American Lung Association.

Something in the Air

How Communities Are Tracking the Air They Breathe

A "State of the Air" Supplemental Report

On the Move: Heavy-Duty Traffic Pollution in Nearby Communities

Index

Introduction

Across the United States, millions of people live near freight corridors and transportation hubs where daily air quality is shaped by heavy-duty truck traffic. Associated activity at ports, highways, railyards, distribution centers and warehouse districts drives steep changes in concentrations over very short distances, with the greatest impacts concentrated in communities that have long experienced elevated levels of air pollution.

A single corridor can function as both an economic engine and an exposure hotspot. In these places, pollution is neither episodic nor accidental; it is ambient and routine, woven into daily life through diesel exhaust, idling vehicles and surrounding industrial activity. Exposure does not arrive all at once; it accumulates—hour by hour, block by block—often invisibly. Pollution levels can shift dramatically from one block to the next, creating sharp gradients that mirror the boundaries of infrastructure design, traffic flow, and land or zoning allocation, yet the systems used to track air quality are not designed to reflect these neighborhood-scale realities.

As freight volumes continue to rise—with the growth of e-commerce, expanded port capacity and logistics hubs moving deeper into residential areas—communities are increasingly turning to participatory science as both a diagnostic tool and a form of self-advocacy to fill persistent information gaps about local exposure. These projects make exposure legible—pinpointing when it peaks, where it concentrates and how it intersects with daily routines—while supporting decisions related to health, transportation and land use. While regulatory monitoring networks are designed to reflect broader regional conditions and regulatory compliance, they are not equipped to capture fine-scale exposure patterns or the cumulative, day-to-day reality of diesel exhaust concentrated at the edges of freight infrastructure, where truck activity rarely pauses. Community-based air sensor networks, mobile monitoring and neighborhood-scale partnerships have become essential complements to the regulatory system, providing the street-level evidence needed to understand how freight operations shape exposure near homes, schools and workplaces.

At the same time, these tools provide policymakers with usable data. When deployed through trusted partnerships, they increase transparency, strengthen cross-agency collaboration, engage regulatory institutions and help sustain monitoring in places where chronic exposure is the norm rather than the exception. *On the Move: Heavy-Duty Traffic Pollution in Nearby Communities* examines how community-centered approaches are reshaping what we know about freight-related air pollution, who has access to data, who has a seat at the table and how solutions are co-produced. The case studies featured here—Albany's South End Neighborhood Air Quality Initiative and the West Oakland Environmental Indicators Project (WOEIP)—demonstrate the practical value of community-generated data not only to characterize exposure, but also to translate lived experience into evidence that informs decision-making, strengthens accountability and supports meaningful policy action. These examples illustrate the broader purpose of this report: community-rooted data systems do not replace the official monitoring record—they strengthen it.

Across both efforts, a clear throughline emerges around transparency across the full data lifecycle—from collection and quality control to analysis, visualization and public communication. Visibility is not treated as an endpoint but as infrastructure. Open dashboards and accessible reporting play a critical role in ensuring that information is interpretable, responsive and fit for use. By pairing transparent data practices with intentional outreach and policy engagement, these programs shift monitoring from a technical function into a civic one, supporting sustained policy adaptation, institutional learning and community action.

When community-driven sensor networks are intentionally aligned with regulatory networks, they transform isolated data points into a coherent picture of on-the-ground conditions creating a stronger evidence base for decisions related to freight routes, transportation, land development, mitigation investments and enforcement. These case studies underscore the need for greater visibility and accountability along the nation's freight corridors, where diesel emissions remain a persistent driver of health burdens and highly uneven exposure patterns.

Freight Pollution Community Impacts

Heavy-duty trucks are the backbone of the national freight system, moving goods through ports, railyards, distribution centers and major logistics corridors. But the infrastructure that supports this economy—port and rail centers, urban trucking routes, warehouse districts and beyond— also concentrates some of the nation's highest levels of diesel pollution within a narrow band of communities. The U.S. Environmental Protection Agency [U.S. EPA] estimates that approximately 72 million people live in areas with elevated rates of multiple health impacts associated with proximity to major trucking corridors (U.S. EPA, 2022b). Freight corridors tend to cluster near highways and industrial zones, creating steady traffic from Class 8 tractor-trailers, medium- heavy box trucks, drayage trucks serving ports and vocational vehicles such as yard tractors. Although these trucks represent a relatively small

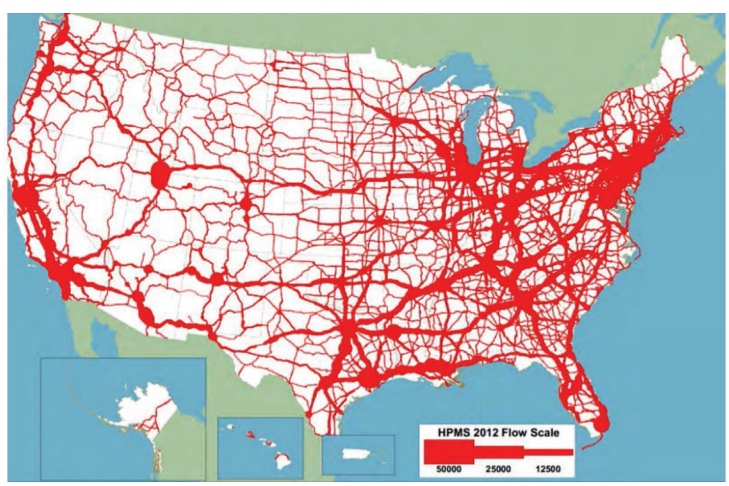

Figure 1: Map of Major U.S. Truck Routes (U.S. EPA, 2022b)

share of total vehicles on the road, they are responsible for a disproportionate share of harmful emissions. In California, for example, heavy-duty trucks constitute about 3% of the fleet but produce more than 50% of on-road nitrogen oxide (NOx) emissions and a similar share of diesel particulate matter [DPM] (California Air Resources Board [CARB], 2024). Technological improvements have reduced emissions from newer engines, yet older, higher-polluting diesel trucks remain common as emissions rise throughout the useful life of these vehicles—especially in freight hubs where aging fleets, weak enforcement and demand for goods movement intersect.

These realities mean that many neighborhoods experience pollution levels far higher than regional averages indicate, with exposure driven not by broad atmospheric trends but the daily flow of freight through neighborhood streets. This case study focuses on roadway-based freight movement, specifically medium- and heavy-duty diesel trucks operating along highways, major corridors and designated truck routes rather than other freight-related sources such as ships, off-road industrial equipment or locomotives (see the American Lung Association's report on locomotive pollution). Medium- and heavy-duty trucks emit a mixture of harmful pollutants —some covered by National Ambient Air Quality Standards

Heavy-duty Vehicles	Medium-duty Vehicles
• Long-haul tractor-trailers • Yard tractors and other industrial freight-movement vehicles • Drayage (vehicles moving freight in and out of ports, railyards, terminals, etc.) trucks serving ports and railyards • Freight haulers and regional distribution trucks • Dump trucks, cement mixers and vocational trucks *Heavy-duty trucks dominate traffic in logistics hubs and along major freight corridors, producing the majority of diesel exhaust, NO_x, DPM, ultrafine particles (UFPs) and black carbon (U.S. Department of Energy [DOE] & EPA, 2024).	• Large delivery vans • Box trucks • Utility and service trucks • Some commercial pickup trucks • Smaller cargo and parcel-delivery vehicles *They operate in and out of distribution centers, commercial corridors and dense urban delivery zones, often making frequent stops that increase emissions from braking and acceleration.

(NAAQS), others not—that collectively define the exposure profile of communities living near these large transportation hubs. Because heavy-duty traffic emits multiple co-occurring pollutants, understanding each is critical for interpreting localized, block-level conditions. The featured cases illustrate how community-driven monitoring can capture this range of pollutants using both established and emerging tools.

Pollutants

Transport-related air pollution is not a single-pollutant problem. Because monitoring truck activity requires understanding what people are actually breathing, it is important to recognize the chemical mixture diesel engines release. Diesel emissions contain a dense blend of particles, gases and air toxics shaped by vehicle duty cycles, including idling, low-load operations in congested conditions and repeated movement along freight corridors. Freight operations emit a complex mixture of pollutants, including fine particulate matter ($PM_{2.5}$), NO_x, carbon monoxide (CO) and volatile organic compounds (VOCs) (U.S. DOE & EPA, 2024). NO_x causes health harms on its own and contributes to ground-level ozone

(O3) formation. $PM_{2.5}$ and black carbon pose serious health risks; black carbon is a major component of DPM and a potent, short-lived climate pollutant.

Exposure is most intense near the physical points of where truck activity concentrates—freeway interchanges, port gates, warehouse districts and distribution centers— and where emissions accumulate from frequent idling, braking, restarting and grade changes that increase engine load. Studies consistently show that residents living closest to these freight operations breathe significantly higher levels of $PM_{2.5}$, NO_x and diesel-related toxics than those just a few blocks farther away (Lathwal, Vaishnav, & Morgan, 2022). In neighborhoods where heavy-duty traffic repeats throughout the day, these pollutants create persistent, hyperlocal exposure zones that the regulatory monitoring network is not designed to detect.

Heavy-duty diesel engines emit:

$PM_{2.5}$ – inhalable particles linked to heart and lung disease.
UFPs – ultrafine particles smaller than 0.1 microns; highly reactive and able to cross into the bloodstream.
Black carbon (soot) – a component of diesel particulate matter; a harmful air contaminant and major short-lived climate pollutant.
NO_x – precursors to ground-level ozone and secondary $PM_{2.5}$.
VOCs – including benzene, formaldehyde and 1,3-butadiene.
CO – an asphyxiant most concentrated during idling and low-speed operations.
Polycyclic aromatic hydrocarbons (PAHs) – carcinogenic compounds that adhere to diesel particles.
Metals – including nickel, chromium and vanadium from fuel and engine wear.

Because diesel pollution is chemically complex and physically concentrated at the street level, understanding exposure requires examining not just which pollutants are released, but also how they interact with human health. The next section summarizes the major health effects linked to truck-related emissions—drawing from federal assessments, epidemiological studies and scientific reviews.

Health Effects

The health risks associated with diesel emissions are among the most thoroughly documented in environmental health science. $PM_{2.5}$ and UFPs from diesel engines can penetrate deep into the lungs, enter the bloodstream and trigger systemic inflammation. These exposures are linked to a wide range of adverse outcomes, including asthma attacks and new-onset asthma, chronic obstructive pulmonary disease (COPD), cardiovascular disease and arrhythmias, heart attacks, stroke, adverse birth outcomes, premature death, lung cancer and emerging evidence of neurodevelopmental harm and cognitive decline (U.S. EPA, 2024b). NOx can worsen respiratory illness, contribute to ground-level ozone formation and react in the atmosphere to create secondary $PM_{2.5}$.

Diesel exhaust also contains hazardous air toxics such as PAHs, benzene and formaldehyde—compounds associated with cancer risk, DNA damage and long-term organ effects (International Agency for Research on Cancer [IARC], 2012). A review by the Health Effects Institute [HEI], drawing on more than 350 studies, found consistent links between traffic pollution and higher rates of all-cause mortality, heart disease, lung cancer, asthma onset in children and adults, and acute respiratory infections in children (HEI, 2023.

The American Lung Association's analyses show that heavy-duty truck pollution remains one of the most consequential sources of air pollution exposure in the U.S. Medium- and heavy-duty vehicles make up only about 6% of the on-road fleet, yet they generate 59% of ozone- and particle-forming NOx emissions and 55% of all on-road particle pollution, including brake and tire particles. These emissions contribute to a national landscape where 41% of Americans—137 million people—live in communities experiencing unhealthy levels of ozone and/or particle pollution. At the neighborhood scale, the burden intensifies. People living near freight hubs experience the highest cumulative exposures and the most severe health consequences.

Many of these neighborhoods face longstanding gaps in resources and limited protective infrastructure—such as tree canopy, indoor air filtration and building insulation—that would otherwise reduce the infiltration of outdoor pollutants. The layering of diesel exhaust with chronic noise, industrial land use, limited healthcare access and other baseline stressors produces a compounding health burden—reflected in elevated rates of asthma, heart disease and pollution-sensitive illnesses (Adegboye et al., 2023). **Figure 2** (below) maps deaths attributable to diesel pollution across the U.S., examining health impacts at the state, county and metropolitan levels, including premature death estimates and related health and economic risks. An interactive version is available through the Clean Air Task Force's [CATF] Deaths by Dirty Diesel map, with mortality and morbidity estimates derived from EPA's CO–Benefits Risk Assessment (COBRA) screening model.

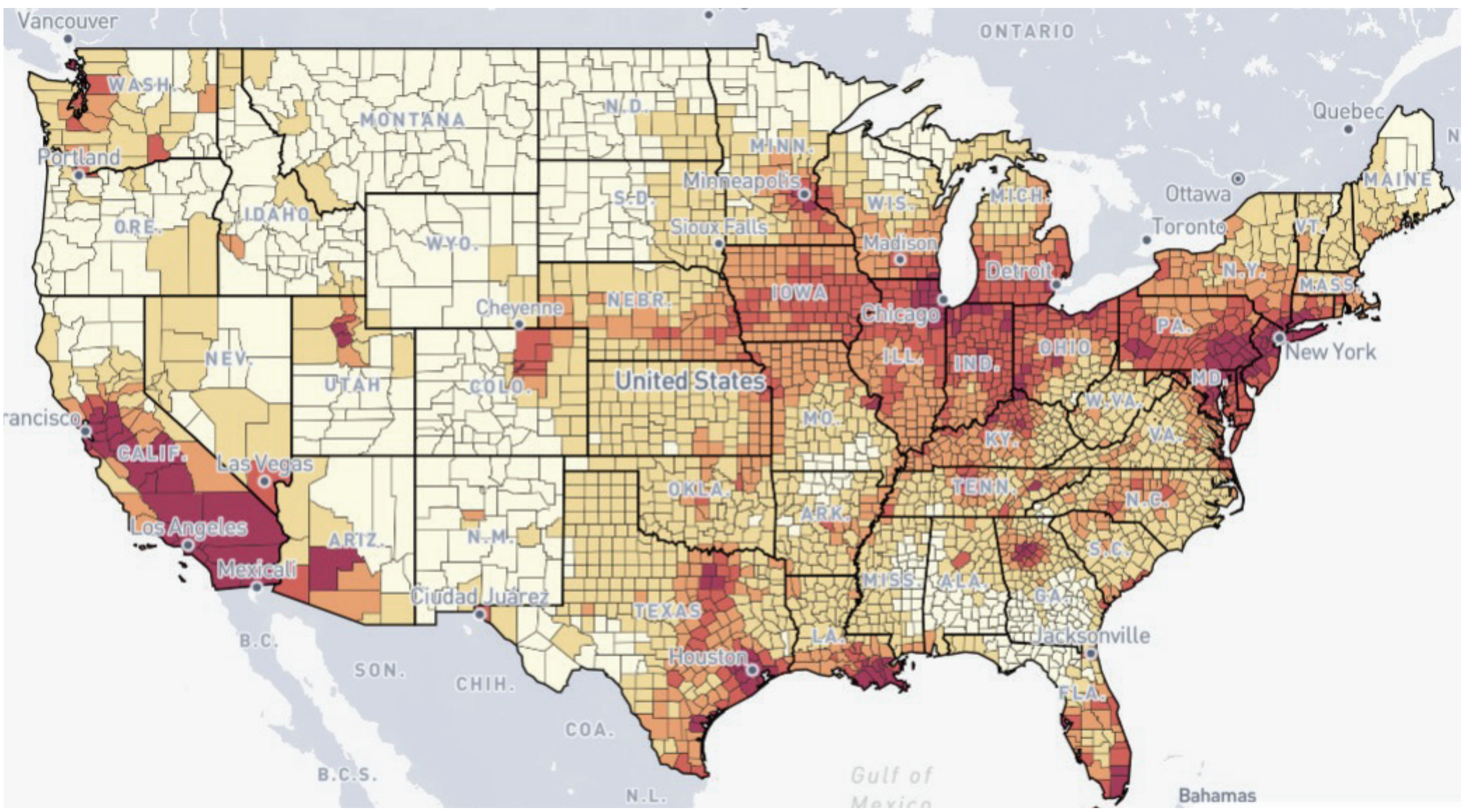

Figure 2: January 2026 CATF's Deaths by Dirty Diesel

Long-term exposure to traffic-related air pollution has been linked to increased rates of respiratory and cardiovascular harm in nearby communities. Heavy-duty trucks amplify these risks even further. These exposure patterns reinforce what communities have described for decades: freight emissions do not disperse evenly across a region but accumulate along specific blocks, intersections and travel routes where truck activity is constant. In response, localities are turning to community-led monitoring networks as a critical tool to address these gaps.

Real-Time, Neighborhood-Scale Monitoring

The limits of the federal regulatory system demonstrate the value of community-scale monitoring as a complementary approach. EPA's network provides the backbone of national air-quality oversight and was built to answer a specific regulatory question: Are regions meeting the NAAQS? The system excels at identifying broad regional trends but cannot track whether a child walking to school, a senior living near a warehouse district or a worker standing at a port gate is breathing more harmful levels of diesel exhaust than the area at large on any given day. Regulatory-grade monitoring remains the standard for demonstrating NAAQS compliance, but its design and coverage mean it often misses the hyperlocal pollution spikes that shape real-world health risks for communities living alongside heavy-duty truck corridors. EPA's regulatory network captures only part of what heavy-duty diesel traffic emits.

Although the NAAQS regulate six criteria pollutants, only two—$PM_{2.5}$ and nitrogen dioxide (NO_2)—are routinely measured in locations relevant to freight corridors, using Federal Reference Method (FRM) and Federal Equivalent Method (FEM) instruments (U.S. EPA, 2025a). In addition to $PM_{2.5}$ and NO_2 monitoring, smaller networks for CO, ozone precursors and particulate matter 10 micrometers or smaller (PM_{10}) provide supplemental information yet coverage for these pollutants remains limited near warehouse districts, port entrances and major trucking routes. As a result, the regulatory system establishes an essential regional baseline while leaving substantial neighborhood-scale data gaps in communities experiencing the highest pollution burdens. These limitations become more pronounced when viewed at the scale of freight activity itself. FRM/FEM monitors track $PM_{2.5}$ and NO_2 effectively at a regional scale, but diesel exhaust reflects a far more complex emissions profile than the NAAQS framework captures. As noted above, heavy-duty trucks emit black carbon, UFPs, PAHs, carbonyl compounds and precursors to secondary organic aerosols (SOAs)—pollutants that fall outside the NAAQS, are rarely monitored continuously and often peak sharply within tens to hundreds of feet of a roadway.

Emissions peak at friction points in the freight system—idling zones, acceleration lanes, freeway ramps, distribution centers and port gates. Because regulatory monitors are spaced miles apart, these short-lived, neighborhood-scale spikes largely go undetected. The result is a system that can confirm regional compliance while overlooking the diesel-related pollutants driving block- by-block exposure and elevated health risks in freight-impacted communities. Even at the county scale, the 921 counties containing the nation's busiest trucking routes exhibit $PM_{2.5}$ levels above more health-protective benchmarks—while countywide averages obscure the sharp, short- term pollution spikes experienced daily by residents living near roadways (National Aeronautics and Space Administration [NASA], 2024). Launched by EPA in 2013, the Near-Road Ambient Monitoring Network established roughly 140–150 sites in major metropolitan areas to measure roadway-adjacent concentrations of NO_2 (and, at some sites, CO and $PM_{2.5}$) in places with high traffic volumes and significant heavy-duty diesel activity; an important step to reduce these gaps (U.S. EPA, 2024c).

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Figure 3: Current Active Near-Road Monitors (U.S. EPA, 2025)

The network was intended to improve the understanding of near-road exposure and support NAAQS compliance, but it covers only select cities and captures only a narrow portion of the diesel emissions mixture as monitors are not necessarily located where truck volumes are highest, where freight has expanded or where warehousing growth and rerouted traffic now concentrate exposure. In addition, research increasingly shows that policies focused solely on primary $PM_{2.5}$ mass underestimate the true health risks from road traffic, given the additional harms from NO_2, black carbon, UFPs and SOAs (Hänninen et al., 2025). Federal monitoring provides a strong regional foundation, while real-world freight operations introduce variability that unfolds at finer spatial and temporal scales. As trucks reroute, idle and respond to port and warehouse activity, air quality conditions shift leaving many neighborhoods without data that reflects local conditions—gaps that neighborhood monitoring systems are designed to fill. This is where community-scale monitoring becomes essential.

The cases in this report pick up precisely where the regulatory system leaves off. They focus on pollutants that traditional monitors miss, on conditions they cannot fully characterize and the core questions residents have raised for decades: What are we breathing? Where is it coming from? And how can credible data drive action?

> "More effort and resources to check sensor accuracy and correct data would address a major gap. This support helps community groups turn raw data into more reliable information that decision makers and scientists take seriously." — Wilton Mui, Ph.D., Program Supervisor in the Monitoring & Analysis Division of South Coast Air Quality Management District [South Coast AQMD]

Different Sensors, Different Needs

Across the country, communities, researchers and public agencies are coordinating efforts to deploy a mix of stationary sensors, mobile monitoring platforms and mid-tier research-grade instruments in freight corridors to capture diesel-related pollution. Stationary $PM_{2.5}$ sensors—such as PurpleAir, AirNote, Clarity Nodes and AirGradient—provide continuous, real-time data that reveals sharp particle spikes from truck queues, idling zones and warehouse traffic.

Mobile monitoring systems, including backpack monitors, bicycle-mounted sensors and instrumented vehicles, are used to map black carbon, UFPs, NO_x and roadway-specific VOCs along freight corridors; programs such as the Environmental Defense Fund/Google Street View mobile mapping work and EPA-supported mobile monitoring pilots demonstrate how these platforms reveal steep near-road gradients and diesel plumes (U.S. EPA, 2022). Meanwhile, mid-tier multi-pollutant monitoring systems—including QuantAQ's MODULAIR and STELLA platforms, AQMesh pods and 2B Technologies' AQ-Sync—support measurement of combinations of NO_2, ozone, black carbon, UFPs and $PM_{2.5}$ (AQMesh, 2026). These tools vary in measurement performance and application: the AQ-Sync is a higher-quality reference-adjacent instrument, while AQMesh and QuantAQ systems are air sensors designed for screening, spatial coverage and pattern identification rather than regulatory-grade precision (AQMesh, 2026).

Importantly, cost alone does not determine data quality; sensor performance depends on pollutant type, deployment context, calibration and data validation practices. Used appropriately, these complementary technologies identify sources, screen hotspots and inform early enforcement, mitigation and risk-reduction decisions—providing a more complete picture of freight-related air pollution (2B Technologies, 2022).

These technologies do have limitations that shape how the data can be interpreted and used. Some commercial $PM_{2.5}$ sensors respond well to changes in fine particles but cannot distinguish between diesel exhaust, brake-and-tire wear, resuspended road dust or other traffic-related sources—and they require calibration or collocation to ensure accuracy near busy roadways (U.S. EPA, 2022). Mobile monitoring provides unparalleled spatial resolution, but measurements capture only the moments and routes sampled, meaning short-lived plumes or nighttime truck activity may be missed without repeated runs. Mid-tier multi-pollutant instruments offer stronger performance for pollutants like black carbon, UFPs and NO_2, but they are costlier and require trained operators. They also demand stringent quality assurance procedures (system-level plans that ensure the monitoring project produces trustworthy data) and quality control procedures (day-to-day checks that ensure the data produced is valid and not drifting, malfunctioning or biased) to ensure regulators view the data as credible (2B Technologies, 2022). These constraints reinforce the need for thoughtful design, collaborative partnerships and clear goals—because the usefulness of any sensor network depends as much on its scientific rigor and community capacity as on the hardware itself.

Selecting the right monitoring approach requires more than choosing a sensor—it begins with understanding what the community wants to uncover, and which partners can help turn data into action. Before deployment, community groups and agencies must clarify core questions: What pollutants matter most along this corridor? Are we trying to document truck-related spikes, identify specific emission sources, evaluate exposure at homes and schools or support rerouting and enforcement? Do local partners have the capacity to host monitors, maintain equipment, download data and apply correction factors? Who will analyze the data, interpret results and ensure findings are credible to regulators? Funding also shapes what is possible—whether small grants can support stationary $PM_{2.5}$ networks or if larger collaborations are needed for mobile mapping or mid-tier multi-pollutant systems. Equally important is establishing a collaborative structure that clarifies roles—whether a community organization can sustain the project, a municipal or state agency can support siting and data transparency and a technical or academic partner can calibrate sensors, validate performance and translate findings into policy-relevant insights. These questions—what to measure, why, with whom and to what end—form the foundation of any effective community monitoring effort. They also help determine whether sensors will primarily be used to document a problem and inform the public, or primarily to inform advocacy for solutions. Either way, when residents have reliable local measurements, the conversation shifts: individuals can better make decisions that protect their health and community groups can enter regulatory discussions with evidence that documents what people are actually breathing.

> "People living near truck routes already know the air feels different. Sensors help make those conditions visible. When communities can see pollution peaks in real time, they are better equipped to advocate for truck rerouting, buffer zones, stronger enforcement, and healthier land-use decisions."
>
> — Nicole Merino Tsui, WOEIP Director of Strategic Partnerships

While no single approach fits every neighborhood, consistent lessons emerge: collaborative design strengthens credibility, transparent data builds trust and locally grounded measurements can shape decisions in ways traditional monitoring cannot. The cases that follow show how partnerships among residents, researchers, advocates, commercial vendors and air agencies translate data into action—demonstrating what becomes possible when communities closest to pollution have the tools and support to understand their air and push for cleaner conditions.

Case Studies

Albany, NY – South End Neighborhood Air Quality Initiative

Albany is the capital of New York State and the core of the Capital Region metropolitan area, which includes surrounding cities such as Schenectady, Troy and Saratoga Springs. The Albany–Schenectady–Troy metropolitan area houses approximately 900,000 residents across several counties. The region has a historic transportation and industrial corridor: the Hudson River, rail lines, truck routes and the Port of Albany are key freight pathways. Albany sits roughly 150 miles north of New York City—positioning it within a major Northeast transportation route that carries significant truck traffic between downstate population centers and upstate industrial hubs. Within the City of Albany, about 40% of residents identify as people of color, and roughly one-quarter of the population lives below the federal poverty line (U.S. Census Bureau, 2023). In 2017, the Albany South End Neighborhood Air Quality Initiative launched a year-long intensive air monitoring study in response to long-standing community air quality concerns. Residents in the South End had long reported diesel odors, soot on windowsills and disruptive late-night truck activity. The neighborhood sits at the intersection of a major transportation and industrial corridor—including Interstate 787, active rail lines and marine traffic on the Hudson River—

—where heavy-duty diesel trucks, trains, cargo-handling equipment and port operations operate in close proximity to homes, schools and community facilities. There was little block-level data available to determine whether pollution was originating from port operations, truck traffic or other nearby sources. A central area of concern was the Ezra Prentice Homes, a public housing community located directly along South Pearl Street (New York Route 32)—a designated truck access highway carrying roughly 1,700 diesel truck trips per day (New York State Department of Environmental Conservation [NYSDEC], 2020). Community engagement was central to the study. Through its Office of Environmental Justice, NYSDEC worked with residents and local stakeholders to incorporate community concerns —particularly around freight-related emissions—into the study design. That engagement was sustained through seven community meetings between 2016 and 2018, with progress shared through in-person updates, a dedicated website and real-time monitoring displays, shaping the study's focus. Defining the questions early helps align expectations with what the tools and methods can actually show, keeping the work focused on practical outcomes.

> "Do your homework first—understand who lives there, what work has already been done, and the community's history. If you skip that, you risk collecting data that isn't interpretable or trusted."
>
> — Marilyn Wurth, Research Scientist 3, Division of Air Resources, NYSDEC

The four main questions in the study

1. How much particulate matter (PM) comes from motor vehicles versus port activities?
2. How far does particulate pollution travel from the road into the neighborhood?
3. How do port activities and road traffic contribute to benzene concentrations?
4. How can the community better understand local air quality?

This early alignment ensured the study generated results that extended beyond analysis, providing a defensible foundation for enforcement actions, policy discussions and longer-term strategies to address freight-related pollution. The study was implementeds through a multidisciplinary partnership that included the New York State Department of Health [NYSDEH], the New York State Department of Transportation [NYSDOT], the Albany County Health Department and researchers and educators from the University at Albany. NYSDEC staff specializing in air quality monitoring, emissions analysis and exposure assessment contributed across all phases of the project, from design through execution. The study targeted traffic- and petroleum-related pollutants, including particulate matter (PM_{10} and $PM_{2.5}$), black carbon, UFPs, NO2, other traffic-related gases, benzene and related VOCs. NYSDOT installed a traffic counter to document vehicle counts, including truck volumes. Meteorological data—such as wind speed, wind direction and temperature—were used to interpret pollutant dispersion patterns. To capture pollution patterns at multiple scales, NYSDEC operated two fixed monitoring stations—one at the Ezra Prentice Homes and one on Third Avenue. These fixed stations continuously collected pollutant concentrations over extended periods, allowing evaluation of diurnal and seasonal patterns (NYSDEC, 2019). The fixed station at Ezra Prentice began operation in July 2017 and continued into late 2018. Quality assurance was a priority throughout the project. Where feasible, portable instruments were collocated, with results generally within 10–30% of the reference site—sufficient to confirm spatial gradients and patterns while clearly communicating the limits of short-term or low-cost measurement tools.

> "You need to know what the government agency, or audience for your data, actually wants before you pursue funding or starting the project—that conversation has to happen at the beginning." — Tim Dye, Founder of TD Environmental Services LLC with over 30 years of experience in monitoring and data technology.

Collocation

Collocation refers to placing two or more air monitoring instruments side-by-side—often pairing portable or research-grade tools with regulatory-grade reference monitors—to compare how measurements align under the same environmental conditions.

Why it matters: Collocation builds confidence in data by showing whether different instruments capture the same trends and timing, even when absolute values differ. In community and research-based monitoring, it helps clarify uncertainty, contextualize measurements, and prevent misinterpretation.

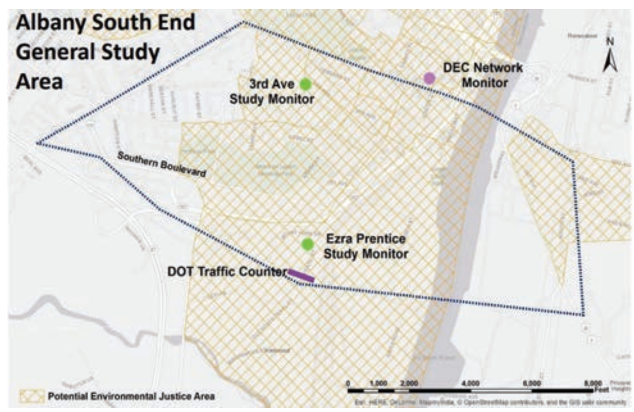


Figure 4: Study Area for Albany South End

Data from the fixed sites informed targeted deployment of portable backpack monitors and temporary "mini-stations" which were used in 3–5-hour sampling sessions to map block-by-block concentrations and assess how far truck emissions extended into nearby residential areas. Portable monitoring was conducted throughout the study period to capture spatial gradients and peak episodes. Near-roadway and walk-around monitoring tracked $PM_{2.5}$, UFPs and black carbon along freight routes and intersections. In parallel, NYSDEC conducted an extensive benzene monitoring campaign, placing two-week passive samplers at more than 100 locations across roadways, residential blocks, commercial zones and port facilities. These fenceline samplers used EPA Method 325A to measure benzene, providing a defensible assessment of petroleum-related impacts alongside particle measurements. These coordinated methods produced a detailed, multi-scale picture of air pollution around the Port of Albany and South Pearl Street, allowing the study to differentiate contributions from trucks, rail activity, industrial sources and port operations The monitoring approach was deliberately multi-layered, combining regulatory grade instruments with portable, research-grade tools to capture short-term, neighborhood-scale variation.


The fixed monitoring station on Third Avenue

Findings

- Mobile sources: Heavy-duty trucks and buses were the primary contributors to elevated particle concentrations, with traffic on South Pearl Street exerting a stronger influence than activities within the Port of Albany.
- $PM_{2.5}$, UFPs and black carbon were consistently highest closest to truck routes, bus corridors and port-related roadways, especially near the Ezra Prentice Homes (concentrations nearly double those measured at nearby background and comparison locations and decreased with distance from the roadway).
- The data show clear near-roadway effects linked to traffic activity on South Pearl Street, with ultrafine particle levels peaking during weekday truck and vehicle periods.
- Walk-around sampling captured sharp spikes during truck queues, turning movements and idling, demonstrating the role of freight-related activity in shaping short-term air-quality conditions.
- Benzene concentrations were highest within the Port of Albany and Port of Rensselaer near petroleum storage and transfer operations, but residential areas outside the ports did not exhibit elevated benzene levels.
- A small number of diesel-fueled heavy-emitting vehicles, particularly trucks and buses, were responsible for short-term pollution spikes, highlighting the impact of specific vehicle types on local air quality.

While **Figure 5** shows the average vehicle counts and related pollution exposures on South Pearl Street, **Figures 6 and 7** (next page) show how vehicle activity shapes local pollution levels in the South End. As vehicle proximity increases, particle counts rise, reinforcing the link between heavy-duty traffic and near-road exposure. Weekday averages further show sustained elevation during peak traffic periods. Together, these findings demonstrate how traffic density and vehicle distance influence neighborhood air quality.

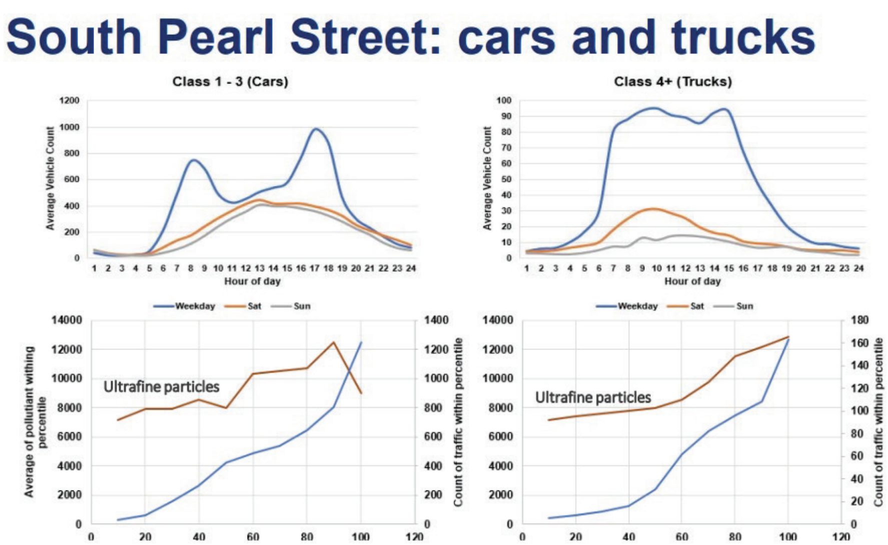


Figure 5: South End Average Vehicle Counts & Pollution Exposure

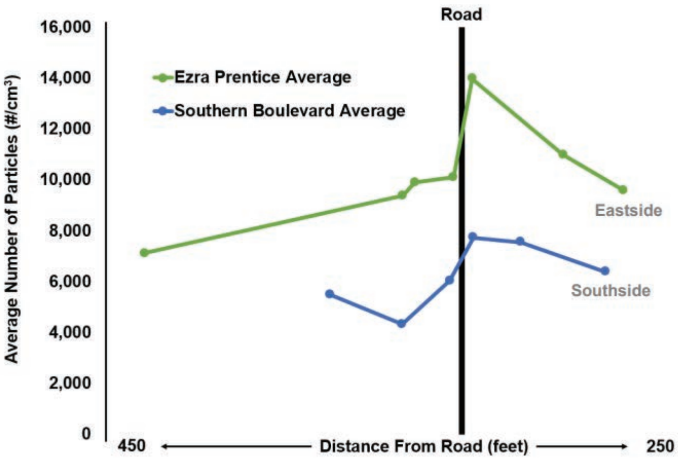


Figure 6: Avg Number of particles & Vehicle Distance

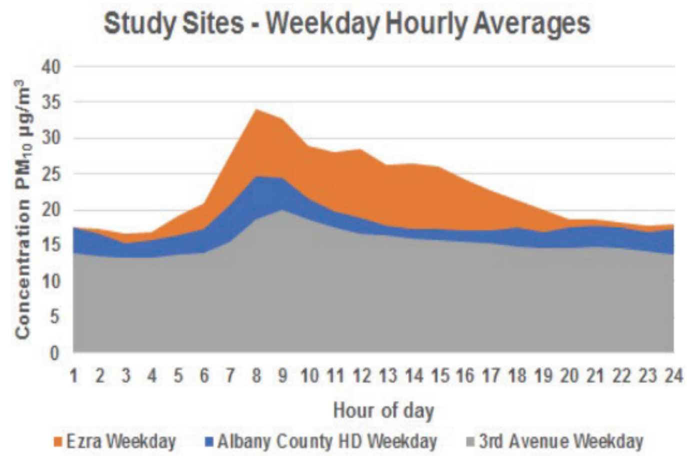


Figure 7: South End Weekday Avg. Pollution Concentration

Figure 8 (below) summarizes the length of time each instrument operated at the fixed monitoring locations. By translating these patterns into place-specific evidence, the project generated data that elevated community voices and informed more targeted discussions about reimagining interstate access and reducing exposure along heavily traveled corridors. information network and a public health intervention.

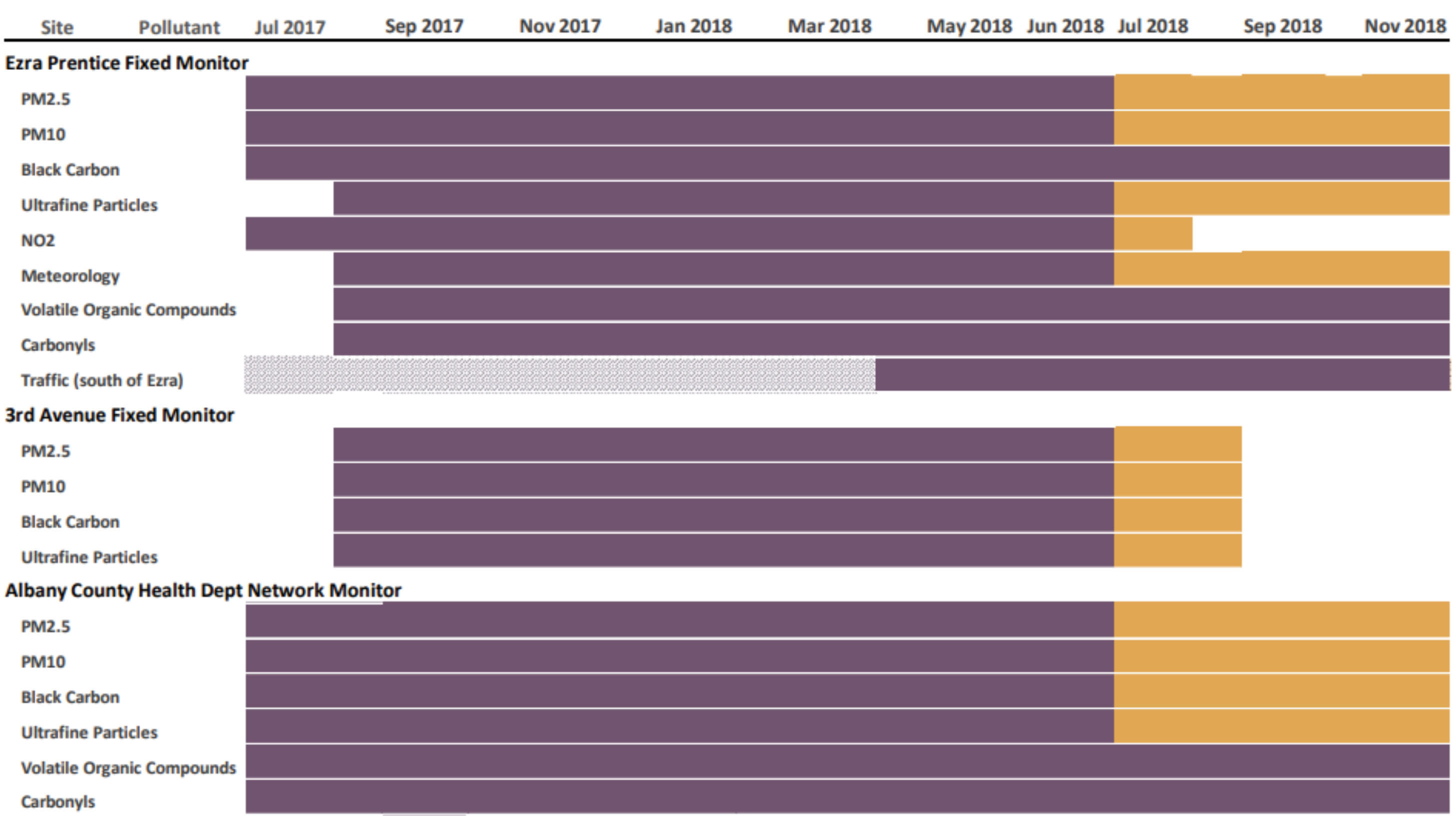


Figure 8: Albany Pollutant Measures — Invalid Data Collection — Data Collection Period — Beyond

The final report, released in 2019, translated monitoring results into concrete recommendations that informed local policy discussions. NYSDEC recommended reducing heavy-duty truck traffic on residential streets, reclassifying priority roadways to restrict diesel access, assessing freight rerouting options through the port and improving coordination among transportation, permitting and land-use planning agencies to address traffic-related air pollution. The City of Albany coordinated voluntary truck rerouting with several commercial entities and prohibited city vehicles from using South Pearl Street. NYSDOT reclassified roads within the Port of Albany to enable trucks to shift routes away from Ezra Prentice. In parallel, the Port of Albany requested that tenant trucks avoid South Pearl Street and required new tenants to route truck traffic through the north or south port entrances rather than past the neighborhood.

Other recommendations stalled due to a combination of funding constraints and limited governmental coordination with the onset of the COVID-19 pandemic—highlighting how difficult it can be to translate monitoring results into infrastructure or policy changes. Alongside the air monitoring analysis, a health outcomes review was conducted to assess patterns in respiratory and cardiovascular conditions within the study area. Using age- and sex-adjusted hospital admission and emergency department visit data from 2005–2015, the health outcomes review compared the South End with a nearby reference area and found consistently higher rates of asthma, COPD, acute bronchitis, hypertension and diabetes, while emphasizing that the results indicate associations rather than causation (NYSDEC, 2020). "That's why we're careful about health conclusions—short-term monitoring can't answer long-term health questions, and it's easy to overreach if you don't have the right exposure and health data," explains Randi Walker. The South End project demonstrated the value of combining near-road, mobile and passive monitoring to capture conditions missed by a single regulatory site. Despite concluding more than five years ago, it helped elevate attention to disproportionate transportation-related burdens in communities with higher exposure to air pollution.

> "Transparency alone isn't enough. Communities need tools and support to analyze and use the data, especially when monitoring is meant to inform decisions, not just document problems." — Randi Walker, Chief, Air Toxics Section, Division of Air, NYSDEC

This community-centered, hyperlocal monitoring framework anticipated elements later adopted statewide through NYSDEC's separate 2024 Community Air Monitoring Initiative, which applied mobile and stationary monitoring, formal community advisory processes and data-to-action tools—such as story maps—to support the development of air pollution reduction strategies in under-resourced communities (NYSDEC, 2024).

> "You don't want communities collecting data for years only to find out it doesn't fit how agencies are allowed to use it."
> — James Bradbury, PhD, Director of Research & Policy Analysis, Georgetown Climate Center, Georgetown Law

Figure 9: Area Surveyed with Peak Pollution Concentrations

Durability Through Collaboration

This project demonstrates how early and sustained collaboration strengthens both the scientific integrity and longevity of community air monitoring. NYSDEC engaged residents and local stakeholders at the outset to define study questions and identify priority locations, then sustained that engagement through regular communication, community meetings and publicly accessible data sharing designed to ensure transparency, build trust and keep findings grounded in community priorities. This ongoing exchange allowed participating stakeholders to develop a shared understanding of the findings and their limitations. It also underscores ongoing challenges: sustaining funding, coordinating across agencies and establishing mechanisms that allow localized data to inform permitting decisions, land-use planning, enforcement and long-term solutions. More broadly, the South End experience shows that neighborhood-scale monitoring efforts are most durable when air quality, health, transportation and research agencies collaborate from the outset, creating shared ownership of the data and clear pathways for findings to inform policy, planning and long-term monitoring frameworks.

Data Lifecycle: Collection, Maintenance and Useability

A robust data lifecycle is foundational to producing air quality datasets that are scientifically defensible and decision-relevant. Defining the questions early helps align community expectations with what the data and methods can realistically support. In the South End project, the lifecycle began with a hypothesis-driven monitoring design informed by community-identified exposure concerns, which guided pollutant selection, site placement and temporal resolution (how frequent data measurements are). NYSDEC implemented a multi-scale measurement strategy that integrated continuous fixed-site monitoring, targeted short-duration mobile and walk-around sampling, and time-integrated passive sampling to characterize spatial gradients, temporal variability and source-related signatures over a year-long study period.

Data quality assurance and quality control procedures were integrated throughout data collection and analysis, including instrument performance checks, documentation of data completeness and collocation with higher-grade reference systems to assess measurement agreement and drift. Collocation strengthened confidence in observed patterns by demonstrating consistency in concentration trends and temporal response, even where absolute values differed. Ongoing data management and analysis incorporated meteorological normalization, traffic activity indicators and distance-to-road assessments to distinguish near-road impacts from broader background conditions. Transparent dissemination of results—paired with explicit communication of uncertainty, detection limits and methodological constraints—ensured findings were interpreted appropriately by residents, agencies and decision-makers. A defining feature of the project was its emphasis on data transparency. Real-time displays of pollutants in neighborhood community rooms allowed residents to see hour-by-hour changes and discuss patterns directly with NYSDEC staff. By sustaining monitoring long enough to capture diurnal, weekday–weekend and seasonal variability, and by documenting methods in replicable terms, the South End study demonstrates how rigorous lifecycle planning can elevate community-centered monitoring into a credible exposure assessment tool capable of informing transportation planning, mitigation strategies and regulatory action.

> “Toxics are challenging to measure with community sensors. Sensors can pick up a signal, but total VOCs and many air toxics aren’t straightforward, so you have to be clear about what the technology can and can’t tell you.” — Randi Walker, Chief, Air Toxics Section, Division of Air, NYSDEC

Data-to-Decision Pathways

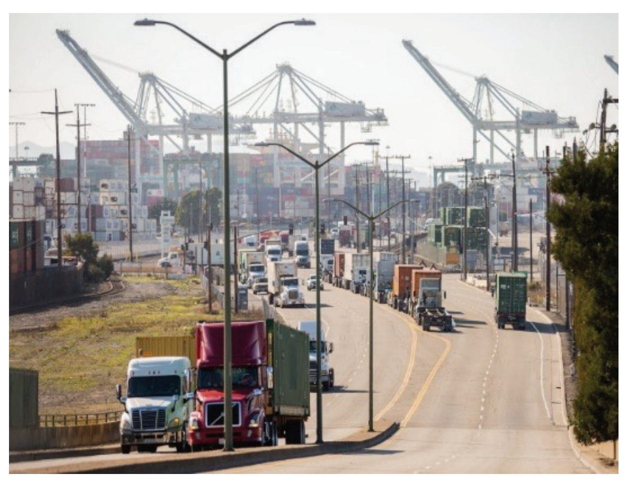
The South End project identified clear near-road pollution gradients, time-of-day traffic peaks and the contribution of heavy-duty trucks and buses, translating long-standing resident concerns into measurable, place-specific evidence. Rather than serving as a standalone technical exercise, the data supported practical decision-making in the City of Albany and clarified where pollution was concentrated, when exposures were highest and which sources mattered most. As seen in the findings and graphics above, this case illustrates how applied, evidence-based community governance functions in practice. Cross-agency partners were able to develop study designs that helped gather and interpret credible data for policymakers to take strategic actions, changing local freight operations based on neighborhood-level conditions. When paired with structured engagement and clear pathways to enforcement, planning or mitigation, community-based monitoring can move beyond documentation to support targeted local action. Programs that integrate education, storytelling and lived experience help translate technical air quality data into resident-, public- and policy-relevant insight while elevating community voices. Through interviews, community events and public-facing communication, these approaches contextualize data, sustain long-term engagement and strengthen local advocacy capacity and strategy.

West Oakland, California – West Oakland Environmental Indicators Project

West Oakland is a historically residential neighborhood in the northwestern corner of the city of Oakland, in Alameda County, California, situated along the San Francisco Bay near the eastern end of the Bay Bridge, just west of Downtown Oakland and south of Emeryville. Bordered on nearly all sides by major freight infrastructure, approximately 29,000 people live within this 7-square-mile area, including long-established Black communities, immigrant families and households living in older single-family homes, duplexes and multifamily apartments (WOEIP, 2024). The neighborhood's geography is unique: three interstate highways—I-580, I-880 and I-980—form a ring around it, while the Port of Oakland, two large railyards, truck lots, distribution warehouses and metal and recycling facilities surround much of the remaining perimeter (Bay Area Air Quality Management District [BAAQMD] & WOEIP, 2020). This area has experienced decades of elevated air pollution tied to historic land-use decisions, industrial activity and major transportation corridors, while residents have long reported diesel odors, visible soot, metallic dust and nighttime freight noise.

> Black residents in West Oakland continue to live approximately 15 years fewer than those with the highest life expectancy (WOEIP, 2024).

This concentration of freight corridors means thousands of diesel trucks pass through West Oakland every day, alongside locomotive activity, port drayage, cargo handling and heavy industrial operations. Homes, schools and childcare centers sit within blocks—and sometimes within feet—of idling queues, warehouse entrances and arterial truck routes, making it one of the Bay Area's most pollution-impacted neighborhoods (WOEIP, 2024), Scientific assessments have consistently documented elevated levels of DPM, black carbon UFPs, $PM_{2.5}$ and air toxics in the area, leading to higher asthma and cardiovascular illness rates.



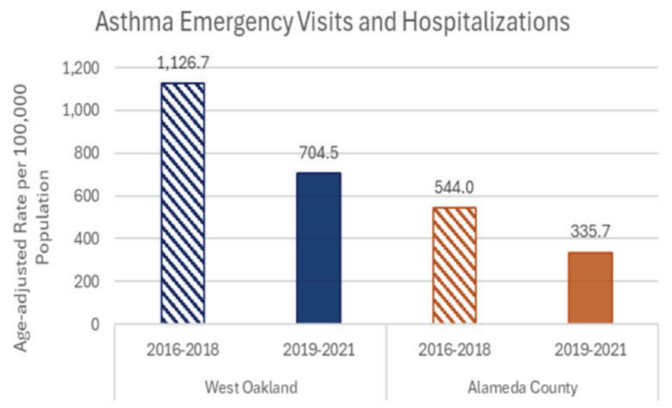


Figure 10: West Oakland & Alameda County Asthma Incidences

In West Oakland, asthma-related emergency visits and hospitalizations were very high in 2016–2018, at about 1,127 per 100,000 residents, and declined to roughly 705 per 100,000 by 2019–2021. While this represents improvement, rates remain substantially elevated compared with Alameda County overall, where asthma-related visits declined from about 544 per 100,000 in 2016–2018 to approximately 336 per 100,000 in 2019–2021— Asthma-related visits in West Oakland occur at more than twice the county average rate (WOEIP, 2019).

The broader San Jose–San Francisco–Oakland metropolitan area continues to rank among the worst in the U.S. for air quality in the American Lung Association's "State of the Air" 2025 report: it is 14th worst for high ozone days, 11th worst for short-term particle pollution and 6th worst for annual particle pollution out of more than 200 metropolitan areas assessed nationally. For decades, the community had access to only one regulatory air-monitoring station, a level of coverage insufficient to describe block-level exposure associated with truck and port activity.

The WOEIP was established around 2000 by local community leaders and has operated for over 20 years as a resident-led organization focused on air quality, health and equitable development in West Oakland. Since 2008, WOEIP has partnered with academic researchers and technology providers to advance hyperlocal monitoring approaches through participatory research and collaborative problem-solving. These models equip community members with scientific, grassroots and advocacy expertise, ensuring that those most affected by pollution help define the questions, conduct the research and interpret the findings. In doing so, they transform monitoring from a technical function into a mechanism of shared governance—redistributing authority, deepening local capacity and elevating community knowledge as a catalyst for planning, enforcement and sustained accountability.

The turning point came in 2017 with the passage of California's AB 617, which established a statewide framework for community-driven air quality planning. West Oakland was selected by the California Air Resources Board as one of the first Community Emissions Reduction Program (CERP) pilot sites, launching a locally guided planning process supported by supplemental environmental grant funding. To complement this planning work, WOEIP built the West Oakland Air Quality (WOAQ) Monitoring Network—21 sensors: seven advanced units capable of measuring black carbon, heavy metals and other diesel tracers, and fourteen PurpleAir $PM_{2.5}$ sensors installed at homes, businesses and community sites across truck-impacted corridors. The first wave of sensors was installed in winter 2023–2024, followed by community training and data testing in spring 2024 and continued monitoring and refinement through summer and fall 2024. Mobile monitoring, first on foot and then with cars—through partnerships with Google/Aclima vehicles—provided millions of additional block-level measurements of black carbon, NO_x, UFPs and localized port plumes (WOEIP, 2020). WOEIP is continuing to develop a public data portal that will house collected data and make it publicly accessible, reinforcing transparency and community ownership.

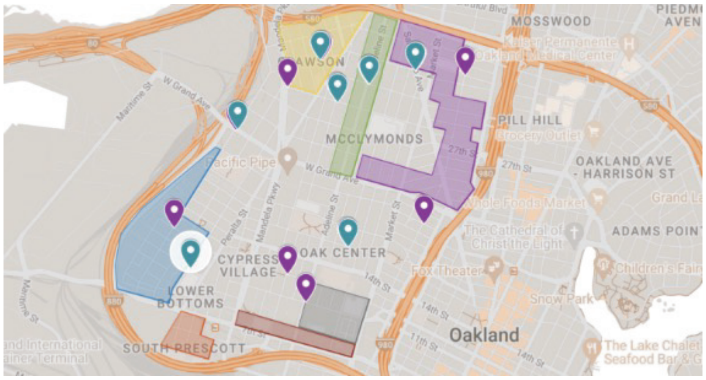


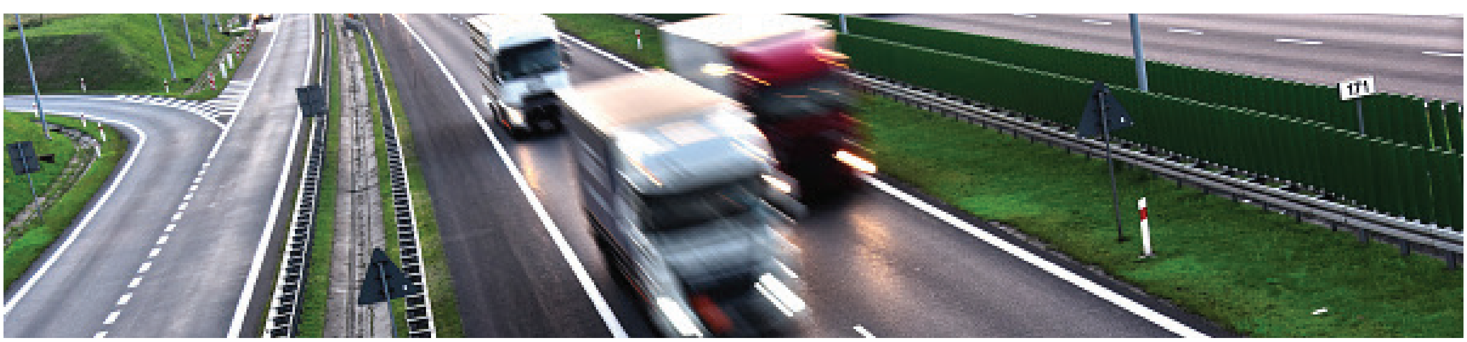
Figure 11: Study Image of WOEIP's sensor network

> "We don't rely on a single sensor or method. We use multiple approaches—mobile monitoring, stationary sensors, modeling—because no one tool tells the full story." — Nicole Merino Tsui, Director of Senior Partnerships, WOEIP

Program Success

WOEIP co-led the development of the West Oakland Community Action Plan (WOCAP) alongside the BAAQMD. The WOCAP Steering Committee—comprising neighborhood residents, technical advisors, local business representatives and city, county and state officials—developed more than 80 implementation-ready strategies addressing freight pollution, land-use conflicts, transportation design and neighborhood buffers. Adopted in 2019 under California's AB 617 framework, the plan is now in its multi-year implementation phase. The Steering Committee meets quarterly in public sessions to guide implementation, track progress and ensure ongoing accountability through monitoring and reporting. Over the past five years, the plan has driven investments and enforceable actions across port, city, county and regional partners. The 2024 5-Year Progress Report documents measurable progress: DPM emissions have fallen by about 31%, measured DPM exposure has dropped by 56% across most impact zones and cancer-risk-weighted emissions have decreased by 28%, contributing to an estimated 54% reduction in community-wide cancer risk (WOEIP, 2024). The combination of plan actions, existing and new statewide regulations, fleet turnover and other changes resulted in significant emissions reductions in West Oakland between 2017 and 2024. Building on the progress, investments and actions detailed above, the following figures illustrate how emissions and exposure outcomes have changed across West Oakland's seven impact zones since 2017. The tables on the next page accompanies **Figures 12** and **13** and documents how on-road vehicle emissions were modeled.

> "Residents knew where pollution was coming from long before there were studies. The challenge has always been translating lived experience into data that government and academic institutions are willing to act on" — Nicole Merino Tsui



SOURCE	UPDATED INFORMATION
On-road Vehicles (Highway and Street)	
On-road vehicles, like cars and trucks, including exhaust, fuel evaporation, brake & tire wear, and road dust	Fleet turnover, regulatory impacts, and activity changes from the EMFAC model; impacts of new CARB regulations

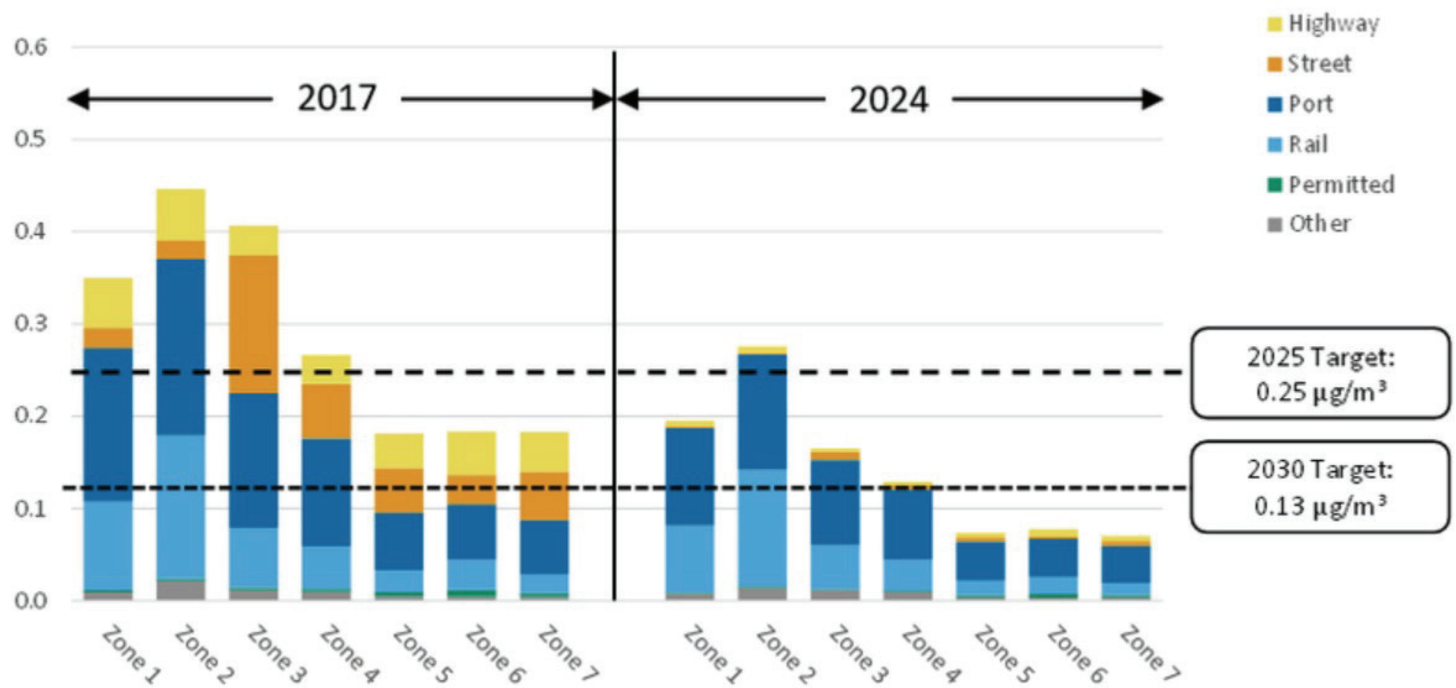


Figure 12: Comparison of DPM levels across 7 impact zones

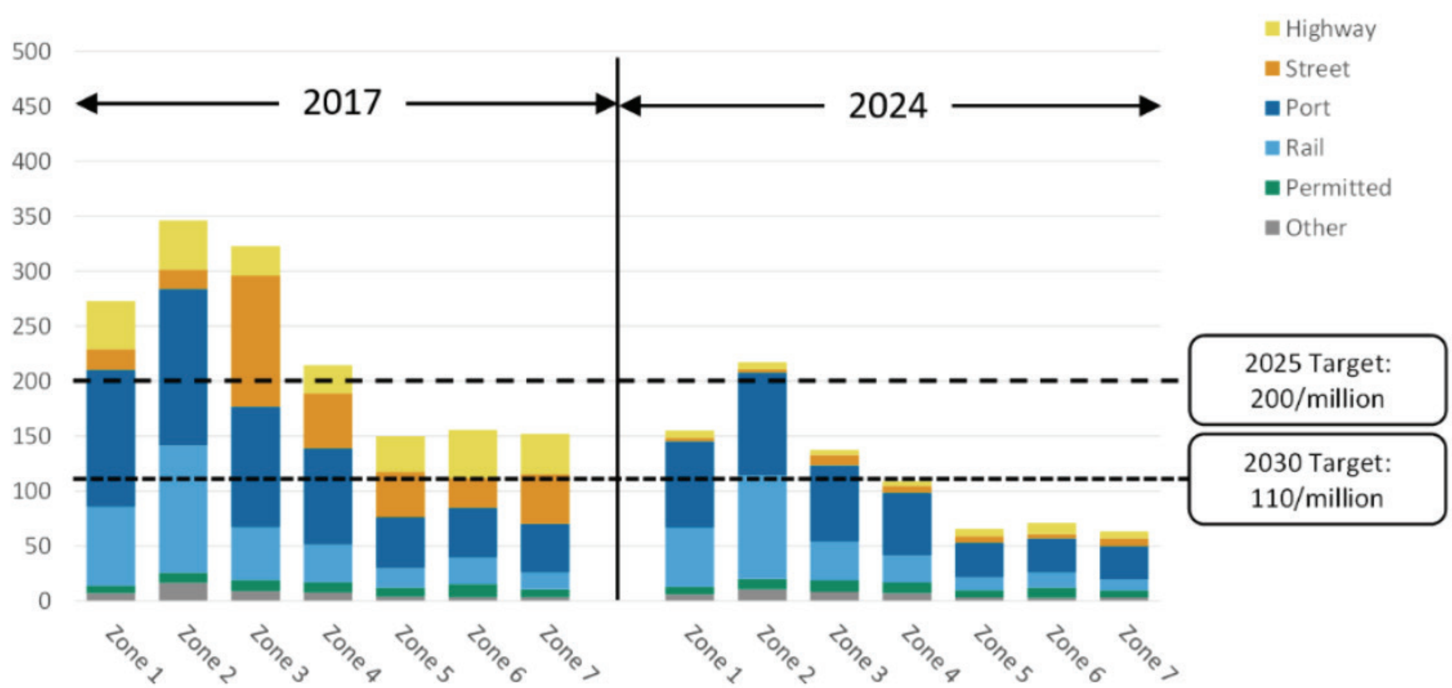


Figure 13: Cancer-risk weighted emissions across 7 impact zones

Figure 12 and 13 show measurable reductions in diesel particulate matter and cancer-risk weighted emissions. Further emissions reductions between 2024 and 2029 are projected at approximately 7%, reflecting continued growth in on-road motor vehicle activity (WOEIP, 2024). These estimates are based on modeling, which is useful for planning but depends heavily on the quality and representativeness of the underlying data—reinforcing the need to pair modeled projections with direct, on-the-ground measurement. Notably, the WOCAP plan moves beyond projections to implementation. Its strategies are implementation-ready and subject to annual progress reporting, with air districts required to submit both qualitative and quantitative updates supported by standardized metric workbooks. This structure enables state oversight while strengthening transparency and public accountability. These outcomes were supported by more than $51 million invested in 114 local pollution-reduction projects—ranging from cleaner truck programs and railyard improvements to industrial retrofits and port upgrades—that collectively prevented over 1,000 tons of NO_x, particulate matter and air toxics. WOEIP's multi-sensor approach has also informed transport and freight decisions in real time—including truck rerouting proposals and street-sweeping strategy changes.

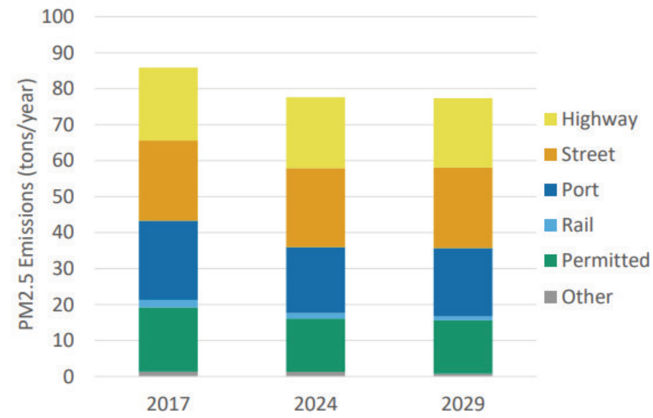


Figure 14: West Oakland PM2.5 emissions by year and source category (WOEIP, 2024)

Open Dashboard and Public Communication

Public dashboards are a vital tool in this effort. WOEIP's WOCAP data and implementation progress are publicly posted on the BAAQMD website, enabling public visibility and accountability. WOEIP will continue to advance the development of a future public-facing portal, designed to make air quality data transparent, accessible and directly usable. Dashboards can translate technical data into visual stories that support neighborhood planning and emissions reductions. Through color-coded maps, mobile sensor readings and comparisons across days and seasons, dashboards allow residents and policymakers to see specific health burdens in their area and make connections between freight activity and air quality. These are not just transparency tools; they are instruments of accountability, advocacy and education. They enable community members to ask more data-informed questions, demand targeted policy responses and build a broader base of air quality literacy. Transparency goes beyond data access to include clear explanations of methods, corrections and uncertainty. By embedding this context directly into dashboards and tools, programs allow users to engage with the data at different levels of technical depth while maintaining trust. When communities understand why corrections are made and what they mean, the data becomes credible, usable and defensible for both residents and regulators (U.S. EPA, 2025b).

> "All data is valuable—it's just a matter of how we use it."
>
> — Michael Ogletree, Senior Director, State Air Quality Programs, Colorado Department of Public Health and Environment

Data Lifecycle: Collection, Maintenance and Useability

Community-generated datasets reveal the acute, street-by-street pollution patterns—capturing short-term spikes, idling hotspots and cut-through truck traffic—and localized burden that can vary dramatically within the span of a few hundred feet. In West Oakland, the air monitoring program was built around a transparent and trusted data lifecycle designed to reflect how pollution is actually experienced. Sensor placement and analysis explicitly accounted for time-of-day and seasonal patterns, capturing elevated nighttime and weekend pollution linked to port activity and train idling—conditions that traditional monitoring often miss. Credibility and usability were strengthened through a staged rollout that paired early sensor deployment with community training, testing and refinement.

Quality assurance was central to this process, with calibration checks, correction factors for conditions such as wildfire smoke and humidity, and clear documentation embedded directly into data sets, so uncertainty and methodology were visible alongside the data. By combining technical rigor, open data practices and sustained resourcing through state funding and technical partnerships, the West Oakland network ensures monitoring is not a one-time exercise but a durable, community-owned system—one that supports accountability, tracks progress over time and turns data into a long-term asset for local action and policy change.

Data-to-Decisions Pathways

The WOEIP shows how community air monitoring can function as a governance mechanism rather than a standalone data exercise. Through calibrated measurement, collaborative evaluation and formal decision pathways, monitoring was embedded into how policies were shaped and enforced. Central to this approach was the resident-led Community Steering Committee that shifted planning authority toward local leadership, positioning residents as decision-makers rather than data subjects. By anchoring monitoring priorities, data interpretation and implementation in lived experience, the program ensured that evidence remained actionable—moving monitoring from observation to sustained systems change. Over time, this participatory framework was institutionalized. WOEIP's role was formalized through contracts with the BAAQMD, embedding community expertise directly into regulatory workflows. This integration improved coordination across air quality, transportation, port and land-use agencies and enabled more timely responses during pollution events. Calibrated, validated monitoring data became actionable—informing enforcement, freight-routing decisions and mitigation investments rather than remaining confined to technical reports. In practice, community-generated pollution maps and exposure analyses were leveraged to advance zero-emission freight goals, restrict diesel traffic near schools and homes and support the development of the West Oakland Truck Management Plan. The longevity of this work underscores a broader lesson for future programs: durable environmental change emerges when community leadership, regulatory authority and scientific rigor advance together.

> "This work has always required partnership—with local agencies, the Port of Oakland, regional regulators, and researchers—to understand emissions, exposure, and health risk in a way that could actually lead to change." — Nicole Merino Tsui

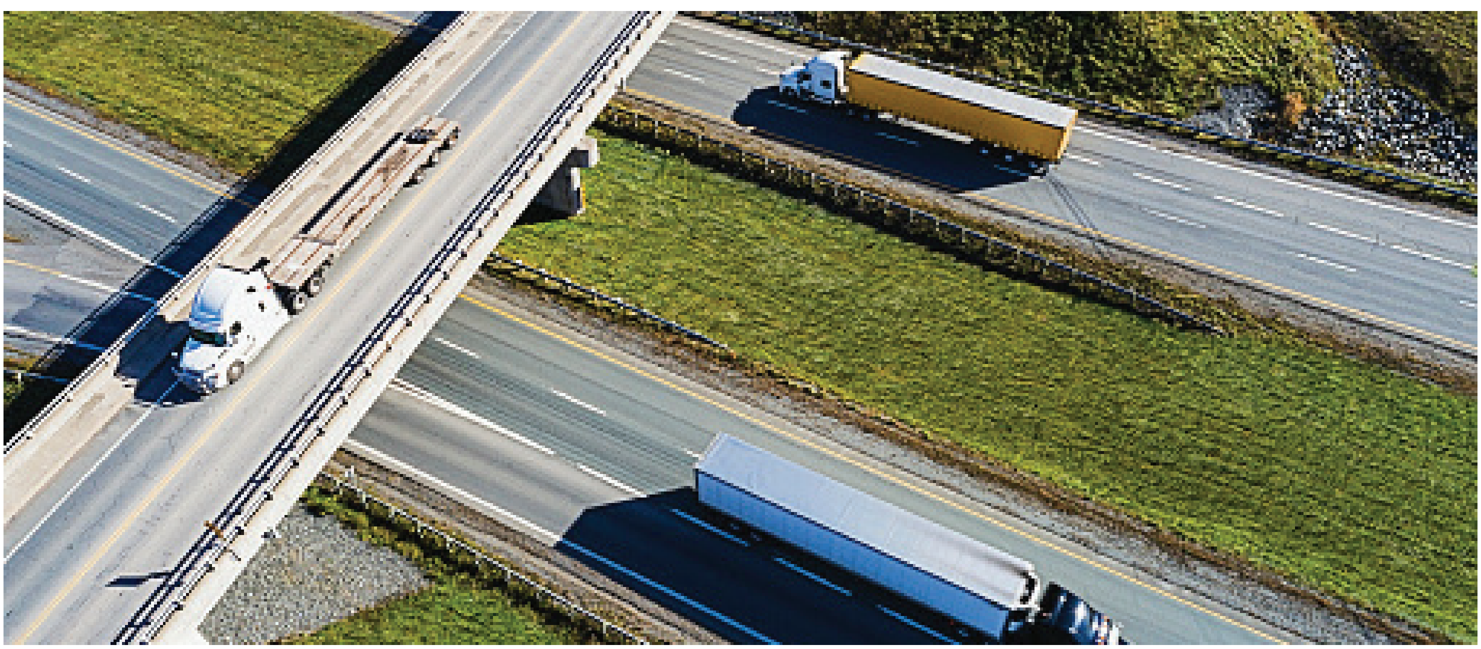
Conclusions

Community-based air monitoring is transforming how pollution is identified, understood and addressed in neighborhoods shaped by heavy-duty traffic. The South End Neighborhood Air Quality Initiative in Albany and the WOEIP demonstrate that community-driven data can reveal exposure patterns that fixed regulatory monitors cannot. By integrating these sensors, mobile monitoring and near-roadway measurements, these efforts document real-world exposure and substantiate long-standing resident concerns about diesel pollution and related health risks (Gao et al., 2022).

Accessible data platforms are critical for turning monitoring into action by making trends, hotspots and progress visible—moving data from observation to leverage and enabling coordination across community partners and public agencies. Across both projects, localized, participatory data drives action not simply because it exists, but because it is shared, trusted and acted upon—reshaping policy pathways and accelerating regulatory and community response. These case studies also make clear that data alone does not produce change.

Sustained investment in training, quality assurance, maintenance and evaluation—alongside mobile monitoring and community capacity-building programs—is essential to keep data credible, community-owned and policy-relevant over time. When monitoring is supported as a long-term public good rather than a short-term project, it becomes infrastructure for governance rather than evidence in isolation. Together, these efforts reflect what scholars describe as shared environmental governance, in which communities actively shape data collection, interpretation and outcomes rather than serving as passive recipients of information (O'Rourke & Macey, 2021).

Taken together, these cases show that reducing pollution from heavy-duty traffic requires more than data collection—it requires continuity, accountability and partnership embedded over time. Participatory science strengthens public health, builds local leadership and repositions data as a bridge between lived experience and institutional decision-making. In freight-impacted communities, this shift is not abstract: it is how invisible exposures become visible, how concerns become evidence and how cleaner, safer conditions move from possibility to practice, shifting power toward the people most affected and enabling measurable change where it matters most.



Looking Forward

These programs signal an evolution in air quality monitoring—toward models that are more adaptive, community-centered and capable of pairing emerging technologies with on-the-ground engagement to address persistent data gaps. Two models of innovative projects in the field are included below.

Mobile Monitoring Innovation

In June 2025, California launched the first-of-its-kind Statewide Mobile Monitoring Initiative (SMMI), deploying sensor-equipped vehicles and mobile labs across 64 communities disproportionately affected by air pollution. Led by CARB in partnership with Aclima, UC Berkeley, UC Riverside and Aerodyne, the project collects block-by-block data on criteria pollutants, black carbon, methane and other toxic air contaminants, with more than 60% of effort focused on low-income and overburdened communities. Over 40 community-based organizations helped shape monitoring priorities, ensuring that residents' concerns drive where and what gets measured. Data collection runs through June 2026, after which all pollution measurements and visualizations will be publicly available to support local air-quality solutions, guide policy, inform research and bolster grant applications. This statewide initiative sets a new precedent for how air monitoring can be reimagined—by centering communities that are under-resourced, integrating advanced mobile technology and creating a replicable model that can expand options for community-driven monitoring in areas historically left out of regulatory data collection.

CleanAIRE North Carolina's AirKeepers

The AirKeepers Dashboard is a dynamic, community-informed air quality platform developed through CleanAIRE North Carolina's community science program over two and a half years, in partnership with ten stakeholder groups across the state. Guided by participatory science efforts, the dashboard integrates sensor data from over 300 deployed monitors and is designed to be responsive to the needs and goals of impacted communities. The tool provides real-time air quality readings, accessible correction factors and community-generated context to support both public understanding and scientific use. Importantly, residents can access individual reports, filter real-time and historic-sensor data and learn why certain corrections are applied, giving them greater ownership of their local data. As a result, the dashboard remains one of the few readily accessible platforms providing localized, community-scale insights in a single, public-facing format. The AirKeepers project emphasizes storytelling, transparency and access—using stipends, language testing and community pilot feedback to build trust and usability. With a growing user base across all 50 states, the dashboard includes a built-in

> "Transparency isn't just publishing numbers. It's explaining correction factors, uncertainty, and why different methods are applied—right next to the data itself."
>
> — Daisha Wall, Director of Programs & Impact, CleanAIRE NC

guided tour to support first-time users in navigating community-scale air quality data. Concurrently, CleanAIRE NC launched the CleanAIRE Academy in August 2025 as a dedicated learning platform that offers training modules on permitting, clean air advocacy and data literacy, enabling communities to interpret and apply air quality information without relying solely on external experts. Together, the AirKeeper Dashboard and CleanAIRE Academy support communities across North Carolina—from Charlotte to Sampson County—using approaches that range from securing EPA reference-grade monitors to challenging industrial permits. This integrated, but not singular, model reflects CleanAIRE's commitment to meeting communities where they are, whether through regulatory engagement, litigation support, policy advocacy or expanded access to health and environmental data. As these tools and programs continue to evolve, they create new opportunities for stakeholders to generate actionable, community-informed data that supports local solutions, policy development and long-term air quality improvements.

> "The AirKeepers dashboard was built with communities, not for them. Over two and a half years, residents tested it, shaped it, and told us what transparency actually needed to look like...The fact that we see users well outside North Carolina tells us this need isn't regional. Communities everywhere are looking for usable air data." — Madison Fragnito, Development Director, CleanAIRE NC.

Recommendations

To reduce freight-related air pollution by ensuring hyperlocal monitoring data reach decision makers and inform mitigation strategies, the American Lung Association offers the following calls to action:

Federal Government

- Implement and enforce science-based, health-protective NAAQS, including the 2024 updated $PM_{2.5}$ standard.
- Strengthen hazardous air pollutant standards and enforcement. Expand fenceline monitoring requirements to more stationary sources of hazardous air pollutants.
- Adequately fund state, local and tribal air agencies to sustain robust regulatory monitoring networks, including staffing, data platforms and infrastructure.
- Invest in dedicated, multi-year funding for community-led monitoring, supported across federal agencies (e.g., EPA, FEMA, USDA and others). Include investments in technical assistance hubs that provide calibration and collocation support, QA/QC protocols, quality assurance and data interpretation guidance. Support ongoing research into best practices.

- Develop guidance on minimum performance, documentation and transparency standards to integrate validated, community monitoring data into federal air quality decisions, including enforcement, inspections, permitting, compliance and rulemaking.
- Establish frameworks to utilize community-scale data for public health communications, emergency response and preparedness, and post-event evaluations.
- Building on the success of the EPA U.S. Fire and Smoke Map, improve and modernize federal data platforms to display validated and corrected community monitoring data alongside regulatory measurements. Permanently fund and expand federal wildfire smoke monitoring programs, including EPA's Wildfire Smoke Air Monitoring Response Technology (WSMART).
- Support cross-agency coordination among air agencies, transportation authorities, port and freight authorities and land-use and zoning regulators to integrate community monitoring into decision-making.

States

- Ensure stable, state-level funding streams, beyond short-term grants and projects, for community monitoring. Sustain cross-agency partnerships that build local expertise and tailor to local needs.
- Partner with universities, air agencies and research institutions to provide technical support – including sensor deployment, data hosting, calibration and validation, assessment and maintenance, data useability and hands-on training—for community, school and tribal monitoring programs.
- Integrate properly corrected community sensor data into dashboards, maps, public advisories and communication platforms that support incident-response systems, neighborhood-level messaging, school and outdoor activity guidance, emergency response decisions, post-event assessments and inclusion in state resilience planning.
- Establish frameworks that formalize community participation and transparency in air quality decision-making, including defining how community input informs agency actions and ensuring feedback loops between residents and decision-makers. Ensure a pathway for community-generated data to be used to identify high exposure areas.
- Use quality-assured community data to inform state permitting decisions, cumulative-impact analyses and targeted inspections, and formalize how neighborhood-scale monitoring feeds into state air quality programs to support enforcement screening, mitigation prioritization, emergency monitoring plans, transportation planning and land-use strategies. SIPs can remain anchored to regulatory monitoring for NAAQS compliance while using quality-assured community data to identify hotspots and better target where emission reductions can be applied.
- Support Tribal sovereignty in air monitoring by strengthening EPA State and Tribal Assistance Grant (STAG) support for tribal air programs, including sustained funding for staff, operations and data ownership and use.

Local Governments

- Commit sustained funding to support the full lifecycle of community air monitoring, including sensor maintenance and replacement, staff capacity and training, partnerships, public data platforms and ongoing engagement that links monitoring to public health and emergency response.
- Coordinate across cities, counties, regional agencies, public health and emergency planners and neighboring jurisdictions to align monitoring with pollution patterns, enabling residents and agencies to co-develop priorities, review data and guide mitigation strategies.

- Embed air quality monitoring into local emergency management and hazard-mitigation plans by establishing formal cross-department protocols that define how community sensor networks are used in public communications, emergency operations, recovery planning and future preparedness, require agencies to use real-time data to guide coordinated response during major pollution events, and document lessons learned to improve future decision making.
    - Wildfire smoke: Use data to guide decisions on outdoor activities, worker safety, school and childcare operations, ventilation and clean-air shelter activation.
    - Heavy-duty trucks: Apply data to inform truck routing, idling enforcement, curb management, port operations and roadway design.
    - Point-source pollution: Integrate data into investigations, permitting review, public comment processes and facility-level mitigation actions.
- Regularly review monitoring data to identify areas of elevated concentrations, dominant sources and exposure trends, and conduct after-action reviews following major events to refine communication, sensor placement, outreach and resource deployment.
- Preserve quality-assured community data for public comment and, when needed, legal review, strengthening the administrative record with real-world exposure evidence.
- Support community events and volunteer networks—including schools, faith-based organizations and health clinics—to engage residents as sensor hosts and data stewards.
- Use transparent, plain-language and multilingual reporting tools with visuals and maps to support public understanding and informed participation in policy discussions.

Individuals/Community Groups

- Collaborate with academic entities, public health organizations, government agencies and commercial vendors to secure multi-year grant funding support for deploying monitoring projects and sustaining staffing, data infrastructure and stewardship.
- Bolster community capacity and support through coordination with local schools, tribal, faith-based and neighborhood organizations in under-resourced or rural areas.
- Use publicly accessible air quality data, supported by cross-sector partnerships, to deliver clear findings, actionable requests and health-protective protocols to local municipal boards, school boards, commissions and decision-making bodies.
- Apply neighborhood-scale data to advocate for health-protective actions, including emergency alerts, clean-air shelter activation and smoke-day school and work adjustments, truck rerouting, idling restrictions, buffer zones near homes and schools, and stronger fenceline monitoring, permit modifications, targeted inspections, health symptom tracking and enforceable mitigation during permit renewals or expansions.
- Build data literacy by training local staff, volunteers, leaders and residents to interpret corrected data, document pollution events and communicate findings effectively, while establishing clear governance structures over roles, authority and data ownerships.
- Plan for the full data lifecycle and continuous improvement—from defining monitoring questions and selecting sensors to placement, calibration and maintenance; data collection, backup and useability; to quality assurance and sustained use of results.

- Document and apply lessons learned to improve communication strategies, locally tailored data models, resource deployment and long-term operation and sustainability.
- Maintain public-facing dashboards that integrate sensor data and forecasts with plain-language health guidance, designed to be mobile-friendly, multilingual and accessible to non-experts.
- Educate residents on local emergency preparedness and response protocols, including the communication channels used to deliver rapid public alerts during pollution events.

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