.

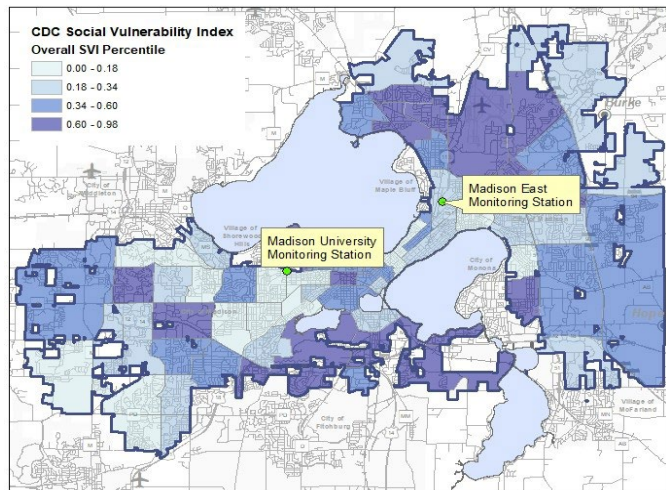


Figure 1. Map of the City of Madison showing census tracts and the location of WI DNR air monitoring stations. Census tracts show CDC overall social vulnerability ranking within Wisconsin – darker colors indicate greater social vulnerability.

Task 3. Design and Install a City-wide PM Sensor Network: The project will install a city-wide PM sensor network, with at least one sensor located in each of Madison’s 68 census tracts. This network will provide full coverage PM monitoring across the city, providing air quality data to underserved neighborhoods and vulnerable populations sensitive to air quality impacts that might not be geographically clustered, such as the elderly, children, and those with pre-existing medical conditions. **Figure 1** shows the relative overall social vulnerability of Madison’s census tracts relative the rest of Wisconsin, according to the CDC’s Social Vulnerability Index.⁴

of PM₁, PM_{2.5}, and PM₁₀. The sensor package is attached to the cellular network enabling real-time data to be displayed for community decision making and awareness.

The project will use MODULAIR-PM (QuantAQ) air quality sensors, which combine a commercial nephelometer with an optical particle counter to achieve high-time resolution (1 min) measurements

Professor Tim Bertram at the University of Wisconsin-Madison (UW-Madison), with input from the Leadership Team, will design the spatial arrangement of air quality sensor network to provide optimal data on ground-level particulate matter. Sensors will be installed on city-owned light and traffic signal poles located by the City’s Streets Division. The location of the sensors within the city will be determined by balancing best practices for monitoring air pollution concentrations that are representative of a census track with specific community input from Task 2. A sensor will also be placed at each of the two Department of Natural Resources’ (DNR) air quality monitoring stations in Madison to enable calibration and quality assurance.

Community members will be invited on-site for installation of 3-5 sensors. At these events, attendees will get the opportunity to learn how the sensors work, why the network is important, and how the air quality information it provides can be useful to them.

Once installed, real-time air quality data will be provided by QuantAQ Cloud. During the commissioning phase of network deployment, PM data will be monitored by the Bertram Lab at UW-Madison to ensure the network is operating as designed (see Section 5). Data will be displayed and available for download on the project web page.

Task 4. Identify, Map, and Share the Air Quality Story: Real-time measurements of PM concentrations from the city-wide network of MODULAIR-PM sensors will be used to characterize the spatial distribution of air pollution across the city. Following the initial 2-week QA/QC commissioning period, we will collect a season (ca. 3 months) of continuous measurements. Prof. Tim Bertram and Prof. Tracey Holloway at UW-Madison will guided analysis of the spatial patterns in PM₁, PM_{2.5}, and PM₁₀ on the neighborhood scale. Measurements from the sensor network will be compared with regional measurements of PM_{2.5} made from the two existing DNR air quality monitoring stations in Madison. This initial analysis will provide key insight on the spatial and temporal availability in PM within the city and the frequency at which we want to report observations to the project website (e.g., 1 minute, 1 hour, daily air quality

updates) and the context (e.g., seasonal average) that we want to report these measurements with. Importantly, this analysis will identify the areas of Madison experiencing the greatest levels of PM pollution.

To share these findings, the City will create a publicly accessible Story Map that enables users to interact with findings from the air quality analysis, along with sociodemographic data, to see how air pollution is affecting their neighborhood and city. The Story Map will include information about the links between health, environmental justice, and air pollution as well as stories about air quality and health from members of the community. The Story Map will be available in English, Spanish, and Hmong on the project web page. The map will highlight which neighborhoods and populations are most impacted by poor air quality. Public Health Madison and Dane County (PHMDC) will provide health information on the map and work with the Leadership Team to provide insight into the upstream variables affecting air quality and the downstream health implications in Madison neighborhoods. Community partners will help ensure the map is accessible to and inclusive of Madison's diverse communities.

Community partners and PHMDC will communicate these findings and their significance for community health and environmental justice using a variety of formats to ensure effectiveness for different audiences, including print, web, audio, video or events. UW-Madison will provide technical support in these efforts as needed.

Task 5. Collaboratively Identify Needs and Next Steps: The City will hold a second round of 3-5 Open House events to share findings on air quality with the community to begin a generative conversation about what the data means, the needs of the communities most impacted by poor air quality, and next steps for improving air quality and protecting the health of residents. These Open House events will focus on connecting with communities in the areas of Madison experiencing the greatest levels of air pollution. Input and ideas generated at Open Houses will be synthesized by the Leadership Team and shared back out to the community on the projects website.

Community partners and PHMDC will provide guidance on the best design for each Open House's audience, location, and content and promote the Open Houses through their own communication channels.

Task 6. Information transfer and dissemination: The City, PHMDC, and UW-Madison will use their communication channels to share the project's approach and outputs, including publicly accessible air quality data, the Story Map, and other materials, to enable other local and state governments and community organizations to replicate this approach. The Project Manager, with input from the Leadership Team, will create a final project report written for EPA upon completion of the project.

B. Project Significance

Particulate matter air pollution, especially fine particles ($PM_{2.5}$), poses serious risks to respiratory and cardiovascular health. The size of this contaminant poses a barrier for removal by the natural defenses of the human body leading to the settling of the material in the lungs. Exposure to $PM_{2.5}$, even short term peaks or spikes in air pollution, can lead to the increased risk of human respiratory and cardiovascular diseases with a greater disease burden among vulnerable populations. In Madison, there are two regulatory-grade air quality sensors - the Madison University station and the Madison East station operated by the Wisconsin Department of Natural Resources (DNR) (Figure 1). Over the period 2018-2020, the Madison University station recorded the second highest annual $PM_{2.5}$ and the highest 24-hour $PM_{2.5}$ of all sensors in Wisconsin DNR's ambient air monitoring network. The Madison East station recorded the fifth highest annual $PM_{2.5}$ and the third highest 24-hour $PM_{2.5}$ in the state.⁵ According to EPA EJScreen, the City of Madison is in the 84th percentile for $PM_{2.5}$ in compared to the rest of the state.

While these regulatory sensors give a broad understanding of air pollution in our region, they do not have the spatial resolution to identify differences in exposure to PM across Madison's neighborhoods. Importantly, these sensors are not located in or near many of Madison's underserved communities (Figure 1). Further, remotely sensed data on NO_2 shows pockets of air pollution are not concentrated near existing regulatory air quality sensors. The absence of air quality data across most of Madison, particularly in underserved communities, contributes to a lack of awareness and community capacity focused on air quality and health related outcomes. Addressing these issues requires targeted, data informed strategies and partnerships.

Exposure and vulnerability to air pollution are experienced more acutely by low to moderate income residents, BIPOC communities, people with disabilities, children, and the elderly. In Wisconsin, BIPOC and low income communities are disproportionately burdened by respiratory and cardiovascular illnesses. Black Wisconsinites have an asthma prevalence nearly 1.5x higher,⁶ a rate of asthma-related hospitalizations 6x higher,⁷ and are almost 3x more likely to die from asthma than white Wisconsinites.³ Asthma-related emergency room visits are 6x times higher for black children.⁸ Hispanic Wisconsinites have an asthma-related hospitalization rate 1.6x higher than non-Hispanic Wisconsinites,⁴ and emergency room visits for Hispanic children are twice that of white children.⁵ Adults in the lowest income group have almost 2.5x the rate of asthma as those in the highest income group. And Dane County, where the City of Madison is located, has the 10th highest asthma hospitalization rate in the state.³

Heart disease also disproportionately impacts Wisconsin's black population. Black Wisconsinites are hospitalized due to heart failure at a rate 5.6x higher and have a death rate due to heart disease 1.6x the rate of white Wisconsinites.⁹ The COVID-19 pandemic has also disproportionately impacted Dane County's BIPOC communities, with black and Latinx residents' infection rates doubling, tripling and nearly quadrupling the rates of white residents during surges.¹⁰

Madison is also home to a large portion of Wisconsin's Hmong population, with Hmong (or Hmoob) being the third most commonly spoken language in the city and state. Hmong residents face health disparities and limited access to health information and care due to many factors, including linguistic isolation, low wages and income, limited access to government services, and discrimination. Communities of color, including the Hmong community, and low-income residents were disproportionately impacted by the COVID-19 pandemic, experiencing greater economic hardship, housing insecurity, and more challenges accessing and affording healthcare.

Real time, ground-level information from a spatially distributed PM sensor network, combined with satellite data, will enable understanding of locations, magnitudes, and potential sources of PM and development of short and long term solutions by multiple actors to improve air quality and protect community health. Community partnerships and engagement, with a focus on BIPOC communities, will ensure the sensor network and findings on air pollution are responsive to communities concerns and needs, and that resources, education, and support reach the community members most vulnerable to and impacted by PM pollution.

This project will not only create a sensor network that provides valuable air quality data but will also build local capacity to interpret and benefit from that information, especially underserved communities. In addition, this network and approach can be used as a model for enhanced air quality monitoring in other medium sized cities, provide valuable data on air quality to fill in information gaps. Midwest air quality and especially winter air quality issues (where PM is most central) have been historically understudied.

Section 2 – Community Involvement

A. Community Partnerships

This project brings together a Leadership Team of community partners and supporting organizations with the range of expertise and experience necessary to successfully carry out this project. The City will lead this project, and PHMDC and UW-Madison will provide capacity, expertise, and resources on project management, atmospheric science, air quality monitoring, and public health information and communication.

Three community partners will serve on the Leadership Team. Each is dedicated to and has extensive experience in providing resources, programming, and communications to advance the health and wellbeing of Madison's BIPOC communities.

The [Foundation for Black Women's Wellness](#) is a Wisconsin based non-profit organization focused on eliminating health disparities and other barriers impacting the lives of Black women, their families, and communities. Their mission is to energize, mobilize, and support Black women to transform their health and their lives through education, advocacy, support, and powerful partnerships. FFBWW has robust health communication and education programming and a network of Wellness Ambassadors that serve as health communicators, informants, and navigators in the community.

The [Latino Health Council](#) is a non-profit composed of over 40 key health care related organizations and agencies throughout Madison and Dane County. LHC's mission is to promote and support the health and well-being of the Latino community through education, advocacy, consulting and networking. They engage the Latinx community in health and wellbeing through events, programming, and media, including a weekly Spanish language radio program focused on health.

[The Hmong Institute](#) is a Madison-based, non-profit community organization focused on empowering the Hmong community through education, health, and preservation of Hmong heritage. They provide education, health, community building, and economic and professional development assistance and programming to overcome cultural, language, and access barriers for the Southeast Asian and immigrant communities in Dane County. Health-focused programs include the Annual Hmong Health Summit and trainings for health service providers and more.

Each community partner will serve as a member of Leadership Team, providing input, expertise, and outreach to make sure the project is designed & delivered in ways that engage and meet the needs of Madison's diverse population. Community partners will:

1. Advise on all elements of the project design, including community engagement (Tasks 2 and 5), design of the sensor network (Task 3), and resources to tell the air quality story (Task 6).
2. Perform outreach through their existing networks and avenues to raise awareness about the project and promote community participation in project activities defined in Tasks 2, 3, and 5.
3. Use their platforms, programs, and events to raise awareness about the sensor network and available air quality data as well as the connections between air quality and health.

For this work, community partners are included as sub-recipients of the grant as shown in Section 7.

Participation in this project benefits community partners by growing their capacity; building and strengthening connections with the projects' other partners; and providing culturally relevant and accessible data, maps, and other resources that they can use in their own programming. Ultimately, these gains strengthen the services each offers to their communities and helps each organization achieve their mission of improving health outcomes in their respective communities.

B. Community Engagement

Discussed above in Sections 1.A and 2.A, three community partners will serve on the project's Leadership Team and provide input and expertise to make sure the project is designed and delivered in ways that engage and meet the needs of Madison's diverse population. These partners have strong ties to Madison's BIPOC communities.

Together, the Leadership Team will develop a public participation plan following the best practices defined in the Public Participation Resource Guide developed by the City of Madison's Racial Equity and Social Justice Initiative.¹¹ As described in Section 1A, members of the community will be invited to provide input and participate in the project through initial Open House events (Task 2), sensor installation events (Task 3), and community partner events, and community members will collaboratively determine community needs and next steps for improving air quality and protecting the health of residents (Task 5).

Task 4 describes the multi-modal public awareness and education activities the Leadership Team will use to build community knowledge about the project and the connections between air quality and health. These activities will be designed to effectively and inclusively engage Madison residents in culturally appropriate and relevant ways with multiple techniques required to reach different demographics.

The project will also leverage partnerships internal to the City, including Neighborhood Resource Teams (NRTs), the Latinx Community Engagement Team, and the Community Connections Team for the Racial Equity and Social Justice Initiative to ensure equitable and inclusive community engagement.

EXPERIENCE WORKING TOGETHER

The City and PHMDC have successfully worked with all three community partners to deliver health-focused community education campaigns, programming, and support services. The City, PHMDC, FFBWW, and LHC

partnered to deliver a comprehensive #MaskUp campaign to provide education and masks at the height of the global pandemic. Other successful partnerships between the City, PHMDC, and community partners include: FFBWW's Saving Our Babies Initiative and LHC's partnership in development of the 2019 – 2021 Dane County Community Health Needs Assessment.

PROJECT INFORMATION & DATA AVAILABILITY

The City will create a web page for this initiative on its website where the public can access information about the project and its outputs. This web page will be created early in the project (Task 2) to serve as a primary information source on the project's aims, progress, community engagement and input opportunities, and resulting communication and educational materials. The Story Map (Task 5) showing air quality data from the sensor network and sociodemographic data and explains their significance will be embedded on this page. The web page will be available in English, Spanish, and Hmong.

Air quality data provided by the sensor network will be available in real-time via the existing QuantAQ Cloud. We expect to be reporting PM₁, PM_{2.5}, and PM₁₀ concentrations as soon as the network is powered. Following the initial commissioning phase, the City of Madison will directly read the sensor data from the QuantAQ server to the project web page where both real-time and recent past measurements (along with historical regional averages) will be displayed for the community.

Section 3 – Environmental Justice and Underserved Communities

The City of Madison is committed to providing a healthy environment for all residents and advancing environmental justice. Building this sensor network in collaboration with community partners and with community engagement will serve as a focal point for raising awareness of residents, with a focus on vulnerable populations, about air quality, environmental justice, and the links between air quality and health.

This project will promote environmental justice in five main ways. First, the project will engage the community through an inclusive process that centers racial equity, as described in Sections 1 and 2. Meaningful involvement of underserved communities ensures that the project's design, outputs, and outcomes support environmental justice. Second, it provides resources to community partners focusing on health and wellbeing in Madison's BIPOC communities to conduct culturally relevant outreach, engagement, and education within the communities most vulnerable to and impacted by particulate matter pollution. This approach provides information and tools to underserved communities to support their own agency and leadership. Third, this project will provide real-time, publicly accessible measurements of PM pollution, which enables public health agencies and professionals, local government decision-makers, and community organizations to characterize and address disparities in exposure to air pollution and related health outcomes in the Madison community. Fourth, awareness about the connections between air quality and health, combined with access to timely and relevant air quality data, also empowers community members to take actions to reduce their own and their family's exposure at times and places with high PM. Finally, this project sets the stage for collaborative and participatory problem solving, where residents have the education and tools to meaningfully engage in decision making about activities that affect their environment and health with regard to air quality. This is a critical enabling condition for effective, collaborative, and inclusive action to improve health, air quality, and environmental justice.

REFERENCES

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