Quality Assurance Project Plan (QAPP)

Local-Scale, Community-Led Monitoring in East Oakland, California

Project Component #3: Community-Conducted Monitoring of Indoor and Outdoor Fine Particulate Matter ($PM_{2.5}$)

EPA Assistance Agreement 98T56701

Prepared By:
University of California, Berkeley
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Prepared By:

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Chelsea V. Preble, PhD
Principal Investigator
University of California, Berkeley

Date

A2 – Approval Page

Approved By:

03/27/2025

Chelsea Preble
University of California, Berkeley
Project Technical Operations Lead

Date

DocuSigned by:
Kate Hoag
74EA636BE0A04CD...

4/1/2025

Kate Hoag
Bay Area Air District
Project Oversight Lead

Date

EPA Concurrence/Approval:

ANGELA LATIGUE Digitally signed by ANGELA LATIGUE
Date: 2025.04.21 10:08:46 -07'00'

Angela Latigue
EPA Regional Grants Coordinator/Project Officer

Date

Audrey L Johnson Digitally signed by Audrey L Johnson
Date: 2025.04.17 16:27:26 -07'00'

Audrey Johnson
EPA Quality Assurance Manager

Date

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Relevant Acronyms

Table 1. List of relevant acronyms.

Acronym	Meaning
BAAD	Bay Area Air District
CARB	California Air Resources Board
CBE	Communities for a Better Environment
CERP	Community Emissions Reduction Plan
EPA	Environmental Protection Agency
$PM_{2.5}$	Fine particulate matter
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
UCB	University of California, Berkeley
US	United States

A4 – Project Purpose and Background

This Quality Assurance Project Plan (QAPP) provides detailed documentation of the planning, implementation, and assessment procedures and how specific quality assurance (QA) and quality control (QC) activities will be applied to Component #3 of the "Enhanced Air Quality Monitoring for Communities: Local-Scale Monitoring for Near-Source Impacts in East Oakland, California" project. The goal of Component #3 is to deploy a community network of outdoor and indoor $PM_{2.5}$ sensors and air filtration units and train community members to interpret data and respond to air quality emergencies, such as wildfire smoke events.

The purpose of this QAPP is to demonstrate that: (1) the project's informational research and educational outreach objectives are identified and agreed upon; (2) the intended measurements, data generation, or data acquisition methods are appropriate for achieving these project objectives; (3) assessment procedures are sufficient for confirming that data of the type and quality needed are obtained; and (4) limitations on the use of the project data are identified and documented. Additionally, this QAPP will address any specific quality assurance and quality control activities for the project as tasked by the U.S. EPA. EPA IT/IM Directive No. CIO 2105-S-02.0, *Quality Assurance Project Plans Standard*, and EPA/600/R-22/213, *The Enhanced Air Sensor Guidebook*, were used as guidance in the preparation of this QAPP.

Issue Background

In general, communities located near industrial and mobile sources experience disparate levels of air pollution compared to other urban areas. These disparate impacts are not always captured by long-term ambient air monitoring stations or modeling efforts that are often limited in spatial resolution since long-term monitoring stations are not designed to capture neighborhood-scale variability in ambient pollution and modeling efforts may not reflect all the local emissions contributing to total exposure. However, air quality studies specifically designed to collect spatially resolved air quality data using sensor networks or other short-duration stationary monitoring deployments can reveal areas with persistently elevated pollutant concentrations, improve our understanding of gradients in ambient pollution levels near sources, help to quantify relative contributions from known emissions sources, and aid in the identification of new sources.

East Oakland community members and organizations have long advocated for health equity, cleaner air, and investments to build a green and regenerative economy. Located in north-western Alameda County near the East Bay waterfront, East Oakland is a predominantly Black, Latinx, and people of color community of approximately 162,600 people. Nearly half of the population in East Oakland is Latinx, and another 30% of the residents are Black Americans. East Oakland is a major transportation corridor with goods moving via ship, rail, congested freeways, and truck routes adjacent to residential communities, and includes I-880, the Oakland International Airport, and industrial and logistics businesses associated with the Port of Oakland. The East Oakland area contains numerous freeways and railways used for diesel-powered freight movement as well as non-commercial travel and borders many truck routes (local streets and truck-allowing freeways) and industrially zoned land, which have businesses that directly emit pollutants to the atmosphere and produce and attract high numbers of daily truck trips. In addition, East Oakland is densely populated, exceeding 3,000 persons per square mile across most of the community and some areas with as many as 5,880 persons per square mile. Consequently, the predominantly Black and Brown residents live near industrial sources and experience significant cumulative impacts associated with high levels of air, water, and soil pollution.

Communities for a Better Environment (CBE) is a local environmental justice advocacy organization that is working to build community power in East Oakland to mitigate air pollution and build healthy and sustainable environments. In partnership with the University of California, Berkeley (UCB) and the Bay Area Air District (Air District), CBE will conduct an informational monitoring project that will provide essential information for the development of effective strategies for reducing air pollution exposure and emissions. This is particularly timely in the case of East Oakland, as it will provide community members with information that will support an ongoing, community-led emissions reduction program already underway under California Assembly Bill 617 (AB617). Despite experiencing some of the worst air quality in the East Bay, East Oakland has very few PurpleAir monitors and is in many ways an air quality "data desert." PurpleAir monitors are an essential community resource to produce the real-time data needed to understand day-to-day air quality concerns, especially during acute, high $PM_{2.5}$ pollution events like wildfires that are increasingly common in California. Participating community members will receive PurpleAir monitors, air filtration resources, and training to build ownership in monitoring and responding to air quality emergencies.

A5 – Project Task Description

Project Description

This informational research and educational outreach study seeks to enhance air quality monitoring in the highly impacted neighborhood of East Oakland, California (CA). UCB and CBE will collaborate to deploy a network of PurpleAir monitors at 35 sites across the study area for informational monitoring of indoor and outdoor $PM_{2.5}$ concentrations over the period of 1 year. The project will center on the AB617-defined boundary that includes the 94621, 94603, and 94601 ZIP codes that are heavily impacted by stationary and mobile air pollution sources.

A PurpleAir sensor will be placed outdoors at each of the 35 monitoring sites. Five of these monitoring locations will be at Oakland Unified School District (OUSD) schools and 30 locations will be at residential homes. For the residential hosts, community members will be able to opt in to receive a second PurpleAir sensor that will be placed indoors, an indoor air filtration device, and a stipend for their participation. As part of their participation, these community members will be trained to monitor and respond to air quality changes within their homes, as well as air quality emergencies, such as wildfire smoke events.

The objective of the training is to build ownership in monitoring and responding to severe air quality events. Through this study, community members will be provided with consumer-grade PM sensors to increase the accessibility of real-time $PM_{2.5}$ data throughout an area that has fewer sensors than other parts of the San Francisco Bay Area, as well as air filters to mitigate and reduce infiltrated outdoor PM pollution inside residences and buildings.

Expected Project Outputs & Outcomes

Project outputs and outcomes are expected to include but are not limited to the following Table 3 summary.

Table 3. Expected outputs and outcomes of the project.

Project Output	Corresponding Project Outcome
Task 1: Deploy PurpleAir sensors & air filtration units	Increase access to real-time $PM_{2.5}$ concentration data within East Oakland; distribute air filters to community members that can mitigate and reduce infiltrated outdoor PM pollution
Task 2: Community outreach & engagement	Increase community engagement and build capacity through neighborhood events, training sessions, quarterly informational sessions, and experience using PurpleAir sensors and air filters
Task 3: Evaluation of relative $PM_{2.5}$ concentrations measured outdoors and indoors	Increase community understanding of the spatial and temporal trends in outdoor and indoor $PM_{2.5}$ concentrations within East Oakland
Task 4: Evaluation of air filtration units	Increase community understanding of how air filters can mitigate indoor $PM_{2.5}$ concentrations
Task 5: Reporting of project results	Inform community about local air quality trends and how to respond to air quality emergencies

Project Schedule

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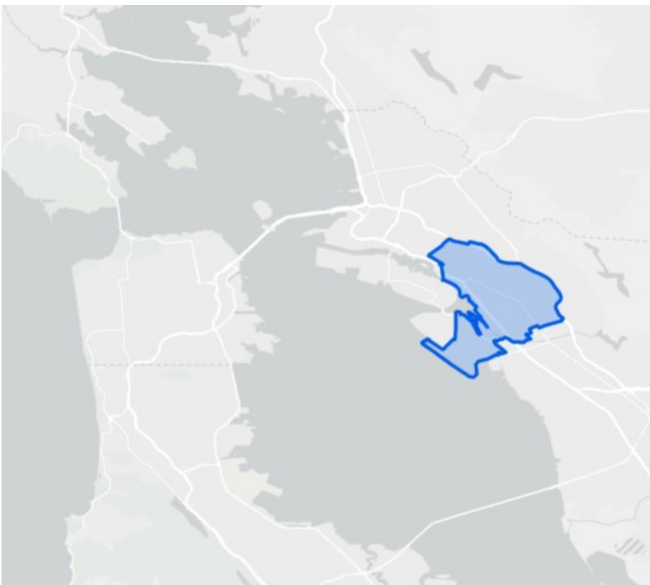
Table 4. Expected project schedule by task.

Project Output	Start Date	End Date
Task 1: Deploy PurpleAir sensors & air filtration units	04/2025	05/2026
Task 2: Community outreach & engagement	03/2025	05/2026
Task 3: Evaluation of relative $PM_{2.5}$ concentrations measured outdoors and indoors	05/2025	04/2026
Task 4: Evaluation of air filtration units	05/2025	04/2026
Task 5: Reporting of project results	05/2025	04/2026

Project Boundaries
The study area will center on the AB617-defined boundary that includes the 94621, 94603, and 94601 ZIP codes that are heavily impacted by stationary and mobile air pollution sources (Figure 1). Specific sensor locations have not yet been determined and will be dependent on host recruitment and community engagement, which are scheduled to begin in March 2025.

Figure 1. The community of East Oakland in California's San Francisco Bay Area.



A6 – Information/Data Quality Objectives & Performance/Acceptance Criteria

Data Quality Objectives
The PurpleAir sensors will be used to describe the relative differences in $PM_{2.5}$ concentrations measured indoors and outdoors across East Oakland. The data collected will be used for informational and educational purposes and are not intended for regulatory applications. The sensors will be installed and operated according to standard procedures outlined by the manufacturer and following *The Enhanced Air Sensor Guidebook* (EPA/600/R-22/213).

The PurpleAir sensor was selected for this study because it is a commonly used low-cost PM monitor that has been deployed in other community-conducted informational monitoring studies and has well characterized performance (Singer and Delp, 2018; Barkjohn et al., 2021; Park et al., 2023). These sensors also offer the most flexibility for future use by our community partners, CBE, who will keep the sensors at the end of the study. The Levoit Vital 100 Plus air filtration device was selected for this study due to the affordability of each cleaner and replacement filters and room size rating (~1000 square feet). This model is ozone-free and is on the California Air Resources Board's (CARB's) list of certified air cleaning devices.

Data Quality Indicators

Prior work by Barkjohn et al. (2021) has established data quality indicators that will be used in this informational study as acceptance criteria for precision and completeness. For precision, only data where the difference between channel A and B is less than 5 µg m^{-3} or 61% will be included. Similarly, a data completeness threshold of 90% of channel A data will be applied to avoid introducing bias when calculating hourly and daily $PM_{2.5}$ concentrations.

Prior work on has experimentally determined limits of detection for a similar model of the Plantower sensors that are used in PurpleAir monitors (PMS 5003) based on field tests in Salt Lake City, Utah in 2017 (Sayahi et al., 2019). Sayahi et al. reported limits of detection for $PM_{2.5}$ that ranged 2.6–5.7 µg m^{-3}, depending on the season and sensor tested. It is important to note that the meteorology and environmental conditions during the Salt Lake City testing are different from those typical of East Oakland. Salt Lake City experiences larger ranges in temperature and relative humidity across seasons compared to East Oakland, which may impact the applicability of the detection limits to the PurpleAir monitors that will be deployed in the present study. Even so, these previously reported limits of detection can inform the sensitivity acceptance criteria in our informational study.

The comparability of the sensors will be tested in the laboratory prior to deployment. Any outlier PurpleAir sensors will be removed from the suite of monitors and not deployed.

To ensure the representativeness of the collected data, UCB researchers and CBE staff will work to recruit hosts and installation locations that are well distributed across the study area. The outdoor PurpleAir sensors will be sited outside of homes, community centers, schools, and businesses across the study area, thereby capturing a representative mix of environments within East Oakland.

A7 – Distribution List

Table 4 lists the individuals who will receive original copies of this Quality Assurance Project Plan (QAPP) and any future updated and revised copies, shared electronically or as printed copies. The QAPP will be distributed to other personnel beyond this list, in accordance with the organizational list outlined in the Project Organization section below.

Table 4. QAPP distribution list.

Name	Title	Organization	Contact
Chelsea Preble	Assistant Research Engineer, Department of Civil & Environmental Engineering	University of California, Berkeley (UCB)	cvpreble@berkeley.edu
Kate Hoag	Assistant Manager, Meteorology & Measurement Division	Bay Area Air District (Air District)	khoag@baaqmd.gov
Josephine Fong	Senior Air Quality Specialist, Meteorology & Measurement Division	Air District	jfong@baaqmd.gov
Daniel Alrick	Principal Air & Meteorological Monitoring Specialist, Meteorology & Measurement Division	Air District	dalrick@baaqmd.gov
Kim Ryan	NorCal Staff Researcher	Communities for a Better Environment (CBE)	kim@cbecal.org
Adele Watts	East Oakland Community Organizer	CBE	adele@cbecal.org
Sharifa Taylor	Staff Researcher	CBE	sharifa@cbecal.org
Audrey Johnson	Quality Assurance Manager	U.S. Environmental Protection Agency (EPA)	Johnson.AudreyL@epa.gov

The official, controlled, and protected version of this QAPP will be stored in the following locations:

- A digital copy that is publicly available on the project's website
- A digital copy that is stored in a shared project folder on UCB's Google Drive

- A digital copy that is stored in the cloud on the Air District's OneDrive server

A8 – Project Organization

Figure 2 illustrates the project organization and communications structure for conducting this work.

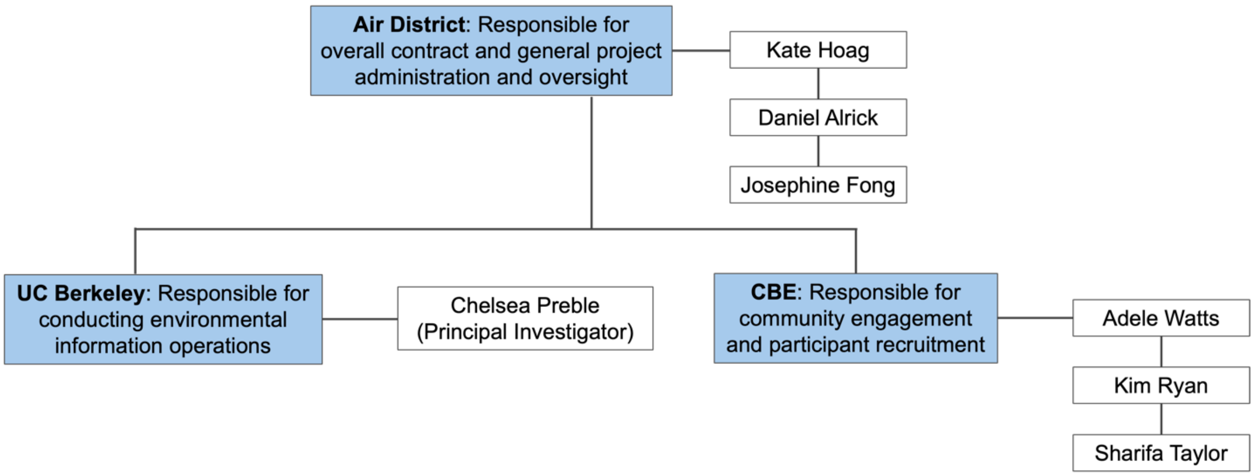
The Air District is the recipient of EPA grant and is acting as a passthrough agency. Kate Hoag and Josephine Fong will be responsible for the overall contract and general administration of the project. Their responsibilities will include coordinating with UCB and CBE, providing fiscal and progress reports, and attending training sessions and quarterly information sessions. Daniel Alrick will serve as liaison between the three components of the project, connecting the mobile monitoring studies (Components #1 and #2, separate QAPP) and community-conducted monitoring of indoor and outdoor $PM_{2.5}$ (Component #3, this QAPP).

UCB is a subrecipient of the EPA grant and will be the technical lead of the community-conducted monitoring of indoor and outdoor fine particulate matter ($PM_{2.5}$), in partnership with CBE. Chelsea Preble is the UCB Principal Investigator (PI) and will be the primary decision maker and manager for the technical side of the project. Dr. Preble will be responsible for sensor testing and installation, data analysis and interpretation, and reporting of results. She is responsible for maintaining the QAPP and will ensure that the QAPP revisions are communicated and distributed to all parties in the distribution list and will oversee that all UCB tasks and deliverables are completed in accordance with the agreement with the Air District.

CBE is a subrecipient of the EPA grant and will be responsible for developing and implementing the community engagement plan. Kim Ryan, Adele Watts, and Sharifa Taylor will coordinate the community engagement efforts and will be responsible for recruiting participants, hosting training sessions, conducting quarterly information sessions, and serving as the main liaison between participants and UCB. They will ensure that all CBE tasks and deliverables are completed in accordance with the agreement with the Air District.

EPA has final approval authority over this QAPP as this project is funded by EPA. EPA approval is required prior to the collection, production, evaluation, or use of environmental data for this project.

Figure 2. Project organization and communications chart.



A9 – Project Quality Assurance Manager Independence

This is a non-regulatory, community-based air monitoring project for informational data that will be led and conducted by a small team from UCB. This team will ensure that the air monitoring project is implemented in accordance with this QAPP and will be responsible for maintaining and revising the QAPP as needed, as described in Section A8. The Air District will provide overall project oversight by conducting spot checks of collected data, reviewing reports, and arbitrating disputes regarding data validation or corrective action as needed, since Air District staff are not actively involved in collecting, analyzing, or validating data.

A10 – Project Organization Chart and Communications

Figure 2 above shows the communications structure for each organization and key personnel working on this project. Communications about the project will primarily take place during meetings and over email. The project team routinely meets (either weekly or biweekly, depending on project needs) and corresponds regularly by email to discuss project status and planning, make decisions, and address issues as they arise. Project leads will contact EPA Operations via email regarding discrepancies, QAPP non-conformances, QAPP revisions, and other matters in a timely manner.

A11 – Personnel Training/Certification

Dr. Chelsea Preble has undergone training and certification in Human Subjects Research through the Collaborative Institutional Training Initiative (CITI Program). She prepared and submitted a protocol for this study to the UCB Committee/Office for the

Protection of Human Subjects (CPHS/OPHS), which was determined to not meet the definition of research with human subjects set forth in Federal Regulations at 45 CFR 46.102. If any changes are made to the study protocol, a revised protocol will be submitted to CPHS/OPHS to determine whether the revised protocol falls within their scope of responsibilities.

Laboratory tests will be conducted by Dr. Preble at UCB. Dr. Preble will train all field personnel at CBE to install PurpleAir monitors and air filters by providing in-person demonstrations of both in the CBE office prior to field installations. As part of this demonstration, Dr. Preble and CBE will work together to create a field protocol in writing that will be used as documentation. This field protocol will be updated as needed, based on experiences and lessons learned during any future field work.

A12 – Documents & Records

As noted above, this QAPP will be provided in a dated electronic format to all members of the project team on the Distribution List (Table 4). Any necessary updates will be transmitted to the same Distribution List in the same manner, with clear instructions that the revised QAPP takes the place of any prior versions.

Copies of the PurpleAir and air filter user manuals, QAPP, and other procedures and protocols will be maintained as electronic copies in each of the shared Google Drive and OneDrive folders. All final data records for the laboratory testing and community-conducted monitoring will be stored with laboratory, installation, and maintenance notes in the same folders. Installation records will include:

- Sensor identification number
- Sensor site number
- Installed latitude and longitude
- Environment (indoor or outdoor)
- Date sensor commenced operation

Community engagement materials developed for host recruitment and training sessions will be kept in the same shared folders, along with the presentation materials that are prepared for each quarterly information session. Data reports will include electronic formats of final data that has undergone all quality assurance and quality control (QA/QC) checks, including sensor location, environment, date/time stamp, and $PM_{2.5}$ concentrations.

All documents and records will be retained for a minimum period as required under the Air District's retention schedule (see Air District Resolution 2023-11). The QAPP will remain in effect until superseded by a later version or the project is completed.

Obsolete, superseded documents will be removed from points of use and retained for a minimum of 5 years following obsolescence.

B1 – Identification of Project Environmental Information Operations

As described in Sections A4, A5, and A6, PurpleAir sensors will be used to collect informational and educational measurements of relative $PM_{2.5}$ concentrations at select indoor and outdoor locations across the community of East Oakland. Using low-cost PM sensors like the PurpleAirs for a community-based air quality monitoring network is an appropriate approach for the proposed work, given the project focus on community outreach and training. The project data quality indicators were developed to ensure that the collected data support the project data quality objectives and overall purpose.

B2 – Methods for Environmental Information Acquisition

Study Procedures

Outreach, Engagement, & Recruitment

CBE will develop and implement an outreach and recruitment plan that leverages their robust, existing community network. Outreach activities will continue until the maximum number of participants have been recruited. Recruitment is anticipated to continue on a rolling basis in order to achieve maximum participation. CBE will recruit and consent all participants, including getting signed host agreement forms and managing all contact information.

Eligible households must reside in the East Oakland study area and have at least one residing adult (≥18 years old) who is able to consent on behalf of their household. Those who plan to move outside of the East Oakland study area during the 1-year study period will be excluded. There will be no exclusion criteria based on income, housing type, or health- or indoor air quality-impactful behaviors like smoking indoors. To participate, households must have accessible power outlets and WiFi connections so that an indoor and outdoor PurpleAir sensor can be installed and transmit data to the publicly available cloud-based platform (https://map.purpleair.com). Given the many benefits of participation in the project (air filtration unit to use in the home, access to air quality data inside and out of the home) and the minimal risks to participants, there are no other exclusion criteria based on age, health status, language, gender, race, or ethnicity.

CBE and UCB will hold a minimum of two training sessions on separate dates and times to inform participants about the air sensors. Training sessions will include information such as:

- How the air monitors and air filters work;

- What the air monitor can tell us (and cannot tell us) about the air quality;
- How to use the air monitor and filter and how to know if either need adjustments or maintenance;
- How to view and interpret air quality data on the PurpleAir platform;
- What are some common indoor air quality impacts and how to reduce them;
- How to contact someone at CBE with any questions or concerns in between planned meetings.

Laboratory Testing
Prior to field deployment, all PurpleAir sensors will be tested in the laboratory to verify sensor comparability, accuracy, and precision. All PurpleAir sensors will first be collocated and tested in a controlled, indoor chamber and repeatedly exposed to a smoke source. These tests will confirm sensor response to rapid increases in $PM_{2.5}$ and subsequent decay due to indoor emission events. Next, all PurpleAir sensors will be collocated outdoors and sample continuously for at least two weeks. This outdoor testing will confirm that the sensors all respond comparably to diurnal changes in temperature, relative humidity, and outdoor $PM_{2.5}$ levels. Any sensors with outlier responses during either the indoor or outdoor testing will not be deployed in the field study.

Installation
Following consent, an appointment will be scheduled with the participant to install the sensors and air filtration device. UCB researchers and CBE staff will enter the participant’s home at the agreed upon time and will confirm their consent to participate in the one-year monitoring study. After consent has been confirmed, the UCB researchers and CBE staff will install the indoor sensor and air filtration device in either the communal living room or a primary bedroom. The host can choose the installation location that best fits their expected use. PurpleAir sensors will be installed on a non-floor surface with at least 1 foot of clearance on all sides, away from any vents, indoor $PM_{2.5}$ sources like candles, and windows that may be opened. The air filtration device will be placed at least 3 feet away from the indoor PurpleAir sensor.

The outdoor sensor will be installed where the host prefers, near an outlet for power and following the siting considerations developed by the EPA and South Coast Air Quality Management District. Ideally, outdoor PurpleAir sensors will be located:

- Away from building exhausts and potential $PM_{2.5}$ sources, including grills, fire pits, and generators
- On the upwind site of a building, if placed next to a building

- With more than 270 degrees of free air flow around the sensor, but no less than 180 degrees
- At least 1 meter above the ground

PurpleAir sensors will be connected to the host's WiFi to transmit data to the cloud-based server and publicly available map (https://map.purpleair.com). The sensor name will be generalized (e.g., CBE1-indoor and CBE1-outdoor) and not specific to the participant. Data will be downloaded regularly from PurpleAir API and handled according to the EPA-derived data cleaning and correction protocol outlined by Barkjohn et al. (2021). The location of the sensor on the publicly available PurpleAir map will be limited to the nearest intersection, rather than specific to the address of the participant. Collected data from the PurpleAir sensors will be assigned a unique ID and will not include any identifiable information of the participant. No personal or identifiable information will be stored with study data.

Five additional monitoring locations will be at elementary and high schools in East Oakland. These will be sited in coordination with and with the permission of the Oakland Unified School District. Technicians will install the sensor outside of school hours when children are not present. The location of the sensor will be chosen by the school representative in a location with accessible power and WiFi. This location may be inside or outside of a classroom and will be out of reach of children. An additional five sensors may be placed outside of businesses as needed to create a well-distributed air quality monitoring network across the community. The researchers will obtain consent from and coordinate the installation of the sensor with the business owner.

Pictures of sensor and air filtration device installations will be taken and may include the researchers. No pictures, video, or audio recordings of subjects will be captured of any participants.

Data Acquisition & Management

Collected data from the PurpleAir sensors will be assigned a unique ID and will not include any identifiable information of the participant. No personal or identifiable information will be stored with study data. CBE will control all participant contact information as part of their community database, and the participants will opt-in to that database as part of the consent process and enrollment in the study.
During the one-year study, CBE will host a minimum of four quarterly informational sessions to discuss the collected data and answer any participant questions. Informational sessions may include:

- Data summaries paired with feedback for participants on how they might be able to improve indoor air quality by using their air purifiers;
- Incentives and/or programs that may be available to improve indoor air quality, such as appliance upgrades and home upgrades such as weather-proofing
- Time for participants to ask questions;
- Requests for feedback from participants regarding the informational session and the general project thus far.

Between sessions, CBE will act as liaison between participants and UCB to support any questions related to the sensors, filtration units, and/ or collected data. No follow-up visits are expected during the one-year monitoring period, unless a sensor has malfunctioned and needs to be replaced. If a participant chooses to dis-enroll from the study, UCB and CBE will uninstall the PurpleAir sensors. At the end of the study period, UCB and CBE staff will uninstall the PurpleAir sensors after scheduling an appointment with the hosts. Participants will also be able to keep the air filtration devices, including a spare replacement filter. CBE will keep the PurpleAir sensors after they have been uninstalled. The PurpleAir sensors will be reset so that no WiFi or location information remains.

B3 – Integrity of Environmental Information

No field sampling on physical media is currently planned for this project.

B4 – Quality Control

Data

Data will be cleaned and corrected on at least a monthly basis, following the protocol reported in Barkjohn et al. (2021) and applying the nationwide correction known as the "US EPA" correction. While Barkjohn et al. used this protocol for 24-hour average $PM_{2.5}$ data, we will use this method for cleaning and correcting the raw data output from each PurpleAir monitor and calculating hourly and daily $PM_{2.5}$ data. The QA/QC procedures will be conducted on at least a monthly frequency and will include the following checks:

- Exclude data points where temperature is unknown or assigned unrealistic values (e.g., greater than 540º Celsius)
- Exclude data points where relative humidity is unknown or outside of the range of 0–100%
- Exclude data where the difference between the A and B channels is greater than 5 μg m^{-3} or greater than 61%
- Apply a 90% data completeness threshold based on channel A before computing hourly or daily averages

- After all cleaning checks have been completed, apply the below US EPA correction equation from Barkjohn et al. (2021) to the cleaned data, where $PM_{2.5}$ is the corrected data, PA_{cf_1} is the average of the A and B channels from the higher correction factor reported by the PurpleAir, and *RH* is the relative humidity reported by the PurpleAir in percent:

$$PM_{2.5} = 0.524 \times PA_{cf\_1} - 0.0862 \times RH + 5.75$$

No additional correction or adjustment specific to the San Francisco Bay Area is planned. If a PurpleAir sensor has persistently inconsistent readings between channels A and B or if reported $PM_{2.5}$ for a given PurpleAir appear to be erroneous compared to the concentrations that are reported by nearby indoor and outdoor sensors, then the UCB researchers and CBE staff may schedule a follow-up visit with the host for inspection, maintenance, and/or replacement.

Reporting

The UCB, Air District, and CBE teams will meet at least once per month to discuss the collected data, and more frequently as needed. These discussions will inform the development of materials for each quarterly informational session. If suspicious or anomalous data is flagged during the monthly data QA/QC, it will be evaluated by the project team. Contextual information or insights like location, nearby known emission sources or events (e.g., July 4th), and frequency of the anomalous signal will be used to determine whether the reported concentrations are likely to be real or indicate sensor malfunction.

B5 – Instrument/Equipment Calibration, Testing, Inspection, and Maintenance

As described above in Section B2, all PurpleAir sensors will be tested in the laboratory prior to field deployment to verify sensor comparability, accuracy, and precision. The sensors will first be tested together in a controlled, indoor chamber and exposed repeatedly to a smoke source. Then, the sensors will be collocated outdoors and sample continuously for at least two weeks. Together, this testing will confirm sensor response to indoor emission events and diurnal changes in temperature, relative humidity, and outdoor $PM_{2.5}$ levels. Any outliers will not be deployed in the field study. No additional sensor calibration work is planned.

As noted above in Section B4, if a sensor is flagged as possibly needing inspection and maintenance during data QA/QC, then UCB researchers and CBE staff will contact the host to determine next steps. Such next steps may include routine cleaning, maintenance, and replacement. If needed, the UCB researchers and CBE staff may ask the host to visually inspect the PurpleAir for possible debris or insects that may be causing measurement interference. Cans of compressed air will be provided to the host to clear any debris or insects as needed, and the UCB researchers and CBE staff will assist the host with any required routine cleaning. If routine cleaning and maintenance does not solve the issue, then further inspection of the PurpleAir will be conducted. If the problem cannot be resolved with typical troubleshooting, then the sensor will be replaced.

B6 – Inspection/Acceptance of Supplies and Services

PurpleAir sensors and Levoit air filtration devices will be ordered specifically for this project. After delivery, all materials will be inspected to confirm the contents and their condition. Additional supplies for installations and conducting field work will be ordered as needed, following UCB's purchasing protocols.

B7 – Environmental Information Management

PurpleAir data will be downloaded from the PurpleAir API using the PurpleAir Data Download Tool. Raw data from each sensor will be downloaded at least monthly and saved as CSV files. These raw files will then be post-processed and cleaned, as described above in Sections A6 and B4. Hourly and daily average $PM_{2.5}$ concentrations that have been corrected using the US EPA correction developed by Barkjohn et al. (2021) will be output as separate CSV files and packaged in a directory containing a description of the project and data content. The directory will also include metadata to provide context for data use and analysis.

The final, validated datasets of hourly and daily average $PM_{2.5}$ will be analyzed and interpreted by UCB. A variety of data analysis tools may be used, including statistical and geospatial software packages. Data analysis, interpretation, and visualization methods will be tailored to inform the informational and educational objectives of describing the spatial and temporal trends in $PM_{2.5}$ across the East Oakland community. Such analyses may include diurnal, weekly, and monthly trends over the year of monitoring for the overall network, by individual locations, and by sensor location type.

C1 – Assessments and Response Actions

Collected data will be assessed for quality assurance and quality control on at least a monthly basis, as described above in Sections A6 and B4. The project team will routinely meet and review the monthly data analysis. If the data analysis shows that data quality is unacceptable, then data control measures will be increased. Such control measures may include sensor inspection, maintenance, or replacement.

C2 – Oversight and Reports to Management

The management and communications structure are described above in Sections A8 and A10. The project team routinely meets (either weekly or biweekly, depending on project needs) and corresponds regularly by email to discuss project status and planning, make decisions, and address issues as they arise. UCB will report any significant quality assurance problems that arise during the project and recommended solutions to those issues to CBE and the Air District, following the organizational chart illustrated in Figure 2.

D1 – Environmental Information Review

PurpleAir data will be reviewed following the procedures outlined above in Sections A6, B4, and B7.

D2 – Useability Determination

Following the QA/QC steps outline in Barkjohn et al. (2021) and visual inspection of the time series of resulting $PM_{2.5}$ concentrations, UCB will certify the usability of the data from the PurpleAir sensors. Paired PurpleAirs will be compared to determine relative differences in indoor and outdoor $PM_{2.5}$ concentrations. The impact of air filtration units on indoor air quality during extreme pollution events like wildfires or Spare the Air days will be evaluated using the paired indoor and outdoor sensors. These results will be communicated to all project partners listed in the Project Organization section of this QAPP to review our collected data, analysis and results, and discuss how this informational monitoring can inform the community's ongoing CERP planning.

Revision History

Table 5. Revision history.

Version Number	Date	Responsible Party	Description of Change
1.0	12/3/2024	Chelsea Preble	New document, first draft for internal review
1.1	01/31/2025	Chelsea Preble	Incorporated Air District comments, including ordering and naming sections to follow the EPA standard
1.2	02/06/2025	Chelsea Preble	Incorporated Air District's minor comments before submission to EPA
2.0	03/20/2025	Chelsea Preble	Addressed the comments and recommendations outlined by the EPA for resubmission and re-review
2.1	03/25/2025	Chelsea Preble	Incorporated Air District's minor comments before resubmission to EPA

References

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