S. HRG. 117–551

A LEGISLATIVE HEARING TO EXAMINE S. 1345, THE COMPREHENSIVE NATIONAL MERCURY MONITORING ACT; S. 2476, THE ENVIRONMENTAL JUSTICE AIR QUALITY MONITORING ACT OF 2021, AND S.——, THE PUBLIC HEALTH AIR QUALITY ACT

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED SEVENTEENTH CONGRESS

SECOND SESSION

JULY 13, 2022

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COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ONE HUNDRED SEVENTEENTH CONGRESS

SECOND SESSION

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C O N T E N T S

A LEGISLATIVE HEARING TO EXAMINE S. 1345, THE COMPREHENSIVE NATIONAL MERCURY MONITORING ACT; S. 2476, THE ENVIRONMENTAL JUSTICE AIR QUALITY MONITORING ACT OF 2021, AND S.——, THE PUBLIC HEALTH AIR QUALITY ACT

WEDNESDAY, JULY 13, 2022

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The committee, met, pursuant to notice, at 10:03 a.m. in room 406, Dirksen Senate Office Building, Hon. Thomas R. Carper (chairman of the committee) presiding.

Present: Senators Carper, Capito, Cardin, Whitehouse, Markey, Duckworth, Kelly, Padilla, Sullivan, Ernst.

OPENING STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. Good morning, everyone.

Two of my favorite colleagues are here. Isn't this great? How wonderful to have my Congresswoman, Lisa Blunt Rochester here, one of my great mentors, and Susan Collins, who has been my collaborator on so many issues over the years. This is like dying and going to heaven. Could you come back every day? That probably wouldn't work. Anyway, on a serious note, we are happy to be here with you and are grateful for your service.

I want to call this hearing to order. As you know, we are here today to examine three bills that are intended to improve our Nation's antiquated air quality monitoring system and better protect Americans from air pollution.

Since enacting the Clean Air Act, I guess it has been a half century ago now, our Nation has made great progress in cleaning up the air that we breathe without harming economic growth. I like to say everything I do I know I can do better, and the same is true with respect to the quality of the air that we breathe.

Soot and smog pollution in the United States have decreased since 1970 by 80 percent. We don't oftentimes reflect on the accomplishments we have made and the progress we have made. That is pretty good, an 80 percent reduction since 1970. Over that same period of time, our gross domestic product has grown by 250 percent.

The question is, can we have cleaner air, cleaner water, and create jobs and economic opportunity? The answer is, I think, clear that we can.

The benefits of clean air far outweigh the costs, and it is not hard to understand why. Clean air is good for human health; it is good for our planet, and as it turns out, it is good for our Nation's economy.

As my colleagues know, I have already said it once today but I will say it again, everything I do, I know I can do better. We can do better still on this front, too. Despite our successes, we still have far too many people in this Country who are negatively impacted by the quality of the air that they breathe, and especially those from low-income and historically disadvantaged communities. According to the EPA, nonwhite children are much more likely to die from air pollution than white children in the United States today.

Why are environmental justice communities at risk? One answer is proximity. More often than not, those in our Nation's environmental justice communities live near or downwind of facilities that emit harmful air pollution. These "fenceline communities" as they are known, bear the immediate impacts of exposure to harmful pollutants and the burdens of the cumulative health effects that can arise from repeated, long-term exposure to air pollution.

But you don't have to live near a source of air pollution to suffer its consequences. When emitted into the air, persistent air toxics like mercury can fall into our waterways and bioaccumulate in fish over decades, long after a source may cleanup or close down. Many Americans today do not even know that they are being exposed to dangerous levels of air pollution. There are real gaps in what the Federal Government knows, as well.

Today, the Government Accountability Office, which we affectionately call GAO, will testify on its troubling 2020 study on the State of our Nation's air monitoring systems. Their report found that our air monitoring systems are woefully out of date and under-resourced.

According to GAO's findings, these out-of-date systems have left our State air quality managers buying replacement parts on eBay. Why do they do that? They do that because the air monitoring technology that States are using today is no longer being manufactured. We continue to rely on yesterday's systems to address today's problems.

GAO also found what we have long known, and that is while the health threats posed by air toxics are well-documented, the data we have on where, when, and how they are released into our air are not well-documented. That is just not acceptable. We can and we must do more to support Federal, State, and local officials who are tasked with maintaining and improving our air monitoring systems.

That brings us to the legislation that we are considering here today. For more than a decade now, I have had the privilege of working alongside Senator Collins on a bunch of issues, but in particular, on the one that is before us today, and that is the Comprehensive National Mercury Monitoring Act. She has been a leader on this for more than a dozen years, and we are grateful for that. I am grateful for her letting me be her wingman on this issue and others.

Mercury is a powerful neurotoxin that is especially dangerous to pregnant women and developing children. An estimated 100,000 to 200,000 children born in our Country each year are exposed to levels of mercury in the womb that are high enough to impair neurological development.

Congresswoman Rochester, I don't know exactly how many children we have in Delaware under the age of 18, but we probably have about 200,000. So how many is 200,000? Every child in our State is really what it is comparable to.

In the last decade, we have known that there have been more mercury consumption fish advisories in U.S. lakes and rivers than all other pollutants combined. However, we still have data gaps on where mercury persists in our environment.

Our legislation fills in the gaps by establishing a first-ever National Mercury Monitoring Network to track long-term trends in mercury concentrations in communities and ecosystems across our Country. Under our legislation, the public would have free access to the network's findings, empowering communities with the information that they need to better protect themselves from mercury pollution. I am grateful that my partner in this effort, Senator Collins, is joining us today to speak further on this legislation, which she leads.

We will also examine Senator Duckworth's and Congresswoman Lisa Blunt Rochester's legislation, the Public Health Air Quality Act, of which I am also a cosponsor. This legislation would upgrade and expand our Nation's outdated air quality monitoring networks, which includes providing immediate monitoring for air toxics in fenceline communities experiencing high cancer rates and other health impacts.

Finally, we will review the Environmental Justice Air Quality Monitoring Act, sponsored by Senator Markey, a member of this committee. His legislation would help ensure that communities have access to relevant, local air quality information. Our current air monitoring systems do not always provide accurate, localized data, which makes it harder for communities to assess their exposure to certain toxics.

All three bills are intended to help Americans understand who is being exposed to air pollutants and who is not. These investments in our air quality monitoring systems are investments in healthier communities and a stronger economy. Where I come from, that is a win-win situation.

We look forward to hearing more from our colleagues and our witnesses on the benefits of these important pieces of legislation.

Before we do, I am pleased to turn to our Ranking Member, Senator Capito, for her opening statement. Senator Capito, please.

OPENING STATEMENT OF HON. SHELLEY MOORE CAPITO, U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

Senator CAPITO. Thank you, Chairman Carper, and welcome to Representative Rochester and Senator Collins, my friend. We are happy to have all of the witnesses joining us here today.

As we consider the topic of air quality monitoring today, it is important, as Senator Carper began his statement, just how much air pollution in the United States has fallen in the past few decades.

With environmental issues, sometimes there is a tendency to just fixate on the negative, but I am an optimist and believe, while there is always room for improvement, we need to recognize and applaud what the U.S. has accomplished.

Looking forward, we must also bear in mind that costs rise and benefits diminish as emission targets approach the limits of what our technology can actually measure and mitigate.

According to the EPA data, between 1970 and 2021, the combined emissions of particulate material, carbon monoxide, lead, nitrogen oxides, sulfur dioxide, and volatile organic compounds were reduced by 78 percent. From 1990 to 2017, emissions of hazardous air pollutants declined by 74 percent. On top of that, U.S. greenhouse gas emissions have also decreased, thanks primarily to the shale revolution and American ingenuity, not our regulatory policies.

While our emissions have been decreasing, this has not been the case around the world. According to the World Air Quality Report for 2021, using particulate matter as a proxy for air quality, Central and South Asia are home to 46 of the world's most polluted cities, and the trends there are dire.

Given the fact that we are seeing continual air quality improvements under current authorities in the U.S., it is unclear to me why the EPA needs new air quality authorities. I especially question granting EPA new powers given the agency's reaction to last month's decision by the Supreme Court in West Virginia v. EPA. That decision should have been a clear signal to the EPA that its planned regulatory overreach needs to be reigned in, but the Administration's immediate reaction to the West Virginia decision has been quite the opposite, doubling down on plants to serve the interests of progressive environmental groups and the trial bar, no matter what the law says, what the costs are to society, or even if there are meaningful environmental benefits as a result.

As Administrator Regan said following the decision, "We are going to continue to use every tool in our toolbox because it is under our legal authority and it is our obligation to protect communities, reduce pollution that is driving climate change, and provide certainty and transparency for the energy sector to grow the clean energy economy."

EPA clearly wants to force wholesale changes on our economy based on overly expansive readings of existing law, regardless of what the Supreme Court has said. This mission means reducing affordable, reliable sources of baseload energy generations and slamming manufacturing with an onslaught of new regulation.

If EPA is going to continue to read existing statutes well beyond Congress's intent and pursue regulations beyond the scope of the law, only to continue losing in court, then I have concerns about giving EPA new authorities to abuse, much less delegate those supposed authorities to illogically favored advocacy groups to feed fundraising drives and frivolous lawsuits.

For example, EPA stated in its proposed methane rule that the agency plans to allow third-party monitoring in an upcoming supplemental proposal. Congress never intended to empower environmental groups to use taxpayer dollars to purchase and use potentially unreliable monitoring equipment with no oversight and report that data back to the agency, and then they have that data, which they use to empower the trial bar to pursue their sue-and-settle lawsuits.

Congress provides funding for air quality management activities, including air quality monitoring, through the annual appropriations process. EPA typically receives that funding through State and Tribal Assistance Grants under two primary authorities: Section 103 and Section 105 of the Clean Air Act. EPA provides that funding to States and local air agencies, which in turn, they decide where and how to spend their funding on a range of air quality management activities.

While the GAO did provide suggestions for EPA to improve implementation in a 2020 report, improvements in implementation of existing authority are not the same as granting new authorities. Indeed, if GAO has concerns about implementation of existing authorities, it begs the question what problem adding new authorities would actually solve.

I am interested in hearing from our witnesses their views on these questions and how monitoring is actually conducted in the field under existing law as they react to the legislative proposals before them.

Thank you, Mr. Chairman.

Senator CARPER. Thank you, Senator Capito.

We are now being joined by Senator Markey. He is just settling into his seat, and just 2 days after his birthday. I sent him a text message, and I said the president, Senator Capito is president host, as you know, of the Annual congressional Picnic yesterday, and somehow they didn't put it on Eddy's birthday. It was a day late.

[Laughter.]

Senator CARPER. So today we are 2 days late. We are having this hearing to honor your birthday.

As Eddy knows and Lisa and others know, Senator Capito and Senator Collins, I love to call my colleagues on their birthdays if I don't see them, and if I don't reach them, I send them a text message or whatever.

We hope you had a great birthday, and we are delighted to be here today to listen to your comments, please, on the legislation that you have proposed. I think it is called the Environmental Justice Air Quality Monitoring Act, and we are pleased today to be examining it today. Senator Markey, you are recognized for your statement.

OPENING STATEMENT OF HON. ED MARKEY, U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator MARKEY. Thank you, Mr. Chairman, and thank you for your birthday wishes.

Senator CARPER. One of the people I love to call, we have three or four Senators who are 88 or 89, and I called Chuck Grassley when he turned 88, and he was in Iowa, and I called him to wish him a happy birthday. I said to him, Chuck, you are amazing. I think he just announced he is running for re-election, I think. I said, I don't think I am going to be running for re-election when I am 88. I just hope I know who I am and where I am. He said, I hope you do too.

[Laughter.]

Senator MARKEY. Satchel Paige, the great baseball player, when asked how could he still be pitching in the major leagues when he was 48 years old, he said, well, let me ask you this question. If you didn't know how old you were, how old would you be?

That is a good question. For me, and I think for you as well, that I think I am still 40 years old, because I don't really know how old I am unless people call me to remind me on my birthday. But other than that, every day, including this hearing, 40 years old. Thank you, Mr. Chairman.

When it comes to Federal efforts to improve air quality in the United States, we must first acknowledge the deep-rooted injustices of air pollution in communities across our Country. Black, brown, and low-income families are historically more likely to be located near pollution sources. As a result, they have been overburdened by the dirtiest air, yet they have not been given enough Federal support to address it or even understand the risks.

Some pilot studies have found that concentrations of air pollutants can vary by as much as 800 percent between one block and another. That exposure makes a big difference for people as they go through their daily lives, and that knowledge could make a big difference as we try to help limit public health challenges.

I would like to ask unanimous consent to submit for the record three articles about this block-by-block disparity and the correlation between race and redlining of neighborhoods on air quality.

Senator CARPER. Without objection.

[The referenced information follows:]

The Washington Post
Democracy Dies in Darkness

Block-by-block data shows pollution's stark toll on people of color

Mobile air quality monitoring in San Francisco and Oakland challenges the accuracy of stationary monitoring sites across the country

By Darryl Fears
May 25, 2022 at 7:00 a.m. EDT

Finding the most polluted places in the San Francisco Bay area is simple, a new air quality analysis shows: Locate places where mostly Black, Latino, Asian and low-income residents live, and pay them a visit.

The data released Tuesday by Aclima — a California-based tech company that measured the region's air quality block-by-block for the first time — found that communities of color are exposed to 55 percent more nitrogen dioxide, which contributes to smog, than mostly White communities.

While the Environmental Protection Agency gauges an area's air quality with fixed monitors, the new survey unearthed more granular data by sending low-emission vehicles equipped with sophisticated technology to traverse neighborhoods at least 20 times each. These forays revealed that poor people of all ethnicities experience a 30 percent higher exposure to nitrogen dioxide compared to wealthier residents, and concentrations can vary up to 800 percent from one end of a block to the next.

The painstaking examination, partly funded by the Bay Area Air Quality Management District through a $6 million contract, took more than a year. The company's fleet traversed every city block in San Francisco, Oakland, San Jose and other municipalities to determine the true extent of pollution.

What they discovered was that the farther their mobile air monitors traveled away from the region's more than two dozen stationary air quality monitors, the more they detected elevated levels of pollution that the fixed monitors missed. Their data questions the reliability of the system the EPA uses to surveil the air that millions of Americans breathe.

"The regulatory stationary network is not inherently designed to provide a detailed picture of air pollution at the street, community or block area level," the analysis said.

It found that the entire Bay Area is exposed to higher levels of floating microscopic pollutants, fine particulate matter, than World Health Organization guidelines recommend. These particles, known as PM2.5, can penetrate the lungs and cause numerous respiratory diseases such as asthma.

Aclima compared its data to an international benchmark, which is far more restrictive than federal standards. The WHO sets its standard for nitrogen dioxide, NO2, at 10 micrograms per cubic meter of air compared with the EPA's 100.

EPA limits the annual average exposure to fine particulate matter to 12 micrograms per cubic meter of air, compared with the WHO's 5 micrograms. During the Trump administration, EPA staff recommended lowering the annual federal threshold to between 8 and 10 micrograms per cubic meter, but the Trump administration kept the standard set in 2012.

For decades, Black, Latino, Asian, Native Americans and low-income White residents have said deadly pollution in and around their homes has been their reality. They have questioned national air quality standards and data from fixed air quality monitors that said the concentration of pollution is acceptable.

"That's not what the community is experiencing," Veronica Eady, senior deputy executive officer for policy and equity at the Bay Area Air Quality Management District, said about the data. "We suspected some of these things but we didn't have this," she said, referring to the community-scale granular data. "We're taking this pivot to add additional tools to the toolbox to improve public health."

During the many years before the pivot to monitoring pollution block-by-block near the source, there were "people dying that didn't have to die," said Margaret Gordon, a community activist and co-director of the West Oakland Environmental Indicators Project. Data provided by hyperlocal monitoring could have led to better planning and siting of pollution sources "where people work live and pray," Gordon said.

In the area around the project's office, bracketed by freeways and a major shipping port that serves as a destination for diesel trucks, the level of nitrogen dioxide pollution is 10.5 parts per billion, according to Aclima's analysis. That lies well below the EPA standard but exceeds international guidelines.

The air quality is much better in one block of the mostly White Oakland Hills, which is far from freeways and the port. At 4.5 parts per billion, the nitrogen dioxide level lies below WHO's standard, according to Aclima's data, and the neighborhood's PM2.5 concentration is at the global threshold.

Aclima ended its first phase of air quality mapping in 2021, when its researchers started to analyze the data. In addition to capturing the heavier pollution burden borne by Latino, Asian American and Black residents, it showed higher exposure for White and non-White residents who either rent their homes, live at two times below the federal poverty line or both.

These patterns are clear in Santa Clara County, home to racially diverse San Jose and Gilroy, a majority White exurb 33 miles south.

Both areas have elevated levels of particulate matter. In Gilroy, major highways slice through fields and farmland dotted by homes, and in San Jose, highways cut through minority and disadvantaged communities.

Dust also hangs in the air over Gilroy, kicked up by farming practices, and San Jose's traffic pollution is exacerbated by a natural air basin that traps particulate matter from fires during wildfire season.

About an hour north in Alameda County, which includes Oakland, around 70 percent of the 180,000 Black residents "live in areas with nitrogen dioxide higher than the latest World Health Organization guideline," the analysis said. That compares to about 40 percent of its White residents.

A growing body of scientific evidence suggests a link between breathing pollution, developing a severe illness and becoming infected or dying from covid-19. A study of 425 young adults, published last month in Sweden, found that brief exposures were "associated with increased risk of SARS-CoV-2 infection despite relatively low levels of air pollution exposure."

Sacoby Wilson, a professor of environmental health at the University of Maryland's School of Public Health who serves on Aclima's environmental justice advisory board, called stationary air quality monitoring "a problem."

"It's really a poor approach," he said. "We call it 'exposure misclassification.' " When you compare the levels of pollution Aclima found to WHO guidelines, Wilson said, "It's like, 'Oh my God.' It's not just a race issue. You have to look at both race and income."

The company's hyperlocal monitoring is well ahead of the EPA, he added. "What they're doing is new because it's mobile based."

The EPA, he said, is "30 to 40 years behind where they need to be."

Bay Area officials defended the monitors they have in place, saying they accurately reflect the region's pollution. Aclima's scientists agreed, saying that when their mobile monitors drove near stationary monitors they collected similar data.

But as their cars drove farther away into communities, the discrepancies were undeniable.

Aclima has deployed its fleet of more than 150 air monitoring vehicles in other regions in the state, such as greater Los Angeles and San Diego. In the near future, company officials said, it will share results from large-scale hyperlocal pollution studies in the Midwest, the Mid-Atlantic between Virginia and New York, and in the South.

State and local government agencies, utilities, community groups and private companies like Google are interested in its data collection, said Davida Herzl, Aclima's co-founder and chief executive, whose firm started operations in 2010.

The Bay Area Air Quality Management District turned to Aclima when a 2017 state law gave local agencies hundreds of millions of dollars to identify areas overburdened with pollution.

Nitrogen dioxide is mostly generated by heavy traffic such as cars, industrial trucks and other pollution sources. They are a constant presence on Interstate 880, which cuts through West Oakland's high concentration of Black neighborhoods.

Under the rules of the California Department of Transportation, known as CalTrans, White people in Oakland are essentially guaranteed to breathe cleaner air. Heavy trucks have never been allowed on Interstate 580, which snakes around a higher concentration of White communities.

Racial disparities were also evident in San Francisco, where pollution in both the freeway-adjacent Tenderloin and Mission districts is significantly higher compared with areas such as the mostly White and higher-income Castro and Noe Valley, which sit far from major roads.

The history of the Tenderloin and Mission are a major part of that story, said Melissa Lunden, Aclima's chief scientist. They were identified as undesirable areas by the federal Home Owners Loan Corporation in the 1940s for having too many Mexican, Asian and Russian immigrants, as well as Black people.

After they were redlined as areas where lending should be avoided, freeways, heavy industry and higher pollution soon followed. "West Oakland didn't have freeways before the redlining maps, but it does now," Lunden said.

Environmental justice activists have suspected a tie between redlining and pollution for decades: Researchers from five universities confirmed those suspicions in a major study last year.

The analysis found that 45 million Americans who live in areas that were formerly redlined are breathing dirtier air. Compared with White people, Black and Latino Americans live with more smog and fine particulate matter from cars, trucks, buses, coal plants and other nearby industrial sources in areas that were redlined.

Like Margaret Gordon in Oakland, the researchers noted that stationary air quality monitors failed to record the extent of the pollution in those overburdened areas. That, Herzl said, is about to change because of technology like Aclima's.

"This represents a breakthrough in how we can manage the health of our environment in a data-driven and human-centered way," Herzl said, noting that the nation's air enforcement system was established a half-century ago. "The world has changed a lot in that time."

SUPPORTING QUOTES

HOUSE SELECT COMMITTEE ON THE CLIMATE CRISIS

THE ENVIRONMENTAL JUSTICE AIR QUALITY MONITORING ACT

February 18, 2022

SUPPORTERS

WE ACT for Environmental Justice; Dr. Sacoby Wilson, Director of the University of Maryland, College Park, School of Public Health, Center for Community Engagement, Environmental Justice, and Health; Gloria Walton, President and CEO of The Solutions Project; American Lung Association, American Thoracic Society, Clean Air Task Force, Aclima, Thermo Fisher Scientific

QUOTES

"It is critical that we support the frontline communities most impacted by air pollution. Investment in hyperlocal mobile air monitoring within the Environmental Justice Air Quality Monitoring Act is important for environmental justice communities and will help reduce the impacts of transportation related emissions on public health."
-Peggy Shepard, Co-founder, Executive Director of WE ACT For Environmental Justice.

"I strongly support the Environmental Justice Air Quality Monitoring Act. People of color have historically been exposed to disproportionately high levels of transportation-related pollution such as particulate matter, nitrogen dioxide (NO2), and volatile organic compounds (VOCs) and have borne higher health burdens and risks (asthma, cancer, heart disease) as a result. This is particularly true in communities impacted by goods movement (ports, rail, truck traffic) in places like North Charleston, SC, Houston, TX, Savannah, GA, Richmond, CA, New Orleans, LA, Detroit, MI, Newark, NJ, among many others. But conventional air quality monitors are unable to identify and map pollution at the community-scale. With the legislation's pilot program on hyperlocal mobile air monitoring,

communities across the country will finally have the tools to understand air pollution at the block-by-block level that affects their daily lives and health."
-Dr. Sacoby Wilson, Associate Professor at the University of Maryland, Director of the Center for Community Engagement, Environmental Justice, and Health

"Environmental justice communities have been calling for healthy air and good jobs for decades. The Environmental Justice Air Quality Monitoring Act shows that these communities are being heard. The legislation is a step in the right direction to support communities most impacted by air pollution, and the investment in street-level air quality monitoring will allow communities to identify and then address the environmental and health inequities in their respective neighborhoods."
-Gloria Walton, President and CEO of The Solutions Project

"Everyone deserves healthy air. Unfortunately, many communities have been left behind when it comes to cleaning up air pollution. The areas near pollution sources are more likely to be underinvested and to be home to communities of color. Those residents deserve to know what is in the air they're breathing. The Environmental Justice Air Quality Monitoring Act is an important step in reducing the air pollution burden for those at greatest risk. Thank you, Chair Castor, Rep. Blunt Rochester and Rep. Torres for working to ensure clean air for all."
-Harold Wimmer, President & CEO of the American Lung Association.

"The ATS strongly supports the legislation introduced by Chair Castor (D-FL), Rep. Blunt Rochester (D-DE), and Rep. Torres (D-NY) to improve local monitoring of air pollution. We know that the burden of air pollution exposures is not shared equally by U.S. communities. Low-income and communities of color are disproportionately impacted by air pollution. When enacted, this legislation will use existing technology to give communities the data they need to understand their local air pollution exposure risks and the information to do something about it."
- Jack Harkema DVM, PhD – Chair of the American Thoracic Society Environmental Health Policy Committee.

"CATF supports the Environmental Justice Air Quality Monitoring Act that will expand our knowledge of local impacts of air pollution in disadvantaged communities. The initiative arrives at a time when EPA is reviewing air quality standards, a process that prompted the Clean Air Scientific Advisory Committee (CASAC) to highlight deficiencies in the air quality monitoring network that hinder the study of sub-daily, multipollutant patterns with biologically relevant exposure times. Data collected

through this program would fill a critical need to inform our understanding of the human health effects of acute air pollution exposures."
-John Graham, Senior Scientist, Clean Air Task Force

"As a result of structural injustices we don't all breathe the same air. For too long, communities of color have faced disproportionate exposure to air pollution and the resulting health burdens. This legislation will drastically improve the availability of air quality measurements -- taken at block-level resolution -- so that resources can be prioritized to clean the air and improve public health in environmental justice communities across the country."
-Davida Herzl, CEO, Aclima

"For many communities, air pollution remains a difficult challenge that encumbers the health and well-being of their residents. As the world leader in serving science, Thermo Fisher Scientific has partnered with communities around the world to provide solutions that help them identify dangerous levels of pollutants so they can be quickly addressed. We're pleased to see Congress working to ensure more communities have access to the technology to help improve air quality for everyone."
-Miguel Faustino, President, Chemical Analysis, Thermo Fisher Scientific

A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP8584.

Disparities in Air Pollution Exposure in the United States by Race/Ethnicity and Income, 1990–2010

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Background: Few studies have investigated air pollution exposure disparities by race/ethnicity and income across criteria air pollutants, locations, or time.

Objective: The objective of this study was to quantify exposure disparities by race/ethnicity and income throughout the contiguous United States for six criteria air pollutants, during the period 1990 to 2010.

Methods: We quantified exposure disparities among racial/ethnic groups (non-Hispanic White, non-Hispanic Black, Hispanic (any race), non-Hispanic Asian) and by income for multiple spatial units (contiguous United States, states, urban vs. rural areas) and years (1990, 2000, 2010) for carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter with aerodynamic diameter $\leq 2.5\ \mu m$ ($PM_{2.5}$; excluding year-1990), particulate matter with aerodynamic diameter $\leq 10\ \mu m$ (PM_{10}), and sulfur dioxide (SO_2). We used census data for demographic information and a national empirical model for ambient air pollution levels.

Results: For all years and pollutants, the racial/ethnic group with the highest national average exposure was a racial/ethnic minority group. In 2010, the disparity between the racial/ethnic group with the highest vs. lowest national-average exposure was largest for NO_2 [54% (4.6 ppb)], smallest for O_3 [3.6% (1.6 ppb)], and intermediate for the remaining pollutants (13%–19%). The disparities varied by U.S. state; for example, for $PM_{2.5}$ in 2010, exposures were at least 5% higher than average in 63% of states for non-Hispanic Black populations; in 33% and 26% of states for Hispanic and for non-Hispanic Asian populations, respectively; and in no states for non-Hispanic White populations. Absolute exposure disparities were larger among racial/ethnic groups than among income categories (range among pollutants: between 1.1 and 21 times larger). Over the period studied, national absolute racial/ethnic exposure disparities declined by between 35% (0.66 $\mu g/m^3$; $PM_{2.5}$) and 88% (0.35 ppm; CO); relative disparities declined to between 0.99× ($PM_{2.5}$; i.e., nearly zero change) and 0.71× (CO; i.e., a ~29% reduction).

Discussion: As air pollution concentrations declined during the period 1990 to 2010, absolute (and to a lesser extent, relative) racial/ethnic exposure disparities also declined. However, in 2010, racial/ethnic exposure disparities remained across income levels, in urban and rural areas, and in all states, for multiple pollutants. https://doi.org/10.1289/EHP8584

Introduction

Air pollution is associated with ~100,000 annual premature deaths in the United States in 2017 (Stanaway et al. 2018) and has been linked to cardiovascular disease, respiratory disease, cancers, adverse birth outcomes, cognitive decline, and other health impacts (Cohen et al. 2017; Darrow et al. 2011; Lelieveld et al. 2015; Paul et al. 2019; Pope et al. 2009; Rivas et al. 2019; Stieb et al. 2012; Underwood 2017). Air pollution and its associated health impacts are not equitably distributed by race/ethnicity or income. Previous research has documented higher-than-average air pollution exposures for racial/ethnic minority populations and lower-income populations in the United States (Brulle and Pellow 2006; Evans and Kantrowitz 2002; Mohai et al. 2009), leading to disparities in attributable health impacts (Bowe et al. 2019; Fann et al. 2019; Gee and Payne-Sturges 2004). Most investigations of disparities in air pollution exposure involve a single pollutant, location, and/or time point [see, e.g., literature reviews by Hajat et al. (2015) and Marshall et al. (2014); see Table S2]. Evidence from broader investigations suggests that exposure disparities by race/ethnicity and/or income can vary by pollutant (Rosofsky et al. 2018), location [e.g., by state (Bullock et al. 2018; Salazar et al. 2019), urbanicity (Mikati et al. 2018), metropolitan area (Zwickl et al. 2014; Downey et al. 2008)], and time point (Ard 2015; Clark et al. 2017; Kravitz-Wirtz et al. 2016; Colmer et al. 2020). However, to our knowledge, broad patterns in exposure disparities have not yet been investigated, using consistent methods, across pollutants, locations, and time points, for the contiguous U.S. population.

The objective of our research was to comprehensively and consistently investigate disparities in exposure to U.S. Environmental Protection Agency (U.S. EPA) criteria air pollutants for the two decades following the 1990 Clean Air Act Amendments in the United States. Specifically, we investigated the following questions regarding disparities in exposure to six criteria air pollutants: *a*) How do exposures vary by race/ethnicity and income? *b*) How do racial/ethnic exposure disparities vary by pollutant? *c*) How do racial/ethnic exposure disparities vary by location (state, urban vs. rural areas)? *d*) How have racial/ethnic exposure disparities changed over time? To address these questions, we combined demographic data from the U.S. Census (Manson et al. 2019) with predictions of outdoor average levels of six criteria air pollutants from a publicly available national empirical model derived from satellite, measurement, and other types of data (Kim et al. 2020) at the spatial scale of census block groups and census tracts. We then analyzed disparities in exposure to six criteria air pollutants [all criteria air pollutants except lead (Pb); i.e., carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), fine and respirable suspended particulate matter with an aerodynamic diameter $\leq 2.5\ \mu m$

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($PM_{2.5}$), particulate matter with aerodynamic diameter $\leq 10\ \mu m$ (PM_{10}), and sulfur dioxide (SO_2)] by race/ethnicity (four racial/ethnic groups: non-Hispanic White, non-Hispanic Black, Hispanic (any race), non-Hispanic Asian) and income (16 household income categories) across time points (decennial census years: 1990, 2000, and 2010) and spatial units (contiguous United States, state, urban vs. rural areas).

Methods

Demographic and Air Pollution Datasets

We obtained demographic data (i.e., population estimates by race/ethnicity, household income, and household income disaggregated by race/ethnicity) and map boundaries (e.g., states, census tracts, and census block groups) for the contiguous United States from the 1990, 2000, and 2010 decennial censuses from the IPUMS National Historic Geographic Information System (NHGIS) (Manson et al. 2019).

NHGIS provides, for each census block group, and for 1990, 2000, and 2010 (standardized to 2010 spatial boundaries), population estimates for six census self-reported racial groups: *a*) White alone, *b*) Black or African American alone, *c*) American Indian and Alaska Native alone, *d*) Asian and Pacific Islander alone, *e*) some other race alone, and *f*) two or more races. NHGIS reports population estimates for two census self-reported ethnic groups: *a*) Hispanic or Latino and *b*) not Hispanic or Latino. Thus, there are a total of 12 combined racial/ethnic groups in NHGIS (six racial groups, two ethnic groups). Our main analyses of racial/ethnic exposure disparities included the four largest racial/ethnic groups, which in total covered 307 million people (97.2% of the population) in the contiguous United States in 2010: *a*) not Hispanic or Latino, White alone (64% of the population; hereafter, "non-Hispanic White"), *b*) Hispanic or Latino of any race(s) (16%; hereafter, "Hispanic"), *c*) not Hispanic or Latino, Black or African American alone (12%; hereafter, "non-Hispanic Black"), and *d*) not Hispanic or Latino, Asian and Pacific Islander alone (4.6%; hereafter, "non-Hispanic Asian").

For analyses by income in 2010, we used 2010 NHGIS household income estimates. For each block group, NHGIS reports the number of households in 16 annual household income categories (total covered in 2010: 114 million households) (in 2010 inflation-adjusted U.S. dollars): <10,000, 10,000–15,000, 15,000–20,000, 20,000–25,000, 25,000–30,000, 30,000–35,000, 35,000–40,000, 40,000–45,000, 45,000–50,000, 50,000–60,000, 60,000–75,000, 75,000–100,000, 100,000–125,000, 125,000–150,000, 150,000–200,000, and >200,000.

For analyses by income disaggregated by race/ethnicity in 2010, data from the 2010 NHGIS were available at the census tract level. For each census tract, NHGIS reports householder data for eight predefined race and/or ethnicity categories within each of the 16 census income categories, including one category based on both race and ethnicity (non-Hispanic White), one based on ethnicity regardless of race (Hispanic or Latino), and six based on race regardless of ethnicity (Black or African American alone, American Indian and Alaska Native alone, Asian alone, Native Hawaiian or Other Pacific Islander alone, some other race alone, and two or more race). To best match demographic variables used in race/ethnicity analysis at the census block group level, we reported results for four largest racial/ethnic groups (total covered in 2010: 113 million census householders, 98.5% of householders with data on income by race/ethnicity): not Hispanic or Latino, White alone (71% of householders; hereafter, "non-Hispanic White"), Hispanic or Latino (12%; hereafter, "Hispanic"), Black or African American alone (12%; hereafter, "Black"), and Asian alone (3.8%; hereafter, "Asian"). Thus, for the data used for the household income by race/ethnicity analysis (but not for other analyses), Black and Asian categories included both Hispanic and non-Hispanic individuals; for these analyses (but not others), Hispanic Black populations ($\sim 0.40\%$ of the population) would be included in results for Hispanic and for Black populations, and Hispanic Asian populations ($\sim 0.08\%$) would be included in results for Hispanic and for Asian populations. Additionally, for the data used for the household income by race/ethnicity analysis (but not for other analyses), the Asian category does not also include Pacific Islander populations.

The U.S. Census Bureau defined census blocks as "urban" or "rural" based on population density and other characteristics (Ratcliffe et al. 2016). We used 2010 census urban/rural block definitions to define a 2010 census block group for all 3 y (1990, 2000, and 2010) as rural if all blocks inside it were rural, and we defined the remaining block groups as urban (i.e., each census block group and urban/rural designation was the same in 1990, 2000, and 2010).

Average estimates of ambient air pollution levels for U.S. EPA criteria pollutants were obtained from the Center for Air, Climate, and Energy Solutions (CACES) empirical models for the contiguous United States (www.caces.us/data). These models incorporate satellite-derived estimates of air pollution, satellite-derived land cover data, land use data, U.S. EPA monitoring station data, and universal Kriging (Kim et al. 2020); estimated pollution levels were available by census block at block centroids based on 2010 census boundaries for the years from 1990 to 2010 for all pollutants except $PM_{2.5}$ (for which monitoring data and exposure models were only available starting in 1999). Estimated levels of O_3 from the CACES empirical model are 5-month summer averages (specifically, the average during May–September of the daily maximum 8-h moving average); for the remaining pollutants pollutants, estimated levels are annual averages.

CACES model performance during the years studied here (2000, 2010 for $PM_{2.5}$; 1990, 2000, 2010 for the other pollutants), as measured by cross-validated R^2, was 0.84–0.89 for NO_2, 0.85 for $PM_{2.5}$, 0.62–0.82 for O_3, 0.56–0.62 for PM_{10}, 0.32–0.66 for SO_2, and 0.34–0.57 for CO (Kim et al. 2020). Mean error (ME) across the census years studied was between -0.02 and 0 ppm for CO, -0.04 to 0 ppb for O_3, -0.09 to -0.06 ppb for NO_2, -0.17 to -0.13 ppb for SO_2, -0.31 to $-0.26\ \mu g\ m^{-3}$ for PM_{10}, and -0.05 to $-0.02\ \mu g\ m^{-3}$ for $PM_{2.5}$. Mean bias (MB) was 13%–22% for SO_2, and <10% for the other pollutants (Table S1); further details about the models and model performance are in Kim et al. (2020) and Liu (2021).

Combining Demographic and Air Pollution Data

We matched the CACES empirical model results and the U.S. census demographic data using the 2010 census spatial boundary definitions (from finest to coarsest spatial resolution: block, block group, and tract boundaries) for the three census years (1990, 2000, 2010). We matched census block–level CACES model predictions for criteria air pollutants (blocks in 2010 in the contiguous United States: $n = \sim 7$ million; average: ~ 44 residents per block) to census block group–level demographic data (block groups: $n = \sim 220{,}000$; average: ~ 1400 residents per block group) by calculating population-weighted mean of the block-level predictions, for all blocks in that block-group. Similarly, to match census tract–level demographic data (tracts: $n = \sim 74{,}000$; ~ 4200 residents per tract), we calculated the population-weighted mean air pollution levels for all census block groups located within that tract.

Estimating Exposures to Pollutants

We estimated annual pollutant-specific exposures for 1990 (excluding $PM_{2.5}$), 2000, and 2010 based on population-weighted mean predicted ambient air pollution levels for each demographic group [race/ethnicity, income, and income by race/ethnicity; results for additional groups (income poverty ratio, age, language, mobility, travel time) are described in the Supplemental Material (SM)]. The data for the five additional groups (income poverty ratio, age, language, mobility, travel time) were extracted from NHGIS (i.e., we are directly employing values calculated by NHGIS; the values employed do not reflect our own data or calculations) (Manson et al. 2019). For all five additional groups, the rationale for including them is to explore whether exposures vary univariately for that demographic attribute. For all five additional groups, the categories used follow NHGIS categories and/or natural breaks in the data [e.g., for a ratio, separating values at, e.g., 0.5, 1.0, 1.5, 2.0; for age, separating young children as age 4 y or below, other children (who, typically, attend K12 education) as age 5–17 y, adults as age 18–64 y, and older adults as age 65+ y (reflecting an assumed retirement age)]. Income poverty ratio is defined by the U.S. Census as the ratio of income to poverty level in the past 12 months (Manson et al. 2019). The poverty level varies by number of people in the family and their ages; poverty level does not vary geographically (i.e., the same threshold is used throughout the United States) (U.S. Census Bureau 2021). In results shown in the SM for income to poverty ratio, we bin this ratio into five categories: <0.5, 0.5–1, 1–1.5, 1.5–2, and >2. The motivation for this analysis is to investigate income relative to the U.S. Census-defined poverty level. Age is binned into four categories: <5 y old, 5–17 y old, 18–64 y old, and 65+ y old. Language refers to language(s) spoken in the home. For households in which language(s) other than English are spoken, the U.S. Census subdivides household counts into *a*) households in which no one age 14 y and over speaks English only, and *b*) households in which one or more people age 14 y and over speaks English "very well." We bin the NHGIS household language data into nine categories: English only, Spanish language and no English, English and a Spanish language, Asian language and no English, English and an Asian language, European language and no English, English and a European language, other language and no English, English and other language. Mobility refers to geographical mobility in the past year for current residence, based on metropolitan statistical areas (MSAs). We bin mobility into six categories: *a*) same house 1 y ago, *b*) different house: moved from same metropolitan, *c*) different house: moved from different metropolitan, *d*) different house: moved from micropolitan, *e*) different house: moved from not metropolitan nor micropolitan, and *f*) abroad 1 y ago. Travel time refers to travel time to work for workers age 16+ y who did not work at home. We divide the data into seven categories: <10 min, 10–20 min, 20–30 min, 30–40 min, 40–60 min, 60–90 min, and >90 min. This approach (average ambient air pollution level at residential census block group or tract) is broadly consistent with many examples in research and practice, including U.S. EPA monitors (Office of Air Quality Planning and Standards 2008), the National Ambient Air Quality Standards (e.g., Clean Air Scientific Advisory Committee 2010; Independent Particulate Matter Review Panel 2020; U.S. EPA 2019, 2020), many influential epidemiological studies (e.g., Di et al. 2017; Laden et al. 2006; Pope et al. 2009, 2020; Shi et al. 2016; Zanobetti and Schwartz 2009), and national empirical models for air pollution in the United States (e.g., Bechle et al. 2015; Di et al. 2020; Goldberg et al. 2019; Kim et al. 2020; Novotny et al. 2011; U.S. EPA 2016; Van Donkelaar et al. 2019; Young et al. 2016). We used the finest publicly available census spatial boundary data to estimate exposures for each analysis (income by race/ethnicity: tracts; all other analyses: block groups) based on availability of census demographic data.

The national annual (for O_3, 5-month average; for remaining pollutants, annual average) exposure (e_i) for demographic group i was calculated for a given pollutant and year as:

$$e_i = \frac{\sum_{j=1}^{n} c_j p_{ij}}{\sum_{j=1}^{n} p_{ij}}, \tag{1}$$

where c_j is the predicted average ambient pollution level for census block group or census tract j [here and after, we use c to represent ambient pollution level (observed or predicted) and e to represent population-weighted value for c), p_{ij} is the population of demographic group i in census block group or census tract j, and n is the number of census block groups or census tracts in the analyzed spatial level [the contiguous United States, each of the 49 "states" (including the District of Columbia plus the 48 contiguous states), and urban vs. rural areas].

National Exposure Disparities Analyses

Our primary exposure disparity metrics are based on absolute and relative differences in population-weighted mean air pollution exposures. We selected metrics based on mean pollution levels for consistency with our focus on broad national average patterns in exposure disparities among multiple pollutants. Absolute disparity metrics are often connect to pollutant-specific health impacts (Harper et al. 2013) (the present article focuses on pollution levels rather than health outcomes). Relative disparity metrics (e.g., ratios, relative percent differences) are relevant for quantifying disproportionality in exposure burdens, in a way that can be compared or summarized among different pollutants. An important limitation of these metrics (based on differences in mean exposures) is that they do not include information about disparities across the full exposure distributions (Harper et al. 2013). To address this limitation, we conducted supplemental analyses using inequality metrics accounting for full exposure distributions (Gini Coefficient and between-group Atkinson Index), as described in the SM, as well as sensitivity analyses comparing metrics based on other specific points of the exposure distribution (i.e., comparing specific exposure percentiles) as described below.

We calculated the absolute and relative exposure disparity metrics using two different approaches nationally: *a*) by race/ethnicity group and/or income category (i.e., the unit of analysis is a national subpopulation defined by race/ethnicity and/or income) and *b*) by local demographic characteristics (i.e., the unit of analysis is a set of census block groups defined based on proportion of racial/ethnic minority residents).

National exposure disparity metrics based on racial/ethnic group and/or income category. Our primary absolute disparity metric for quantifying national racial/ethnic exposure disparities is the pollutant-specific absolute difference in population-weighted average pollution level, as calculated using Equation 1 with block group–level data, between the racial/ethnic group with the highest national mean exposure ("most-exposed group") and the racial/ethnic group with the lowest national mean exposure ("least-exposed group") among the four racial/ethnic groups (non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, Hispanic); here, the unit of analysis is a racial/ethnic group. In addition, we derived the percent difference relative to the model-predicted national mean exposure level for that pollutant {[(population-weighted mean in most exposed − population-weighted mean in least exposed)/national mean exposure] × 100%}. We also included relative exposure disparity metric as the pollutant-specific exposure ratio (i.e., population-weighted mean of most-exposed group/population-weighted mean of least-exposed group). Both the absolute and relative exposure disparity metrics are constructed based on differences between most- and least-exposed racial/ethnic groups, to provide a measure of overall racial/ethnic disparities that avoids preselecting two specific groups for comparison and accounts for exposure disparities across multiple groups, in a consistent way for each pollutant (accounting for potential differences in the most- and least-exposed racial/ethnic groups by pollutant). We also report averages in relative disparities across pollutants as a representation of overall average inequalities in exposure to multiple pollutants, not as a representation of inequalities in health risks, which are pollutant-specific and depend on absolute levels of pollution exposure. Last, as a supplemental comparison among pollutants, we also calculated inequality metrics that account for the full exposure distributions: Gini coefficients by race/ethnicity and between-group Atkinson Indices.

To quantify national income-based exposure disparities, we calculated the pollutant-specific absolute difference in population-weighted average pollution level, using Equation 1 with block group–level data, between the lowest (<\$10,000) and the highest (>\$200,000) household income categories (of the 16 census categories). Additionally, as a relative disparity metric, we calculated the relative percent difference in mean exposures between the lowest and highest income categories. As a supplementary analysis, we calculated similar absolute and relative exposure disparity metrics between the income categories containing the 25th percentile (\$20,000–\$25,000) and the 75th percentile (\$75,000–\$100,000) of the income distribution.

To quantify national exposure disparities by race/ethnicity and income, we first calculated the absolute difference in population-weighted average pollution level between the most- and least-exposed racial/ethnic group (among the four racial/ethnic groups, not mutually exclusive with four racial/ethnic groups in racial/ethnic disparity, as described in "Demographic and Air Pollution Data Sets" in the "Methods" section) within each of the 16 census income categories, and then averaged that income category-specific racial/ethnic exposure disparity across all 16 income categories, for each pollutant. In the analyses for both race/ethnicity and income, we used census data for householders to calculate exposures for the four racial/ethnic groups using Equation 1 with tract-level data. Reflecting publicly available census data for racial/ethnic groups by income category, for this section only, the Black and Asian groups include Hispanic and non-Hispanic individuals, and the Asian group does not include Pacific Islander individuals. As a relative disparity metric, we divided the absolute exposure disparity metric by the national mean pollution level, for each of the pollutants.

National exposure disparity metrics based on local demographic characteristics (i.e., block group bins by proportion of racial/ethnic minority residents). We also investigated exposure disparities based on racial/ethnic minority resident percentages; here, the unit of analysis is bin of census block groups. Each block group bin was defined as single percentile (i.e., 1%) of all block groups stratified by the proportion of racial/ethnic minority residents. There were approximately 215,000 block groups in 2010, so each block group bin contained approximately 2,150 block groups. To investigate racial/ethnic disparities among block group bins, we rank ordered all census block group bins based on percent of racial/ethnic minority residents (i.e., people self-reporting any race/ethnicity other than non-Hispanic White alone). For example, the first block group bin was the first percentile and consisted of all block groups with between 0% and 0.67% racial/ethnic minority residents; the second block group bin was the second percentile, consisting of all block groups with 0.67%–0.97% racial/ethnic minority residents; the third block group bin consisted of all block groups with 0.97%–1.2% racial/ethnic minority residents, and so on through all 100 block group bins. The last block group bin consisted of all block groups with 99.1%–99.6% racial/ethnic minority residents. The annual exposure (e_{ig}) for demographic group i for the gth percentile census block group bin (i.e., the average exposure across all block groups in the gth percentile for proportion of residents that belong to a racial/ethnic minority group) was calculated for a given pollutant and year as:

$$e_{ig} = \frac{\sum_{j=1}^{n_g} c_j p_{ij}}{\sum_{j=1}^{n_g} p_{ij}}, \tag{2}$$

where c_j is the predicted average ambient pollution level for census block group j, p_{ij} is the population of demographic group i in census block group j, and n_g is the number of census block groups in the gth percentile block group bin. The absolute disparity is calculated as the exposure difference between block groups with the highest vs. lowest deciles of proportion racial/ethnic minority residents, and, similarly, the relative disparity is calculated as the exposure ratio between block groups with the highest vs. lowest deciles of proportion racial/ethnic minority residents.

Sensitivity Analysis on Robustness of National Exposure Disparity Estimates

We conducted three sensitivity tests to investigate the robustness of conclusions based on estimated exposure disparities. First, as a sensitivity test for conclusions based on comparisons of mean values' rank order for exposures between groups, we calculated disparities using different metrics of the exposure distribution (10th, 25th, 50th, 75th, 90th percentiles).

The remaining two sensitivity tests investigated whether conclusions here are robust to uncertainty in empirical model predictions. Specifically, in the second sensitivity test, we repeated the analysis of national mean exposures by racial/ethnic group, but for only the population living in a census block group with a U.S. EPA monitor in 2010. In this sensitivity test, for the pollution levels, we employ the monitor observations rather than the empirical model results. We then calculated Spearman rank order correlation of relative disparities by pollutant (between the most- and least-exposed group) between base case and sensitivity test.

In the third sensitivity test, we compared the magnitude of uncertainties in the estimated racial/ethnic exposure disparities with the magnitude of the estimated racial/ethnic exposure disparities. To assess the potential impact of model error on racial/ethnic disparities, we first calculated population-weighted mean error (ME_i) for each racial/ethnic group, i, using Equation 3:

$$ME_i = \frac{\sum_{j=1}^{n_o} (c_{jm} - c_{jo}) p_{ij}}{\sum_{j=1}^{n_o} p_{ij}}, \tag{3}$$

where c_{jm} is the predicted average ambient pollution level for census block group j, c_{jo} is the measured average ambient pollution level across all reporting U.S. EPA monitors within census block group j, p_{ij} is the population of demographic group i in block group j, and n_o is the total number of census block groups with EPA monitors. For each pollutant, the ME of disparity between two racial/ethnic groups i_1 and i_2 induced by the model was calculated as the difference between populated-weighted ME for the most- and least-exposed racial/ethnic groups i_1 and i_2. Calculated uncertainties are based on comparison with U.S. EPA measured pollution level in 2010. We then derived the ratio between the uncertainty due to exposure model error (i.e., the difference in population-weighted mean errors between racial/ethnic groups) and the estimated disparity in mean annual exposures between the most- and least-exposed racial/ethnic groups.

National Analysis of High-End Exposure Disparities in 2010

To quantify racial/ethnic disparities at the highest exposure levels, we analyzed the racial/ethnic composition of census block groups above the 90th percentiles of the pollution level among all census block groups. This analysis was done separately for each pollutant. First, for each of the four largest racial/ethnic groups, we estimated the proportion of that group's national population who lived in a high-exposure block group; here, our unit of analysis is a racial/ethnic group. This calculation reflects the proportion of a racial/ethnic group's total U.S. population who lived in heavily polluted (above the 90th percentile) block groups. We performed this calculation for each pollutant and each racial/ethnic group, using Equation 4.

$$a_i = \frac{\sum_{j=1}^{n_{90}} p_{ij}}{p_{total\_national_i}} \times 100\%, \tag{4}$$

where a_i is the percent of racial/ethnic group i living in a block group with concentration above the 90th percentile for that pollutant, p_{ij} is the population of group i in census block group j, $p_{total\_national_i}$ is the total population for demographic group i in the United States, and n_{90} is the number of census block groups with mean pollutant concentration >90th percentile.

In the second analysis, which was the converse of the first, we investigated the racial/ethnic composition of block groups above the 90th percentile for average pollution level. Here, our unit of analysis is all block groups above the 90th percentile. This calculation reflects the demographics of only people that lived in heavily polluted block groups. We completed this calculation for each pollutant and each racial/ethnic group using Equation 5.

$$b_i = \frac{\sum_{j=1}^{n_{90}} p_{ij}}{p_{total\_block\,group}} \times 100\%, \tag{5}$$

where b_i is (when considering only the people counted toward $P_{total\_block\,group}$) the percent of people who are in demographic group i, and $p_{total\_block\,group}$ is the total population of census block groups above the 90th percentile for that pollutant.

In addition, we explored differences in exposures to multiple pollutants by race/ethnicity by using data for 2010 and Equation 3 to estimate the proportion of each major race/ethnicity group's total U.S. population living in block groups with mean exposure levels above the 90th percentile for 0, 1, 2, 3, and ≥4 pollutants, respectively.

Counterfactual Analysis of Migration

We investigated whether changes in racial/ethnic exposure disparities over time were mainly attributable to changes in air pollution levels ("air pollution") or changes in where people lived (abbreviated as "migration", but also including immigration and other shifts in demographic patterns) as a sensitivity analysis. To do so, we employed two counterfactual scenarios (Clark et al. 2017) during two decades (1990 to 2000; 2000 to 2010). For each scenario and year, we calculated exposures for the four largest racial/ethnic groups for the contiguous U.S. population using Equation 1 based on census block group data. We then calculated the absolute racial/ethnic exposure disparity between the most- and least-exposed racial/ethnic groups (referred to in this section as "disparity") for all pollutants with available data (i.e., all except $PM_{2.5}$ in 1990). To analyze the period 1990 to 2000, we calculated the change in disparity attributable to air pollution changing from 1990 to 2000 levels but with demographics remained constant at 1990 values (counterfactual scenario A—i.e., "counterfactual" because it includes consideration of year-2000 pollution levels with year-1990 demographics) and, separately, used 1990 air pollution levels with demographic data changing from 1990 to 2000 values (counterfactual scenario B—includes consideration of year-1990 pollution levels with year-2000 demographics). To estimate the separate contribution of changes in *air pollution* during the period 1990 to 2000, we divided the disparity-changes from counterfactual scenario A by the "true" calculated disparity changes between 1990 and 2000 (i.e., using 1990 air pollution levels with 1990 demographic data, and using 2000 air pollution levels with 2000 demographic data). Similarly, to estimate the separate contribution of *migration* during 1990 to 2000, we divided the disparity changes from counterfactual scenario B by the "true" calculated disparity change between 1990 and 2000. Last, we used an analogous approach to analyze the next decade: 2000 to 2010.

Exposure Disparities Comparison Metrics for States

We investigated patterns among the 48 states of the contiguous United States plus the District of Columbia (DC) (hereafter, "states" refers to 48 states and DC, a total of 49 geographic units in state-level related calculations) using two metrics for absolute exposure disparity by race/ethnicity. First, for each state, pollutant, and race/ethnicity group, we calculated the normalized population-weighted disparity ($d1_i$) as the absolute difference in the annual exposure for racial/ethnic group i in the state (e_i) and the annual exposure for the state population as a whole (e_{state}) relative to the annual exposure across the contiguous United States ($e_{national}$):

$$d1_i = \frac{e_i - e_{state}}{e_{national}}. \tag{6}$$

Second, for each state, we used Equation 7 to calculate a normalized population-weighted disparity ($d2_m$) between the annual exposure for all non-Hispanic Black, non-Hispanic Asian, and Hispanic people combined (e_m), and for the non-Hispanic White population (e_{NHW}). This metric has the advantage of consistently comparing, for each state, exposures between racial/ethnic minority populations and the majority racial/ethnic group population (non-Hispanic White, 64% of the population).

$$d2_m = \frac{e_m - e_{NHW}}{e_{national}}. \tag{7}$$

Last, for each state, we averaged both metrics across the six pollutants.

Results

National Exposure Disparities by Race/Ethnicity and Income in 2010

By race/ethnicity. To investigate national disparities in exposure to criteria air pollution by race/ethnicity, we first compared national population-weighted mean exposures by U.S. Census self-reported race/ethnicity in 2010, the most recent decennial census year with available data. We first present results for differences among subpopulations (unit of analysis: racial/ethnic group), then we present differences among locations, depending on the proportion of each racial/ethnic group residents in that location (unit of analysis: census block groups binned by proportion of racial/ethnic minority residents).

Estimated national mean air pollution exposures for 2010 were higher for all three racial/ethnic minority groups than for the non-Hispanic White group for four of the six criteria pollutants (CO, NO_2, $PM_{2.5}$, and PM_{10}) (Table 1; Table S2–S3; Figure 1). For all six pollutants, the most-exposed group was a racial/ethnic

Table 1. Population distribution and population-weighted exposure distribution for six criteria pollutants for four main racial/ethnic groups and the national average in year 2010.

Demographic	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic Asian	Entire population
Proportion of population	64%	12%	16%	4.6%	100%
$PM_{2.5}$ ($\mu g/m^3$)					
10th percentile	6.1	7.9	6.5	6.7	6.3
25th percentile	7.7	9.2	7.7	8.2	7.9
50th percentile	9.3	10	9.6	9.7	9.5
Mean (SD)	9.1 (2.2)	10 (1.8)	9.4 (2.2)	9.4 (1.9)	9.3 (2.2)
75th percentile	11	11	11	11	11
90th percentile	12	13	12	12	12
NO_2 (ppb)					
10th percentile	3.1	3.8	4.6	5.4	3.4
25th percentile	4.3	5.8	6.6	7.5	4.9
50th percentile	6.2	8.7	9.5	10	7.4
Mean (SD)	7.2 (4.1)	9.7 (5.3)	11 (6.1)	12 (5.9)	8.7 (5.1)
75th percentile	8.9	12	15	15	11
90th percentile	12.5	18	21	21	16
O_3 (ppb)					
10th percentile	38	39	33	39	38
25th percentile	43	43	42	44	43
50th percentile	47	47	46	47	47
Mean (SD)	46 (6.0)	46 (6.1)	45 (7.2)	46 (5.9)	46 (6.2)
75th percentile	50	50	49	50	50
90th percentile	52	53	52	53	52
SO_2 (ppb)					
10th percentile	0.91	1.0	0.83	0.79	0.95
25th percentile	1.1	1.2	1.0	1.0	1.2
50th percentile	1.5	1.6	1.3	1.2	1.5
Mean (SD)	1.6 (0.65)	1.7 (0.63)	1.4 (0.55)	1.4 (0.58)	1.6 (0.64)
75th percentile	1.9	2.1	1.7	1.7	2.0
90th percentile	2.4	2.5	2.2	2.3	2.5
PM_{10} ($\mu g/m^3$)					
10th percentile	12	14	15	14	13
25th percentile	14	16	17	16	15
50th percentile	17	19	20	19	18
Mean (SD)	18 (4.4)	19 (3.7)	21 (4.9)	20 (4.5)	18 (4.6)
75th percentile	21	21	23	22	22
90th percentile	23	23	28	25	24
CO (ppm)					
10th percentile	0.23	0.25	0.26	0.27	0.24
25th percentile	0.27	0.29	0.30	0.30	0.28
50th percentile	0.31	0.32	0.34	0.34	0.31
Mean (SD)	0.30 (0.057)	0.32 (0.067)	0.35 (0.079)	0.35 (0.071)	0.31 (0.066)
75th percentile	0.33	0.35	0.39	0.38	0.35
90th percentile	0.37	0.40	0.45	0.45	0.39

Note: CO, carbon monoxide; NO_2, nitrogen dioxide; O_3, ozone; $PM_{2.5}$, fine particulate matter with aerodynamic diameter less than or equal to 2.5 micrometers; PM_{10}, 10 micrometers, SD, standard deviation; SO_2, sulfur dioxide.

minority group: for $PM_{2.5}$ and SO_2, national mean exposures were highest for the non-Hispanic Black population; for CO, NO_2, and O_3, the non-Hispanic Asian population; and for PM_{10}, the Hispanic population. For CO, NO_2, $PM_{2.5}$, and PM_{10}, national mean exposures were lowest for non-Hispanic White population; for O_3, Hispanic population; and for SO_2, non-Hispanic Asian population. Disparities between the most- and least-exposed racial/ethnic groups were largest (based on the relative disparity ratio) for NO_2 [absolute disparity: 4.6 ppb (54%), relative disparity (ratio): 1.6]; intermediate for SO_2 [0.29 ppb (19%), 1.2], PM_{10} [3.0 $\mu g/m^3$ (17%), 1.2], CO [0.044 ppm (16%), 1.1], and $PM_{2.5}$ [1.2 $\mu g/m^3$ (13%), 1.1]; and lowest for O_3 [1.6 ppb (3.6%), 1.0] (Table S4). Across the five pollutants, normalized disparities were also largest for NO_2 and smallest for O_3 for all the additional demographic groups considered (income poverty ratio, age, language, mobility, and travel time) (Table S5). Among those additional demographic groups, disparities that stand out as comparatively larger are income poverty ratio (NO_2), mobility (NO_2, CO), and travel time (NO_2) (see Figure S1; Table S5).

Sensitivity tests on robustness of conclusions based on mean values showed that, for all pollutants, the rank order (i.e., most- to least-exposed racial/ethnic group, among the four racial/ethnic groups) was consistent throughout the exposure distributions (Figure 1). Results for the supplemental inequality metrics (Gini coefficient; between-group Atkinson Index) indicate that exposure inequality was largest for NO_2 and smallest for O_3 (Tables S6 and S7). This finding is consistent with the findings based on our primary metrics. The remaining two sensitivity tests investigated whether conclusions here are robust to uncertainty in exposure model predictions. Results reveal that the conclusions are robust to exposure model uncertainty. Results for analyzing only the population living in a census block group with a U.S. EPA monitor in 2010 were essentially the same as results using exposure model predictions: the non-Hispanic White group was the least-exposed group on average for most pollutants (CO, NO_2, $PM_{2.5}$, PM_{10}, and O_3), and the relative disparities by pollutant (between the most- and least-exposed group on average) were highly correlated (Spearman rank order correlation between base case and sensitivity test: 0.89) (Tables S8 and S9). The ratio between the uncertainties in estimated racial/ethnic exposure disparities and the estimated racial/ethnic disparities between the most- and least-exposed racial/ethnic groups were small: on

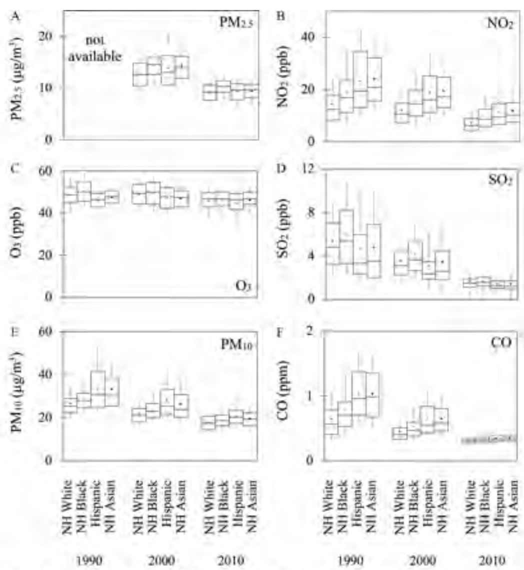

Figure 1. Distribution of exposure to pollutants in years 1990, 2000, and 2010, stratified by racial/ethnic group, for (A) $PM_{2.5}$, (B) NO_2, (C) O_3, (D) SO_2, (E) PM_{10}, and (F) CO. For all panels, the highest/lowest bound represents the 90th/10th percentile value, the box shows the 25th and 75th percentiles, and the horizontal line in the box represents the median. Color circles indicate the national population-weighted mean. $PM_{2.5}$ has no estimates in 1990 because of a lack of monitoring data prior to 1999. Note: CO, carbon monoxide; Hispanic, Hispanic people of any race(s); NH, non-Hispanic; NO_2, nitrogen dioxide; O_3, ozone; $PM_{2.5}$, fine particulate matter with aerodynamic diameter less than or equal to 2.5 micrometers; PM_{10} 10 micrometers; SO_2, sulfur dioxide.

average across the six pollutants, 0.0073 (if using absolute values of the ratio, 0.083). The largest absolute ratio was −0.17 (O_3). That result indicated that the uncertainty in the exposure model predictions was always small in comparison with the predicted racial/ethnic exposure disparities (Tables S10 and S11).

We also performed an analysis to determine whether average air pollution levels varied based on the racial/ethnic composition of a given census block group. For CO, NO_2, $PM_{2.5}$, and PM_{10}, average pollution levels were higher in census block groups with higher proportions of racial/ethnic minority residents (Figure 2). For O_3, estimated average levels were approximately equal across census block group bins, regardless of census block group racial/ethnic characteristics (Figure 2). For SO_2, estimated average levels were generally higher in census block group bins with the highest and lowest proportions of racial/ethnic minority residents (i.e., higher in more racially segregated census block groups) (Figure 2). This approach also reveals that the disparities were much larger for NO_2 than for other pollutants. The disparity in average air pollution levels between block groups with the highest vs. lowest deciles of proportion racial/ethnic minority residents (block groups with >88% vs. <4% racial/ethnic minority residents) was larger for NO_2 [absolute disparity: 9.4 ppb, relative disparity (ratio): 3.1] than for other pollutants [relative disparity (ratio) range: 0.8–1.4, median: 1.1] (Table S12).

Last, we investigated racial/ethnic disparities in exposure to the highest air pollution levels. First, for each racial/ethnic group we calculated the proportion of people nationally who lived in a block group with air pollution levels above the 90th percentile for each pollutant. Averaged across all pollutants, the proportion of people nationally who lived in those highest-exposure block groups was: 9.6% for the overall population, 17% for the Hispanic population, 15% for the non-Hispanic Asian population, 12% for the non-Hispanic Black population, and 7.2% for the non-Hispanic White population. Racial/ethnic minority populations were more likely than non-Hispanic White populations to live in a census block group with air pollution levels above the 90th percentile, for all pollutants (range: 1.0× to 4.1×, median: 2.1×) except SO_2 (0.88×) (Figure S2; Table S13). Next, we calculated the racial-ethnic composition of the block groups with air pollution levels above the 90th percentile for each pollutants; the proportion of the population in those block groups that is non-Hispanic White is less than the national average, for all pollutants except SO_2 (Figure S3; Table S14). Racial/ethnic minority populations were also disproportionately likely to live in a census block group having *multiple* pollutants with levels above the 90th percentile. For example, the proportion of population living in a census block group with levels above the 90th percentile for four or more criteria pollutants was 5.2% for the Hispanic population (3.6 times the national population average proportion), 2.2% for the non-Hispanic Asian population (1.5 times the average), 1.9% for the non-Hispanic Black population (1.3 times the average), and 0.36% for the non-Hispanic White population (0.25 times the

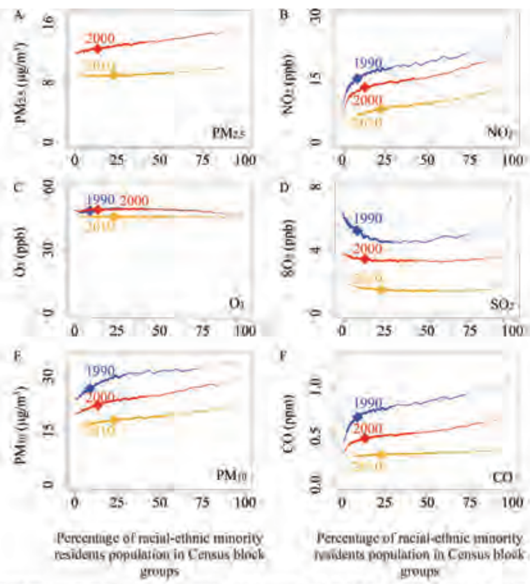

Figure 2. Relationship between the proportion of racial/ethnic minority residents in census block groups and average criteria air pollution concentrations in the years 1990, 2000, and 2010 for (A) $PM_{2.5}$, (B) NO_2, (C) O_3, (D) SO_2, (E) PM_{10}, and (F) CO. For each panel, the thicker portion of the line indicates the 25th to 75th percentile of census block groups, the thin line indicates the 10th to 90th percentiles, the dashed line indicates the 1st to 99th percentiles, and the diamond icon indicates the median. Note: CO, carbon monoxide; Hispanic, Hispanic people of any race(s); NH, non-Hispanic; NO_2, nitrogen dioxide; O_3, ozone; $PM_{2.5}$, fine particulate matter with aerodynamic diameter less than or equal to 2.5 micrometers; PM_{10} 10 micrometers; SO_2, sulfur dioxide.

average) (for comparison: 1.4% for the overall U.S. population) (Table S14). The ratio of the non-Hispanic White population relative to the national population average in each block group category declined monotonically as the number of pollutants above the 90th percentile increased from 0 to ≥ 4 (ratios from 1.1 to 0.25), whereas corresponding ratios increased monotonically for non-Hispanic Black (from 0.88 to 1.3) and for Hispanic populations (from 0.84 to 3.6) and increased nonmonotonically for non-Hispanic Asian populations (from 0.88 for 0 pollutants to 2.3 and 1.5 for 3 and ≥ 4 pollutants >90th percentile, respectively) (Figure S4; Table S15).

By income. To investigate national exposure disparities by income, we first compared national mean exposures to criteria air pollution by census income category in 2010. For all pollutants except O_3, national mean exposures were higher for lowest-income (<\$10,000; 7.2% of the households with income data) than for highest-income (>\$200,000; 4.2%) households, with all pollutants except NO_2 (and, to a lesser extent, CO and O_3) exhibiting a monotonic trend (Figure S5). (Consistent with those findings, we also found that for the remaining three pollutants (SO_2, $PM_{2.5}$, PM_{10}), but not for O_3, NO_2, and CO, the most-exposed income category is the lowest-income category and the least-exposed income category is the highest-income category; see Table S16). Relative to the overall population-weighted mean exposure for all households in 2010, the absolute difference between mean exposures among those in the lowest- vs. highest-income category households were 16% (relative to national mean exposure) higher for SO_2, 6.6% higher for $PM_{2.5}$, and 5.2% higher for PM_{10}. For NO_2, CO, and O_3, exposures for lowest- and highest-income households were similar ($\sim \pm 2\%$) (Table S17). (For comparison, for NO_2, CO, and O_3, exposure differences between the most- and least-exposed income categories were 2.5% to 9.4%; see Table S16.)

Based on differences in average exposures between the approximate 25th and 75th percentiles for income [\$20,000–\$25,000 (midpoint: \$22,500) and \$75,000–\$100,000 (midpoint: \$87,500)], a \$10,000 increase in income was associated with an average reduction in concentration (expressed as a percent of the national mean concentration) of 0.90% for SO_2, 0.41% for $PM_{2.5}$, 0.36% for NO_2, and 0.22% for PM_{10} and CO, and an increase of 0.16% for O_3. For NO_2, the change in average exposure per \$10,000 increase in income was 0.59% between the 25th and 50th [\$40,000–\$45,000 (midpoint: \$42,500)] percentiles, and 0.26% between the 50th and 75th percentile (Table S18).

By both race/ethnicity and income. In this section, we present exposure disparities accounting for both race/ethnicity and income together for census householders (hereafter, "households"). For all six pollutants in 2010, the absolute exposure disparity between the most- and least-exposed racial/ethnic groups was larger [on average, ~6 times larger; 1.1 times (i.e., 10% larger) for SO_2, 21 times for NO_2, and 1.4 (i.e., 40% larger) to 6.8 times for the remaining

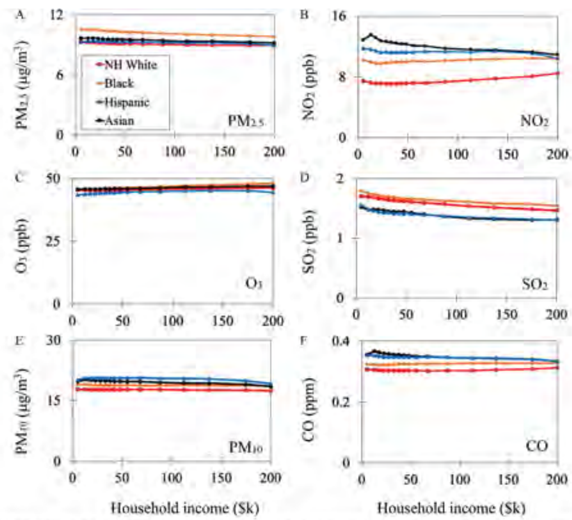

Figure 3. Population-weighted criteria air pollution concentration in 2010 for 16 household income groups, stratified by race/ethnicity, for (A) $PM_{2.5}$, (B) NO_2, (C) O_3, (D) SO_2, (E) PM_{10}, and (F) CO. For all panels, each data point represents pollution exposure for one income category and racial/ethnic group. Values plotted for household income are, for values below \$200,000 (i.e., for the first 15 income categories), the midpoint value; for the highest income category (">\$200,000"), the value plotted is the low end of the range (\$200,000). Note: Asian, Hispanic and non-Hispanic Asian people; Black, Hispanic and non-Hispanic Black people; CO, carbon monoxide; Hispanic, Hispanic people of any race(s); NH White, non-Hispanic White people; NO_2, nitrogen dioxide; O_3, ozone; $PM_{2.5}$, fine particulate matter with aerodynamic diameter less than or equal to 2.5 micrometers; PM_{10} 10 micrometers; SO_2, sulfur dioxide.

pollutants] than the absolute exposure disparity between the lowest- and highest-income categories [relative disparity: on average, ~1.2 times (i.e., 20% larger)]. The absolute exposure disparity between the most- and least-exposed racial/ethnic groups is 5.8 times for NO_2, 1.1 times (i.e., 10% larger) for SO_2, and 1.4 to 4.4 times for remaining pollutants than the absolute exposure disparity between the most- and least-exposed income categories (Table S19). For all income levels and pollutants, the most-exposed racial/ethnic group was a racial/ethnic minority group (Figure 3; Table S20). For five of the six pollutants (not SO_2; Figure 3), average exposures were higher on average for Black households at the approximate 75th percentile for income (income category midpoint: \$87,500) than for non-Hispanic White households at the approximate 25th percentile for income (midpoint: \$22,500). Racial/ethnic exposure disparities tended to be comparatively smaller at higher incomes than at lower incomes (except for O_3), but the size of that effect was modest. For example, the absolute exposure disparity between the most- and least-exposed racial/ethnic groups (Figure 3) was, on average, 9.5% lower for households at the approximate 75th percentile than at the approximate 25th percentile of income.

Income distributions varied by racial/ethnic group. For example, non-Hispanic White households represented 61% of the lowest income category (<\$10,000) and 85% of the highest income category (>\$200,000), vs. 23% and 3.5%, respectively, for Black households, 13% and 4.3% for Hispanic households, and 3.5% and 6.9% for Asian households (Table S21). To quantify racial/ethnic exposure disparities after accounting for racial/ethnic income distribution variation, we calculated the absolute exposure disparity between the most- and least-exposed racial/ethnic groups within each income category in 2010 and then averaged across all 16 income categories. The resulting national absolute exposure disparity between most- and least-exposed racial/ethnic groups averaged across income categories and normalized to national mean exposure (i.e., expressed as a percent of the national mean concentration) was 58% for NO_2, 4.5% for O_3, 12%–17% for the remaining pollutants. Conversely, to quantify income exposure disparities after accounting for race/ethnicity, we calculated the absolute income disparity within each racial/ethnic group and averaged across the four racial/ethnic groups. The resulting national absolute exposure disparity between lowest and highest income categories normalized to national mean exposure was 15% for SO_2, −2.9% for O_3, and 2.7%–6.3% for the remaining pollutants (Table S22). In conclusion, the results given here, consistent with Liu (2021), indicate that racial/ethnic exposure disparities were distinct from, and larger than, exposure disparities by income.

Racial/ethnic Exposure Disparities by State and by Urbanicity in 2010

By state. We explored how exposures varied by state, pollutant, and racial/ethnic group in 2010 (Figure 4). The analysis separately considers the District of Columbia (DC) plus the 48 states of the contiguous United States (hereafter, "states" refers to 48 states and DC, a total of 49 geographic units in state-level related calculations). There are 294 pollutant-state combinations (6 pollutants × 49 units) and

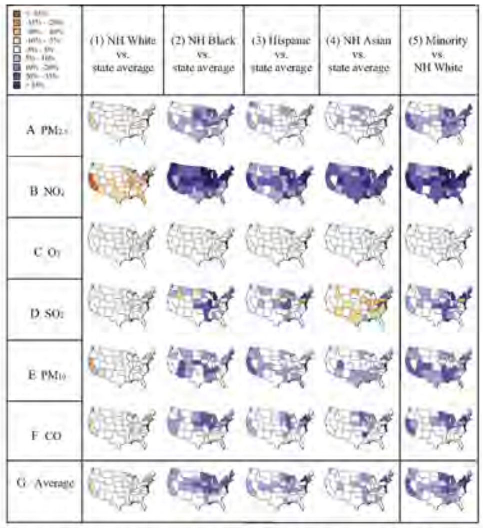

Figure 4. State racial/ethnic disparities in pollution exposure in 2010, showing the difference between (1) NH White vs. state average, (2) NH Black vs. state average, (3) Hispanic vs. state average, (4) NH Asian vs. state average, and (5) Minority vs. NH White for the six pollutants. (A) $PM_{2.5}$, (B) NO_2, (C) O_3, (D) SO_2, (E) PM_{10}, and (F) CO, and (G) average across the six pollutants. Columns 1–4: exposure disparity relative to state average; calculated as mean exposure for a racial/ethnic group in that state minus the overall mean for that state, then divided by the national overall mean. Column 5: exposure disparity for racial/ethnic minorities relative to the racial/ethnic majority group; calculated as mean exposure for racial/ethnic minorities minus mean exposure for non-Hispanic White people, then divided by the national overall mean. Mean values are population-weighted. States displayed in white indicate that the disparity is within $\pm 5\%$ of the national overall mean. Purple shading indicates that mean exposures are higher than average by more than 5% of the national overall mean (columns 1–4) or that mean exposures are higher for racial/ethnic minorities than for non-Hispanic White people, by more than 5% of the national overall mean (column 5). Orange shading indicates the reverse: mean exposures are lower than average for that group (columns 1–4) or mean exposures are lower for racial/ethnic minorities than for non-Hispanic White people (column 5), and the disparity is greater than 5% of the national overall mean. See Excel Table S1 for corresponding numeric data. Note: CO, carbon monoxide; Hispanic, Hispanic people of any race(s); NH, non-Hispanic; NO_2, nitrogen dioxide; O_3, ozone; $PM_{2.5}$, fine particulate matter with aerodynamic diameter less than or equal to 2.5 micrometers; PM_{10} 10 micrometers; SO_2, sulfur dioxide.

1,176 pollutant-state-group combinations (294 pollutant-states × 4 racial/ethnic groups). For this section, we define $\pm 5\%$ (all percentages used in this section were expressed as a percent of the national mean exposure in 2010) as "similar to" and therefore report examples where exposures differ from the average by >5% (or, in a sensitivity test, >20%). For example, ">5% lower-than-average" means the exposure is lower than state average by an amount greater than 5% of the pollutant's national mean.

Overall, several spatial patterns emerge across states. First, racial/ethnic exposure disparities were ubiquitous among U.S. states. In all 48 states and DC in 2010, one or more racial/ethnic groups experienced exposures disparities >5% of the pollutant's national mean. Second, racial/ethnic minority populations within states were much more likely to have been more exposed vs. less exposed than the state average; in contrast, none of the non-Hispanic White populations within states experienced exposures >5% above the state average. Third, having exposures >5% lower than average within a state was much more likely to happen for non-Hispanic White populations than for racial/ethnic minority (non-Hispanic Black, non-Hispanic Asian, and Hispanic populations combined) populations (Figure 4, right column). Fourth, racial/ethnic exposure disparities were most pronounced (in magnitude and with regard to the number of states affected) for NO_2, whereas mean O_3 exposures were similar among all racial/ethnic groups in all states.

Those findings reflect underlying trends across states, pollutants, and racial/ethnic groups. For example, for the non-Hispanic White group, 87% of the 294 pollutant-states had exposures that were similar ($\pm 5\%$) to the average, 13% had exposures >5% less than average, and none were >5% greater than average. In contrast, for exposures for the three racial/ethnic minority groups, 42% (of 882 pollutant-state-group combinations) were >5% greater than average, 55% were $\pm 5\%$ of the average, and only 4% were >5% lower than average. Thus, within individual states, the non-Hispanic White group was exposed to pollution levels that were similar to or cleaner than average, whereas the three racial/ethnic minority groups were more likely to be exposed to dirtier rather than cleaner pollution levels. For example, averaged across pollutants, the proportion of the states for which exposures were >5% greater than average is 73% for non-Hispanic Black populations, 57% for Hispanic populations, 35% for non-Hispanic Asian populations, and zero for non-Hispanic White populations.

The three racial/ethnic minority groups were disproportionately *likely* to be the *most*-exposed group, and disproportionately *unlikely* to be the *least*-exposed group of the four racial/ethnic groups across states. For example, the most-exposed group (for all cases, not just cases >5% greater than average) was the non-Hispanic Black group for 45% of the 294 pollutant-states, the Hispanic group for 29%, the non-Hispanic Asian group for 18%, and non-Hispanic White group for 7.5%. In contrast, the least-exposed group was rarely a racial/ethnic minority group (of the 294 pollutant-states, ~8%, each for the non-Hispanic Black and the Hispanic groups, 15% for the non-Hispanic Asian group) and was usually (70% of 294 pollutant-states) the non-Hispanic White group.

In a sensitivity test, we changed the analysis threshold to exposures >20% (rather than >5%) greater than average and similarly found that the air pollution disproportionately impacted racial/ethnic minority groups. For example, exposure disparities >20% of national mean exposure for one or more pollutant-groups occurred for 67% of states (Figure 4, left four columns for six pollutants, darkest two purple shades), further emphasizing that disparities were widespread across states in 2010.

Figure 4 reveals differences among states. For example, the four most populous states (California, Florida, New York, and Texas), all have large, racially/ethnically diverse urban areas. However, average disparities between racial/ethnic minority populations and non-Hispanic White populations (Figure 4, bottom right) were notably larger (on average, 6 times larger) for California and New York than for Florida and Texas (Excel Table S1). Some small, relatively rural states also had substantial exposure disparities; examples include NO_2 in Nebraska (19%) and $PM_{2.5}$ in Nebraska (8.1%).

By urbanicity. We investigated racial/ethnic and income-based exposure disparities in 2010 separately for block groups that were defined as urban (89% of the population) vs. rural (11% of the population). Overall, urban populations experienced larger exposure than that of rural populations for all pollutants (Table S23).

The most- and least-exposed of the four racial/ethnic groups differed between urban and rural areas for SO_2 and O_3. For SO_2, the most-exposed racial/ethnic group was the non-Hispanic Black group in urban areas and the non-Hispanic White group in rural areas. For O_3, the most-exposed racial/ethnic group was the non-Hispanic Asian group in urban areas and the non-Hispanic White group in rural areas. For the remaining four pollutants, the most-exposed group was a racial/ethnic minority group in both urban and rural areas (Table S24).

The racial/ethnic exposure disparities were generally larger for urban than for rural block groups. Specifically, the average exposure disparity between the most- and least-exposed racial/ethnic group was 5.5 times larger for absolute disparity [1.2 times for relative disparity (ratio between relative disparity in urban areas and relative disparity in rural areas)] for urban block groups than for rural block groups for NO_2, 3.1 times (1.0 times) larger for O_3, 2.4 times (1.1 times) larger for CO, 1.3 times (1.0 times) larger for SO_2, and 1.2 times (1.0 times) larger for PM_{10}. [Here, 1.2 times larger would indicate 20% larger, and 1.0 times larger would indicate 0% larger (i.e., not larger).] In contrast, for $PM_{2.5}$, the average racial/ethnic exposure disparity was 1.2 times (1.0 times) larger for rural block groups than for urban block groups (Table S24).

Exposure disparities by income category were also larger in urban than in rural areas. Absolute exposure disparities between lowest and highest income category were 1.1 times ($PM_{2.5}$) to 25 times (O_3) (median: 3.5 times) greater [for relative disparity (ratio), range: 0.98–1.1 times; median: 1.0 times] in urban than in rural areas (Table S25). Of the 12 pollutant-urbanicity categories (6 pollutants × 2 urbanicities), exposures were higher for the lowest-income category than for the highest-income category in all cases except for O_3 in urban areas and NO_2 in rural areas (Table S25).

Changes in National Exposures and Exposure Disparities from 1990 to 2010

Criteria air pollution levels have declined in the United States in the decades following the 1990 Clean Air Act amendments (U.S. EPA 2020) (Table S26). To investigate whether these reductions have led to reductions in racial/ethnic exposure disparities, we compared average exposures by racial/ethnic group from 1990 to 2010, for five of the pollutants. Exposure model results for $PM_{2.5}$ were available only from 2000 to 2010, so those results are presented separately.

National mean pollution levels for all six pollutants fell over the study period. For example, from 1990 to 2010, the national mean exposures decreased for all five pollutants by an average of 40% relative to national mean exposures in 1990 [range: −6% (O_3) to −71% (SO_2); −34% to −55% for remaining three pollutants]. $PM_{2.5}$ exposures decreased 29% from 2000 to 2010 (Table S27).

Average racial/ethnic exposure disparities also declined from 1990 to 2010. The amount of change depends in part on whether one considers *absolute* or *relative* disparities. In terms of *absolute* disparities, the disparities between the most- and least-exposed racial/ethnic groups decreased on average by 69% relative to absolute disparity in 1990 across the five pollutants. The largest change was an 88% decrease for CO disparities [0.40 ppm in 1990, 0.044 ppm in 2010, a 0.35 ppm (i.e., 88%) change], and the smallest change was a 54% decrease for NO_2 [9.8 ppb (1990), 4.6 ppb (2010), a 5.3 ppb (54%) change]. From 2000 to 2010, $PM_{2.5}$ disparities decreased by 35% [1.9 $\mu g/m^3$ (2000), 1.2 $\mu g/m^3$ (2010), a 0.66 $\mu g/m^3$ change] (Table S28).

In terms of *relative* disparities, the greatest change during the period 1990–2010 was a decrease for CO [disparities: 1.63 (1990), 1.15 (2010), 0.71 times (i.e., 29% reduction)], and the smallest was a decrease for O_3 [1.10 (1990), 1.04 (2010), 0.95 times (i.e., 5% reduction)]; remaining three pollutants (NO_2, PM_{10}, SO_2) were between 0.94 times and 0.95 times (i.e., 5%–6% reduction in relative disparity). $PM_{2.5}$ relative disparity remained nearly constant (0.99 times) during the period 2000–2010 (Table S28).

Absolute disparities between census block group bins with the highest vs. lowest deciles of proportions of racial/ethnic minority residents (90th–100th vs. 1st–10th percentiles in Figure 2) decreased for CO, NO_2, PM_{10}, and SO_2 [by 10% (SO_2) to 164% (CO)] and decreased by 17% from 2000 to 2010 for $PM_{2.5}$ (Table S29). For O_3, absolute disparities increased slightly, from −1.7 ppb in 1990 to −1.3 ppb (which is 0.74% of the national mean exposure) in 2010.

In addition to national changes, we investigated changes in absolute racial/ethnic exposure disparities from 1990 to 2010 by state and by urban vs. rural areas. Most states (>75%) experienced a reduction in racial/ethnic exposure disparities for pollutants, except for PM_{10} (and, except for $PM_{2.5}$ during the period 2000–2010) (Figure S6; Table S30). Urban areas experienced larger reductions in racial/ethnic exposure disparities than did rural areas for NO_2 and PM_{10} (13 times larger reductions in urban areas, for both pollutants), CO (2.4 times), and SO_2 (1.2 times). Conversely, $PM_{2.5}$ (during the period 2000–2010) and O_3 (during the period 1990–2010) had larger reductions in absolute racial/ethnic disparities for rural than for urban (2.4 times and 3.4 times larger in rural areas, respectively) (Figure S7; Table S31).

Finally, we investigated whether the changes in absolute racial/ethnic exposure disparities from 1990 to 2010 were more attributable to changes in air pollution levels or to changes in demographic patterns (migration, immigration, and other factors). Based on a counterfactual analysis, reductions in racial/ethnic exposure disparities between the most- and least-exposed racial/ethnic groups were mainly attributable to changes in air pollution levels rather than to changes in demographic patterns. On average across all pollutants, 87% of the reduction in the absolute racial/ethnic disparity metric was attributable to changes in air pollution levels from 1990 to 2000 (excluding $PM_{2.5}$ based on lack of available data), and 97% from 2000 to 2010 (Tables S32 and S33).

Discussion

Our research provides the first national investigation of air pollution exposure disparities by income and race/ethnicity for all criteria pollutants (except lead). Our results reveal trends by pollutant and across time and space.

In 2010, on average nationally, racial/ethnic minority populations were exposed to higher average levels of transportation-related air pollution (CO, NO_2) and particulate matter ($PM_{2.5}$, PM_{10}) than were non-Hispanic White populations. This finding, which holds even after accounting for uncertainties in the predictions from exposure models, is consistent with prior national studies of NO_2, $PM_{2.5}$, and PM_{10} (Clark et al. 2017; Kravitz-Wirtz et al. 2016; Mikati et al. 2018; Tessum et al. 2019; Colmer et al. 2020). Disparities for the remaining pollutants (CO, O_3, and SO_2) had not been previously studied in detail for the national population, and few studies have considered how disparities for any pollutant have changed across 20 y (Kravitz-Wirtz et al. 2016; Bullard et al. 2008).

Our findings on "which group was most exposed over time?" (on average, nationally) varied by pollutant, but in all six cases the most exposed group was a racial/ethnic minority group. That result is consistent with prior national studies, which have reported, for example, highest average NO_2 exposures for Hispanic Black and non-Hispanic Asian populations (Clark et al. 2017) and highest average proximities to industrial $PM_{2.5}$ emissions (Mikati et al. 2018) and highest average exposures to industrial air toxins (Ard 2015) for non-Hispanic Black populations.

We found that racial/ethnic minority populations were more than two times as likely than non-Hispanic white populations to live in a census block group with highest air pollution levels (above 90th percentile) on average. Those results are consistent with existing literature on disproportionate environmental risks for racial/ethnic minority populations (Collins 2016) and on groups or locations with higher risks for one environmental factor having higher risks for other factors, too (Morello-Frosch and Lopez 2006; Su et al. 2012).

We found that air pollution exposures were generally higher for lower-income than for higher-income households (for all pollutants except O_3). This finding is consistent with previous national research [e.g., for industrial $PM_{2.5}$ emissions (Mikati et al. 2018), industrial air toxins (Ard 2015), and $PM_{2.5}$ and NO_2 (Clark et al. 2014; Kravitz-Wirtz et al. 2016)]. Additionally, we found that, in 2010, absolute racial/ethnic exposure disparities were distinct from and were larger than (on average, ~ 6 times larger than) absolute exposure disparities by income. The findings here are *inconsistent* with the idea that racial/ethnic exposure disparities can be explained by, or are "merely" a reflection of, income disparities among racial/ethnic groups (Liu 2021).

The findings from this study can be used to compare relative exposure disparities for different criteria air pollutants in a consistent way, providing additional context for previous studies of single pollutant. We found that in 2010, relative racial/ethnic exposure disparities (i.e., ratios of average exposures between the most- and least-exposed groups) were largest for NO_2 and smallest for O_3. Relative income-based exposure disparities (i.e., ratios of average exposures between the lowest and highest income groups), although smaller than racial/ethnic exposure disparities for each pollutant, were largest for SO_2 and smallest (and similar) for NO_2, CO, and O_3. (These results provide information on the rank order of relative disparities in air pollution levels by pollutant; information on the rank order of relative disparities in associated health impacts by pollutant would require further analysis, as discussed next.)

Exposure disparities often connect with health disparities. Based on the magnitude of exposure disparities (e.g., 2010 national average $PM_{2.5}$ exposures for non-Hispanic Black people were 1.0 $\mu g/m^3$ higher than average), the resulting health disparities may be substantial (Liu 2021). Future research could usefully extend our exposure disparity results to provide rigorous, comprehensive investigation of the associated health impacts.

State-level results may be especially useful given the important role that states play in air pollution and environmental policy making (Abel et al. 2015). Exposures >5% greater than the national mean exposure within states were common for racial/ethnic minority populations, but not for non-Hispanic White populations. Indeed, we found no case (no state and no pollutant) for which the non-Hispanic White group experiences exposures >5% greater than the state average. This finding reflects disparity in exposure as well as non-Hispanic White populations representing a large percentage of states' populations. Exposure disparities varied substantially among states, even among states with similar characteristics (e.g., urbanicity, population, region). Our results emphasize differences among states in the level and makeup of exposure disparities, yet also demonstrate that exposure disparities were ubiquitous, including both large and small states, and states in all regions of the United States, in 2010.

Our analyses by urbanicity were in part motivated by and reflect urban–rural differences in demographics and air pollution levels (Clark et al. 2017; Mikati et al. 2018; Rosofsky et al. 2018). Racial/ethnic disparities were larger for urban block groups for all pollutants except $PM_{2.5}$. Of the six pollutants, the largest ratio between urban and rural racial/ethnic absolute disparities (5.5 times larger) was for NO_2 (Table S24). The NO_2 results are consistent with prior research (Clark et al. 2014, 2017). Over our study period, reductions in absolute racial/ethnic exposure disparities for $PM_{2.5}$ and O_3 were larger for rural than for urban areas. Analyzing urban and rural block groups separately, exposures were mostly higher for the lowest income category than the highest. Absolute income-based exposure disparities were also 7.5 times larger on average in urban than in rural areas.

The results by state and by urbanicity reflect that exposure disparities differ by spatial units (e.g., urban/rural, and by state); future research could explore these aspects further, for example, through a spatial decomposition of national exposure disparities.

Regulations such as the 1990 Clean Air Act Amendments have achieved substantial reductions in the concentrations of many pollutants. Our analysis reveals that, as a concomitant benefit, falling pollution levels have reduced absolute exposure disparities among racial/ethnic groups. These findings are consistent with previous national research for NO_2, $PM_{2.5}$, and industrial air toxins (Ard 2015; Clark et al. 2017; Kravitz-Wirtz et al. 2016; Colmer et al. 2020). We found that a larger share of the racial/ethnic exposure disparity reduction was attributable to air pollution level reduction rather than changes in demographic and residential patterns.

Our study described patterns in exposure disparities but did not investigate aspects such as underlying causes or ethical or legal aspects. Systemic racism and racial segregation are two major causes discussed in multiple previous studies (Jones et al. 2014; Morello-Frosch and Lopez 2006; Schell et al. 2020). Future longitudinal research could further investigate the underlying causes of exposure disparities. One important dimension not considered here is responsibility for generating pollution. Recent analysis suggests that Hispanic and Black populations have disproportionately lower consumption of goods and services whose emissions lead to $PM_{2.5}$ air pollution (Tessum et al. 2019).

Our study has several limitations. The finest spatial scale of publicly available census demographic data for race/ethnicity and income, at consistent spatial geographies across time (Manson et al. 2019), is at the census block group level; race/ethnicity across income data is at census tract level with slightly different categories (see "Methods" section); we were unable to assess disparities at finer spatial scales than publicly available census data; we only included the four main racial/ethnic groups. Our analysis of exposures by income is based on national-level income distribution data and does not account for spatial variations in income distributions (e.g., among states). Our disparity estimates do not account for *a*) daily mobility for work, shopping, recreation, and other activities; *b*) direct indoor exposure to indoor sources such as cigarette smoke, cooking, or incense; *c*) indoor–outdoor relationships in pollution levels, such as particle losses during airflow in ducts or ozone losses to indoor surfaces; or *d*) occupational exposures. Our exposure disparity estimates were limited by uncertainties in the CACES exposure model predictions and in census demographic data. Our uncertainty analysis (but not our main analysis) was limited to U.S. EPA monitoring locations; we were not able to test potential exposure errors at locations without monitors on the national scale. However, sensitivity analyses (Results section) indicate that the general results are robust to model uncertainty.

To our knowledge, our study provides the first national analysis of air pollution exposure disparities among income and racial/ethnic groups, for all criteria pollutants (except Pb), including trends across time (by decade, 1990–2010) and spatial location (by state and for urban vs. rural areas). On average, exposures were generally higher for racial/ethnic minority populations than for non-Hispanic White populations. Among pollutants, national racial/ethnic exposure disparities were largest for NO_2 and smallest for O_3. Exposures were also, on average, higher for the lowest-income households than for the highest-income households. However, exposure disparities by race/ethnicity were not explained by disparities in income. Racial/ethnic exposure disparities declined from 1990 to 2010 (on an absolute basis, and to a lesser extent, on a relative basis), but still existed in all states in 2010.

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J.L. conducted the research and most of the analysis; developed the methods; visualized the data; and wrote, reviewed, and edited the text. M.B. and L.P.C. designed the research; performed the research; analyzed the data; and wrote, reviewed, and edited the text. A.H., SY.K., A.L.R., L.S., and A.A.S. conceptualized and designed the research, oversaw the methods and analysis, and reviewed and edited the writing. J.D.M. conceptualized and supervised the project; designed the research, methods, and analysis; and wrote, reviewed, and edited the text. A.L.R. and J.D.M. acquired the funding.

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All data used are publicly available. Demographic data are available via IPUMS NHGIS (www.nhgis.org); air pollution estimates are available via the U.S. EPA CACES project (www.caces.us).

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Redlining means 45 million Americans are breathing dirtier air, 50 years after it ended

Boyle Heights, a heavily Latino area in Los Angeles singled out for its 'detrimental racial elements,' has one of the highest pollution scores in California

By Darryl Fears
March 9, 2022 at 8:00 a.m. EST

Decades of federal housing discrimination did not only depress home values, lower job opportunities and spur poverty in communities deemed undesirable because of race. It's why 45 million Americans are breathing dirtier air today, according to a landmark study released Wednesday.

The practice known as redlining was outlawed more than a half-century ago, but it continues to impact people who live in neighborhoods that government mortgage officers shunned for 30 years because people of color and immigrants lived in them.

The analysis, published in the journal Environmental Science and Technology Letters, found that, compared with White people, Black and Latino Americans live with more smog and fine particulate matter from cars, trucks, buses, coal plants and other nearby industrial sources in areas that were redlined. Those pollutants inflame human airways, reduce lung function, trigger asthma attacks and can damage the heart and cause strokes.

"Of course, we've known about redlining and its other unequal impacts, but air pollution is one of the most important environmental health issues in the U.S.," said Joshua Apte, a co-author of the study and an assistant professor in the School of Public Health at the University of California at Berkeley.

"If you just look at the number of people that get killed by air pollution, it's arguably the most important environmental health issue in the country," Apte said.

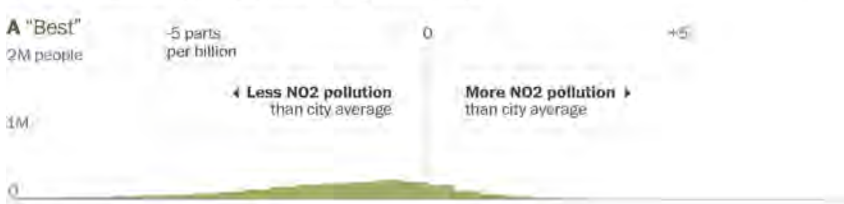
The federal Home Owners' Loan Corporation (HOLC) marked areas across the United States as unworthy of loans because of an "infiltration of foreign-born, Negro, or lower grade population," and shaded them in red starting in the 1930s. This made it harder for home buyers of color to get mortgages; the corporation awarded A grades for solidly White areas and D's for largely non-White areas that lenders were advised to shun.

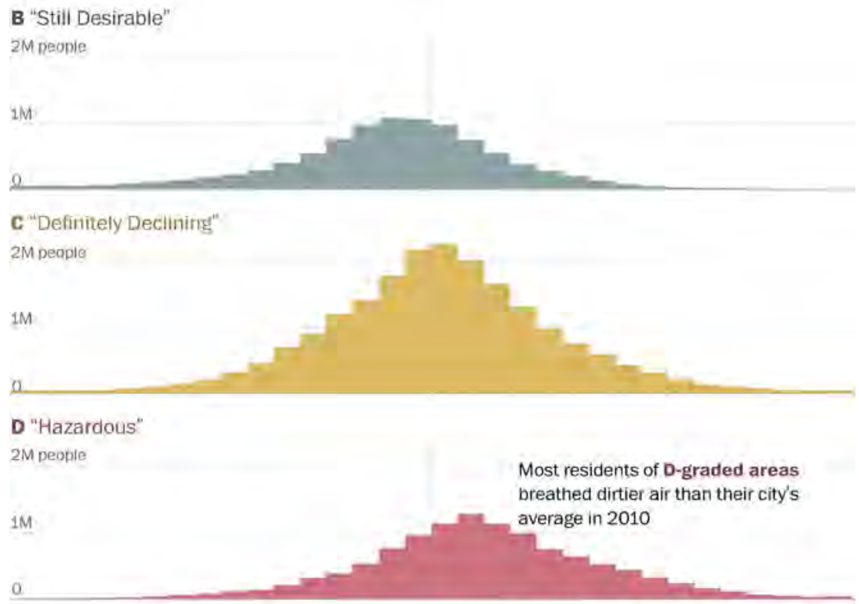
Throughout redlining's history, local zoning officials worked with businesses to place polluting operations such as industrial plants, major roadways and shipping ports in and around neighborhoods that the federal government marginalized.

The researchers analyzed air quality data in 202 cities where communities were redlined and found a consistent disparity in the level of nitrogen dioxide, which forms smog, and PM2.5 pollution, the small particles than can become embedded in people's lungs and arteries.

Redlining's fingerprint lingers in the nation's air

Levels of nitrogen dioxide pollution in 2010 tended to be worse in areas graded **C** or **D** than areas graded **A** or **B** on government mortgage maps dating to the 1930s.





Note: City averages are population-weighted mean values calculated for HOLC-graded blocks only.

Source: Lane et al., 2022

JOHN MUYSKENS/THE WASHINGTON POST

With nitrogen dioxide, pollution levels were higher in 80 percent of communities given D grades and lower in 84 percent of communities given A grades. That trend held regardless of whether a city was as large as Los Angeles or Chicago, or as small as Macon, Ga., or Albany.

Haley Lane, a graduate student in the civil and environmental engineering department at UC-Berkeley and the study's lead author, said the team embarked on the research to show that a "widespread, federally backed, and well documented" practice like redlining was indelibly linked to air pollution. The research took about two years.

"These maps allowed us to analyze conditions in cities across the country, and the consistency we found shows us how many of the pollution problems we have today are tied to patterns that were present in cities more than 80 years ago," Lane said.

While air quality has improved in the United States overall, several recent studies — including the one released Wednesday — show that people of color, especially African Americans and Latinos, are still disproportionately affected by pollution.

A large body of research has already shown that redlined communities experience other environmental challenges, including excessive urban heat, sparse tree canopy and few green spaces. The new analysis, according to the authors, is the first look nationwide at how redlining leads to disparities within different cities.

"This groundbreaking study builds on the solid empirical evidence that systemic racism is killing and making people of color sick, it's just that simple," said Robert D. Bullard, a distinguished professor of urban planning and environmental policy at Texas Southern University and the author of "Dumping in Dixie: Race, Class and Environmental Quality."

Bullard, who was not involved in the study, said that it "makes clear the elevated air pollution disparities we see today between Black Americans and White Americans have their roots in systemic racism endorsed, practiced and legitimated by the federal Home Owners' Loan Corporation some eight decades ago."

During the early days of the coronavirus pandemic, public health officials said underlying diseases suffered by people of color as a result of air pollution and other conditions in marginalized communities contributed to their disproportionate hospitalization and death from covid-19.

President Biden addressed that concern after taking office by signing an executive order to help marginalized communities that are overburdened by pollution. He established the Justice40 Initiative to direct 40 percent of federal resources to those communities and established the White House Environmental Justice Advisory Council to help guide the administration's decisions.

Beverly Wright, the founder and executive director of the Deep South Center for Environmental Justice, the Deep South Center for Environmental Justice, said the research confirms what she and other activists have said for decades: Redlining led to zoning decisions that exposed people of color to pollution.

"Any time we can get a study that takes the anecdotal stories of communities and we end up having scientific findings to support those anecdotal stories, that's a good thing," said Wright, who, like Bullard, sits on the White House Environmental Justice Advisory Council. "It supports community claims on the ground."

Julian D. Marshall, a professor of civil and environmental engineering at the University of Washington and one of the study's co-authors, said the research provides the kind of information that helps societies move toward solutions.

"One way is to document that the disparities we see today have a long history," Marshall said. "The decisions and the actions we're talking about were made by people who are no longer alive, and yet we're suffering the consequences of this structural, race-based planning."

Racial inequality is so baked into redlined communities that even when it shouldn't matter, it did, the study said. Black and Latino Americans who live within the very same HOLC grade as White people still breathe dirtier air because of their closer proximity to pollution.

"This point is really key," said Lane, the lead author. "People of color can be living in the same cities, and even in neighborhoods with the same redlining grade as nearby White residents, and they will still tend to experience worse pollution on average."

The finding suggests that redlining added to inequities that developed from long-standing racial discrimination, Lane said. "Racist segregation was always essential to redlining, but there is a long history and a wide range of factors contributing to the disparities we see today. We can't point to any single decision or program which brought about current conditions because the problem is systemic."

The disproportionate impact of smog and particulate

The disproportionate impact of smog and particulate matter is more pronounced in four major metropolitan areas: Los Angeles, Atlanta, Chicago and Essex County/Newark, said Rachel Morello-Frosch, a co-author who is a professor of environmental and community health sciences at UC-Berkeley.

In Boyle Heights, a community just east of downtown Los Angeles, federal map drawers ostracized the people who lived there before marginalizing their community in the late 1930s.

"It is seriously doubted whether there is a single block in the area which does not contain detrimental racial elements," they wrote, "and there are very few districts which are not hopelessly heterogeneous in type of improvement and quality of maintenance."

Following its designation as one of the city's least desirable communities for investment, Boyle Heights was encircled by four major freeways — Interstates 5, 10, 710 and 110 — in a city with some of the heaviest automobile traffic in the world.

CalEnviroScreen, a mapping tool that tracks state pollution by census tracts, gives large parts of Boyle Heights the highest pollution burden score available, 100 percent. More than 86,000 people live there, most of them Latino.

"It's not like one part of Los Angeles is considered, you know, necessarily less polluted than another," said Cyrus Rangan, director of the toxics epidemiology program for the Los Angeles County Department of Public Health. "We have these air quality problems all over."

But areas that hug freeways, such as Boyle Heights, get the worst of around-the-clock diesel truck traffic that spews fine particulate matter. "When it comes to the ports and the ways our freeways are situated, in the way we kind of squeezed in a lot of residential areas in and around all of those economic developments, that's what's created a major issue," Rangan said.

Government planning and zoning officials gravitate toward Boyle Heights and underprivileged communities where inexpensive real estate is easier to purchase for freeway projects or site-polluting industries that wealthier residents would manage to resist.

"The land and housing tends to be cheaper, so people who tend to live there tend to be people of lower-cost origins," Rangan said.

Paul Simon, the Los Angeles health department's chief science officer, said Long Beach and San Pedro, where mostly Latino and Black residents live near major shipping ports, have pollution levels similar to Boyle Heights.

Simon praised the redlining study, calling it something he's never seen. "It ... highlights the challenges moving forward in trying to address these disparities and inequities to change the pattern of land use and transportation planning to sort of alter the built environment," Simon said.

"The agency that concocted the racist grading system itself deserved an F grade," Bullard said.

It discriminated against mostly Black and Latino families, robbed them of the wealth their homes could have generated, he said, "and created pollution magnets that threatens the health, well-being and quality of life of families who settle in formerly redlined neighborhoods."

Senator MARKEY. Let me also use this as an opportunity to ask unanimous consent to submit for the record a congressional Research Service Report released on July 12th, 2022 on the West Virginia v. EPA decision, which states, and I quote, "on that decision, EPA retains the ability to regulate greenhouse gas emissions from power plants and other sources." Without objection.

[The referenced information follows:]

…Public Health Now News

Last Updated 12:14pm Jun 7, 2022

See Coronavirus Updates for information on campus protocols.

ENVIRONMENTAL HEALTH **Jul. 07 2022**

Racial Disparities in Air Pollution Where Most Americans Live Worse Than Previously Understood

An analysis of racial disparities in urban air pollution reveals starker differences than previously understood in the communities where most Americans live. Compared to earlier studies, researchers found more substantial increases in concentrations of fine particulate matter (PM2.5) comparing census tracts with no Black residents with census tracts with a small percent of Black residents. The findings are published in the journal *Environmental Health Perspectives*.

Scientists at Columbia University Mailman School of Public Health and partners modeled census tract level PM2.5 concentrations using a nonlinear method that accounts for poverty and population density using data from 2010. The nonlinear method allows for the relationship between race/ethnicity and air pollution to change across communities.

"Much research has documented racial disparities but in communities at the tail of the distribution, such as where a community is 80 percent Black. We see this disparity begin when just a few Black individuals enter a community, meaning we see an immediate disparity in communities where most Americans live," says senior author Joan Casey, PhD, assistant professor of environmental health sciences at Columbia Mailman School.

The researchers found that the standard linear method underestimated the severity of air pollution in areas with low percentages of Black residents. Using the new nonlinear method, the difference in PM2.5 concentrations between an area without any Black residents and 10 percent Black residents is +1.1 µg/m3 of PM2.5 versus a difference of +0.09 µg/m3 in the linear model. The linear method also seems to overestimate the severity of air pollution in areas with high percentages of white residents. Using the nonlinear method, the difference in air pollution concentrations between an area with 80 percent vs. 90 percent white is -0.47 µg/m3 of PM2.5 vs. -0.17 µg/m3 in the linear model.

These differences are important because even a 1 µg/m3 increase in PM2.5 can increase risk of numerous health outcomes including adverse birth outcomes and cardiovascular disease. The larger than previously recognized disparities in air pollution where most Americans live may have implications for persistent racial health disparities in the United States.

The researchers' use of this method was informed by their understanding of how historical sociopolitical processes differently impacted neighborhoods with small vs. large non-white populations.

First author Misbath Daouda, a PhD candidate in environmental health sciences at Columbia Mailman School of Public Health, says: "History shows that even a relatively small Black population can set-off racist practices that restrict where these individuals can live and work, which can lead to additional exposure to environmental hazards like air pollution. For instance, a slight relative increase of the Black population in Birmingham, Alabama, in the early 1900s led to the implementation of a racially restrictive zoning ordinance in 1926, which resulted in the least desirable and most hazard-prone land in the city being zoned for Black residence. In 2010, Black Americans were about twice as likely to live in areas where PM2.5 concentrations exceeded the 90th percentile nationwide than white and Hispanic Americans."

Co-authors include Lucas Henneman, George Mason University, Fairfax, Virginia; and Jeff Goldsmith and Marianthi-Anna Kioumourtzoglou at Columbia Mailman School.

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RELATED STORIES

Senator CARPER. Back to you.

Senator MARKEY. Thank you, Mr. Chairman. Formerly redlined communities experience as much as double the amount of air pollution as non-redlined communities, and race plays a big role, even within the same communities. We can't accept that, and we have to do a better job of understanding it. We can't properly manage what we don't measure.

This is why I partnered with health experts and advocates, including the Clean Air Task Force and WE ACT, who are represented by some of our esteemed witnesses here with us today, to write and to introduce the Environmental Justice Air Quality Monitoring Act of 2021, which is co-sponsored by several members of this committee, including Senators Padilla and Sanders and Duckworth.

This legislation would authorize $100 million annually to establish a 5-year pilot program for hyper-local air quality monitoring projects in environmental justice communities. Under this program, State, local, and tribal air agencies would be able to partner with local nonprofit organizations or air quality data providers to identify block level hotspots for multiple pollutants, increased community engagement, informed air pollution management decisions, and recommend action for reducing pollution burden in identified hotspots.

While our current network of traditional monitors is sparse and often misses areas of poor air quality, hyper-local air quality monitors can better detect air pollution in the specific areas in which people live and work and go about their daily lives. When it comes to approaches to improve air quality, one size does not fit all from block to block all across our Country. With more air quality monitors to capture hyper-local data and better inform ways to cut down pollution exposure in hotspots, we can make sure that healthy air is no longer determined by ZIP code.

I would also like to submit a statement of support from House Select Committee on the Climate Crisis Chair, Kathy Castor, who introduced the Environmental Justice Air Quality Monitoring Act in the House of Representatives along with the support and statements from stakeholders.

Senator CARPER. Without objection.

[The referenced information follows:]

WRITTEN STATEMENT OF

KATHY CASTOR

CHAIR, HOUSE SELECT COMMITTEE ON THE CLIMATE CRISIS

BEFORE THE U.S. SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

REGARDING: A LEGISLATIVE HEARING TO EXAMINE S. 1345, THE COMPREHENSIVE NATIONAL MERCURY MONITORING ACT; S. 2476, THE ENVIRONMENTAL JUSTICE AIR QUALITY MONITORING ACT OF 2021; AND S. ___, THE PUBLIC HEALTH AIR QUALITY ACT

JULY 13, 2022

Chairman Carper, Ranking Member Capito, and members of the Committee, thank you for the opportunity to address your committee in support of the S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act; and S.___, the Public Health Air Quality Act.

In the House, I chair the Select Committee on the Climate Crisis. Environmental justice is at the center of our plan to solve the climate crisis, and that begins with ensuring clean air for vulnerable Americans. Communities of color and low-income Americans have long been disproportionately harmed by legacy pollution, and we must prioritize these communities as we transition to cleaner energy sources and electric vehicles. By improving access to air quality data, we can address widespread disparities and ensure our clean energy future improves the lives of all Americans, especially those whose communities are burdened by the air pollution caused by the burning of fossil fuels.

Our Climate Crisis Action Plan contains over 700 policy recommendations. Since releasing our recommendations in June 2020, more than 400 Climate Crisis Action Plan recommendations have passed the House and at least 200 have been signed into law.

But our work is not finished. The COVID-19 pandemic brought a new urgency to our recommendations on environmental justice because the pandemic showed how frontline communities are experiencing multiple crises at the same time. As just one example, exposure to air pollution increases the likelihood of severe impacts from COVID-19, including death.

Motor vehicles are a major source of this harmful air pollution and the transportation sector is the largest source of greenhouse gas emissions. Communities across the country lack access to hyperlocal, i.e. block-by-block, data that would show how harmful this pollution is to their neighborhoods. And the Environmental Protection Agency does not have the resources to invest in hyperlocal air quality monitoring. This critical information would empower communities to advocate for better policies and investments, like clean electric cars, buses, and trucks that would improve air quality, reduce noise, and improve quality of life in so many communities.

We've seen positive examples at the state level. On July 6, 2022, New York Governor Kathy Hochul announced a landmark statewide air quality and greenhouse gas mobile monitoring initiative that will work in partnership with community-based organizations. We need to take this nationwide.

That's why I, along with Rep. Lisa Blunt Rochester (D-DE) and Rep. Ritchie Torres (D-NY) introduced the Environmental Justice Air Quality Monitoring Act of 2022 (H.R. 6759) in February 2022, the House companion to Sen. Ed Markey's bill in the Senate.

We were very pleased to see report language supporting community air quality monitoring in Fiscal Year 2022 appropriations and the same language in the House committee report for Fiscal Year 2023 appropriations.

But this is not enough – we need much more investment to stop the scourge of harmful air pollution. Air pollution is a killer.

My bill would establish a five-year pilot program for hyperlocal air quality monitoring projects in communities of color, low-income communities, and other underserved neighborhoods. Under a $100 million annual budget, the program would enable state, local, and Tribal air agencies to partner with local nonprofit organizations or air quality data providers to identify block-level hotspots for multiple pollutants, empowering them to use this data to build online mapping tools, inform local communities and air pollution managers about where poor air quality exists, and recommend a course of action to reduce pollution in identified hotspots.

In addition to my co-leads Rep. Blunt Rochester and Rep. Torres, my bill is cosponsored by Reps. Stephen Lynch (D-MA), Nanette Barragan (D-CA), Sean Casten, (D-IL), Marc Veasey (D-TX), Yvette Clarke (D-NY), Suzanne Bonamici (D-OR), Andre Carson (D-IN), Mark Takano (D-CA), Veronica Escobar (D-TX), Mikie Sherrill (D-NJ), Jerry McNerney (D-CA), Jared Huffman (D-CA), Earl Blumenauer (D-OR), Raul Grijalva (D-AZ), Diana DeGette (D-CO), Doris Matsui (D-CA), Bobby Rush (D-IL), Alan Lowenthal (D-CA), Jamaal Bowman (D-N), Bonnie Watson Coleman (D-NJ), Julia Brownley (D-CA), John Sarbanes (D-MD), Donald McEachin (D-VA), Joe Neguse (D-CO), Mike Levin (D-CA), Barbara Lee (D-CA), Ruben Gallego (D-AZ), Jerrold Nadler (D-NY), Adam Smith (D-WA), and Bobby Scott (D-VA).

It is also endorsed by WE ACT for Environmental Justice; Dr. Sacoby Wilson, Director of the University of Maryland, College Park, School of Public Health, Center for Community Engagement, Environmental Justice, and Health; Gloria Walton, President and CEO of The Solutions Project; American Lung Association; American Thoracic Society; Clean Air Task Force; Aclima; and Thermo Fisher Scientific.

Supporting quotes from many of these organizations are available here: https://climatecrisis.house.gov/news/documents/quotes-support-environmental-justice-air-quality-monitoring-act [Appendix 1]

In conclusion, I thank you again for the opportunity to provide this testimony and for your attention to this important topic that is so critical to protect public health and the climate and environmental justice.

Senator MARKEY. Thank you. I want to thank Chairman Carper and Ranking Member Capito for including my Environmental Justice Air Quality Monitoring Act of 2021 in today's hearing. I look forward to hearing from the witnesses. Thank you.

Senator CARPER. Thanks so much. Before we turn to Senator Duckworth, who I think is going to join us remotely to make a statement about her legislation, the Public Health Air Quality Act, one last word from Satchel Paige.

Not only did Satchel Paige break into the majors in his early 40's, as Senator Markey has said, he used to, when he pitched in the Negro Leagues, he was so good, that when he would take the mound, his infield, he would call his infielders and tell them to sit down. They would sit down in the outfield grass, and he would strike out the team, game after game, week after week, he was that good.

He broke into the majors in his early 40's, and made the All-Star team, pitched for another half-dozen years or so. Eddy gave at the beginning of the quote about how old you are. He also said, the rest of that quote goes something like this: work like you don't need the money, dance like nobody is looking, love like you have never been hurt, live each day like it is your last, and someday, you will be right.

[Laughter.]

Senator CARPER. With that introduction, here is a Senator who needs no introduction, Senator Tammy Duckworth.

Senator, it was great to be with you and your kids last night at the picnic, and you are recognized to speak about your legislation, the Public Health Air Quality Act. I am proud to be one of your co-sponsors.

You are recognized to speak. Please proceed.

OPENING STATEMENT OF HON. TAMMY DUCKWORTH, U.S. SENATOR FROM THE STATE OF ILLINOIS

Senator DUCKWORTH. Thank you so much, Mr. Chairman. That was a great quote. It was great to see everybody at the White House yesterday.

Thank you also to Ranking Member Capito for holding this important hearing to examine important legislative proposals to improve air quality and monitoring, including the Public Health Air Quality Monitoring Act of 2022. I was very proud to partner with Congresswoman Lisa Blunt Rochester in developing our legislation, and I am very pleased that the Congresswoman is testifying this morning as the author of the House version of our bill.

Protecting our Nation's public health requires achieving clean air for all Americans, yet our current air monitoring system is woefully deficient, both in terms of capacity and capability. This is simply unacceptable status quo. It inflicts devastating and disproportionate harm on low-income communities and communities of color that suffer from higher rates of cancer, asthma, and other diseases just because of where they happen to live. It is outrageous that in the wealthiest Country in the world, communities of color are exposed to 63 percent more air pollution than they create.

Last month, I had the opportunity to tour Altgeld Gardens, a public housing community just outside of Chicago, that is known as the birthplace of environmental justice. Their community leader and activist, Cheryl Johnson, explained the environmental justice challenges her community faces and finished the tour by showing me the Altgeld Gardens cancer memorial wall.

On the wall, one can see name after name after name of community members who have fallen to cancer and respiratory illnesses resulting from the cumulative impacts of a variety of sources, creating poor air quality that has plagued the area for decades. This harrowing physical representation of the devastating effects of cumulative air pollution should inspire us all to act. No community, no community should have a wall of fallen mothers, fathers, sisters, and brothers because they were denied one of the most fundamental human rights: clean air to breathe.

That is why this committee must swiftly advance the Public Health Air Quality Monitoring Act and other air quality monitoring legislation. Our bill doesn't seek to reinvent the wheel. Instead, we propose building upon existing monitoring framework to require EPA to implement immediate fenceline monitoring for toxic air pollutants at facilities contributing to high local cancer rates and other health rates from dangerous pollutants. This increased mapping will help support local communities on further actions to confront air pollution, better inform local government and agencies on permit decisions, and illustrate where Federal investments will have the largest benefits to health and equity.

By increasing our air monitoring network, updating our existing regulations and methods, and improving our data collection and public engagements, we can help to close the gaping holes in our air monitoring systems. Advancing my Public Health Air Quality Monitoring Act is an important first step toward clean air for all.

I look forward to today's discussion. I also want to thank the Chairman for helping me introduce this bill as an original co-sponsor, along with Senators Durbin, Booker, Markey, and Warren.

Thank you, Mr. Chairman, and I yield back.

Senator CARPER. Thank you, Senator Duckworth.

Now, it is time to hear from our first panel of witnesses. We are fortunate to have Senator Collins with us today. She is the lead sponsor of the third and final piece of legislation we are examining today, the Comprehensive National Mercury Monitoring Act.

I am grateful to co-sponsor, to work with you on this legislation and so many other bills in the past. You are recognized and warmly welcomed. Thank you.

OPENING STATEMENT OF HON. SUSAN COLLINS, U.S. SENATOR FROM THE STATE OF MAINE

Senator COLLINS. Thank you very much.

Mr. Chairman, Ranking Member Capito, I want to begin by thanking you for holding today's hearing and to also say what a pleasure it is to share the witness table with my friend from the House, Representative Lisa Blunt Rochester. It is great to have you over on the Senate side.

I appreciate the opportunity to testify on the Comprehensive National Mercury Monitoring Act, which I have introduced with the distinguished Chairman. Chairman Carper mentioned it in his opening comments that this is the 50th anniversary of the Clean

Air Act, and it is a point of pride for me that that landmark law was authored by Maine Senator Edmund Muskie. Earlier this summer, I participated in an event in Senator Muskie's hometown of Rumford with his son, Ned Muskie, where we commemorated the 50th anniversary of the Clean Air Act.

Senator CARPER. Boy, it doesn't get much better than that.

Senator COLLINS. It doesn't. So, your hearing is particularly timely.

Our bipartisan mercury monitoring bill would help ensure that we have accurate, scientifically based data about mercury pollution in our Country.

As this committee well knows, mercury is a potent neurotoxin. Exposure can lead to significant health problems, especially in children and pregnant women. Mercury exposure has gone down as U.S. mercury emissions have declined; however, levels remain unacceptably high, and in some cases, we really don't know how much mercury is in our environment.

In Maine, some of our lands and bodies of water face higher mercury pollution compared to the national average. That is because of Maine's location. It is sometimes called the tailpipe of the Nation.

Senator CARPER. Delaware is oftentimes, we refer to us as the tailpipe, right at the tailpipe, just like you.

Senator COLLINS. It is the same concept, that the winds from the west are blowing pollution into the pristine air of my beautiful State.

A system for collecting information, such as we have already for acid rain and other pollution, does not currently exist for mercury, despite its dangers. A comprehensive national mercury monitoring network is needed to protect human health, safeguard our fisheries, and track the effect of reduced emissions. This monitoring network would also help policymakers, scientists, and the public better understand the sources, consequences, and trends in mercury pollution.

Specifically, our legislation would do the following. First, it would direct the EPA, in conjunction with other agencies, to establish a national mercury monitoring program to measure and monitor levels in the air and watersheds, water and soil chemistry, and in marine, freshwater, and land organisms at multiple sites across our Country.

Second, it would establish a scientific advisory panel to make recommendations for the establishment, site selection, measurement, recording protocols, and operations of the monitoring program.

Third, our bill would establish a centralized data base for existing and newly collected environmental mercury data that could be accessed easily on the internet. These data would be compatible with similar international efforts.

Fourth, the reporting requirements in our bill will help Congress assess the mercury pollution reduction levels that are needed in order to help prevent adverse human and ecological effects.

Finally, our bill would authorize a modest $95 million over 3 years to carry out these important activities.

A robust national mercury monitoring network is needed to provide the data to help Congress and others make informed decisions to protect the people of our Nation. I would ask unanimous consent that two endorsement letters, one from the American Lung Association and another from the American Geophysical Union, be entered into the hearing record, which further explain the need for this legislation.

Senator CARPER. Without objection.

[The referenced information was not received at the time of print.]

Senator COLLINS. The Chairman mentioned that he and I have worked together to try to get up this monitoring system so that we have accurate data nationwide, for many years. I hope that this can be the year where we finally enact it into law.

I hope the committee will favorably report our bill for consideration by the full Senate, and I thank you both for the opportunity to testify before the committee today. Thank you.

[The prepared statement of Senator Collins follows:]

Testimony of Senator Susan M. Collins
Senate Committee on Environment and Public Works
Hearing on Air Monitoring Legislation
July 13, 2022

Chairman Carper and Ranking Member Capito, thank you for holding today's hearing to examine air quality monitoring proposals. I appreciate the opportunity to testify about the Comprehensive National Mercury Monitoring Act, which I have introduced with the distinguished Chairman. Our bipartisan bill would help ensure that we have accurate information about mercury pollution in the United States.

As this committee knows, mercury is a potent neurotoxin. Exposure can lead to significant health problems, especially in children and pregnant women. Mercury exposure has gone down as U.S. mercury emissions have declined; however, levels remain unacceptably high.

In Maine, some of our lands and bodies of water face higher mercury pollution compared to the national average. Maine is located at what has been called the "tailpipe of the nation," as the winds carry pollution, including mercury, from the west into Maine.

A system for collecting information, such as we have for acid rain and other pollution, does not currently exist for mercury, despite its dangers. A comprehensive national mercury monitoring network is needed to protect human health, safeguard fisheries, and track the effect of emissions reductions. This monitoring network would also help policy makers, scientists, and the public better understand the sources, consequences, and trends in mercury pollution.

Specifically, our legislation would do the following:

First, it would direct the EPA, in conjunction with other appropriate federal agencies, to establish a national mercury monitoring program to measure and monitor mercury levels in the air and watersheds, water and soil chemistry, and in marine, freshwater, and terrestrial organisms at multiple sites across the country.

Second, it would establish a scientific advisory committee to make recommendations for the establishment, site selection, measurement, recording protocols, and operations of the monitoring program.

Third, our bill would establish a centralized database for existing and newly collected environmental mercury data that could be accessed easily on the Internet. These

data would be compatible with similar international efforts.

Fourth, the reporting requirements in our bill will help Congress assess the mercury pollution reduction levels that need to be achieved in order to help prevent adverse human and ecological effects.

Finally, our bill would authorize $95 million over three years to carry out these important activities.

A robust national mercury monitoring network is required to provide the data needed to help Congress and others make decisions that can protect the people of Maine and the nation. I would ask consent that an endorsement letter from the American Geophysical

Union be entered into the hearing record.

Thank you again for holding this important hearing. I hope the Committee will favorably report our bill for consideration by the full Senate.

Senator CARPER. From your lips to God's ears. Thanks so much for joining us today. I know you got a lot on your schedule this morning. Feel free to leave us when you need to go. Thank you so much for joining us, for your testimony, and for your leadership for so long on this issue and so many other issues. Thank you.

Senator COLLINS. Thank you. I appreciate it.

Senator CARPER. Now, it is a special privilege to introduce a woman who has not only served as Cabinet Secretary and administration-wise, privileged to be the Governor and the subsequent Governor as well, she has led several major departments in the State of Delaware for many, many years. Not only the first African American to serve in the House of Representatives from Delaware, the first woman to be elected and to serve in the House of Representatives from Delaware, and someone we are just extremely proud of and have great respect and affection for.

Thank you for coming to our committee today to discuss your legislation with us. You may proceed with your statement at this time. Thank you.

STATEMENT OF HON. LISA BLUNT ROCHESTER, U.S. REPRESENTATIVE FROM THE STATE OF DELAWARE

Ms. ROCHESTER. Good morning, Chairman Carper and Ranking Member Capito and members of the committee, and also our fellow witnesses. A special thank-you. It was good to be with Senator Collins, who was one of the great supporters of me in my freshman term. Thank you, Senator, for all of your years of service, as well, for Delaware and our Nation.

I want to start by thanking you and the Ranking Member for calling this important hearing today and giving me the opportunity to speak about the need to protect the health and wellbeing of all Americans by expanding our air quality monitoring system. I also want to thank Senator Duckworth for her leadership and partnership on this important issue.

"Living with a time bomb." That was the headline emblazoned across the front page of Delaware's largest newspaper, the News Journal, earlier this year. The story underneath the headline went on to describe the fear and anxiety that residents of New Castle County's Route 9 corridor feel every day as they live in the shadow of chemical and industrial plants. Communities such as Newport, Belvedere, and Southbridge have lived with this reality, with this time bomb, for decades and suffer from higher cancer rates and respiratory hazards as a result.

This is an issue of health, education, but more importantly, justice, both environmental and racial. The justice cannot come as an afterthought. It has to be at the center of our response.

We know that decades of discrimination and environmental racism have resulted in disproportionate numbers of communities of color at the frontlines where they risk significant disparities in health outcomes. These disparities are then passed on from generation to generation. It is past time we break the cycle.

Communities like the ones I described in New Castle County aren't an anomaly. Communities across the Country that neighbor industrial and chemical facilities are more likely to suffer from higher rates of cancer and respiratory disease.

In these communities, it is often the most vulnerable, including children and the elderly, that suffer the most from air pollution health emergencies. For example, exposure to toxic pollutants during a child's development phase has been shown to cause lifelong health and education problems, and ongoing exposure to toxic pollutants may cause premature death in the elderly population, often due to existing comorbidities.

We need to work together to address these health disparities and the impacts. Our first step in protecting these communities is to use our air quality monitors in each neighborhood to identify the pollutants of greatest concern. We cannot address the issue without addressing the problem, which is why we need to have a more robust air monitoring system across the Country.

That is why, today, I am proud to join Senator Duckworth and other House and Senate environmental justice leaders in reintroducing the Public Health Air Quality Act, and why I am also proud to partner with Representatives Castor and Torres and Senator Markey on the Environmental Justice Air Quality Monitoring Act.

The Public Health Air Quality Monitoring Act will better inform and protect communities by requiring EPA to enhance and expand its air quality monitoring network and will ensure that EPA has the resources they need to do it well. Beyond collecting the data, this legislation will help the community access and understand the data.

All too often, the communities that live closest to polluting facilities are the last to find out what toxic pollutants are in their air and how these toxic pollutants impact their health. With the Public Health Air Quality Act, they will be one of the first to know.

From enhancing air monitoring systems at the highest-polluting facilities to supporting pilot program for hyper-local air monitoring project in under-resourced communities and communities of color, we need to work together to expand our environmental protection infrastructure.

Too many communities throughout our Country are living with that time bomb, wondering when or if their government will be there to protect their health. Well, today, let's come together to say that we are here to give them the protection they deserve. We are here to hold polluters accountable, and here to make our communities safer and healthier. Health care costs are impacted, education costs are impacted, but the ultimate cost is the cost of life.

Thank you so much for this opportunity, and I look forward to working with the Senate to pass these important pieces of legislation. I yield back.

[The prepared statement of Ms. Rochester follows:]

Senate Committee on Environment and Public Works
Witness Testimony
of
Congresswoman Lisa Blunt Rochester

Legislative Hearing to Examine S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021; and S.___, the Public Health Air Quality Act

July 13, 2022

Good morning Chairman Carper, Ranking Member Capito, members of the Committee, and fellow witnesses.

I want to start by thanking the Chairman and Ranking Member for calling today's hearing and for giving me the opportunity to speak about the need to protect the health and wellbeing of all Americans by expanding our air quality monitoring system. I also want to thank Senator Duckworth for her leadership and partnership on this important issue.

"Living with a time bomb." That was the headline emblazoned across the front page of Delaware's largest paper, the News Journal earlier this year. The story underneath the headline went on to describe the fear and anxiety that residents of New Castle County's Route 9 corridor feel every day, as they live in the shadow of chemical and industrial plants. Communities such as—Newport, Belvedere, and Southbridge have lived with this reality – with this time bomb – for decades – and suffer from higher cancer rates and respiratory hazards as a result.

This is an issue of justice— both environmental and racial— and justice cannot come as an afterthought. It must be at the center of our response.

We know that decades of discrimination and environmental racism have resulted in a disproportionate number of communities of color at the frontlines, where they risk significant disparities in health outcomes.

These disparities are then passed on from generation to generation – it's past time to break the cycle.

Communities like the ones I described in New Castle County aren't an anomaly—communities across the country that neighbor industrial and chemical facilities are more likely to suffer from higher rates of cancer and respiratory disease.

In these communities, it is often the most vulnerable, including children and the elderly, that suffer the most from air pollution health emergencies. For example, exposure to toxic pollutants during a child's development phase has been shown to cause lifelong health and education problems—and ongoing exposure to toxic pollutants may cause premature death in the elderly population, often due to existing comorbidities.

We need to work together to address these disparate health impacts. Our first step in protecting these communities is to use air quality monitors in each neighborhood to identify the pollutants of greatest concern. We cannot address the issue without assessing the problem, which is why we need a more robust air monitoring system across the country.

That is why, today, I'm proud to join Senator Duckworth and other House & Senate environmental justice leaders in reintroducing the *Public Health Air Quality Act*—and why I'm also proud to partner with Representatives Castor and Torres and Senator Markey on the *Environmental Justice Air Quality Monitoring Act.*

The *Public Health Air Quality Act* will better inform and protect communities by requiring EPA to enhance and expand its air quality monitoring network and will ensure that EPA has the resources they need to do it well.

And beyond collecting the data, this legislation will help the community access and understand the data.

All too often, the communities that live the closest to polluting facilities are the last to find out what toxic pollutants are in their air, and how these toxic pollutants impact their health. With the *Public Health Air Quality Act,* they'll now be one of the first to know.

From enhancing air monitoring systems at the highest-polluting facilities to supporting pilot programs for hyperlocal air monitoring projects in under-resourced communities and communities of color—we need to work together to expand our environmental protection infrastructure.

Too many communities throughout our country are living with that time bomb – wondering when, or if, their government will be there to protect the public. Well today, let's come together to say that we are here to give them the protection they deserve– we're here to hold polluters accountable, and here to make our communities safer and healthier.

Thank you for the opportunity to testify today.

Senator CARPER. We look forward to it as well. Thank you so much for joining us today.

I understand the House is not doing anything today, so you can stay with us for the whole hearing, but if that is not true, feel free to leave when you have to go. Great to see you. Thanks for your leadership on this and so many other issues.

Ms. ROCHESTER. Thank you so much, Senator.

Senator CARPER. See you soon. It was a great pleasure with your mom and dad yesterday at the White House, along with your sister.

Ms. ROCHESTER. Thank you so much. I also have to join in your conversation about birthdays and say that I broke into Congress in the mid–50's, and I am happy this year to turn 60, so I am proud of that 60. Thanks, and thanks for all the happy birthdays over the past 30 years.

Senator CARPER. You keep having them, I will keep calling.

I now get to call the witness for our second panel. As Congresswoman Rochester leaves, our next witness is Alfredo Gomez.

I am going to go ahead and give a brief introduction, Mr. Gomez. Welcome. I got to say hello to you before we started. It is good of you to come and join us today. Alfredo Gomez is the Director for Natural Resources and Environment at the U.S. Government Accountability Office, or GAO. I just spoke with Gene Dodaro yesterday, the Comptroller General, which is always a pleasure.

You are, I understand, a leader on GAO's recent comprehensive study on the State of our Nation's air quality monitoring system. Mr. Gomez, we welcome you. Thank you for being here today to discuss your agency's important findings. You may begin your statement at this time.

Welcome. Thank you.

STATEMENT OF J. ALFREDO GOMEZ, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. GOMEZ. Chairman Carper, Ranking Member Capito, and members of the committee, good morning. Thank you for the opportunity to testify today. I hope that GAO's work helps inform the committee as it considers legislation related to air quality monitoring.

Mr. Chairman, as you noted, while the U.S. has made significant progress in reducing air pollution levels since the 1970's, air pollution continues to harm public health and the environment in certain locations. Concerns remain about the health effects of air toxics and wildfire smoke and concentrations of air pollutants in local areas.

The air quality monitoring system includes thousands of monitoring sites across the Country that measure specific air pollutants. The EPA is responsible for ensuring that this system produces information that is needed to manage air quality. EPA sets the requirements for the system's design, and State and local agencies are the ones that operate the majority of monitoring sites, ensure that data are accurate, and report the data to EPA and the public. EPA, State, and local agencies provide funding for the system.

I would like to focus today on two areas covered in our 2020 Air Quality Monitoring Report. The first is the need for additional air quality monitoring information, and the second is challenges that EPA and selected States and local agencies face in meeting these needs.

Regarding information, in November 2020, we reported that more information was needed in several areas. The first is the need for information about local-scale air quality in real time. This information would help identify air pollution hotspots and provide insights into air quality in rural areas.

The second is the need for information about the concentrations of air toxics in key areas. This information would help EPA and other understand hotspots like cancer clusters. It could also help promote environmental justice by highlighting where pollutants are concentrated.

The third is information about the quality and performance of low-cost sensors. While low-cost sensors are increasingly available to measure air quality and offer much promise, some officials express concerns about the quality of the data they produce. Having this information could help give insights about the reliability and accepted uses of low-cost sensors.

Moving now to the topic of challenges that EPA and States face in providing this information, the challenges include establishing priorities for air toxics monitoring, developing and improving air quality monitoring methods, integrating emerging technology such as low-cost sensors, and managing and integrating additional monitoring data. EPA, State, and local officials told us that they have incomplete information about the public health risk associated with air toxics, making it difficult to understand which present the highest risks and should be priorities for monitoring.

With regard to challenges with air quality monitoring methods, some existing methods were not sufficiently cost-effective, timely, or sensitive, meaning that they did not detect pollution at low enough levels needed to understand health effects.

With the third challenge of integrating emerging technologies, EPA has worked with State and local agencies to study low-cost sensors, but performance issues with low-cost sensor measurements have persisted.

While EPA has strategies aimed at better meeting needs for additional information on air quality, we found that these strategies were outdated and incomplete. For example, these strategies did not reflect needs for additional information or changes in the agency's approaches and resources.

To address these challenges, we recommended that one, EPA develop and implement an asset management framework so that limited resources are directed toward the highest priorities, and two, to develop an air quality monitoring modernization plan that aligns with leading practices. Such a plan can help EPA provide information needed to understand and address changing air quality issues, such as wildfire smoke and air toxics, and to make better use of new technologies. EPA agreed with our recommendations and has begun implementing them.

Chairman Carper and Ranking Member Capito, members of the committee, this completes my statement, and I am happy to answer questions.

[The prepared statement of Mr. Gomez follows:]

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AIR QUALITY INFORMATION

Need Remains for Plan to Modernize Air Monitoring

Statement of J. Alfredo Gómez, Director,
Natural Resources and Environment

GAO-22-106136

GAO Highlights

Highlights of GAO-22-106136, a testimony before the Committee on Environment and Public Works, U.S. Senate

July 13, 2022

AIR QUALITY INFORMATION

Need Remains for Plan to Modernize Air Monitoring

Why GAO Did This Study

Information from the national ambient air quality monitoring system shows that the United States has made progress in reducing air pollution. It also shows that risks to public health and the environment continue in certain locations. EPA and state and local agencies cooperatively manage the system.

Since the system was established in the 1970s, air quality concerns have evolved. For example, concerns have increased about the health effects of air toxics, such as ethylene oxide. Congress is considering legislation related to some of these emerging air quality monitoring concerns.

This testimony discusses (1) needs for additional air quality information and (2) challenges in meeting those needs. This statement is based on a November 2020 report (GAO-21-38). For that report, GAO reviewed literature, laws, regulations, and agency documents. In addition, GAO interviewed EPA officials, selected state and local officials, representatives from air quality associations, and stakeholders such as academic researchers. GAO has also tracked EPA's actions to implement the recommendations made in the report.

What GAO Recommends

In its November 2020 report, GAO made two recommendations, including that EPA develop an air quality monitoring modernization plan that aligns with leading practices for strategic planning and risk management. EPA generally agreed with the recommendations. EPA has begun working with state, tribal, and local air agencies to implement them.

View GAO-22-106136. For more information, contact J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

What GAO Found

The national ambient air quality monitoring system provides standardized information essential for implementing the Clean Air Act and protecting public health. But, in November 2020, GAO found that the system was unable to meet users' current needs for information to better manage health risks from air pollution. Air quality managers, researchers, and the public use the information from this system to characterize levels of pollution and study the human health and ecological effects of air pollution. They also use it to develop strategies to reduce adverse health effects, and demonstrate progress in addressing air quality issues over time. The system comprises sites across the United States that are equipped with monitors to measure air pollution levels.

Examples of Monitoring Sites in the National Ambient Air Quality Monitoring System

(Left to right) National Core network (NCore) monitoring site; canisters used to collect samples for measuring air toxics; near-road monitoring site.

Source: GAO. | GAO-22-106136

Additional air quality monitoring information would enable users of the system to better understand and address the health risks from air pollution, according to a review of literature and interviews with government officials, associations, and stakeholders that GAO conducted for its November 2020 report. GAO identified information needs related to (1) local-scale, real-time air quality; (2) air toxics; (3) persistent and complex pollution; and (4) use of low-cost sensors. For example, many stakeholders told GAO that they need more data to understand health risks in potential hotspots (local areas of high pollution), and other key locations.

The Environmental Protection Agency (EPA) and state and local agencies face persistent challenges in meeting additional information needs in four key areas. These are: (1) establishing priorities for air toxics monitoring; (2) developing and improving air quality monitoring methods; (3) integrating emerging technologies, such as low-cost sensors; and (4) managing and integrating additional monitoring data.

EPA has strategies aimed at better meeting needs for additional information on air quality, but GAO found that these strategies were outdated and incomplete. Developing a modernization plan that aligns with leading practices for strategic planning and risk management, would better position EPA to ensure that the ambient air quality monitoring system meets the additional information needs. It would also help position EPA to protect public health as future air quality issues emerge.

Chairman Carper, Ranking Member Capito, and Members of the Committee:

Thank you for the opportunity to discuss our work on air quality information needs that can help manage the risks that air pollution poses to public health. While the United States has made significant progress in reducing air pollution levels since the 1970s, air pollution continues to harm public health and the environment in certain locations, according to data from the national ambient air quality monitoring system.[1] This system consists of sites that measure air pollution levels at fixed locations across the country. The sites are equipped with monitors that use specific methods approved by the Environmental Protection Agency (EPA). Air quality managers, researchers, and the public use the information from this system to characterize levels of pollution, study the human health and ecological effects of air pollution, develop strategies to reduce adverse health effects, and demonstrate progress in addressing air quality issues over time.

EPA and state and local agencies, which cooperatively manage the monitoring system, face challenges in sustaining this system. EPA and state and local agencies play different roles in the system's design, operation, oversight, and funding. For example, EPA establishes minimum requirements for the system. State and local agencies operate the monitors and report data to EPA. And, EPA and state and local agencies provide funding for the system.[2] We reported in November 2020 that EPA and state and local agencies faced challenges in sustaining the monitoring system in the face of decreasing funding and increasing demands on resources.[3] From 2004 to 2019, federal funding for state and local monitoring programs declined by nearly 20 percent after adjusting for inflation, and state and local funding for these programs also generally

[1]"Ambient air" means that portion of the atmosphere, external to buildings, to which the general public has access. 40 C.F.R. § 50.1(e).

[2]EPA provides federal funding for the monitoring system through grants to state and local agencies under the Clean Air Act for a range of state and local air quality management activities, including air quality monitoring. EPA regional offices administer and oversee the federal grants to state and local agencies. In fiscal year 2022, from EPA's appropriation for grants, Congress provided that approximately $230 million was to be for state and local air quality management grants, including those authorized under the Clean Air Act.

[3]GAO, *Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System*, GAO-21-38 (Washington, D.C.: Nov. 12, 2020).

declined.[4] Concurrently, EPA and state and local agencies face increasing demands on these limited resources, including aging monitoring infrastructure and rising operating costs.

Air quality concerns have changed since the national ambient air quality monitoring system was established by amendments to the Clean Air Act in the 1970s.[5] For example, concerns have emerged about issues such as the health effects of air toxics; local areas of high pollution, particularly in lower-income or minority communities; and growing effects of wildfire smoke on air quality and public health.[6] Additionally, technologies for measuring air quality, such as low-cost sensors, have improved since the system's inception, providing opportunities to enhance information on air quality.[7]

Congress is considering various legislative proposals related to air quality monitoring. For example, one bill would call for EPA to establish a pilot program for hyperlocal air quality monitoring projects in environmental justice communities that could provide information on localized levels of high pollution, while another would require EPA, in consultation with other agencies, to establish a national mercury monitoring program.[8] Another bill would expand monitoring and access to air quality information for communities affected by air pollution, such as environmental justice communities, and call for the deployment of low-cost sensors in certain communities.

My statement today focuses on (1) additional air quality monitoring information that could help meet the needs of air quality managers,

[4]Since we reported on these funding trends, congressional appropriations for fiscal years 2020 through 2022 for the EPA air quality management grants related to the monitoring system remained similar to fiscal year 2019 levels.

[5] 42 U.S.C. §7401 et seq. The Clean Air Act was also significantly amended in 1977 and 1990.

[6]Air toxics are a category of pollutants that are known to cause, or are suspected of causing, cancer, birth defects, reproduction problems, and other serious illnesses.

[7]See also GAO, *Science and Technology Spotlight: Air Quality Sensors*, GAO-21-189SP (Washington, D.C.: Dec. 7, 2020).

[8]The term "environmental justice communities" generally refers to areas where disproportionately high health and environmental risks are found among low-income and minority communities. The precise definition and scope of this term may vary among legislative proposals.

researchers, and the public; and (2) challenges that EPA and selected state and local agencies face in meeting these air quality information needs. My statement is based on our November 2020 report on the national ambient air quality monitoring system.[9]

For our November 2020 report, we identified and reviewed federal laws and regulations governing the national ambient air quality monitoring system; EPA reports, guidance, and information on the oversight and operation of the monitoring system; and 10 studies and articles, identified in a literature review, that discussed the performance of the monitoring system or emerging air pollution issues. We also conducted a series of interviews with knowledgeable federal, state, and local officials; representatives from air quality associations; and stakeholders.[10] Specifically, we interviewed (1) EPA officials from the Office of Air Quality Planning and Standards within the Office of Air and Radiation, the Office of Research and Development, and six selected regional offices; (2) officials from 14 state and local air quality monitoring agencies within the six selected EPA regions; (3) representatives from the two national and six regional associations of state and local air quality agencies; and (4) 10 stakeholders, such as academic researchers and individuals from the private sector.

We selected our interviewees based on various criteria. First, we selected EPA regional offices in areas across the country with different characteristics that might be associated with a range of monitoring needs and considerations, such as different air quality concerns and population densities. Also, we selected state and local agencies to include jurisdictions with a range of characteristics potentially affecting the design and operation of their air quality monitoring networks, such as different air quality issues, population densities, and approaches to air toxics monitoring. Finally, we selected stakeholders based on their experience

[9]In addition to the objectives noted above, the November 2020 report also examined (1) the role that the national ambient air quality monitoring system plays in managing air quality and how EPA and state and local agencies manage the system and (2) the challenges that EPA and selected state and local agencies face in managing the national ambient air quality monitoring system and the extent to which EPA has addressed and could better address these challenges. See GAO-21-38.

[10]To identify the number of interviewees who expressed particular views, we use the following modifiers throughout the issued report and testimony statement. "Some" represents two to four interviewees, "several" represents five to eight interviewees, and "many" represents nine or more interviewees. We considered officials from a state or local agency or representatives from a national or regional association to be one interviewee, even though multiple officials or representatives may have participated in the interview.

in using air quality information and their knowledge about the extent to which the monitoring system produces needed air quality information. Our findings from these selected interviews cannot be generalized. More detailed information on our objectives, scope, and methodology is in the issued report. Since November 2020, we have tracked the actions that EPA has taken to implement the recommendations we made in the report.

We conducted the work on which this statement is based in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Air Pollutants Defined by the Clean Air Act

The Clean Air Act provides the framework for protecting air quality in the United States.[11] Under the Clean Air Act, EPA sets different types of limits—ambient air standards and emissions standards—for two categories of air pollutants. The first category comprises "criteria" pollutants for which EPA has established standards for the allowable levels of each pollutant in the ambient air. Such pollutants include carbon monoxide, lead, ozone, particulate matter, nitrogen dioxide, and sulfur dioxide.[12] EPA sets these allowable standards—called the National Ambient Air Quality Standards (NAAQS)—at levels intended to protect public health, including the health of susceptible and vulnerable populations such as people with asthma, children, and elderly people.[13] The criteria pollutants are commonly found throughout the United States and can harm public health, harm the environment, and cause property

[11]The purposes of the Clean Air Act are, among other things, to protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the productive capacity of its population. 42 U.S.C. § 7401(b)(1).

[12]EPA has established standards for two different sizes of particulate matter: particulate matter less than or equal to 10 micrometers in diameter, known as PM10, and particulate matter less than or equal to 2.5 micrometers in diameter, known as fine particulate matter or $PM_{2.5}$.

[13]In addition, EPA sets "secondary standards" to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air.

damage. They often come from sources such as power plants, factories, and motor vehicles.

The second category of pollutants currently includes 188 pollutants listed under the 1990 Clean Air Act Amendments and subsequent EPA regulations as "hazardous air pollutants."[14] For these pollutants, EPA has not established ambient air standards but regulates them by establishing emissions standards for individual categories of hazardous air pollutant sources. EPA also refers to hazardous air pollutants as "air toxics." Air toxics are pollutants known to cause, or suspected of causing, cancer, birth defects, reproduction problems, and other serious illnesses. Air toxics include pollutants such as benzene, found in gasoline, and mercury, which is emitted from sources such as power plants. The health risks of air toxics can vary considerably. Therefore, small quantities of more harmful pollutants can pose greater health risks than large quantities of less harmful pollutants. In addition, some air toxics can fall to the ground in rain or dust and contaminate land and waterways.

The National Ambient Air Quality Monitoring System

The national ambient air quality monitoring system provides standardized information essential for implementing the Clean Air Act and protecting public health. The system contains a suite of networks across the country that focus on different air quality issues but that have common methods for producing data at their monitoring sites, allowing the comparison of data across the country to provide a national perspective on various air quality issues.[15] This standardized information helps air quality managers, researchers, and the public understand and manage risks from air pollution, according to some literature we reviewed and stakeholders we interviewed.

Table 1 describes the networks within the national ambient air quality monitoring system:

(1) required networks of State and Local Air Monitoring Stations (SLAMS), which measure levels of the criteria pollutants and the precursor pollutants that mix to form criteria pollutants; (2) voluntary networks designed to measure air toxics, including a national network for

[14]For a list of these pollutants, see Environmental Protection Agency, *Initial List of Hazardous Air Pollutants with Modifications*, accessed July 1, 2022. https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications.

[15]Certain state and local air toxics monitoring programs use common methods for producing data. However, since these are not required networks, the use of common methods across all state and local air toxics monitoring is not assured.

establishing trends in air toxics and state and local networks designed to target specific concerns about air toxics; and (3) specialized networks focused on certain pollution issues, such as visibility and deposition of pollutants from the atmosphere into ecosystems.

Table 1: National Ambient Air Quality Monitoring System

Network	Purpose	Start year	Number of sites[a]
Required networks of State and Local Air Monitoring Stations (SLAMS)			
Criteria pollutant networks	Provide air pollution data to the general public in a timely manner; support compliance with the National Ambient Air Quality Standards (NAAQS) and emissions strategy development, and support air pollution research studies.	1980	4,300+
Photochemical Assessment Monitoring Stations (PAMS)	Measure ozone precursors to better characterize the nature and extent of ozone problems in areas not attaining NAAQS.	1994	69
$PM_{2.5}$ Chemical Speciation Network (CSN)	Provide data on the chemical composition of particulate matter less than or equal to 2.5 micrometers in diameter ($PM_{2.5}$) to assess trends, develop emissions control strategies, and support health studies, among other things.	2002	154
Near-Road NO_2 Network	Measure nitrogen dioxide (NO2) and other pollutants near roads in larger urban areas where peak hourly levels are expected to occur.	2010	74
National Core (NCore) network	Support air quality model evaluations, long-term health assessments, compliance through comparison with NAAQS, and ecosystem assessments.	2011	78
Voluntary networks for assessing air toxics			
National Air Toxics Trends Stations (NATTS) network	Identify trends in air toxics levels to assess progress toward emission reduction goals, evaluate public exposure, and characterize risk.	2003	24
State and local air toxics monitoring	Support state and local air toxics programs and identify geographic areas at high risk.	1985	240+
Specialized networks			
Interagency Monitoring of Protected Visual Environments (IMPROVE)	Establish current visibility conditions in visibility-protected federal areas, identify emissions sources, document trends, and provide regional haze monitoring.	1985	110
Clean Air Status and Trends Network (CASTNET)	Assess environmental results of emissions reductions programs, such as a program to reduce acid rain, and pollutant impacts to sensitive ecosystems and vegetation.	1991	96
National Atmospheric Deposition Program (NADP)	Provide data on the amounts, trends, and geographic distributions of ammonia, mercury, and other pollutants found in precipitation that can affect the environment.	1978	473

Source: GAO analysis of Environmental Protection Agency information. | GAO-22-106136

[a]As of November 2020. These numbers include sites on tribal lands that report data to the Environmental Protection Agency; monitoring on such lands was not included in the scope of our

analysis in GAO, *Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System*, GAO-21-38 (Washington, D.C.: Nov. 12, 2020).

Air Quality Managers, Researchers, and the Public Need Additional Information to Better Understand and Address Health Risks from Air Pollution

In November 2020, we reported that air quality managers, researchers, and the public need additional information to better understand and address health risks from air pollution, according to some literature we reviewed and officials from EPA and selected state and local agencies, representatives of national and regional air quality associations, and stakeholders. These information needs related to (1) local-scale, real-time air quality; (2) air toxics; (3) persistent and complex pollution; and (4) use of low-cost sensors.

Local-Scale, Real-Time Air Quality

More local-scale, real-time information is needed to meet evolving public demands, according to many EPA, state, and local agency officials, representatives of regional associations, and stakeholders we interviewed for our November 2020 report. Some of these officials and stakeholders said that the increasing availability of other types of local-scale, real-time information—such as for traffic and weather—is creating a demand for such information on air quality. In addition, according to some public health researchers we interviewed, they need air quality information on a localized scale to get an accurate picture of the exposure that individuals face and the associated health effects. However, we reported that the monitoring system is unable to meet all such needs.

Specifically, we reported that the system is unable to meet needs for information on the following areas:

- **Air pollution hotspots, or local areas of high pollution.** Air pollution levels can change significantly from one location to another, and pollution hotspots may occur between existing monitoring sites. Some state and local officials said at the time that they have used mobile air quality monitoring units—such as monitoring equipment set up in movable vans or trailers (see fig.1)—to temporarily monitor air quality in certain areas.

- **Short-term, real-time air quality changes.** Some monitoring equipment in the system does not have the capability to provide real-time information. For example, particulate matter monitors that use manual, filter-based methods provide data once over a 24-hour period, as opposed to hourly for continuous monitors.
- **Air quality in rural areas.** In rural areas, the distance between monitoring sites is often much greater than in urban areas, and some rural areas may not have any monitoring.

Figure 1: Example of a Mobile Air Quality Monitoring Unit

Exterior and interior of a mobile monitoring unit operated by the Delaware Department of Natural Resources and Environmental Control

Source: GAO. | GAO-22-106136

Air Toxics

In a 2004 report on air quality management in the United States, the National Academies of Sciences, Engineering, and Medicine (National Academies) noted that exposure to air toxics was an important concern that is not well quantified on account of limited information.[16] The report also noted that the many unknowns associated with a large number of unlisted pollutants, and stated that the development and use of many new toxic substances each year makes it challenging for the monitoring system to evolve quickly enough. More recently, in 2019, the California Air Resources Board identified over 800 new substances and proposed that they be reported to assess air toxics risk.[17]

In November 2020, we reported these specific needs included the following:

[16]National Academies of Sciences, Engineering, and Medicine, *Air Quality Management in the United States* (Washington, D.C.: The National Academies Press, 2004).

[17]The California Air Resources Board oversees all air pollution control efforts in California.

- **Air toxics information in key locations.** Additional air toxics information is needed in key locations near identified cancer clusters, environmental justice areas, industrial facilities, and other potential hotspots.[18] In addition, some air toxics, such as mercury, can affect aquatic and terrestrial ecosystems through deposition from the air to the water or land. More consistent monitoring is needed to track trends in and understand the sources and transport of such pollutants that can affect ecosystems, according to representatives from a regional air quality association we interviewed at the time.
- **More timely information on air toxics.** Frequent air quality measurements that are available quickly are more useful for risk reduction and for understanding pollution sources. To measure air toxics levels, samples of air are typically sent to laboratories for analysis, which takes time. In addition, monitoring for air toxics often uses canisters or other sampling devices that capture air over a defined amount of time, such as a 24-hour period (see fig. 2). This can make it difficult to understand which sources emitted the air toxics affecting that location throughout the day. All air toxics samples at National Air Toxics Trends Stations (NATTS) are collected over a 24-hour period once every 6 days.
- **Information on air toxics at low levels.** Some methods for analyzing air toxics samples cannot detect air toxics at levels low enough to allow identification of potential public health threats. For example, we reported that according to EPA officials, two of the 19 core air toxics have methods with a detection limit that is above or near the level that would be relevant for assessing health effects.[19] In such cases, officials cannot conclusively identify whether the air toxics present a public health risk. An inconclusive result is difficult to explain to the public, according to some state and local agency officials.

[18] For more information about federal efforts related to environmental justice, see GAO, *Environmental Justice: Federal Efforts Need Better Planning, Coordination, and Methods to Assess Progress*, GAO-19-543 (Washington, D.C.: Sept. 16, 2019).

[19] Acrolein and ethylene oxide have detection limits that are above health-relevant levels. "Core air toxics" refers to the National Air Toxics Trends Stations' (NATTS) Tier I analytes, which are a group of 19 air toxics that have been identified as major risk drivers based on a relative ranking performed by EPA. We reported that EPA officials said the agency has taken some steps to improve monitoring methods for air toxics.

Figure 2: Example of Air Toxics Monitoring Equipment

Canisters used to collect samples for measuring air toxics operated by the Wisconsin Department of Natural Resources

Source: GAO. | GAO-22-106136

Persistent and Complex Pollution

In November 2020, we also reported that more specialized information is needed to better understand persistent and complex pollution issues to, in turn, help identify options for reducing the pollution and its health effects. Understanding persistent or complex pollution issues often requires information that the monitoring system does not comprehensively provide, including information about pollution precursors and their sources, the chemistry of the atmosphere, and the transport of the pollutants.

Specific information needs related to persistent and complex pollution included information on (1) particulate matter less than or equal to 2.5 micrometers in diameter ($PM_{2.5}$) and ozone formation and transport; and (2) effects of wildfires on air quality and public health. Although programs exist that are specifically designed to gather specialized information about $PM_{2.5}$ and ozone, we reported that additional information would help inform emissions control strategies.[20] Also, we noted that more information is needed to better understand the complex effects of wildfires

[20]Emissions can mix with other substances in the environment to form other pollutants, so understanding interactions can be important for designing an emissions control strategy for a given area. The Photochemical Assessment Monitoring Stations (PAMS) network provides information about the precursors and other factors that influence the formation of ozone, and the $PM_{2.5}$ Chemical Speciation Network (CSN) provides information on the chemical composition of particulate matter, which can help inform emissions control strategies.

on air quality and human health. We have ongoing work examining this issue.

Use of Low-Cost Sensors

Low-cost sensors are increasingly available as a tool for government agencies and the public to directly measure air quality. EPA defines low-cost sensors as those costing less than $2,500. Because low-cost sensors can be deployed in many locations without significant initial investment, they can help meet some of the information needs related to monitoring that require pollution measurements in additional locations or more real-time data. For example, many state and local officials we interviewed for our November 2020 report said that low-cost sensors could be used for applications such as identifying ideal locations for regulatory monitors, locating pollution hotspots, supporting community-based monitoring initiatives, expanding air toxics monitoring, addressing citizen concerns and questions, and tracking wildfire smoke.

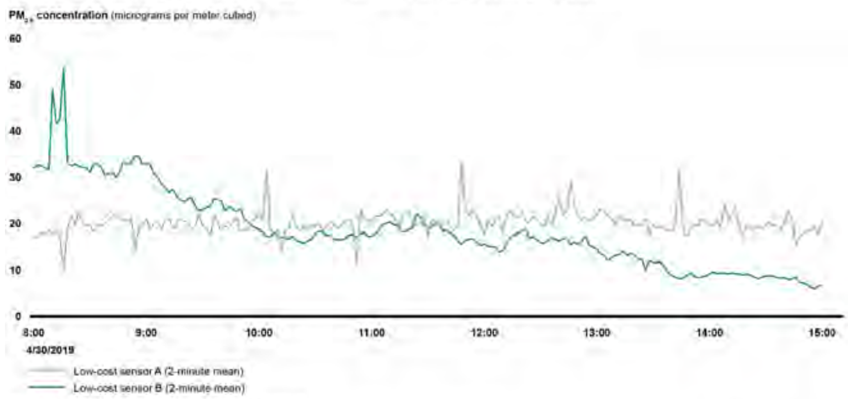
We reported that although many officials cited potential uses of low-cost sensors, some expressed concerns about potential limitations, such as the quality and use of the information. For example, while officials from some state and local agencies said that their agencies used low-cost sensors to supplement their monitoring for limited purposes, some had concerns about the quality of the information that these sensors produce.[21]

In addition, we reported that the public, government agencies, and researchers need additional information on how to use low-cost sensors and the data they produce, according to many EPA and state and local officials we interviewed. Specifically, this information included (1) accepted and cost-effective applications of sensors, (2) proper sensor calibration, and (3) proper siting of sensors. Many EPA and state and local officials we spoke with said that they were aware of external stakeholders—such as community groups, members of the public, private companies, and research groups—using low-cost sensors. We also reported that many EPA and state and local officials and regional representatives were concerned about the need to ensure that these external stakeholders appropriately interpret and apply the information from these sensors.

[21]The sensors have been used for such applications as special studies related to wildfires, identifying sources, and engaging the community on pollution issues.

To demonstrate and understand the use of sensors to gather air quality information, for our November 2020 report, we purchased five low-cost sensors from four different manufacturers to measure fine particulate matter. One sensor operated from April 2019 to March 2020, and the others operated from April to June 2019. Our sensor demonstration illustrated (1) the difficulty of measuring specific pollution levels without properly calibrating the sensors and (2) the need to understand how the siting of the sensor can affect the data that it produces to help avoid misinterpretation. Our sensor demonstration also illustrated that even when two different sensors are located side by side, they may produce different pollution measurements (see fig. 3).[22]

Figure 3: Differences in $PM_{2.5}$ Sensor Measurements from Two Sensors in the Same Location



Source: GAO analysis of GAO low-cost sensor data. | GAO-22-106136

Note: $PM_{2.5}$ is particulate matter less than or equal to 2.5 micrometers in diameter. The data presented in the figure illustrate sensor differences over a short period of time, and this period is too limited to draw broad conclusions.

[22]When measured by EPA-approved monitors, the 24-hour health-based standard for $PM_{2.5}$ exposure is 35 micrograms per meter cubed, and the annual health-based standard for $PM_{2.5}$ exposure is 12 micrograms per meter cubed.

EPA and State and Local Agencies Faced Persistent Challenges in Meeting Needs for Air Quality Information Even with Targeted Efforts to Address Such Needs

In November 2020, we found that EPA and state and local agencies faced challenges in meeting needs for additional air quality information, and these challenges persisted in four key areas:

- **Establishing priorities for air toxics monitoring.** Partially due to the large number of existing air toxics, monitoring for these substances needs to be prioritized, according to the National Academies and some EPA, state, and local officials, and regional representatives we interviewed at the time. We reported that some state and local agency officials also said that monitoring for air toxics needed to be prioritized because their agencies' budgets were mainly used to support required monitoring for criteria pollutants. Officials at some state and local monitoring agencies said that they looked to EPA for help with prioritizing what to monitor in their areas. Specific prioritization challenges that EPA and state and local agencies identified included (1) identifying air toxics that present the highest public health risks and might, therefore, be priorities for monitoring; and (2) anticipating emerging air toxics issues in order to prioritize monitoring for those air toxics.
- **Developing and improving air quality monitoring methods.** We reported that the limited availability of adequate analysis methods to meet information needs, primarily for air toxics, was a challenge, according to many EPA and state and local agency officials and regional representatives we spoke with at the time. Some existing analysis methods for pollutants were not sufficiently cost effective, timely, or sensitive, according to these officials and representatives. For example, state officials said that laboratory methods for analyzing formaldehyde—a relatively common air toxic—were prohibitively expensive. In addition, we reported that some state agency officials and regional representatives said continuous monitoring equipment was not available for some air toxics and was not cost effective. Finally, as previously mentioned, some monitoring methods did not detect pollution at low enough levels needed to understand health effects.

  EPA has programs to improve or develop new monitoring technologies, but these efforts had been targeted to specific monitoring purposes and did not fully addressed the challenges described above. Furthermore, the EPA Office of Research and Development's internal budget for air quality monitoring research, including development of methods, has remained flat for the past decade. According to EPA officials at the time, methods development priorities must compete with other Office of Research and Development research priorities for resources. As a result, the office was only able to take action on some monitoring technology research and development needs, and only one air toxics monitoring method had been updated in the past 20 years.

- **Integrating emerging technologies.** EPA and state and local agencies faced challenges in integrating emerging technologies into the monitoring system to help address needs related to real-time, local-scale information and the use of low-cost sensors. EPA had undertaken targeted actions to address these challenges, such as (1) working with state and local monitoring agencies to study low-cost sensors' performance in specific environmental conditions and (2) developing workshops and a tool—the Air Sensor Toolbox—to communicate the performance of these sensors.[23] However, we reported that challenges persisted, such as performance issues with low-cost sensor measurements. These issues had been documented and included issues with accuracy, interference from other pollutants, and variable performance in different temperature and humidity conditions. In addition, as new low-cost sensors continue to become commercially available, communicating the performance of these emerging sensors persisted as a challenge, according to EPA officials.
- **Managing and integrating additional monitoring data.** We reported that EPA and state and local agencies faced challenges in meeting current data management needs, and these challenges likely would persist, according to some EPA and state and local officials. The Air Quality System, EPA's data management system, barely meets current data management needs because the architecture of the system—which dates back to the 1990s—is antiquated and inflexible. Furthermore, increasing continuous monitoring for more pollutants will create substantially more data to manage, which could challenge the current system's capabilities, some EPA and state and local officials noted at the time. We have ongoing work assessing EPA's progress in modernizing data systems for air quality data, including the Air Quality System.

While EPA has strategies aimed at better meeting the needs for additional air quality information, we found in our November 2020 report

[23]The Air Sensor Toolbox provides information on the performance, operation, and use of low-cost sensors. See https://www.epa.gov/air-sensor-toolbox, accessed July 5, 2022.

that these strategies were outdated and incomplete.[24] Specifically, EPA's strategies did not reflect needs for additional information or changes in the agency's approaches and resources. Furthermore, these strategies did not fully address challenges with meeting information needs, such as establishing priorities for air toxics monitoring.[25]

We made two recommendations to help EPA, along with state and local agencies, manage and modernize the air quality monitoring system to ensure that it meets information needs and helps protect public health as future air quality issues emerge. These recommendations, which we have identified as priority recommendations, are that EPA, in consultation with state and local agencies, should[26]

1. develop, make public, and implement an asset management framework for consistently sustaining the national ambient air quality monitoring system. Such a framework could be designed for success by considering the key characteristics of effective asset management. These include identifying the resources needed to sustain the monitoring system, using quality data to manage infrastructure risks, and targeting resources toward assets that provide the greatest value; and
2. develop and make public an air quality monitoring modernization plan to better meet the additional information needs of air quality managers, researchers, and the public. Such a plan could address the ongoing challenges in modernizing the national ambient air quality monitoring system by considering leading practices for strategic planning and risk management. These include establishing priorities

[24] Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, *Final Draft: National Monitoring Strategy: Air Toxics Component* (Research Triangle Park, N.C.: July 2004); Office of Air Quality Planning and Standards, *Ambient Air Monitoring Strategy for State, Local, and Tribal Air Agencies* (Research Triangle Park, N.C.: December 2008); and *Draft Roadmap for Next Generation Air Monitoring* (March 2013).

[25] According to EPA officials, the larger air pollution community is doing a great deal of work on sensors but very little work on air toxics, yet the officials noted that the risk is likely in air toxics.

[26] Priority open recommendations are the GAO recommendations that warrant priority attention from heads of key departments or agencies because their implementation could save large amounts of money; improve congressional or executive branch decision-making on major issues; eliminate mismanagement, fraud, and abuse; or ensure that programs comply with laws and that funds are legally spent; among other benefits. Since 2015, GAO has sent letters to selected agencies to highlight the importance of implementing such recommendations. See GAO, *Priority Open Recommendations: Environmental Protection Agency*, GAO-22-105600 (Washington, D.C.: July 1, 2022).

and roles, assessing risks to success, identifying the resources needed to achieve goals, and measuring and evaluating progress.

In its comments on our draft November 2020 report, EPA generally agreed with our recommendations and stated that, if fully implemented, they would add value and help sustain the national monitoring program. Since we issued our report, EPA has been working with its state, tribal, and local partners on plans for an asset management framework and an air quality monitoring modernization plan. By continuing to take steps to implement our recommendations to manage and modernize the air quality monitoring system, EPA will better ensure that it can meet additional information needs and help protect public health as future air quality issues emerge.

Chairman Carper, Ranking Member Capito, and Members of the Committee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

GAO Contacts and Staff Acknowledgments

If you or your staff have any questions about this testimony, please contact J. Alfredo Gómez, Director, Natural Resources and Environment, at 202-512-3841or gomezj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. GAO staff who made key contributions to this testimony are Anne Hobson (Assistant Director), Kate Shouse (Analyst-in-Charge), Marya Link, Tara Congdon, and Adrian Apodaca. Other staff who made key contributions to the report cited in the testimony are identified in the source product.

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Senate Committee on Environment and Public Works
Hearing Entitled, "*A Legislative Hearing to Examine S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021; and S. ___, the Public Health Air Quality Act.*"
July 13, 2022
Questions for the Record for J. Alfredo Gomez

Senator Cardin

1. **In your testimony, you state that GAO has found that EPA and state and local agencies faced challenges in meeting needs for additional air quality information. How might additional air quality monitoring information help downwind states hold their upwind neighbors accountable?**

   GAO Response: In our November 2020 report, we reported that air quality managers, researchers, and the public told us they need additional air quality monitoring information to better understand persistent and complex pollution, including information on pollution formation and transport.[1] Such information can help states, such as those that are downwind, better understand and analyze pollution sources to help develop strategies to reduce the pollution. Understanding pollutant interactions can be important for designing pollution control strategies for a given area because air emissions can mix with other substances in the environment to form other pollutants—such as fine particulate matter ($PM_{2.5}$) and ozone—including in downwind areas.

   We reported that understanding complex pollution issues often requires air quality information that the monitoring system does not comprehensively provide, such as information about pollution precursors and their sources, chemistry of the atmosphere, and transport of the pollutants. Certain monitoring networks, such as the $PM_{2.5}$ Chemical Speciation Network (CSN) and the Photochemical Assessment Monitoring Stations (PAMS), are designed to gather information about $PM_{2.5}$ and ozone. Specifically, CSN provides information on the chemical composition of particulate matter, which can inform emission reduction strategies, and PAMS provides information about the precursors and other factors that influence the formation of ozone.

   As we reported, however, many state and local agency officials and regional associations told us that they need additional information to help develop strategies to control the sources of pollution. For example, state and regional officials we interviewed for the report said they need additional information, such as information at multiple heights in the atmosphere, to determine the causes of elevated ozone levels near large bodies of water, such as the Great Lakes. Some state and local officials we interviewed said that they need additional meteorological equipment at monitoring sites to help pinpoint pollution sources and understand how pollution moves through an area.

Senator Duckworth

2. **Director Gomez, studies have shown that conventional regional monitoring is insufficient in determining the impacts of air pollution on public health. It is no surprise that the communities that suffer most from insufficient collection of air quality data are underserved communities and communities of color. A practice called hyperlocal monitoring allows for a more holistic**

[1] GAO, *Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System*, GAO-21-38 (Washington, D.C.: Nov. 12, 2020).

picture of air quality with data collected right at the source and at a much higher frequency. One of the most efficient methods of hyperlocal monitoring is fenceline monitoring, which describes the use of technology to measure the ambient air concentration of specific chemicals at the property line of a fixed source, like a chemical plant. This data can then be used by air quality managers and the public to better understand the health risks of hazardous air pollution and facilitate targeted solutions.

Can you describe why if EPA facilitated increased hyperlocal and fenceline monitoring this could create a better, more holistic understanding of the public health impacts of cumulative air pollution?

GAO Response: Our November 2020 report identified certain air quality information needs that relate to hyperlocal and fenceline monitoring.[2] For example, our report identified a need for more information on local-scale, real-time air quality and air toxics to better understand and address the health risks from air pollution.

In particular, we reported that more local-scale real-time information was needed to meet needs for (1) information on air pollution hotspots (local areas of high pollution), (2) real-time information on short-term changes in air quality, and (3) air quality information in rural areas. Air pollution levels can change significantly from one location to another, and pollution hotpots may occur between existing monitoring sites. Therefore, according to some public health researchers we interviewed for the report, such localized air quality information is needed to get an accurate picture of the exposure that individuals face and the associated health effects.

Furthermore, we reported on needs for air quality monitoring information about air toxics, including (1) air toxics information in key locations, (2) more timely information on air toxics, and (3) information on air toxics at low levels. For example, we reported that there was a need for more information about levels of air toxics near identified cancer clusters, environmental justice areas, industrial facilities, and other potential hotspots, according to stakeholders, regional associations, and EPA, state, and local officials. We also reported that more timely information on air toxics would help reduce risks from and understand sources of air toxics, according to some of these sources. Most air toxics samples are sent to laboratories for analysis, which takes time. In addition, monitoring for air toxics often uses canisters that capture a sample of air over a defined amount of time, such as over a 24-hour period. This approach can make it difficult to understand which sources emitted the air toxics affecting that location throughout the day.

3. **Protecting our Nation's air resources is no small feat. The National ambient air quality monitoring system, which relies on a collaboration between the Federal, tribal, state and local governments, provides data that informs the implementation of the Clean Air Act and the management of our Nation's public health. The network of over 4,000 sites has been in use since the 1970s and the current systems are deteriorating, making it difficult to track poor air quality. Yet, GAO has noted that annual EPA funding for state and local air quality management grants have decreased by roughly 20 percent since 2004. That is why my bill would increase the funding for air monitoring so that we can repair or replace old equipment and increase the sites we are monitoring significantly.**

[2] GAO-21-38

Director Gomez, will you speak to the importance of sufficient funding for EPA to facilitate its Air Quality Monitoring Programs effectively and how a lack of funding to these programs and equipment could put public health at risk?

GAO Response: We reported that EPA and state and local agencies faced challenges related to sustaining the national ambient air quality monitoring system.[3] These challenges included declining funding and increasing demands on resources available for monitoring. From 2004 to 2019, federal funding for state and local monitoring programs declined by nearly 20 percent after adjusting for inflation, and state and local funding for these programs also generally declined. Concurrently, we reported that EPA and state and local agencies faced increasing demands on these limited resources, including aging monitoring infrastructure and rising operating costs, and that state and local governments face challenges in replacing aging monitoring equipment.

Our November 2020 report also stated that, according to EPA officials, aging infrastructure can affect the quality of the air pollution data from the monitors. For example, EPA officials we interviewed for the report said that several states had to invalidate ozone data for 2015 and 2016 because old calibration equipment affected the quality of the data, leading to significant costs from the loss of valuable data. Furthermore, we reported that aging equipment creates challenges, such as equipment no longer being serviced by the manufacturer or extra time and resources needed to maintain the equipment, according to some state and local agency officials.

We also reported that EPA had initiated efforts that partially address these challenges, but its efforts had been inconsistent across regions. As we noted in the report, an asset management approach to managing the monitoring system could provide opportunities for EPA to address the challenges more consistently.

EPA officials told us that they believe the agency needs to more effectively plan for and invest in sustaining the monitoring system as a national asset in which the public has confidence. We recommended that EPA work with state and local agencies to develop, make public, and implement an asset management framework that includes key characteristics such as identifying resources needed to sustain the monitoring system, using quality data to manage infrastructure risks, and targeting resources toward assets that provide the greatest value. In doing so, EPA could better ensure that limited monitoring resources are targeted toward the highest priorities for consistently sustaining the monitoring system.

4. **As required by the Clean Air Act, the EPA makes decisions based on the data received from its air quality monitoring network. For several years, the EPA has struggled to produce reliable data and would benefit from Congressional direction to modernize air quality monitoring frameworks. By developing a modernization strategy that incorporates the most up to date practices and technologies for air quality monitoring, the EPA would position itself to acquire more accurate and reliable air quality data. This data is essential in formulating many of EPA's decisions, evaluating their impact, and determining future strategies to protect public health.**

   Director Gomez, can you elaborate on the challenges GAO has found that the EPA faces in acquiring reliable air quality data and what, in your opinion, would help ease that difficulty?

   GAO Response: While our November 2020 report did not assess the reliability of air quality data, we reported that aging infrastructure can affect the quality of monitoring data, according to EPA officials,

[3] GAO-21-38

and that EPA and state and local agencies faced challenges in sustaining the monitoring system. We recommended that EPA work with state and local agencies on an asset management framework for the monitoring system to better ensure that limited resources are directed toward the highest priorities for consistently sustaining the monitoring system.

Furthermore, we reported that EPA and state and local agencies faced challenges in providing needed air quality information to better understand and address the health risks from air pollution. These challenges included:

- Establishing priorities for air toxics monitoring, such as by identifying the air toxics that present the highest public health risks and anticipating emerging air toxics issues.
- Developing and improving air quality monitoring methods to, for example, help ensure the availability of cost-effective methods and methods capable of detecting air pollution of levels low enough to understand health effects.
- Integrating emerging technologies—such as low-cost sensors and satellites—into the monitoring system. Challenges include understanding the performance of low-cost sensors and communicating differences in low-cost sensor performance.
- Managing increasing amounts of air quality data that challenge the capabilities of current data management systems.

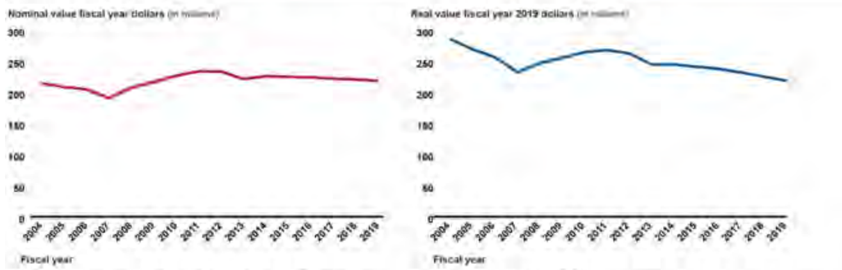
While EPA had strategies aimed at better meeting needs for additional air quality information, we reported that the strategies were outdated and incomplete. We recommended that EPA work with state and local agencies to develop a plan to modernize air quality monitoring. Such a plan could help EPA optimize the value of the monitoring system by better ensuring it meets additional information needs and is positioned to protect public health as future air quality issues emerge.

Additional Information for the Record

Mr. Gomez stated at the July 13, 2022 hearing that GAO could submit for the record more details about the annual amount of federal grant funding that EPA provided for air quality management programs, which includes the national ambient air quality monitoring system, between 2004 and 2019 (see p. 46 of the attached transcript). The remainder of this response provides that information.

We reported in November 2020 that the annual amount of federal grant funding that EPA provided for air quality management programs, which includes the national ambient air quality monitoring system, had remained relatively level between 2004 and 2019, varying from a low of approximately $190 million in 2007 to a high of approximately $230 million in 2011 and 2012. When adjusted for inflation, the amount of federal funding available for these grants declined on average by approximately $4 million per year between 2004 and 2019, resulting in an approximately 20-percent decrease in purchasing power for state and local agencies over this period. Figure 7 from GAO-21-38 is also shown below.

Annual EPA Grant Funding for State and Local Air Quality Management, Which Includes Air Quality Monitoring



Note: The funding presented in this figure includes grants authorized under Sections 103 and 105 of the Clean Air Act. EPA provides this funding for air quality management programs, which includes air quality monitoring. Other activities funded by these grants include states' development of required programs, including air pollution emission control programs, to achieve attainment of the National Ambient Air Quality Standards. Real values are values adjusted for inflation and expressed in 2019 dollars using the U.S. Gross Domestic Product Price Index from the U.S. Department of Commerce, Bureau of Economic Analysis.

Senator CARPER. Great, thanks so much for doing that. From time to time, I say to my staff when we are dealing with a particular issue or challenge, I ask them to help make me or a committee or the Senate a guided missile, as opposed to an unguided missile. What I think I read in listening to your testimony and preparing for this hearing, my sense is that what you are trying to do, what GAO is trying to do here, is help make us a guided missile as we face what is a real challenge, but an opportunity as well.

As I mentioned in my opening statement, GAO found that some of the air monitoring technology in use in our Country is so outdated that air officials have to resort to eBay to purchase equipment because the manufacturer has discontinued the needed parts. I am struck, in fact, I am disappointed by this story, and what it tells us about the State of air quality monitoring systems, I think, and my colleagues ought to be, as well.

Are you able to tell us more about this story, or share with us any other anecdotes that you and your team heard directly from air agency officials? Was this a unique incident, or does this story reflect a pattern in the challenges of our air agencies across the Country that they are facing?

Mr. GOMEZ. Thank you for that question, Chairman Carper, and yes. This is an aging infrastructure, as we have been talking about. Those were the stories that we have heard. We have heard other stories where the air conditioning, for example, failed. There were leaking roofs. One of the States told us how they had to throw away a whole week of data because the air conditioning wasn't working, and it affected the measurements that they were collecting.

That is one of the challenges that we heard across the board from State and local air quality monitoring agencies. It is just an old system that needs to be updated, which is consistent with our recommendation, as why we told the EPA, we really need to modernize the system, figure out what you need, what the resources are, and put that into place, and really to partner with the State and local agencies who are really the ones operating the system.

Senator CARPER. That is a good point. Thank you.

Second question: GAO's report found that Federal funding for State and for local air monitoring programs has declined by about 20 percent over the last 16 years, adjusted for inflation. At the same time, air agencies at the Federal, at the State, and local levels are facing rising costs associated with maintaining aging, inefficient infrastructure, purchasing new, more expensive equipment, and staffing needs.

Given the dire financial situation, many air monitoring programs find themselves in it appears that additional Federal funding may well help to alleviate much, not all, but much of the strain that these agencies are facing. Would additional funding for updating our Nation's air quality monitoring systems help address some of the challenges found in GAO's report?

Mr. GOMEZ. Right. So, that is exactly what we learned when we looked at the funding across the last 15 years, that it had decreased by 20 percent. We did hear from local and State agencies and from EPA, that more resources would help them do the job. Again, I go back to our recommendation. It is really up to EPA as they modernize the system to identify what resources they need and come forward to Congress with that.

Senator CARPER. OK. My last question deals again with monitoring of air toxics. I believe that GAO found EPA's strategies for air toxic and local monitoring were, I think this is a correct quote, "outdated and incomplete." I think that is the correct quote. Briefly, based on the GAO report, what are the greatest gaps in how EPA currently monitors for air toxics in local air pollution, and how could Congress help address these gaps?

Mr. GOMEZ. Sure. So, in the areas of air toxics, we did find where there are additional information needs for air toxics in key locations, such as identified cancer clusters and environmental justice areas around industrial facilities. There is also a need for timely information on air toxics. What I mean by that is currently, when you monitor air toxics, the samples are collected in canisters over a 24-hour period. They are sent to the lab. So, there is really a lack of information for real-time, exactly when do those elevated readings happen, for example.

Then, there is also information, as I noted in my opening statement, about air toxics at low levels. So currently, the methods that we have for analyzing toxic samples, they are not sensitive enough at these low levels to detect and see if, in fact, these things might be causing bad health effects.

Senator CARPER. Thanks so much. Senator Capito.

Senator CAPITO. Thank you, and thank you for coming before the committee, and thank you for your work at GAO.

I would like to go to the two recommendations that you mentioned in your statement. You mentioned for EPA to develop and implement an asset management framework for National Ambient Air Quality monitoring systems, and second for EPA to develop and make public an air quality modernization plan. You addressed this a little bit.

I am wondering, what has EPA done, your study came out 2 years ago, in the last 2 years to implement your recommendations?

Mr. GOMEZ. Yes, thank you for that question, Senator Capito. We do followup with our recommendations. First of all, EPA agreed with those recommendations. They have been meeting and working with their local and State partners. They have plans already in place to develop an asset management framework, which we think would be really useful, as that would allow them to focus their limited resources on the highest priorities.

We understand, at the upcoming conference that EPA is having next month on air quality monitoring in Pittsburgh, our report and our recommendations are part of the discussion as they partner with State and local folks to figure out the bigger job on a modernization plan. We are touching base with them and following up, so we are hopeful that those recommendations will be implemented, as well.

Senator CAPITO. Let me ask you a question on the modernization plan. Let me ask first about the funding issue. It was 20 percent down, funding since 2004, adjusted for inflation. Is that real dollars down, or is that, I don't have the figures in front of me. Has the amount gone up, or just hasn't gone up as much to keep up with inflation, or how is that?

Mr. GOMEZ. Sure. So, when we did the report in 2020, we looked back 15 years. What we found was that, for that time period, there was a decrease in funding of 20 percent while controlling for inflation. We can also submit for the record the more details about those numbers.

Senator CAPITO. OK. So, I guess what I am wondering is, why do you think EPA, with knowing, you cited some of the real physical problems, lack of air conditioning and things of that nature, why do you think they haven't already moved to a modernization where you can have low-cost monitoring, you can reshape? Do you think it is a bureaucracy that is kind of immovable, or you like to do it the way it has always been and think it is accurate? Are States resisting? Where do you think the real problems are with why they haven't already moved to a modernization plan 10 years ago?

Mr. GOMEZ. I think it is a variety of issues. This is an aging infrastructure. It is fairly complex, and many different networks. You can look at our statement and our report. There are thousands of monitors across the Country.

Now, EPA has been working with its local and State partners, especially as they are looking at these low-cost sensors to figure out where they can be deployed, what the particular uses of them could be. We just didn't see an overall plan, where they are really focusing on this aging infrastructure, and really coming up with ways to modernize it. Again, they are supportive, they are moving in that direction, so we are hopeful to see that come about.

Senator CAPITO. Well, I would hope sooner. You mentioned it, and I just caught what you said in your opening statement. I went back and tried to find it, but I couldn't find it. You said something about an incomplete list as to what is more toxic than, can you go back to your statement and read that?

Mr. GOMEZ. Let's see. If it was about air toxics——

Senator CAPITO. Yes, and you started—I do have the quotes on here about an incomplete list.

Mr. GOMEZ. With air toxics, it was more that EPA needs to better understand the hotspots, like cancer clusters. It could also help promote environmental justice by highlighting where the pollutants are concentrated.

Essentially, there is just a need for additional information when it comes to air toxics, like more local-scale information about where those hotspots are, and then also the timing information in real time.

Senator CAPITO. Maybe I was thinking what you were saying is that local and State authorities working with the EPA don't have a clear view of what is the most toxic, or what the toxicity level of certain things, that is not what you are saying.

Mr. GOMEZ. No, I mean, there are already 188, I believe, air toxics that have been identified. It is more the measurement of these toxics in particular locations that is needed.

Senator CAPITO. OK, I heard that wrong, because I thought what you were saying was that the EPA hasn't provided the data to the local and States to say, this type of toxin is more critical or should be monitored more.

Mr. GOMEZ. So, that is one of the challenges, prioritizing air toxics.

Senator CAPITO. Yes, that was the incomplete list.

Mr. GOMEZ. There is a need for EPA to figure out which air toxics need priority, because of a lack of information, so that is why we are saying there is information that is needed so that the agency can begin to prioritize which air toxics they should monitor.

Senator CAPITO. Yes, well it seemed to me that would be a critical responsibility for the EPA, in my view, should already be pretty apparent with all the science and data that they generate. Thank you very much.

Senator CARPER. Senator Capito, thanks very much.

We have been joined, as you may have noticed, Mr. Gomez, by several of our colleagues. Senator Whitehouse has been able to come and stay for a bit. He has to leave very shortly. Senator Ernst from Iowa just joined us.

We all serve on multiple committees and subcommittees, and for some reason, a lot of them are meeting right now at the same time, so folks are coming and going. Senator Padilla from California joined us by WebEx for an earlier part of the hearing, including your testimony, and Senator Cardin has joined us and had to leave and go to another meeting that he is scheduled to have at the same time.

I am going to do something, since we have an extra minute or two here, that I don't often do, but I want to do it right now. Is there a question that you wish you had been asked by somebody on our committee? Is there a question that you wish you had been asked by somebody on our committee, and what would that question be?

Mr. GOMEZ. Sure. I would say, again, there is a lot of information needs for air toxics, as we were just talking about them, information about air toxics in key locations, more timely information on air toxics, and then also, again, being able to have analysis methods so that you can get measurements for them.

The other question, maybe, that we haven't talked about as much is about these low-cost sensors, because low-cost sensors are widely available. GAO, as part of our report, purchased some of these low-cost sensors, and we actually deployed them outside the building because we wanted to test them to see——

Senator CARPER. Outside this building?

Mr. GOMEZ. Outside the GAO building, we put our low-cost sensors to see what kind of information we got. This was for PM 2.5. This is one of the things that we have reported on, that there is a need for more work in looking at the quality and performance of the sensors, because we had two sensors, different sensors, and they gave us different measurements. It is a question about, what do you do with the data, do they need to be calibrated, so that is something that EPA, again, is focused on, because low-cost sensors do provide a lot of information and are widely available now. We need to figure out where we can use them and how we can use them.

Senator CARPER. Good. Thank you. Thank you for asking and answering the same question. Not every witness gets that opportunity. To our friends at GAO and to our Comptroller General, our best regards and thanks for all the good work that you and your colleagues do. Thank you so much.

Mr. GOMEZ. Thank you.

Senator CARPER. And I am sure we will have some questions for the record, so we look forward to your responses. Thank you.

All right, our third and final panel for the morning. Let me introduce and welcome four witnesses: Kathy Fallon, Hon. Jason Isaac, Dana Johnson, and Bart Eklund. We thank you all for joining us today and for appearing.

OK, I understand that Kathy Fallon is joining us virtually, and I understand that Dana Johnson is joining us virtually. We have, live and in person, Jason Isaac and Bart Eklund, who is named after the Bay Area Rapid Transit Authority.

[Laughter.]

Senator CARPER. I was a Naval flight officer stationed at Moffett Field, California. I used to occasionally travel on your systems. It is nice to see what you look like in person.

[Laughter.]

Senator CARPER. Kathy entered a bio by way of introduction. Kathy Fallon, joining us remotely, is currently serving as the Director of Land and Climate at Clean Air Task Force in Boston Massachusetts. Prior to joining Clean Air Task Force, Ms. Fallon was a senior advisor at the Center for Climate Health and Global Environment at Harvard, T.H. Chan School of Public Health.

Ms. Fallon, you may begin your statement at this time. Thank you for joining us remotely.

STATEMENT OF HON. KATHY FALLON, DIRECTOR OF LAND AND CLIMATE, CLEAN AIR TASK FORCE

Ms. FALLON. Thank you, Chairman Carper, Ranking Member Capito, and members of the committee for the opportunity to testify today.

I am Kathy Fallon. I am Director of Land and Climate at the Clean Air Task Force, which is an environmental organization founded in 1996 to curb air and climate pollution through policy and——

Senator CARPER. Kathy, where are you today?

Ms. FALLON. I am actually sitting in the Town of Hartland, Vermont.

Senator CARPER. All right. Why?

Ms. FALLON. Interestingly, I hail from Maine, and my family is from Rumford, Maine, where apparently, Senator Collins celebrated the Clean Air Act.

Senator CARPER. That is great. Small world, small world. Go right ahead. Sorry to interrupt.

Ms. FALLON. Small world indeed. Thank you. The Clean Air Task Force strongly supports all three bills before the committee today. There is an urgent need to improve air quality monitoring, especially in overburdened and underserved communities, as called for in the Environmental Justice Air Quality Monitoring Act and in the Public Health Air Quality Act. My oral testimony today will focus on the comprehensive National Mercury Monitoring Act.

Here are my key takeaways: mercury poses serious health risks, and millions of Americans are exposed to elevated methylmercury through fish consumption. Remarkable progress has been made in reducing mercury emissions in the U.S., particularly from power plants, and that has brought the American public major health benefits. Despite this progress, mercury pollution remains a widespread problem, due in part to the long-range transport of mercury emissions from China.

Unfortunately, about half of our mercury deposition monitoring sites have closed due to lack of funding, and there is no federally supported long-term mercury monitoring for fish and wildlife and water. The problem hasn't been solved, and the nature of the problem is changing, and it is more important than ever to establish and fund a National Mercury Monitoring Network.

Mercury in the form of methylmercury can lead to lost IQ, impaired motor function, and cardiovascular disease, including risk of stroke and fatal heart attacks at elevated levels. Approximately 200,000 children are born in the U.S. each year exposed to elevated methylmercury at levels that exceed EPA's reference dose. Unfortunately, there is no threshold below which neurodevelopmental impacts don't occur.

Most people are exposed to methylmercury through fish consumption. Sensitive populations include the developing fetus, pregnant women, women of child-bearing age, and people who consume a lot of fish. This can include people from households with lower incomes and education levels, as well as high-income populations and individuals from several non-white racial and ethnic groups, as detailed in my written testimony.

Most of the methylmercury in fish originates from air emissions. Mercury, once emitted, can be transported locally or globally, depending on its form, and methylmercury is staggering in its ability to bioaccumulate in food chains. It can reach levels 100 million times higher in fish than levels in water.

Unfortunately, mercury is also somewhat of an equal opportunity contaminant. Any watershed anywhere with the right conditions, like areas in rural Maine with lots of forest cover and wetlands, can have high mercury levels in fish and wildlife, even if they are far from sources and have relatively low mercury inputs.

Remarkable progress has been made in cutting mercury emissions from the U.S. In fact, coal-fired power plants have cut their mercury emissions by an incredible 90 percent. Despite this progress, though, the total mercury deposited to the U.S. has shown only modest improvements and may be increasing in some areas, but we don't know, for lack of monitoring. According to the most recent compilation in 2013, fish consumption advisories for mercury still exist in all 50 States.

Here are three of the reasons why mercury pollution is still a problem. Global emissions, particularly emissions from China, have increased, offsetting the benefits of emissions reductions here at home. Climate change is making the problem worse. Mercury is being released from thawing permafrost and by more frequent wildfires, and it is bioaccumulating to higher levels as waters warm. Third, there are sensitive watersheds across the U.S. where even a small amount of mercury can have a large impact.

Mercury monitoring today is pieced together with annual funding from various sources. Funding levels have fluctuated over time, and we have lost about half of our mercury deposition monitoring sites, so that we can no longer even produce a map of deposition for the whole Country. There are large gaps in Western States and in Gulf States.

Also, even though fish consumption is the dominant pathway of human exposure, there is no coordinated national long-term mercury monitoring for fish and water.

To wrap up, given the hazardous nature of mercury pollution, it is wonderful that we have made so much progress here in the U.S., but the problem hasn't been solved, and the nature of the problem is changing. It is more important than ever to establish and fund a national mercury monitoring so that the American public can know where it is a problem and where it is not and can make informed choices about mercury exposure and their health; so that environmental managers can determine whether to delist water bodies that may no longer be impaired by mercury or to list new ones that now are'; and so that policymakers have the data needed to understand how the American public is being impacted by mercury emissions that originate from outside our borders.

Thank you for the opportunity to testify.

[The prepared statement of Ms. Fallon follows:]

Testimony before the United States Senate Committee on Environment and Public Works

A Legislative Hearing to Examine S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021; and S. ___, the Public Health Air Quality Act

Testimony of Kathy Fallon, Director of Land and Climate
Clean Air Task Force

July 13, 2022

1. Introduction

Thank you, Chairman Carper, Ranking Member Capito, and members of the committee for the opportunity to testify in support of Senate Bills S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021; and S. ___, the Public Health Air Quality Act.

My name is Kathy Fallon, and I am the Director of Land & Climate at Clean Air Task Force (CATF), a nonprofit environmental organization founded in 1996 that works to curb air and climate pollution through policy and technology innovation. CATF was founded in the U.S. and is now a global organization. We have offices in Boston, Washington D.C., and Brussels, with staff working remotely around the world. Our scientific staff have expertise encompassing all three bills under consideration, with detailed understanding of the sources, fate and transport, measurement methods and the human and environmental health effects of air pollutants including mercury, air toxics, criteria pollutants, and greenhouse gases.

Prior to joining CATF earlier this year, I spent over twenty years working on air quality, the cycling of pollutants such as mercury, and the effects of air pollution on people and the environment. I have served as executive director of the Hubbard Brook Research Foundation—the research site where acid rain was first documented in North America, as the Science and Policy Integration Program Director at the Harvard Forest of Harvard University, and as a Senior Advisor at the Center for Climate Health and the Global Environment at the Harvard T.H. Chan School of Public Health. I have co-authored more than a dozen peer-reviewed journal papers and reports on mercury and its effects.

Collectively, these three bills would provide funding to establish and expand the nation's pollution monitoring capabilities and provide communities with data to quantify their risk from exposure to potentially harmful contaminants. While a robust monitoring network currently operates to assess criteria pollutant concentrations in ambient air, the network does not characterize the full spatial and temporal variations in pollution experienced by individuals at the neighborhood level. Accurately characterizing local conditions is especially important for communities that experience elevated air and mercury pollution. This includes overburdened and underserved communities near major point sources and highways as well as people who live remote from sources and consume fish from waters that are contaminated by the long-range transport of mercury.

2. S. 1345, the Comprehensive National Mercury Monitoring Act

a. Mercury Synopsis

The National Comprehensive Mercury Monitoring Bill would establish and, for the first time, fund an air, water, and fish and wildlife monitoring network for mercury. Mercury is a hazardous air pollutant that causes neurocognitive impairment and other harmful health impacts at elevated levels. Mercury monitoring has been pieced together with annual funding from state agencies, universities, and nonprofit organizations. Funding levels have fluctuated over time and the number of air quality and deposition sites monitoring mercury has been cut by one-third or more since 2010.[1] Moreover, while fish consumption is the primary pathway of human exposure, there is no coordinated, national long-term monitoring program for mercury in water or fish in the U.S.

While the U.S. has made remarkable progress in reducing mercury emissions over the past two decades, it is more important than ever to fund mercury monitoring due to (1) rising global mercury emissions, (2) changes in energy generation with energy security concerns, (3) climate change impacts on mercury cycling, (4) the persistence of sensitive watersheds where a small amount of mercury has large impacts, (5) disparities in mercury exposure among people with lower incomes and education levels as well as those from certain ethnic and racial groups in the U.S., and (6) growing knowledge about mercury's health impacts, including its effects at low concentrations.

b. How does mercury harm people and the environment?

Health effects

Mercury, in the form of methylmercury, is a potent neurotoxicant with harmful health effects for children and adults, including lost IQ, motor impairment, and cardiovascular disease. Importantly, no known threshold exists for methylmercury below which neurodevelopmental impacts do not occur.[2]

Children exposed to methylmercury during a mother's pregnancy can experience persistent and lifelong IQ and motor function deficits.[3] Based on blood mercury levels in women of childbearing age from the Centers for Disease Control between 2001-2018, approximately 100,000 to 300,000 children born in the United States each year are exposed to mercury levels that exceed EPA's Reference Dose (RfD) for methylmercury.[4] The societal costs of neurocognitive deficits associated with methylmercury exposure in the U.S. were estimated in 2017 to be approximately $4.8 billion per year.[5]

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[1] Sites in the Mercury Deposition Network (MDN) dropped from 120 sites in 2010 to about 80 today. Similarly, the number of sites in the atmospheric mercury monitoring network (AMNet) has declined from a high of 26 sites in 2016 to fewer than 15 in 2022. National Atmospheric Deposition Program (NADP), Program Office Report: 2022 Spring Meeting. Joint Subcommittee, D. Gay (2022), https://nadp.slh.wisc.edu/spring2022/.

[2] Glenn E. Rice et al., *A probabilistic characterization of the health benefits of reducing methyl mercury intake in the United States*, 44 Env't Sci Tech. 5216 (2010); Phillipe Grandjean & Martine Bellanger, *Calculation of the disease burden associated with environmental chemical exposures: application of toxicological in health economic estimation*, 16 Env't Health, no. 123, 2017.

[3] Phillipe Grandjean & Martine Bellanger, *Calculation of the disease burden associated with environmental chemical exposures: application of toxicological in health economic estimation*, 16 Env't Health, no. 123, 2017; Driscoll et al. Mercury Matters: A Science Brief for Journalists and Policymakers. 2018. https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2238/2018/12/Mercury-science-backgrounder_final1.pdf

[4] Center for Disease Control (CDC), National Health and Nutrition Examination Survey (2021). https://wwwn.cdc.gov/nchs/nhanes/; Elsie Sunderland et al., *Mercury Science and the Benefits of Mercury Regulation*, Harvard T.H. Chan School of Public Health, Center for Climate Health and the Global Environment (Dec. 16, 2021), https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/12/Mercury_WhitePaper_121621.pdf.

[5] Grandjean, *supra* note 3.

Although many studies of methylmercury toxicity focus on prenatal exposure, effects of adult exposures have also been documented, such as accelerated age-related declines.[6] Fine-motor function and verbal memory are compromised among adults who are exposed to elevated amounts of methylmercury.[7] Adults with high levels of methylmercury exposure can also experience cardiovascular effects, including increased risk of strokes and fatal heart attacks.[8] Other adverse health impacts of methylmercury exposure that have been identified in the scientific literature include endocrine disruption, diabetes risk, and compromised immune function.[9,10,11]

Populations that are sensitive to adverse health effects from methylmercury include the developing fetus, pregnant women and women of childbearing age, and adults who frequently consume fish and seafood. High fish consumers include people from households with lower incomes and education levels, people with higher incomes, and individuals from the following ethnic groups: Asian, Pacific and Caribbean Islander, Native American, Alaska Native, and those who identify as multi-racial.[12] Wildlife can also suffer the effects of mercury contamination—particularly those that depend on fish, such as the common loon and the bald eagle.

Exposure pathway

The dominant pathway of methylmercury exposure for people in the U.S. is the consumption of contaminated fish and seafood (fish and shellfish). The consumption of marine fish, often harvested from U.S. coastal waters, accounts for more than 80 percent of methylmercury intake by the general U.S. population.[13] Yet, millions of recreational and subsistence anglers who consume freshwater fish are among the most highly exposed populations.[14]

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[6] Deborah Rice & Stan Barone Jr., *Critical periods of vulnerability for the developing nervous system: Evidence from humans and animal models*, 108 Env't Health Persp. 511 (2000).

[7] Edna M. Yokoo et al., *Low level methylmercury exposure affects neuropsychological function in adults*, 2 Env't Health, no. 8, 2003.

[8] Giuseppe Genchi et al., *Mercury Exposure and Heart Diseases*, 14 Int'l J. Env't Rsch. Pub. Health 74 (2017); Elsie Sunderland et al., *Mercury Science and the Benefits of Mercury Regulation*, Harvard T.H. Chan School of Public Health, Center for Climate Health and the Global Environment (Dec. 16, 2021), https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/12/Mercury_WhitePaper_121621.pdf.

[9] Shirlee W. Tan et al., *The endocrine effects of mercury in humans and wildlife*, 39 Critical Rev. Toxicology 228 (2009).

[10] Ka He et al., *Mercury exposure in young adulthood and incidence of diabetes later in life: the CARDIA trace element study*, 36 Diabetes Care 1584 (2013).

[11] Jennifer F. Nyland et al., *Biomarkers of methylmercury exposure and immunotoxicity among fish consumers in the Amazonian Brazil*, 119 Env't Health Persp. 1733 (2011).

[12] Elsie Sunderland et al., *Mercury Science and the Benefits of Mercury Regulation*, Harvard T.H. Chan School of Public Health, Center for Climate Health and the Global Environment (Dec. 16, 2021), https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/12/Mercury_WhitePaper_121621.pdf; Susan Silbernagel et al., *Recognizing and preventing overexposure to methylmercury from fish and seafood consumption: information for physicians*, J Toxicol. 2011 (Jul. 12, 2011).

[13] Elsie Sunderland et al., *Changes in the Edible Supply of Seafood and Methylmercury Exposure in the United States*, 126 Env't Health Persp., no. 1, 2018.

[14] Katherine von Stackelberg et al., *Results of a national survey of high-frequency fish consumers in the United States*, 158 Env't Rsch. 126 (2017).

The problem of elevated fish mercury levels is widespread across the U.S. The most recent national compilation of waterbodies that are listed by states as impaired is for the year 2011 and was published in 2013. At that time consumption advisories for mercury were in effect in all 50 states, one U.S. territory, and three tribal territories, and accounted for 81 percent of all U.S. advisories.[15] This constitutes more advisories for mercury than for all other contaminants combined.

Fate and transport

The primary pathway by which mercury enters the environment is air emission. The major sources of air emissions in the U.S. include coal-fired electric utilities and "other industrial process" as well as smaller sources such as electric arc furnaces used in steel production, and waste disposal.[16] Globally, the largest sources of mercury air emissions are small-scale gold mining operations, coal-fired power plants, and ferrous metal and cement production.[17] The countries of China, India, and Indonesia were reported to be the top three emitters in 2015 of total mercury.[18]

Once emitted to the atmosphere, mercury can travel anywhere from several hundred yards to hundreds of thousands of miles, depending on the species of mercury.[19] Eventually, it deposits onto the landscape in rain, snow, or aerosols or dust. Once deposited, mercury makes its way into soils and surface waters, where it can be converted into methylmercury—the only form that bioaccumulates in food chains. Through bioaccumulation, methylmercury can reach levels in fish tissue that are 100 million times higher than the concentrations in water—so even small amounts of mercury can have large impacts.[20]

c. How have mercury levels changed?

Important progress has been made in decreasing mercury emissions in the U.S. in recent years. The National Emissions Inventory shows that annual U.S. mercury emissions declined more than

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[15] U.S. EPA, 2011 National Listing of Fish Advisories, EPA-820-F-13-058 (Dec. 2013), https://19january2017snapshot.epa.gov/sites/production/files/2015-06/documents/technical-factsheet-2011.pdf.

[16] U.S. EPA, National Emissions Inventory (NEI) (2020), https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-documentation.

[17] United Nations Environment Programme (UNEP), Global Mercury Assessment 14 (2018), https://www.unep.org/globalmercurypartnership/resources/report/global-mercury-assessment-2018.

[18] UNEP, Global mercury assessment, https://www.unep.org/explore-topics/chemicals-waste/what-we-do/mercury/global-mercury-assessment (last accessed July 8, 2022).

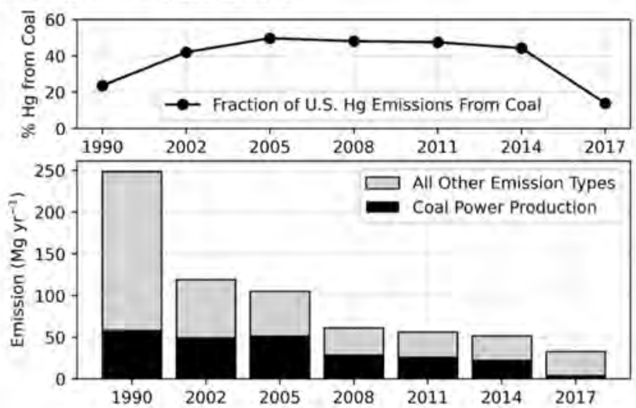
[19] Mercury can be emitted to the atmosphere as elemental mercury, reactive gaseous mercury, or particulate mercury. Gaseous and particulate mercury are oxidized forms that are more chemically reactive and soluble in water, so they have lower residence times on the order of hours to days and tend to deposit locally and regionally. Elemental mercury is more inert with a residence time on the order of approximately 6 months and is therefore capable of long-range global transport. Once mercury is emitted and deposited, it can also be re-emitted so it can persist in the environment for centuries to millennia.

[20] H. Chan et al., *Impacts of Mercury on Freshwater Fish-eating Wildlife and Humans*. Human and Ecological Risk Assessment, Jun 18, 2010, https://www.tandfonline.com/doi/abs/10.1080/713610013; Celia Chen et al., *Marine mercury fate: From sources to seafood consumers*. Env't Rsch. (Oct. 13, 2012), https://pubmed.ncbi.nlm.nih.gov/23121885/.

four-fold between 1990 and 2017.[21] Mercury emissions from electricity generating units (EGUs) decreased by 90 percent during that period.[22] The reduction in emissions from EGUs in the U.S. resulted in widespread reductions in utility-attributable mercury deposition with an average decrease in the contiguous U.S. of 90 percent.[23] As a result of the success of domestic mercury regulations and emissions control strategies, the fraction of mercury deposition in the U.S. from U.S. emission sources has decline from a surface area-weighted mean of 23-35 percent of total deposition in 1990 to 1-5 percent in 2020.[24]

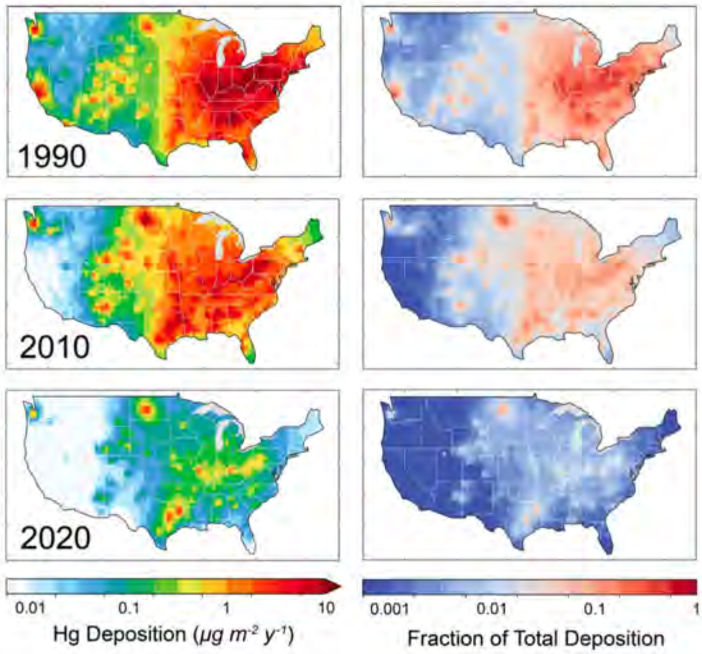
Figure 1. United States mercury emissions (1990 - 2017).

Bottom: Annual mercury emissions from coal-fired power plants (*black*) and total U.S. emissions (*black + gray*). Top: the fraction of total domestic emissions from coal combustion. Data is from the U.S. EPA *National Emissions Inventory.*[25]



[21] Connor I. Olson et al., *Mercury emissions, atmospheric concentrations, and wet deposition across conterminous United States: changes over 20 years of monitoring*, 7 Env't Sci. & Tech. Letters 376 (2020).
[22] U.S. EPA, NEI (2017), https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.
[23] Elsie Sunderland et al., *A Template for a State-of-the-Science Assessment of the Public Health Benefits associated with Mercury Emissions Reductions for Coal-fired Electricity Generating Units*, Harvard Chan C-CHANGE White Paper (2022), https://www.hsph.harvard.edu/c-change/news/mercury-emissions-reductions/.
[24] Sunderland, *supra* note 13, at 16.
[25] Sunderland, *supra* note 13, at 14.

Figure 2. Simulated mercury deposition to U.S. ecosystems resulting from electric power generation (*left*) and the utility attributable deposition fraction (*right* for 1990, 2010, and 2020.[26]



These declines in U.S. mercury emissions and deposition associated with EGUs have produced substantial health benefits. New modeling analysis suggests reductions in power plant mercury emissions between a 2008-2010 baseline and 2020 produced the following health benefits[27]:

- Blood mercury levels in 60,000 to 100,000 women of childbearing age (16-49) dropped from above to below levels associated with the EPA RfD.
- As a result, 3,700 to 5,600 fewer babies are born per year with exposures above the RfD.
- Lower incidence of neonatal exposure led to 1900 fewer IQ points lost annually.
- 380,000 fewer adults experience increased risk of ischemic heart disease due to methylmercury exposure.
- 160,000 fewer individuals face increased risk of cardiovascular mortality.
- $1.2 to $1.5 billion in monetized health benefits due to reduced IQ deficits and cardiovascular mortality.

[26] Sunderland, *supra* note 13, at 16 (simulations based on the new atmospheric chemistry described in Viral Shah et al., *Improved mechanistic model of the atmospheric redox chemistry of mercury*, 55 Env't Sci. & Tech. 14445 (2021)).

[27] Sunderland, *supra* note 23.

d. Why is mercury still a concern and why is monitoring needed?

Despite the substantial progress in reducing mercury emissions from sources in the U.S., mercury remains an important problem and health concern in need of federal funding for a national monitoring network for the following reasons:

i. Global mercury emissions, particularly from Asia, increased during the same period that electric utilities in the U.S. dramatically reduced their emissions. The most recent Global Mercury Assessment of 2018 reports that mercury emissions declined between 2010 and 2015 in North America and the European Union but increased in all other regions, with the largest increase by volume occurring in East and Southeast Asia and the highest emissions originating in China.[28] Given the long-range transport of mercury, these global emissions trends contribute to total mercury deposition in the U.S., offsetting some of the important reductions associated with declines in U.S. emissions. These trends raise renewed concerns about mercury deposition and its effects on fisheries and people who consume fish from U.S. waters. Mercury monitoring is needed to track these changing global emissions and their impact on atmospheric deposition, to understand the implications for exposure and health risks in the U.S., and to distinguish the impacts of global sources from U.S. sources.

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[28] UNEP, Global Mercury Assessment. (2018). https://www.unep.org/globalmercurypartnership/resources/report/global-mercury-assessment-2018.

Figure 3. Decadal *(left)* and annual *(right)* changes in global emissions of mercury from anthropogenic sources.[29]

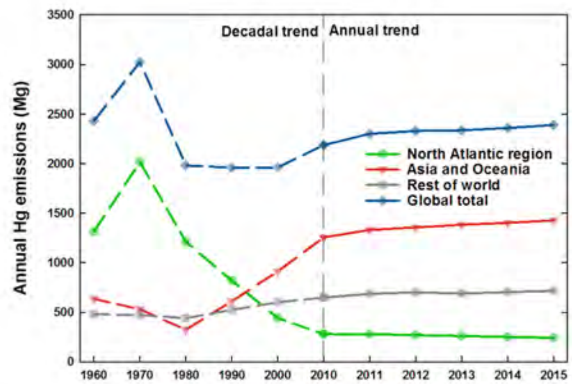
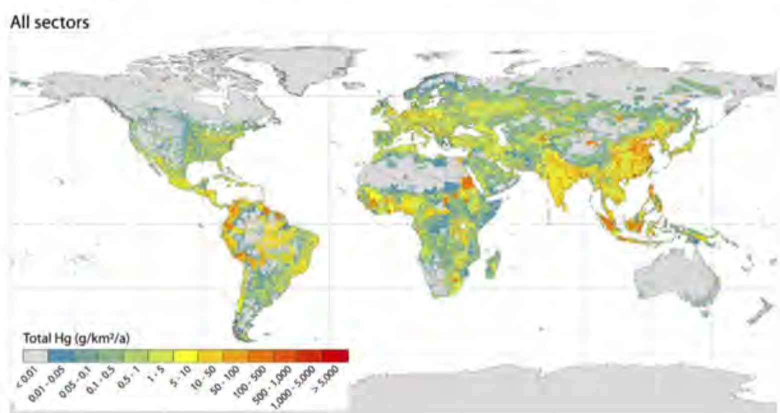


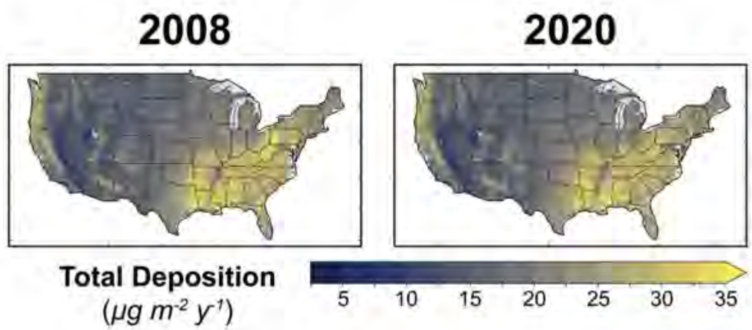
Figure 4. Spatial distribution (total) mercury emissions to air from anthropogenic sources in 2015 in kilograms per square kilometer per year.[30]



[29] David G. Streets et al., *Global and regional trends in mercury emissions and concentrations, 2010–2015,* 201 Atmospheric Env't 417 (2019).

[30] Frits Steenhuisen & Simon Wilson, *Development and application of an updated geospatial distribution model for gridding 2015 global mercury emissions,* 211 Atmospheric Environment 138 (1994).

Figure 5. Modeled Total U.S. Mercury Deposition from All Sources for 2008 and 2020. Darker blue colors represent lower deposition.[31]



ii. Global mercury emissions are likely to continue to increase globally given the resurgence in coal-fired generation in some countries in response to energy security concerns. For example, according to the National Bureau of Statistics, coal consumption in China increased 4.6 percent in 2021, the highest rate of growth in a decade.[32] Such trends raise further concerns about potential mercury deposition and exposure risks here in the U.S. Mercury monitoring is needed to better characterize changes in mercury deposition to the U.S. and its resulting exposure and health risks.

iii. Climate change is making the mercury problem worse by contributing to the re-release of legacy mercury from thawing permafrost,[33] the mobilization of more mercury from soils to surface waters under high rainfall events and wildfires,[34] the increased production of methylmercury due to amplification of productivity in some aquatic systems along with increased lake,[35] and increased bioaccumulation in some food chains as

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[31] Sunderland, *supra* note 23. Results are based on a nested simulation using the GEOS-Chem global chemical transport model described in Shah, *supra* note 26. Total deposition (top panels) shows mercury deposited from all sources.

[32] *China sees biggest growth in energy and coal use since 2011*, Reuters (Feb. 28, 2022). https://www.reuters.com/markets/commodities/china-sees-biggest-growth-energy-coal-use-since-2011-2022-02-28/.

[33] M. Florencia Fahnestock et al., *Mercury reallocation in thawing subarctic peatlands*, 11 Geochemical Persp. Letters (Oct. 14, 2019); Kevin Schaefer et al., *Potential impacts of mercury released from thawing permafrost*, 11 Nature Commc'ns 1 (Sept. 16, 2020)

[34] Aditya Kumar et al., *Mercury from wildfires: Global emission inventories and sensitivity to 2000–2050 global change*, 173 Atmospheric Env't 6 (1994).

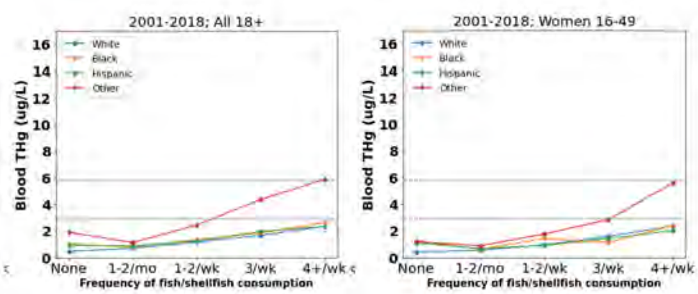
[35] David Krabbenhoft & Elsie Sunderland, *Environmental science. Global change and mercury*, 342 Sci. 1457 (Sept. 27, 2013).

surface waters get warmer.[36] Mercury monitoring is needed to identify and understand these changes as well as to recommend actions to safeguard the health of all people in the U.S. who consume fish and shellfish.

iv. Sensitive watersheds generate high fish mercury from low mercury inputs so even as emissions decline, some regions will continue to be hotspots of methylmercury in fish and wildlife. Mercury monitoring is needed to better understand what contributes to mercury sensitivity and where these sensitive watersheds exist.

v. Nationwide survey data show that methylmercury exposure among high-frequency fish consumers of more than 3 fish meals per week is higher among lower-income households and those with less than a high school education.[37] Data on mercury levels in blood show that disparities in methylmercury exposure exist in the U.S. population. For example, U.S individuals who identified their ethnicity as "other" (i.e., Asian, Pacific and Caribbean Islander, Native American, Alaska Native, multi-racial and unknown race) consistently have blood mercury levels that are higher than other demographic groups between 2001-2018 based on NHANES/CDC data. Mercury monitoring is needed to better characterize differences in methylmercury exposure among people in the U.S. by income, education, and race and ethnicity.

Figure 6: Blood mercury concentrations in U.S. individuals identifying with different ethnic groups (2001-2018) for all people over age 18 (left) and for women between the ages of 16 and 49 (right). Dashed lines correspond to EPA's reference dose (RfD) for methylmercury (upper dashed line) and alternative RfD (lower dashed line).[38]



[36] Amina T. Schartup et al., *Climate change and overfishing increase neurotoxicant in marine predators*, 572 Nature 648 (2019).

[37] von Stackelberg, *supra* note 14.

[38] Based on the analysis by Phillipe Grandjean & Esben Budtz-Jorgensen, *Total imprecision of exposure biomarkers: implications for calculating exposure limits*, 50 Am. J. Indus. Med. 712 (2007).
Data from CDC, National Health and Nutrition Examination Survey (NHANES), https://wwwn.cdc.gov/nchs/nhanes/ (last accessed July 8, 2022).

vi. There is no known safe level of mercury consumption and effects are known to occur below the reference dose. In fact, serious health effects have been identified at methylmercury concentrations below the current EPA RfD of 0.1 ug/kg per day. Neonatal studies conducted in the United States, Europe, China, and Japan have consistently found low-level exposure to methylmercury below the EPA RfD for adverse neurobehavioral development.[39] For example, a study conducted in Boston showed adverse effects associated with prenatal methylmercury exposure on memory and learning, especially visual memory, in children.[40] Mercury monitoring is needed to better understand the prevalence and distribution of low-level mercury exposure and to inform people about how much fish and seafood to consume.

e. What will the Comprehensive National Mercury Monitoring Act achieve?

Critical investments in mercury monitoring have been made through the American Rescue Plan, but we need to do more. Even as mercury emissions decline in the U.S., high emissions are still common around the world. As we reduce emissions here at home, a Comprehensive National Mercury Monitoring Network will provide national-scale data to track changing mercury concentrations in air, atmospheric deposition, soils, surface waters, and fish and wildlife.

Data generated by the Network will allow policymakers and researchers to quantify the benefits of emissions reductions and help understand on-going risks from global emissions. As climate change alters mercury cycling, reliable, consistent monitoring will help scientists understand the implications for methylmercury exposure. Monitoring data will also provide information for knowing which waters can be removed from the list of impaired waters as mercury deposition declines. The data from this network will improve models that are relied upon for policy and human health risk assessments and strengthen our understanding of the disproportionate risks to lower income people and overburdened populations. Finally, as national policies and international actions take effect, measurements will help understand what residual risk exists, where, and for whom.

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[39] Sally Ann Lederman et al., *Relation between cord blood mercury levels and early child development in a world trade center cohort,* 116 Env't Health Persp. 1085 (2008); Emily Oken et al., *Maternal fish intake during pregnancy: Blood mercury levels and child cognition at age 3 years in a US cohort,* 167 Am. J. of Epidemiology 1171 (2008); Kristine Vejrup et al., *Prenatal mercury exposure, maternal seafood consumption, and associations with child language at five years,* 110 Env't Int'l 71 (2006); Wieslaw Jedrychowski et al., *Effects of prenatal exposure to mercury on cognitive and psychosocial function in one-year old infants: Epidemiological cohort study in Poland,* 16 Annals of Epidemiology 439 (2006); Jinhua Wu et al., *Effect of low-level prenatal mercury exposure on neonate neurobehavioral development in China,* 51 Pediatric Neurology 93 (2014); Yu Gao et al., *Prenatal exposure to mercury and neurobehavioral development in Zhoushan City, China,* 105 Env't Rsch. 390 (2007); Keita Suzuki et al., *Neurobehavioral effects of prenatal exposure to methylmercury and PCBs, and seafood intake: Neonatal behavioral assessment scale results of Tohoku study of child development,* 110 Env't Rsch. 699 (2010).

[40] Sara T.C. Orenstein et al., *Prenatal organochlorine and methylmercury exposure and memory and learning in school-age children in communities near the New Bedford Harbor Superfund Site, Massachusetts,* 122 Env't Health Persp. 1253 (2014).

Fish provides a healthy, low-cost source of protein and other nutrients that are essential for pregnant women, young children, and the general population. This summer, many people shopping for their 2022 July 4th barbecues experienced beef and chicken costs as much as 36 percent higher than this time in 2021. These price spikes make fish from local waters an important, low-cost alternative source of protein. As supply chain disruptions become more commonplace, a national mercury monitoring network is critical for helping people make good choices about where to fish and securing a safe, local, low-cost source of protein for all people in the U.S.

3. S. ___, the Public Health Air Quality Act of 2022, and S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021

a. Policy Overview

S. ___, The Public Health Air Quality Act of 2022, to be introduced by Senator Duckworth, and and S.2476, the Environmental Justice Air Quality Monitoring Act of 2021, introduced by Senator Markey, are motivated in part by the November 2020 report "Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System" prepared by the Government Accounting Office (GAO) and the August 2018 release of the National Air Toxics Assessment (NATA)[41] by US EPA.

The GAO found that the nation's monitoring infrastructure is aging while annual appropriations for state and local grants to fund pollution monitoring has decreased by an inflation-adjusted 20 percent since 2004. As a result, air quality managers have struggled to maintain the high-quality, comprehensive data collection required to properly assess ongoing health risks to the public from air pollution. The report found insufficient emphasis on measurements of air toxics near sources to assess risk and limited information on the use of low-cost sensors, which are a set of emerging technologies that could potentially transform how community members understand the air they breathe. A network of these instruments could report air pollution levels in real-time, available on every street corner, and readily accessible on a phone app or connected device.

State and Local Air Monitoring Stations (SLAMS) provide core air pollution data to the general public, support compliance with the National Ambient Air Quality Standards (NAAQS) and emissions strategy development, and support air pollution research studies. As a subset of SLAMS, National Core Network (NCore) monitoring locations have a large complement of monitoring devices that go beyond a SLAMS site to further support air quality model evaluations, long-term health assessments, and ecosystem assessments. To assess air toxics constituents in the air, States operate National Air Toxics Trends Stations (NATTS) that identify trends in air toxics levels to assess progress toward emission reduction goals, evaluate public exposure, and characterize risk.

These established networks have their role and provide critical information to regulators, researchers, and the public. However, they are not designed to meet the other important goals that these two Senate bills would address. Expanded monitoring capabilities would permit

[41] U.S. EPA, National Air Toxics Assessment (Aug. 22, 2018), https://www.epa.gov/national-air-toxics-assessment.

assessment of (1) air pollution hotspots, or local areas of high pollution; (2) spatially dense, short-term air quality changes in real-time; and (3) air quality outside of major metropolitan areas, including rural communities as necessary.

While the GAO report assessed monitoring needs, US EPA relies on air quality modeling to conduct its periodic assessment of the exposure risk to air toxics. For two decades this effort was called the National Air Toxics Assessment, and in 2022 has been rebranded as the Air Toxics Screening Assessment.[42] The 2014 NATA incorporated updated unit risk values for Ethylene Oxide[43] that brought new attention to the potential cancer risk due to inhalation exposure for communities near industrial sources of this chemical.

CATF has relied on air quality modeling results like EPA's NATA as a critical tool to inform communities of their risk from exposure to air pollution. Our work includes assessing the health impacts from exposure to particulate derived from coal-fired power plants[44] and diesel engines.[45] Our efforts have also brought focus to differential impacts of air pollution between communities, as documented in assessments of the air toxics exposure risk from oil and gas production (in African American Communities: "Fumes Across the Fenceline"[46] and Tribal Communities: "Tribal Communities at Risk: the Disproportionate Impacts of oil and gas pollution on tribal air quality")[47] and to diesel and mobile source air toxics in environmental justice communities in Allegheny County, PA.[48]

Air pollution models are a cost-effective tool designed to provide estimates of pollution based on emissions and meteorological factors, and the results can highlight both spatial and temporal variability at fine resolutions. Model results are limited by a number of factors, including the accuracy of emission inputs, meteorological fields and parameterization of production and loss terms, like chemistry and deposition. They can provide evidence to help direct ambient measurements that more reliably determine risk in a community. This application of models was the impetus for the initial sections of the Public Health Air Quality Act of 2022.

The public health bill covers multiple monitoring initiatives. The first is described in section 3 and addresses health emergency monitoring at industrial facility fencelines, as indicated by EPA's NATA for 2014. Section 4 anticipates additional continuous monitoring at the release point and at the interface between the source and the community (i.e., fenceline) and the establishment of action levels for the most hazardous compounds. Section five directs EPA to double the number of NCore monitoring sites, with at least half of the new locations situated to

[42] U.S. EPA, Air Toxics Screening Assessment, https://www.epa.gov/AirToxScreen (last accessed July 8, 2022).
[43] U.S. EPA, Evaluation of the Inhalation Carcinogenicity of Ethylene Oxide, EPA/635/R-16/350Fa (Dec. 2016), https://iris.epa.gov/static/pdfs/1025tr.pdf.
[44] CATF, Toll from Coal, https://www.tollfromcoal.org/ (last visited July 8, 2022).
[45] CATF, Deaths by Dirty Diesel, https://www.catf.us/deathsbydiesel/ (last visited July 8, 2022).
[46] CATF, Fumes Across the Fence-Line (Nov. 2017), https://cdn.catf.us/wp-content/uploads/2017/11/21092330/catf-rpt-naacp-4.21.pdf.
[47] CATF, Tribal Communities at Risk (May 2018), https://cdn.catf.us/wp-content/uploads/2018/05/21094517/Tribal_Communities_At_Risk.pdf.
[48] CATF & Cancer & Environmental Network of Southwestern Pennsylvania, National Air Toxics Assessment and Cancer Risk in Allegheny County Pennsylvania (updated May 2021), https://censwpa.org/wp-content/uploads/2021/07/NATA-Factsheet.pdf.

determine pollution levels in disadvantaged communities (e.g., excess disease incidence, impoverished, or otherwise vulnerable).

b. S. ___, the Public Health Air Quality Act

i. Health Emergency Air Toxics Monitoring Network

The monitoring proposal under this section responds to high cancer risk modeled by EPA for its 2014 National Air Toxics Assessment (NATA). Generally, the model allows the Agency to routinely, at reasonable cost and effort, estimate risk levels due to exposure to toxic contaminants without the need for excessive or expensive monitoring. The assessment for 2014 identified potentially harmful exposure levels to Ethylene Oxide (EtO), which mobilized a response to collect ambient samples to evaluate the accuracy of the modeled results.

As noted in the bill text, the routine toxics monitoring method may not be sufficient to determine ambient levels of EtO with sufficient precision. Experienced scientists recognize that multipollutant analytical methods often cannot be optimized for multiple components simultaneously due to different instrument sensitivity for each compound, wide ranges of toxicity, and variability in ambient concentrations. With the updated toxicity factor for EtO, the routine monitoring method detection limit is insufficient to determine the risk accurately at ambient levels near the 1 in 10,000 cancer risk threshold.

EPA has already made progress with researchers to develop new methods for use with an acceptable detection limit for the task at hand.[49] In addition, EPA has completed its air toxics assessment for 2017. The results of that year are somewhat different than 2014. Equally important, since that year, EPA reports updated emissions that indicate ten facilities stopped using EtO altogether, while another 20 installed emission controls for EtO. The one-point source that emits chloroprene has also implemented controls to reduce emissions.[50] These updates do not relieve the need to conduct fenceline monitoring at the locations with additional emission controls, although the expectation would be ambient levels may be substantially less than the model predictions based on recent emissions inventory reporting.

This section also considers further monitoring at locations where exposure levels are predicted to be near the 10^{-4} threshold. This is an important recognition of uncertainties inherent in modeling best estimate emissions. Multiyear monitoring represents a sound approach given that cancer risks are based off lifetime exposure periods and substantial interannual variation can exist due to meteorological factors alone.

ii. Community Air Toxics Monitoring

This section outlines additional monitoring of major sources of air toxics that might reasonably be expected to emit enough pollution to result in ambient concentrations near levels of concern.

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[49] Aurelie Marcotte, The Current State of Ethylene Oxide in Ambient Air, The Magazine for Environmental Managers (May 2022), https://entanglementtech.com/wp-content/uploads/2022/05/marcotte.pdf.
[50] U.S. EPA, 2017 AirToxScreen Emissions Updates (Mar. 3, 2022), https://www.epa.gov/system/files/documents/2022-03/2017airtoxscreen-emissions-updates.pdf.

Generally, the effort would entail supplemental evaluation of the periodic modeling results and could provide stronger assurances to residents near major pollution sources that they are not exposed to dangerous levels of air pollution.

iii. NAAQS Monitoring Network

There are two primary elements under this section. The first is focused on expanding the number of NCore sites by a factor of 2, while providing some additional funding to assure existing locations are operating effectively. The second allocates resources to add at least 100 monitors to the SLAMS network to better characterize pollution in areas that may have insufficient or a complete lack of ambient pollution measurements. Based on the 2021 monitoring network for $PM_{2.5}$ and O_3, at least one monitor operated in 886 distinct counties where over 261 million people live. Nonetheless, over 70 million people live in a county without a regulatory monitor, representing just over 20% of the population and nearly 80% of US counties.

The intent of these additional monitors is to provide high quality pollution measurements in areas that generally lack direct knowledge of the local pollution burden. Siting criteria prioritizes communities with higher than average disease burden, poverty level and other socioeconomic factors, or susceptible individuals at increased risk of harm from air pollution exposure. In its Policy Assessment for the PM NAAQS review, EPA has reported wide discrepancies in exposure to $PM_{2.5}$ between Blacks and whites in major urban areas with existing monitors.[51] One might reasonably expect similar disparities exist in locations that currently lack measurements. The bill advocates an additional novel approach to use hybrid methods to assist in locating monitors in areas that are expected to have pollution concentrations near or above a NAAQS level. Hybrid methods combine multiple information sources like satellite estimates and air quality modeling surfaces.

iv. Sensor Monitoring

The final section of the Public Health bill allocates resources sufficient to deploy at least 1000 low-cost sensors with no fewer than 5 sensors per census tract. This move toward a low-cost sensor network overlaps in concept with the Environmental Justice Air Quality Monitoring Act. Monitors installed could be used to help identify local gradients in pollution and would complement the hybrid methods to help determine if and where more sophisticated regulatory monitors should be installed to assess compliance with ambient standards.

c. S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021

This bill would establish a pilot program to expand air quality monitoring into EJ communities in recognition that the existing monitoring network does not provide data that fully represents the spatial and temporal variability of air pollution concentrations and associated human exposures.

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[51] U.S. EPA, Policy Assessment for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter, EPA-452/R-22-004 (May 2022), https://www.epa.gov/system/files/documents/2022-05/Final%20Policy%20Assessment%20for%20the%20Reconsideration%20of%20the%20PM%20NAAQS_May2022_0.pdf.

The program has several key components. First, each funded monitoring project would install a dense network of sensors to determine block level variability in pollutants of concern. Collected data would be readily accessible in real time to community members and regulatory agencies, providing critical information for people to plan their daily activities and alert air pollution managers of pollution events or persistence that may require a mitigating response. Priority will be given to projects situated in communities with high incidence of air pollution related illnesses, like asthma, and could be used by health researchers to better understand the connections between air pollution exposure and related illnesses. Each project should include a community engagement component to spread awareness regarding air pollution in the neighborhood and would provide employment and training opportunities for a range of positions, including monitoring device technicians, scientific staff, communication and technology specialists, community engagement liaisons and environmental health professionals. Resources provided under this program would be equally distributed between equipment acquisition/operation and human resources (staffing).

Under this program, the Administrator is required to track each funded project and evaluate its effectiveness. A final report would describe the suite of data collected and detail lessons learned. This information would include total project costs and determine the utility and cost of maintaining an existing program and would assist in decision-making regarding program expansion into new communities.

Funding from this effort would help jumpstart a movement across the nation to more accurately and completely monitor the spatial and temporal variability within neighborhoods. The recent development of low-cost technologies for air pollution monitoring has made such an effort affordable.

Already some communities have moved in this direction to their own benefit. In Pittsburgh, PA, local community members became frustrated because they were repeatedly impacted by emissions from local industry, but regulatory monitors were not situated to capture the plumes that wafted through their neighborhoods. They could often see or smell pollution, but lacking monitors, had little knowledge of what pollutants were carried in them or at what concentrations.

In response, the community members worked with scientists at Carnegie Mellon University, who helped develop a suite of monitors to generate data in support of community concerns. Their novel approach included installation of fixed location low-cost sensors for criteria pollutants (SO2, PM2.5, NO2), limited mobile monitoring from van-based equipment, high resolution cameras pointed toward known stationary sources of pollution and even a phone-based application called "Smell Pittsburgh", which allows users to report time, geolocation, and severity of industrial smells.

This coordinated effort to monitor real-time pollution within their neighborhoods provided community members with quantified pollution estimates and an ability to track over time the variability of exposures to local air pollution. Armed with this information, the community was empowered to bring their knowledge to the Allegheny County Health Department to advocate for better enforcement of emissions limits for pollution sources embedded in their neighborhood.

4. Conclusion

Together, the three bills that are the subject of today's hearing represent a major leap forward for our nation's public health infrastructure. The United States currently lacks a comprehensive federally funded air and environmental monitoring system that informs individuals of air quality conditions in their local neighborhoods and tracks the transport of mercury and levels of methylmercury in fish and seafood from local waterways. These bills would establish critical monitoring networks for mercury, shore up our existing air quality monitoring infrastructure, and expand air quality monitoring into underserved locations that currently lack measurements needed to inform people in overburdened communities of their potential pollution exposures. Collectively, these air and environmental monitoring programs would help safeguard the health of people across the U.S. as we contend with shifts in global climate, energy security, and air emissions.

Senate Committee on Environment and Public Works
Hearing Entitled, *"A Legislative Hearing to Examine S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021; and S. ___, the Public Health Air Quality Act."*
July 13, 2022
Questions for the Record for Kathy Fallon

Chairman Carper:

1. Mr. Eklund noted in his testimony that industries already have air monitoring stations at their fencelines and in adjacent communities. However, research shows that many fenceline communities do not have accurate air quality monitoring systems in place, especially for air toxics monitoring. Is that true? If yes, please explain the shortcomings of the current system.

It is true that many communities do not have adequate air quality monitoring systems in place. The existing regulatory network does not provide data that fully represent the spatial and temporal variability of air pollution concentrations and associated human exposures, especially for air toxics. Sharp changes in air quality persist at the block-by-block level near industrial facilities and while some communities have air quality monitoring, many do not, and most networks are not dense enough to detect important spatial and temporal variation at the neighborhood scale. In addition, most monitors do not make data readily available to the public in real time so that people can make choices to protect their health when and where needed.

The U.S. Government Accountability Office (GAO) found in its November 2020 report "Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System" that the nation's monitoring infrastructure is aging while annual appropriations for state and local grants to fund pollution monitoring have decreased by 20 percent since 2004 after adjusting for inflation.[1] As a result, air quality managers have struggled to maintain the high-quality and comprehensive data collection required to properly assess ongoing health risks to the public from air pollution. The report found insufficient emphasis on measurements of air toxics near sources to assess risk and limited information on the use of low-cost sensors, which are a set of emerging technologies that could potentially transform how community members understand the air they breathe. A network of these instruments could report air pollution levels in real-time, available on every street corner, and readily accessible on a phone app or connected device.

S. 4510, the Public Health Air Quality Act, would allocate resources sufficient to deploy at least 1,000 low-cost sensors with no fewer than five sensors per census tract. This move toward a low-cost sensor network overlaps in concept with S. 2476, the Environmental Justice Air Quality Monitoring Act. Monitors installed could be used to help identify local gradients in pollution and would complement the hybrid methods to help determine if and where more sophisticated regulatory monitors should be installed to assess compliance with ambient standards. The funding

[1] U.S. GAO, Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System (Nov. 2020), https://www.gao.gov/assets/gao-21-38.pdf.

and deployment of these additional sensors would supplement the current system and address the gaps identified in the GAO report.

2. History has shown that we can reduce air pollution, lower energy prices and grow our economy all at the same time. Yet, history has also shown that we often underestimate the health and economic impacts of air pollution on communities, especially frontline communities. That is especially true for air toxics, which can impact human health years after exposure and which have health impacts that can be difficult to quantify in economic metrics.

   With that in mind, what is your response to Mr. Isaac's claims that reducing mercury and other air toxics in the environment has resulted in few health and economic benefits for Americans and that there is little need to further track such pollution?

Mr. Isaac's claims about the benefits of reducing mercury and air toxics emissions are incorrect and based on outdated information. The U.S. Environmental Protection Agency (EPA) currently estimates in a document supporting the 2022 proposal to reinstate the Appropriate and Necessary finding that for a subset of quantifiable human health benefits, reducing emissions associated with the Mercury and Air Toxics Standards results in $1.1 billion in annual benefits.[2] Using a different analytical approach, an independent team of researchers estimated that reducing these emissions would result in $1.2 to $1.5 billion in benefits for the year 2020.[3] These updated values reflect more accurate estimates of mercury deposition in the U.S. and changes in exposure for all people—not just freshwater anglers—and include consideration of exposure from marine and freshwater fish and seafood consumption as well as cardiovascular effects.

Even as the U.S. reduces mercury and air toxics emissions here at home, we know that mercury emissions are on the rise in China. Therefore, despite these benefits and given that mercury can circulate globally, it is critical to continue to track how mercury levels in the environment are changing to protect public health.

   a. Why should we continue to regulate our largest sources of air toxics, and why should we better monitor air toxics?

For mercury, there is no known methylmercury exposure threshold below which neurodevelopmental impacts do not occur.[4] In addition, disproportionate impacts from mercury

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[2] U.S. EPA, National-Scale Mercury Risk Estimates for Cardiovascular and Neurodevelopmental Outcomes for the National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units – Revocation of the 2020 Reconsideration, and Affirmation of the Appropriate and Necessary Supplemental Finding; Notice of Proposed Rulemaking, Docket ID. No. EPA-HQ-OAR-2018-0794 (Sept. 2, 2021), https://www.epa.gov/system/files/documents/2021-09/risk-tsd_mats-finding-2060-av12-proposed-rule_20210921_0.pdf.

[3] Elsie Sunderland et al., *A Template for a State-of-the-Science Assessment of the Public Health Benefits associated with Mercury Emissions Reductions for Coal-fired Electricity Generating Units*, Harvard Chan C-CHANGE White Paper (Apr. 11, 2022), https://www.hsph.harvard.edu/c-change/news/mercury-emissions-reductions/.

[4] Glenn E. Rice et al., *A probabilistic characterization of the health benefits of reducing methyl mercury intake in the United States*, 44 Env't Sci Tech. 5216 (2010); Phillipe Grandjean & Martine Bellanger, *Calculation of the*

exposure exist among high frequency fish consumers including for people from households with lower incomes and education levels, people with higher incomes, and individuals from the following ethnic groups: Asian, Pacific and Caribbean Islander, Native American, Alaska Native, and those who identify as multi-racial.[5] The residual risk to these populations from power plant air toxics emissions is currently under review by EPA. The need for continued monitoring and regulation of air toxics may be informed by that analysis—taking into account the full range of potential health effects and the lack of a known threshold for neurodevelopmental effects.

Despite the substantial progress in reducing mercury emissions from sources in the U.S., mercury remains an important problem and health concern that is in need of federal funding for a national monitoring network for the following reasons.

Global mercury emissions, particularly from Asia, increased during the same period of time that electric utilities in the U.S. dramatically reduced their emissions.[6] Given the long-range transport of mercury, these global emissions trends contribute to total mercury deposition in the U.S., offsetting some of the important reductions associated with declines in U.S. emissions. These trends raise renewed concerns about mercury deposition and its effects on fisheries and people who consume fish from U.S. waters. Mercury monitoring is needed to track these changing global emissions and their impact on atmospheric deposition, to understand the implications for exposure and health risks in the U.S., and to distinguish the impacts of global sources from U.S. sources.

Climate change is making the mercury problem worse by contributing to the re-release of legacy mercury from thawing permafrost,[7] the mobilization of more mercury from soils to surface waters under high rainfall events and wildfires,[8] the increased production of methylmercury due to amplification of productivity in some aquatic systems,[9] and increased bioaccumulation in some food chains as surface waters get warmer.[10] Mercury monitoring is needed to identify and

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disease burden associated with environmental chemical exposures: application of toxicological in health economic estimation, 16 Env't Health, no. 123, 2017.

[5] Elsie Sunderland et al., *Mercury Science and the Benefits of Mercury Regulation*, Harvard T.H. Chan School of Public Health, Center for Climate Health and the Global Environment (Dec. 16, 2021), https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/12/Mercury_WhitePaper_121621.pdf; Susan Silbernagel et al., *Recognizing and preventing overexposure to methylmercury from fish and seafood consumption: information for physicians*, J Toxicol. 2011 (Jul. 13, 2011).

[6] United Nations Environment Programme (UNEP), Global Mercury Assessment (2018), https://www.unep.org/globalmercurypartnership/resources/report/global-mercury-assessment-2018.

[7] M. Florencia Fahnestock et al., *Mercury reallocation in thawing subarctic peatlands*, 11 Geochemical Persp. Letters (Oct. 14, 2019); Kevin Schaefer et al., *Potential impacts of mercury released from thawing permafrost*, 11 Nature Commc'ns 1 (Sept. 16, 2020).

[8] Aditya Kumar et al., *Mercury from wildfires: Global emission inventories and sensitivity to 2000–2050 global change*, 173 Atmospheric Env't 6 (1994).

[9] David Krabbenhoft & Elsie Sunderland, *Environmental science. Global change and mercury*, 342 Sci. 1457 (Sept. 27, 2013).

[10] Amina T. Schartup et al., *Climate change and overfishing increase neurotoxicant in marine predators*, 572 Nature 648 (2019).

understand the impact of these climate-driven changes on mercury exposure and to recommend actions that will safeguard the health of all people in the U.S. who consume fish and shellfish.

Nationwide survey data show that methylmercury exposure among high-frequency fish consumers of more than 3 fish meals per week is higher among lower-income households and those with less than a high school education.[11] Data on mercury levels in blood show that disparities in methylmercury exposure exist in the U.S. population. For example, U.S. individuals who identified their ethnicity as "other" (i.e., Asian, Pacific and Caribbean Islander, Native American, Alaska Native, multi-racial and unknown race) consistently have blood mercury levels that are higher than other demographic groups between 2001-2018 based on NHANES/CDC data.[12] Mercury monitoring is needed to better characterize differences in methylmercury exposure among people in the U.S. by income, education, and race and ethnicity.

3. In an April 2022 article, Mr. Isaac wrote, "Levels of the criteria air pollutants tracked by the U.S. Environmental Protection Agency are now so low they're nearly indistinguishable from natural levels."[13] Do you agree with Mr. Isaac's assessment that there are nearly zero places in the United States where the ambient ozone or particulate pollution levels are indistinguishable from natural levels? If no, please explain.

No, I do not agree with Mr. Isaac's written statement cited here. The statement indicates a lack of understanding of the high degree of variability in air quality across the United States. While ozone and fine particulate matter concentrations have declined in many parts of the nation, an estimated 130 million people still live in areas where National Ambient Air Quality Standards are not attained, with ozone non-attainment accounting for the largest share.[14] Areas of non-attainment are not limited to just a few geographic areas: 37 U.S. states or territories have one or more counties that are not attaining air quality standards for one or more criteria pollutants.[15] Mr. Isaac also stated in his oral testimony that attainment is not, but it should be, based on transportation emissions, which is incorrect. Attainment is based on ambient concentrations from all sources of emissions within and beyond a given county's borders.

a. Are there places in the United States where ambient air pollution levels are rising above unhealthy levels? If yes, please explain.

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[11] Katherine von Stackelberg et al., *Results of a national survey of high-frequency fish consumers in the United States*, 158 Env't Rsch. 126 (2017).

[12] Based on the analysis by Phillipe Grandjean & Esben Budtz-Jorgensen, *Total imprecision of exposure biomarkers: implications for calculating exposure limits*, 50 Am. J. Indus. Med. 712 (2007).
Data from National Health and Nutrition Examination Survey (NHANES), CDC, https://wwwn.cdc.gov/nchs/nhanes/ (last accessed July 8, 2022).

[13] Jason Isaac, *For a cleaner Earth, invest in – don't divest from – fossil fuels*, Texas Public Policy Foundation (Apr. 21, 2022), https://www.texaspolicy.com/for-a-cleaner-earth-invest-in-dont-divest-from-fossil-fuels/.

[14] U.S. EPA, Summary Nonattainment Area Population Exposure Report (July 31, 2022), https://www3.epa.gov/airquality/greenbook/popexp.html.

[15] U.S. EPA, Current Nonattainment Counties for All Criteria Pollutants (July 31, 2022), https://www3.epa.gov/airquality/greenbook/ancl.html.

Areas that have been identified as in "non-attainment" for one or more of the criteria pollutants have air quality that is above unhealthy levels based on the primary standards within the National Ambient Air Quality Standards and associated concentration-response functions for human health effects. Analysis from the EPA in July 2022 shows the location of these counties based on current air quality monitoring.[16] Based on supporting data from the U.S. EPA, 222 counties were newly listed as being in non-attainment in 2018 or later, showing that some areas of the U.S. are experiencing rising air pollution levels.[17]

The most recent Design Values for 2019-21 show 41 PM2.5 monitors violate the current NAAQS but were not previously designated as being in nonattainment, and 7 PM2.5 monitors exceed the current annual standard without a nonattainment designation.[18] In fact, 95 monitors showed a Design Value increase of at least 1 ug/m3 in 2019-21 as compared to 2016-18 across 28 states, with another 217 monitors showing an increase of 0.1 to 0.9 ug/m3 between those periods. Annual PM design values also increased at 66 monitors comparing 2010-12 values to current levels, although those increases are primarily in Western states. Presumably, the increases in the West are likely related in part to increased wildfire impacts.

There are 19 monitors that fail to meet the current ozone NAAQS but are not designated as nonattainment based on 2019-21 data. Similar to PM2.5, there are 175 monitors that have current design values that exceed the level recorded in 2016-18 and 103 sites with current levels greater than 2010-12. About half of the locations that have worse ozone today currently exceed the NAAQS. The vast majority of the monitors showing increased ozone levels are in Texas, Western states, and Southwestern states.

4. What is the status of the mercury deposition monitoring network in the United States today?

Mercury monitoring is pieced together with annual funding from various sources. Funding levels have fluctuated over time, and the U.S. has lost about half of our mercury deposition monitoring sites due to lack of funding. As a result, the U.S. can no longer produce a map even of estimated mercury deposition for the whole country. A map produced by researchers at the University of Wisconsin shows where the current mercury deposition sites exist (black dots),[19] the deposition at that site, and where that data can be used together with models to estimate mercury deposition (colored areas). The areas on the map that are white lack sufficient monitoring to even hazard a guess as to what the mercury deposition levels might be. Notably, large areas of the Pacific Coast lack estimates of mercury deposition, which is a region of the U.S. that may be the most susceptible to rising mercury with increasing emissions from China and other parts of Asia. This

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[16] U.S. EPA, Counties Designated "Nonattainment" (July 31, 2022), https://www3.epa.gov/airquality/greenbook/map/mapnpoll.pdf.

[17] U.S. EPA, Nonattainment/Maintenance Area Status for Each County by Year for All Criteria Pollutants (July 31, 2022), https://www3.epa.gov/airquality/greenbook/anayo_ak.html (from this page all other counties can be accessed by changing the "state" value).

[18] U.S. EPA, Air Quality Design Values, https://www.epa.gov/air-trends/air-quality-design-values (last accessed Aug. 19, 2022).

[19] National Atmospheric Deposition Program/Mercury Deposition Network, Total Mercury Wet Deposition, University of Wisconsin-Madison (2020), https://nadp.slh.wisc.edu/filelib/maps/MDN/pdfs/Hg_dep_2020.pdf.

map demonstrates that our current monitoring network is insufficient to track changes in mercury and protect public health.

5. What, in your view, is the most important thing Congress can do to help improve our nation's air quality monitoring system?

In light of the funding provided for local and air toxics monitoring in the Inflation Reduction Act, the next most important thing that Congress can do is fund a Comprehensive National Mercury Monitoring Network, starting with funding for atmospheric deposition, surface waters, and fish tissue.

6. Some have stated before this committee that somehow the Supreme Court decided in *West Virginia v. EPA* that EPA cannot regulate greenhouse gas emissions from power plants under the Clean Air Act. However, legal scholars, including the legal experts at the Congressional Research Service, don't agree with that assessment. They say that EPA still has authority to regulate greenhouse gas emissions from power plants under section 111 of the Clean Air Act. Do you agree that under the Supreme Court decision *West Virginia v. EPA*, EPA retains authority to regulate greenhouse gas emissions under the Clean Air Act?

EPA still has authority to choose the best system of emission reduction for greenhouse gases from power plants, and to set binding emission limits. *Massachusetts v. EPA* remains good law and the basic authority of EPA is still intact and untouched. The Clean Air Act continues to provide EPA with ample authority to set stringent standards based on pollution control technologies and the Court did not preclude them from being paired with trading and other market mechanisms both in setting the standard and in complying with it.

7. Please describe one or two areas of agreement you took away from the hearing. Where did we find common ground on the state and needs of our nation's air quality monitoring system?

- Air quality has improved dramatically over time in many areas of the U.S., but non-attainment areas where people experience unhealthy air remain.
- Innovation in air quality monitoring is consistent with the strong history in the U.S. of evolving new technologies to support air quality management and should continue with appropriate safeguards.
- There is high variability in air quality across the United States, and people have should have access to information about the air quality in their neighborhoods so that they can make informed decisions about their health.
- Industry has reduced mercury emissions from electricity generating units by approximately 90% since 2010 and the public health threat from mercury pollution is now largely from sources outside the U.S. Mercury monitoring can help detect where concentrations remain high and where the pollution is coming from.

<u>Senator Cardin:</u>

1. In your testimony, you describe the persistence of mercury in sensitive watersheds, where a small amount has large impacts. What can more localized monitoring data tell us about impaired waters, particularly given that mercury disposition disproportionately harms low-income communities with relatively high proportions of subsistence anglers?

More funding for localized monitoring of mercury in fish tissue, as is called for in S.1345, the Comprehensive National Mercury Monitoring Act, will allow states to test more lakes and streams for mercury levels in fish that people consume, more often. States could choose to test more frequently in water bodies that supply fish to low-income communities with relatively high proportions of subsistence anglers to provide information about where to fish and how much fish should be consumed to protect their health. More monitoring of mercury in fish tissue can also help to improve computer models and our ability to predict where mercury levels are likely to be high and where they are likely to be low given estimated mercury deposition levels.

Senator CARPER. Thank you so much. We look forward to asking you some questions in just a few minutes, but first we want to welcome Mr. Isaac, who is currently serving, as I understand, as the Director of Life:Powered, a national initiative of the Texas Public Policy Foundation. Do you live in Texas?

Mr. ISAAC. Yes.

Senator CARPER. Where?

Mr. ISAAC. Just outside of Austin, in the hill country.

Senator CARPER. Welcome back to our committee, Mr. Isaac. We have, I think, seen you here before.

Mr. ISAAC. Yes, it is great to be back.

Senator CARPER. We are happy you are back, and you are recognized and welcome to proceed with your statement. Thank you.

STATEMENT OF HON. JASON ISAAC, DIRECTOR, LIFE: POWERED, A PROJECT OF THE TEXAS PUBLIC POLICY FOUNDATION

Mr. ISAAC. Thank you. Good morning, Chairman and members. I am Jason Isaac, the Director of Life:Powered, a national Initiative of the Texas Public Policy Foundation to raise America's energy IQ.

From 2011 to 2019, I served in the Texas House of Representatives, and during my freshman session, carried the Texas Emission Reduction Plan legislation. I was a House sponsor for the ozone standards set by the EPA under the Clean Air Act in our State.

Senator CARPER. How long were you in State legislature?

Mr. ISAAC. Eight years, yes, four terms. That was our SIP that I carried, the State Implementation Plan.

The EPA's National Emissions Inventory finds that mercury emissions from stationary sources in the U.S. fell 85 percent from 1990 to 2017, over 200 tons annually to about 30 tons annually. According to a 2018 U.N. study, 80 percent of the mercury deposited in North America comes from other continents, with half coming from Asia.

A mercury deposition network already exists at the University of Wisconsin. The network consists of approximately 100 stations across the Country and is supported by State, Federal, and private funding.

The Mercury Air Toxics Rule, which cost billions of dollars and resulted in the closure of many coal plants, increased electricity prices and reduced grid reliability in many areas. It was estimated, originally, by the EPA that there would be $90 billion in health benefits, but resulted in only $6 million in health benefits from reducing mercury emissions.

Instead of repeating the narrative that we are dirty and setting impossible emission reduction goals for ourselves, we need to recognize our success, which you both have touted, in our clean air here in the United States. We need to get the rest of the world to align with our air quality standards that improve human health. Until we do, our Nation will continue to export jobs and import pollution.

Regarding environmental justice, the real injustice: American's lack of access to affordable and reliable energy. This year, Americans will pay $5,200 more than last year to cover rising prices of gas, electricity, and everyday items.

Even before the current energy crisis that Americans are facing, a lawsuit was filed in California that specifically addressed the issue. The plaintiff, the more than 200 civil rights organizations accuses the California Air Resources Board of being racially biased in its environmental regulations and environmental lobby organization. The evidence they present for this case is that the regulations they created primarily hurt minorities, while not doing anything to help the environment in California.

The effects of clean energy policies have been catastrophic, as are the measures being taken by the Federal Government that ignore the science behind air quality and responsible energy practices. When it comes to air quality, we are a world leader. We have reduced the six criteria pollutants that the EPA has the authority to regulate under the Clean Air Act by 78 percent in the past five decades, which both of you have touted.

The message in the bill is clear: environmental extremists want to say that the air in these communities is racist and unfair, but what matters more to Americans is not having to choose between food and electricity.

The last bill on public health air quality refuses to acknowledge the monumental wins I have already mentioned, as well as the fact that we have the cleanest air of any Country with over 50 million people. We should be celebrating our success, not spending more money to spread unnecessary climate alarmism.

If we want to improve the lives of all Americans, then we should do so with our affordable, reliable energy from fossil fuels. Until the EPA demonstrates that it will ends its war on American energy, Congress should not bless it with more funding.

Environmental leadership and economic prosperity do go hand-in-hand. We cannot address injustice without monitoring, but we can with energy. To improve the global environment and eradicate poverty as we know it, we should produce and export our energy and our clean air around the world.

Thank you for the opportunity to be here.

[The prepared statement of Mr. Isaac follows:]

Life:Powered

July 2022

Testimony Before the U.S. Senate Committee on Environment and Public Works

The Honorable Jason Isaac
Director, Life:Powered
Texas Public Policy Foundation

Chairman and Members:

On behalf of Life:Powered, a national initiative of the Texas Public Policy Foundation to raise America's energy IQ, thank you for the opportunity to testify today.

From 2011 to 2019, I served more than 200,000 people in the Texas Hill Country as a member of the Texas House of Representatives. During my four terms in office, I primarily served on the Environmental Regulation, Energy Resources, and Economic Development committees. During my freshman session, I was the House sponsor of the Texas Emission Reduction Program, our state implementation plan, or SIP, for the ozone standards set by the EPA under the Clean Air Act (CAA).

Of the three bills being put forward in this committee, the first that I want to discuss is Senate Bill 1345, which will establish a national mercury monitoring program. The question at hand is whether we need to know more about mercury emissions, deposition, and ambient levels than we already know and what we would do with such information.

The EPA's National Emissions Inventory finds that mercury emissions from stationary sources in the U.S. fell 85% from 1990 to 2017, from over 200 tons annually to about 30 tons annually. Vehicle emissions contribute a couple more tons. According to a 2018 U.N. study, 80% of the mercury deposited in North America comes from other continents, with half coming from Asia. A Mercury Deposition Network already exists, which is part of the National Atmospheric Deposition Program at the University of Wisconsin. The network consists of approximately 100 stations across the country and is supported by state and federal funding as well as private philanthropy. So, we already know a fair amount about mercury emissions in the U.S., we have monitoring programs in place, and we are doing a great job reducing our emissions to very low levels.

However, supposing we could gather more complete data on mercury in our environment, what purpose would such data serve? With only 32 tons of emissions from domestic sources, it seems there is not much room to cut. The Mercury Air Toxics Rule promulgated by the EPA a decade ago was created to limit mercury emissions from coal power plants. The rule, which cost billions of dollars and resulted in the closure of many coal plants, which increased electricity prices and reduced grid reliability in many areas, was estimated by the EPA to result in only $6 million in health benefits from reducing mercury emissions. The EPA justified the rule not based on the reductions in mercury emissions but rather on

$90 billion in health benefits from reducing emissions of fine particulate matter, an estimate derived from badly flawed science that the EPA refuses to change.

We already have monitoring systems for mercury emissions and deposition. We know that domestic emissions of mercury are small and declining. We know that a large majority of mercury deposited in the U.S. comes from other countries. And we know that reducing domestic mercury emissions further comes at a very high cost with very little quantifiable public health benefits. Instead of repeating the narrative that we are dirty and setting impossible emissions reductions goals for ourselves, we need to recognize our success and get the rest of the world to align with our air quality standards. Until we do, our nation will continue "exporting jobs and importing pollution."

The second bill this committee is considering, Senate Bill 2476, would establish hyperlocal air quality monitoring projects in what the bill calls "environmental justice communities."

The real injustice? Americans' lack of access to affordable and reliable energy. This year, Americans will pay $5,200 more than last year to cover rising prices of gas, electricity, and everyday items. That's what matters. Even before the current energy crisis that Americans are facing, a lawsuit was filed in California that specifically addresses this issue.

The plaintiff, The Two Hundred (more than 200 civil rights organizations), accuses the California Air Resources Board (CARB) of being racially biased in its environmental regulations and environmental lobby organization. The evidence they present for this case is that the regulations they created primarily hurt minorities, while not doing anything to help the environment in California.

The Two Hundred specifically addresses two major problems with the CARB's agenda. First, the agenda is unconstitutional, as it disadvantages one group specifically:

> "In addition to being Legislatively unauthorized and unlawful, the 'net zero' GHG threshold would operate unconstitutionally so as to disproportionately disadvantage low income minorities in need of affordable housing relative to wealthier, whiter homeowners who currently occupy the limited existing housing stock."

The lawsuit also observes that California's "progressive environmental regulators and environmental advocacy group lobbyists are as oblivious to the needs of minority communities, and are as supportive of ongoing racial discrimination in their policies and practices, as many of their banking, utility and insurance bureaucratic peers."

Since 2007, the complaint states, California has had the highest poverty rate, highest homelessness population, and highest homelessness rate in the country. This is for no other reason than its progressive policies that hurt poor people the most. When our leaders try to "fix" climate change, they cannot ignore civil rights, administrative law checks and balances, and liberty.

Now, all Americans are feeling those higher costs due to progressive policies. Low- and middle-income families are struggling to make ends meet. The effects of "clean" energy policies are catastrophic, as are the measures being taken by the federal government that ignore the science behind air quality and responsible energy practices.

When it comes to air quality, we are a world leader. We have reduced the 6 criteria pollutants that the EPA has the authority to regulate under the Clean Air Act by 78% in the past five decades.

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The message in the bill is clear: Environmental extremists want to say that the air in these communities is racist and unfair, but what matters more to Americans is not having to choose between food and electricity. With this bill, their precious tax dollars will be spent on making the energy and products that are derived from fossil fuels more expensive, at a time when they can least afford such expenses. This won't reduce demand for the products and energy we need, it will just shift where they are produced, almost certainly to countries that care less about protecting the environment, and much less protecting human rights.

And the last bill on Public Health Air Quality refuses to acknowledge the monumental wins I have already listed, as well as the fact that we have the cleanest air of any country with over 50 million people. We should be celebrating our success, not spending more money to spread unnecessary climate alarmism.

If we want to improve the lives of all Americans, then we should do so with our affordable, reliable energy from fossil fuels. Until the EPA demonstrates that it will end its war on American fossil fuels, Congress should not bless it with more funding that allows it to further that goal.

What Americans do need is access to more affordable reliable energy. Environmental leadership and economic prosperity go hand in hand. Our country's environmental leadership should be celebrated, and we should stop the destructive drive to eliminate all air pollution with no consideration of the costs. Today, let's focus on our successes and not put more taxpayer dollars toward monitoring that will do nothing but steer our country in the wrong direction. We cannot address injustice with monitoring but we can with energy. To improve the global environment and eradicate poverty as we know it, we should export our energy and our clean air around the world.

I urge the committee not to proceed with any further consideration of these three bills and instead focus on increasing production, transportation, and refining of American energy to help the pocketbooks of those you serve as well as to lift millions around the globe out of abject poverty.

Sincerely,

The Honorable Jason Isaac
Director, Life:Powered
Texas Public Policy Foundation

Texas Public Policy Foundation   Life:Powered

Senate Committee on Environment and Public Works

"A Legislative Hearing to Examine S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021; and S. ___, the Public Health Air Quality Act."

July 13, 2022

Questions for the Record for Jason Isaac

Chairman Carper:

1. During an exchange with Senator Sullivan during the hearing, you stated the following: "I am glad you brought up CO2, because I am ingesting higher concentrations than what is prevalent in the atmosphere, and I am not spontaneously combusting, so we can't demonize CO2. It is necessary for life on Earth." Does this mean you reject the evidence that carbon dioxide pollution is causing the earth to warm, that human activity is responsible for that warming, and that with increased warming comes an increased frequency and intensity of extreme weather like flooding and heat? If not, what did you mean by your statement?

   Although I accept the evidence that both naturally occurring and anthropogenic greenhouse gas emissions (GHGs) are causing the earth to warm, I reject the premise that carbon dioxide (CO_2) is "pollution" in that it is essential for life on earth. We should not conflate GHGs with pollution that is directly harmful to human health or demonize CO_2 as "toxic," which intentionally misleads the public.

   The last 100 years show us that warming from GHGs will continue to be mild and manageable for centuries to come. Over the last 100 years, we have seen deaths from extreme weather-related events drop 98%, all while our global population has quadrupled. During the same 100 years, the number of people living in extreme poverty has decreased 90%. Access to affordable reliable dense energy has made those advancements possible. Furthermore, even if EVERY signatory fulfilled its emission reductions targets under the Paris Accord—which appears less and less likely—global temperatures would decrease by just 0.17°C by 2100. Similarly, if the United States' CO_2 emissions were completely eliminated by 2030, temperatures would be less than two tenths of a degree lower—just 0.14°C—according to climate data models used by the United Nations and most global climate organizations.

2. On April 17, 2012, Dr. Jerome Paulson, Chair, Council on Environmental Health, American Academy of Pediatrics, testified before the EPW Committee, stating, "Methylmercury causes localized death of nerve cells and destruction of other cells in the developing brain of an infant or fetus. It interferes with the movement of brain cells and the eventual organization of the brain... The damage it [methylmercury] causes to an individual's health and development is permanent and irreversible. ... There is no evidence demonstrating a 'safe' level of mercury exposure, or a blood mercury concentration below which adverse effects on cognition are not seen. Minimizing mercury exposure is essential to optimal child health."[1] It is my understanding the American Academy of Pediatrics has not changed its position.

   a. Do you agree with the American Academy of Pediatrics' finding on the importance of minimizing mercury exposures for child health? If not, please cite the scientific studies that support your position.

   b. Do you agree that the record supports EPA's findings that mercury, non-mercury hazardous air pollutant metals, and acid gas hazardous air pollutants emitted from uncontrolled power plants pose public health hazards? If not, why not?

   c. Do you agree that there are places in this country where Americans are exposed to unhealthy levels of air toxic pollution, such as benzene and ethylene oxide? If not, why not?

   d. Do you agree that it is currently difficult, and sometimes impossible, to monetize the reduced risk of human health and ecological benefits from reducing mercury and other air toxic emissions? If not, why not?

   Yes, it is difficult to monetize these benefits in large part because they are difficult to measure. At current pollution levels, simply measuring the effect of changes in air toxic emissions on levels in the ambient environment is a difficult task. Then trying to discern the long-term health effects of pollution, intertwined with other causes of those health effects, is an even taller task. We should not be regulating emissions at levels where it is almost impossible to accurately measure their effects, especially when those regulations have enormous impact on our economy,

[1] https://www.epw.senate.gov/public/_cache/files/4/3/4324fd62-dc89-4820-bd93-ff3714fcbe30/01AFD79733D77F24A71FEF9DAFCCB056.41712hearingwitnesstestimonypaulson.pdf

raising the costs of goods and services for the poorest among us and sending good jobs overseas.

e. Do you agree that communities should have access to air quality and other environmental monitoring system data to keep informed on possible air toxic exposures? If not, why not?

To the extent that the benefits of such information outweigh the costs, then yes, that information can be useful. However, such information is likely not very useful for the communities themselves as it is for activist groups that are seeking to penalize industrial activity in any way possible, without concern for the benefits of that activity. Given the abusive litigation tactics of such groups, we are very concerned that this data would be used for that purpose.

3. The Texas Public Policy Foundation, which is your current employer, has a long history of opposing the Renewable Fuel Standard and other policies that support investments in biofuels as part of a clean energy solution. Your employer also has a history of opposing greenhouse gas emission standards for vehicles.

a. Do you support the Renewable Fuel Standard and do you support policies that further promote investments in biofuels as part of reducing consumer costs and U.S. emissions? If not, why not?

No, because biofuels are a low energy density, high land-use, low-efficiency fuel source. They are in every way inferior to fossil fuels on any measure of affordability, reliability, and environmental impact.

b. Do you agree the transportation sector is the largest source of carbon and nitrogen oxide pollution in this country? If not, why not?

Yes. However, we disagree with the notion that existing levels of carbon and nitrogen oxide pollution from the transportation sector are harming the public health. We have reduced pollution levels from vehicles by well over 90% over the past 50 years, and the cost of trying to cut emissions would far outweigh any benefits.

c. Do you agree that EPA's recent greenhouse gas standards for light-duty vehicles will save consumers in the long run in terms of energy savings? If not, why not?

The GHG standards will force consumers to use more fuel-efficient vehicles, which will save consumers' energy. However, that will come at the cost of more expensive vehicles, which harms those who most depend on low-cost transportation. It will come at the cost of reduced safety by forcing people to drive smaller vehicles as is documented in the EPA's regulatory impact statement, which widely overstates the monetized climate and health benefits. Also, the Inflation Reduction Act of 2022 gives a $7,500 tax credit for electric vehicles (EV), but not all EVs apply and other subsidies hide the real cost for the car. Most Americans cannot afford EVs.

d. Do you agree that upgrading our air quality monitoring systems may help us to better track the air pollution being emitted from the transportation sector? If not, why not?

More air quality monitoring systems will improve tracking of air pollution. However, we believe existing monitoring is adequate to serve the needs of the public and adding more monitors is not worth the cost. Most of the monitoring being suggested by the proposed bills is designed to target important industrial activities and attempt to penalize them for emissions that, in the vast majority of cases, are not actually the cause of public health problems in nearby communities. Therefore, these extra monitors will likely not provide any benefit for public health.

4. In an April 2022 article, you wrote, "Levels of the criteria air pollutants tracked by the U.S. Environmental Protection Agency are now so low they're nearly indistinguishable from natural levels."[2] Yet, there are areas in this country that are in nonattainment for many criteria pollutants. Do you agree that there are places in this country where Americans are exposed to unhealthy levels of fine particulate matter pollution? If so, please explain. If not, please explain and include in your answer your views on the health impacts of fine particulate matter pollution.

[2] https://www.texaspolicy.com/for-a-cleaner-earth-invest-in-dont-divest-from-fossil-fuels/

a. Do you agree that there are places in this country where Americans are exposed to unhealthy levels of ozone pollution? If so, please explain. If not, please explain and include in your answer your views on the health impacts of ozone pollution.

No. According to the EPA's green book, there is only one area of the country, the Los Angeles Basin, that currently has ozone levels exceeding 100 ppb. While it is impossible to rule out small health effects of 100 ppb ozone levels on sensitive groups, this level is not harmful for the vast majority of the population and certainly not more harmful than the economic cost of complying with the national standards. Our view is that the current national ozone standard of 70 ppb is scientifically unjustified and should be raised. Furthermore, most of California suffers from high ozone not due to its own emissions but due to its geography, natural factors, and emissions transported from Asia. California researchers have documented these effects and have found that attempts to reduce the state's ozone emissions will be mostly futile at reducing ambient ozone levels in the state.

b. Do you agree that there are places in this country where Americans are exposed to unhealthy levels of air lead pollution? If so, please explain. If not, please explain.

No. Ambient lead concentrations at the existing 92 monitoring sites throughout the U.S. are at 0.03 μg/m³ on average, with only two small towns that barely miss the national standard of 0.15 μg/m³. This standard is more than adequate to protect human health, so we believe it is unlikely any Americans are being exposed to unhealthy levels of airborne lead on a routine basis. The vast majority of unhealthy lead exposures occur through our water system. Resources to prevent lead exposure should be focused in that area and not wasted on the miniscule problem of airborne lead pollution.

c. Do you agree that there are places in this country where Americans are exposed to unhealthy levels of sulfur dioxide pollution? If so, please explain. If not, please explain.

No. Nationally, sulfur dioxide (SO2) levels have declined 94% since 1980, and only a few areas of the country do not meet the current standard of 75 ppb. In general, the connections between SO_2 and harm to human health are tied to the role of SO_2 in the formation of particulate matter. However, as we have documented, the link between particulate matter exposure at the levels currently observed in the U.S. and harm to human health is scientifically very weak. We believe the current standard has more than an adequate margin of safety and exposure to unhealthy levels of SO_2 is extremely rare.

5. Are you familiar with the CO2 Coalition, which is an organization that promotes misinformation about climate science? If yes, do you support the organization and do you work with this organization in any way?

   Yes, I am familiar with the CO_2 Coalition, which is a group of 45 scientists committed to the dissemination of accurate climate change science. In November 2019, the Texas Public Policy Foundation (TPPF) partnered with the CO_2 Coalition to submit public comments to the Environmental Protection Agency regarding proposed revisions to federal methane regulations. Neither TPPF nor I financially support the CO_2 Coalition, but we encourage this organization's efforts to share the science, not the politics, regarding climate change and CO_2.

6. Please describe one or two areas of agreement you took away from the hearing. Where did we find common ground on the state and needs of our nation's air quality monitoring system?

   One area where we have common ground is that we agree on the substantial improvements the United States has made in improving air quality over the last 5 decades; we have reduced the 6 criteria pollutants 78% over the last 50 years. Utilizing existing air quality monitors showed that during the first two months of the COVID lockdowns, with 40-50% fewer vehicles on the road, that air quality in the U.S. was not significantly impacted. Our air in the U.S. is near a natural state.

Ranking Member Capito:

1. Given your personal experience in implementing air programs at the state level, do you believe it is helpful for Congress to recommend a one-size-fits-all program for air monitoring funding? Or are these decisions better left up to state and local air agencies?

   A great example of the success of a state implementation plan was the effort to bring the Houston-Galveston area into compliance with the 2008 ozone standard. This is one of the most heavily industrialized areas of the country, in a region that is geographically prone to ozone formation. Yet the region has been steadily reducing its ozone levels and should come into compliance with the standard in the near future. However, since the Obama administration EPA lowered the standard again from 75 ppb to 70 ppb in 2015, the region will still be in nonattainment for some time to come. In contrast, federal implementation plans have a history of being punitive to many states and having no connection to real cost-benefit analysis. For example, the EPA's transport rule for the 2015 ozone standard will likely result in the closure of more than half of Texas' coal fleet, all in an effort to attain a 1 ppb reduction of ozone in Wisconsin.

Senator Inhofe:

1. Under the Biden Administration, gas prices have risen to record levels due in large part to Biden's policies that have restricted fossil energy development. Can you elaborate on why domestic energy production is essential to both our energy and national security?

   a. What could the Biden Administration do today that would support America's energy security?

   As a matter of national policy, investment in fossil energy keeps our electricity affordable, and it encourages more LNG exports to trading partners and allies, which is a win for national security. The Biden administration should stop encouraging energy discrimination, because denying capital or investments to American energy companies will not eliminate our need for fossil fuels, it will just transfer energy purchases to overseas producers. Instead, the Biden administration should champion affordable and reliable energy for all Americans. We should return to energy dominance, which will relieve Americans and our allies abroad who have been so heavily dependent on Russia.

Senator CARPER. Thank you very much, Mr. Isaac.

Next, I want to welcome, I believe remotely, Dana Johnson, currently serving as the Senior Director of Strategy and Federal Policy at WE ACT for Environmental Justice.

Welcome, Ms. Johnson. Please begin your statement at this time. Welcome.

STATEMENT OF DANA JOHNSON, SENIOR DIRECTOR OF STRATEGY AND FEDERAL POLICY, WE ACT FOR ENVIRONMENTAL JUSTICE

Ms. JOHNSON. Good morning. Thank you, Chairman Carper, Ranking Member Caputo, and all the members of the committee.

Senator CARPER. It is Capito. It is confusing because we have a witness, a nominee just before this committee, whose name is Caputo.

Ms. JOHNSON. Senator Capito, I am sorry.

Senator CAPITO. You are confusing her even more.

[Laughter.]

Senator CARPER. You are not entirely wrong. Where are you today, Ms. Johnson? Where are you talking to us from?

Ms. JOHNSON. I am talking to you from Washington, DC, and I am a Chicago native.

Senator CARPER. Oh, welcome. This is a home game. Chicago, good. Welcome aboard. Senator Capito and I are delighted to welcome you.

Ms. JOHNSON. Yes, my apologies, Senator Capito.

Senator CAPITO. Not a problem, don't worry about it.

Ms. JOHNSON. Thank you.

I want to thank all of you for convening this important dialog on how we can improve the air quality in communities across this Country for all Americans. As noted, my name is Dana Johnson. I serve as Senior Director of Strategy and Federal Policy with WE ACT for Environmental Justice.

We are a member-based organization whose mission is to build healthy communities by ensuring that people living in a community of color or low-income residents are able to participate meaningfully in decisionmaking at every level of government when it comes to environmental and public health policies and practices. We are based in Northern Manhattan and organized in New York City, New York State, and here in Washington, DC.

We are the only environmental justice organization that has a Federal presence here, a Federal policy office. In this office, we convene the Environmental Justice Leadership Forum, which is a network of EJ groups representing 22 States, and there are about 50 members that make up that body.

Americans living in communities of color have a racially disproportionate exposure to air pollution because of institutionalized bias in our environmental, energy, land use, and economic decisionmaking. Last year, researchers at the University of Illinois at Urbana-Champaign found that African Americans have a higher-than-average exposure to particulate matter from every pollution emitting source studied, including cars, trucks, power plants, construction, industrial operations, and agriculture. This outsized and dangerous exposure was repeated in nearly all categories where researchers grouped Blacks, Hispanics, and Asians into a "people of color" category and compared the risk pollution exposure to whites.

Millions of Americans live, work, and play in conditions that can only be described as environmental emergencies. This was true in 1997 when our Northern Manhattan community housed six of the eight bus depots in New York City. We had one-third of the city's bus fleet, which was diesel at the time, emitting pollution in our communities, and we did not have a single particulate matter air monitor present during the 8-hour period when particulate matter pollution was four times higher than it would be for annual levels set by the Environmental Protection Agency.

We saw this again in 2005 in the Sauget community of St. Louis, which is an area of importance to Senator Duckworth, where there was a lack of air quality monitoring data available for an investigation into the health hazards associated with the operation of a waste incinerator.

We saw it again in Chelsea, Massachusetts, where Congresswoman Pressley and Senator Markey intervened to have an air quality monitor placed in that city when no air quality monitor was present before 2020, and that area of the community ranked third in the State for environmental hazards and had the highest asthma rates in the city.

There are hundreds of cases like these across the Country, and they tell us an important theme. Every facet of existence, including the health and economic conditions for those living in a front and fenceline community demands bold and decisive action to alleviate the cumulative burden of being exposed to carbon, ozone, nitrous oxide, particulate matter, methane, and sulfur dioxide. The proposed legislation for modernizing our air quality monitoring processes, our tools, our resources, staff, and technology that we are discussing today is that bold and decisive action that we need to begin to dramatically improve the quality of lives for all Americans.

I just want to flag four things really quickly from the bills that we think are important to highlight. The community engagement and data gathering processes that are available really partner well with the principles of environmental justice that note that people have the right to participate in decisionmaking at every level of government. This includes needs assessment, planning, implementation enforcement, and evaluation.

Communities have the right to know and be educated when it comes to pollution where they live, work, and play. For pollution present in their community, we have a right to know about the health risks associated with it and how it might exacerbate any present health conditions.

And we have a right to corrective action. Once there is an awareness and understanding of air pollution in our communities, corrective action must be taken. Environmental justice principle No. 6 demands that there be a cessation of the production of all toxins, hazardous wastes, and radioactive materials, and that all present and current producers be held strictly accountable to the people for detoxifying contaminants at the point of production. We believe that these three bills being discussed today give us the opportunities to do that.

I will just make quickly one final point around the investments. I think it was noted that there has been a 20 percent decrease in funding for the EPA to do this important work, and we want to highlight the need to have the financial resources available to invest in the people, the technology, and the equipment necessary to really do quality monitoring in communities that have a legacy of harm as it relates to air pollution.

Thank you.

[The prepared statement of Ms. Johnson follows:]

Written Testimony for Senate EPW Committee Hearing on Proposed Legislation for Air Quality Monitoring

Wednesday, July 13, 2022

Background on WE ACT for Environmental Justice

WE ACT for Environmental Justice (WE ACT) is a Northern Manhattan-based member organization whose mission is to build healthy communities. We do this by ensuring communities of color and people of low-income lead in creating sound and fair environmental health and protection policies and practices.

We are the first people of color-led environmental justice organization in New York State and are the only environmental justice group with a permanent office in Washington, DC. Our Federal Policy Office also serves as the administrative anchor for the Environmental Justice Leadership Forum (EJ Forum) – a network of approximately 50 environmental justice advocates and groups in 22 states working together to advance policies that ensure the protection and promotion of communities of color and low-income communities throughout the U.S.

My name is Dana Johnson and I serve as Senior Director of Strategy and Federal Policy at WE ACT. I have more than 20 years of strategy, operations and advocacy professional experience in fields ranging from health and science advocacy, climate and environmental justice policies to cultural competence and diversity and inclusion leadership.

WE ACT has played a foundational role in the environmental justice movement, including contributing to the planning and execution of the First People of Color Environmental Leadership Summit over 30 years ago where the "Principles of Environmental Justice" were crafted (National People of Color Environmental Leadership Summit, 1991). These 17 principles of environmental justice are the bedrock for our movement and will be referenced implicitly and explicitly throughout my testimony.

Part 1: Environmental Justice and Poor Air Quality

Environmental Justice communities are communities of color and low-income communities that disproportionately face the brunt of environmental pollution. Within the context of air pollution, these pollution sources include but are not limited to; power plant facilities, transportation corridors, chemical facilities, and plastic production factories. The siting of communities of color and low-income communities near these pollution sources is intentional. "Redlining" was the discriminatory process of grading communities that would be eligible for federally supported loans. Communities that were given lower grades tended to be Black communities and immigrant communities. The process of redlining in the 1930s created many of the environmental inequities in communities of color that persist to this day (Lane et al., 2022). Studies have identified that communities that were historically redlined are now associated with increased concentrations of air pollution (Lane et al., 2022); (Nardone et al., 2020). These same redlined communities have also been associated with worse health outcomes, such as higher rates of emergency room visits for asthma (Nardone et al., 2020).

The impacts of polluting industries intentionally being sited near communities of color and low-income communities are costly to both the health and economic viability of these communities. Air pollution and poor air quality have been associated with a myriad of negative health outcomes such as pre-term birth, low birth weight, respiratory conditions (asthma, COPD), cardiovascular conditions (heart disease, increased risk of heart attacks), cancer, and stroke (Manisalidis et al., 2020).

Air pollution can worsen asthmatic symptoms and trigger asthma attacks (Environmental Protection Agency, 2018). A report found that asthma caused 11-12% of African American and Puerto Rican children to be absent from school, missing at least a day per month, in comparison to only 3-5% of white children (Mayrides & Levy, 2005). This causes students to miss pertinent classes and educational opportunities, and also has negative impacts on parents who must miss work to care for their children. In adults with asthma, studies have proven that having asthma can increase work absences, especially among those with uncontrolled asthma (Meng et al., 2008). Missed school and missed work creates challenges for economic mobility in environmental justice communities, with chronic health challenges decreasing job performance and impeding academic success. This is coupled with the rising cost of healthcare that can worsen the economic hardship and put families in mounting medical debt.

The financial burden of asthma, and thus the economic impacts on environmental justice communities, cannot be overstated. A study found that those with asthma spent twice as much on healthcare than those without asthma (Nurmagambetov et al., 2018). Those with asthma living in poverty spent more on treating their asthma than those that fall in a high-income bracket(Nurmagambetov et al., 2018). This is due to a myriad of factors, including the siting of polluting facilities in low-income communities. These injustices are truly cyclical where the pollution present in your community makes you sick to the point where you can no longer afford to leave your community.

In the midst of the ongoing COVID-19 pandemic, numerous studies have identified connections between communities with poor air quality and increased COVID-19 morbidity(Xu et al., 2021); (Ali & Islam, 2020). For example, in New Orleans, the areas with the highest per-capita COVID-19 deaths were located in St. John the Baptist Parish and neighboring St. James parish also known as "Cancer Alley" (Hernandez, 2020). Cancer Alley is an industrial corridor that is predominantly Black and low-income.

Part 2: Using Air Quality Monitors to Decrease Environmental Inequities

When reports came out about the connection between air quality and COVID-19 deaths, community members in New Orleans sounded the alarm and wrote to their representatives. In November of 2021, Administrator Regan visited Cancer Alley (Environmental Protection Agency, 2022). Following his visit, the Administrator committed to taking action including increasing inspections for facilities and dedicating $600 thousand to mobile air pollution monitoring in the community (Environmental Protection Agency, 2022). In June of 2022, Chair Grijalva of the House Natural Resources Committee, visited New Orleans to discuss environmental justice concerns (Center for Constitutional Rights, 2022). The advocacy of environmental justice community members in "Cancer Alley" gained much-needed traction through concrete data available on health outcomes and air pollution. Once communities had the knowledge available to them on air quality and its subsequent health impacts, they were able to educate, mobilize, and spark action.

While there is now increased monitoring happening in New Orleans, there are likely many other "Cancer Alleys" throughout the United States that we are unaware of due to a lack of high-quality data. I will provide three clear and simple steps for air quality monitoring and data utilization in environmental justice communities, grounded in the principles of environmental justice:

1. Community Engagement and Data Gathering

The need for robust air quality monitoring in environmental justice communities has been widely demonstrated. In development of air quality monitoring projects and programs, there should be direct consultation and meaningful involvement of environmental justice communities. Environmental Justice principle #7 states that "Environmental Justice demands the right to participate as equal partners at every level of decision making, including needs assessment, planning, implementation, enforcement, and evaluation. (National People of Color Environmental Leadership Summit, 1991)" Environmental justice communities have been created out of inequities both racially and financially, projects to address these inequities have the potential to worsen community tensions and reinforce power imbalances through improper engagement with communities.

2. Education, and Community Right to Know

Communities have the right to know about the pollution where they live, work, and play. For pollution present in their community, they have the right to know about the health risks associated with the pollution and how it might exacerbate any present health conditions. Environmental Justice Principle #13 states that: "Environmental Justice calls for the strict enforcement of principles of informed consent," (National People of Color Environmental Leadership Summit, 1991). Communities cannot make informed decisions about current and future developments in their community as well as understand the full picture of their health risk factors, without widely available data to inform their decisions.

3. Corrective Action

Once there is an awareness and understanding of air pollution in communities, corrective action must be taken. Environmental Justice Principle #6 states that "Environmental Justice demands the cessation of the production of all toxins, hazardous wastes, and radioactive materials, and that all past and current producers be held strictly accountable to the people for detoxification and the containment at the point of production. (National People of Color Environmental Leadership Summit, 1991)" Without corrective action such as, but not limited to, the removal of facilities, communities are left to suffer. While education is important, without accountability to improve the environmental conditions and the resulting health outcomes in communities, then the money that goes into monitoring is not being utilized effectively.

There are multiple case studies that demonstrate the success of this model. In 1997, Northern Manhattan was home to six of the eight diesel bus depots, accounting for one-third of the entire city's bus fleet. At the time PM10 monitors were one of the most common monitors for tracking particulate matter. Despite Northern Manhattan having a high concentration of diesel buses, and thus air pollution there were no PM10 monitors in Northern Manhattan, in contrast to four PM10 monitors present in wealthier Lower Manhattan (Environmental Protection Agency, n.d.). WE ACT and the Columbia Children's Center for Environmental Health (CCCEH) partnered on a community-based participatory research study to gather data on air pollution in Northern Manhattan. Paid youth interns, known as the "Earth Crew," wore backpack air quality monitors in "hotspots" for vehicular traffic proximate to the bus depots. Their monitors found that in an 8-hour period, the fine particulate matter range was between 22 to 69 mg/m3, in comparison to the annual fine particle standard set by the EPA at 15.1 mg/m3 (Vasquez et al., 2006). At the urging of WE ACT, the EPA placed ambient air quality monitors in these same areas, which validated the data accuracy. With the data to support their claims of air pollution and respiratory health issues, WE ACT and its team of concerned community members, were better able to advocate for change (Vasquez et al., 2006). One historic win was negotiations with the Metropolitan Transit Authority (MTA) on their capital plan that resulted in the conversion of the entire bus fleet from "dirty diesel" to a lower emission diesel.

In 2005, the EPA released data about air quality in Cook County, Chicago that showed there were elevated levels of lead and other hazardous chemicals in the air. In Cook County, Latinos and Black people are more likely to live near industrial facilities. Following the release of the air quality information, concerned community members wrote to their representatives and the EPA demanding change (Hawthorne & Little, 2008). This resulted in action from the EPA, such as citing facilities with Clean Air Violations (Environmental Protection Agency, 2005), and some facilities agreeing to clean up and reduce emission levels (Hawthorne & Little, 2008). Cook County was ranked in 2005 as the worst in the nation for dangerous air pollution (Hawthorne &

Little, 2008). Due to environmental justice advocacy air pollution has gradually improved with Cook County dropping in rank to #18 for air pollution in 2019 (Cotto, 2022). However, ongoing action, including monitoring and industry accountability, is still needed to ensure that Cook County does not backslide, as recent trends suggest (Cotto, 2022).

The Environmental Justice Hyperlocal Air Quality Monitoring Act and the Public Health Air Quality Act are both needed to address air quality concerns in environmental justice communities. Passage of these two bills has the potential to make more success stories, like in Northern Manhattan, possible.

The Environmental Justice Hyperlocal Air Quality Monitoring Act creates a pilot program on hyperlocal air quality monitoring in environmental justice communities. Some key features of this bill include the creation of equity maps, community notification and training, and the hiring of local residents to carry out the air quality monitoring work.

As demonstrated in previous case studies, community mobilization and participation in air quality monitoring is a well-tested method for success. These opportunities for community-based participatory air quality research usually stem from community concern, with community members being compensated minimally, if at all. By hiring local residents to do air quality monitoring work, we have the opportunity to reduce the burden on community volunteers who are doing the work out of necessity, with the joint benefit of decreasing underemployment in our communities. As outlined in our "Green Jobs Report," creating new opportunities for employment is critical as we embark on a "just transition" from our fossil-fuel-dependent economy (Environmental Justice Leadership Forum, 2020). A "just transition" envisions an economy where "good-paying jobs, healthy communities, and a sustainable planet can coexist" (Environmental Justice Leadership Forum, 2020).

While hyperlocal air quality monitors tend to be lower cost and require less training, they play a critical role in providing data that can be used for "ground-truthing" community concerns and necessitating further screening from additional monitors. The initial involvement and training used for hyperlocal air quality monitors can also serve as a stepping stone for more complex technical training for advanced monitors.

The Public Health Air Quality Act includes funding for a variety of high-capacity monitors in communities that have high health risks. Some key features of this bill include community notification and input on where monitors will be located as well as corrective action for identified sources that are above air quality standards.

Part 3: The Need for Robust Funding for Air Quality Monitoring Programs and Corrective Action

A 2020 GAO report on: "Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System" found that there has been a 20% decrease in federal funding available to states and localities for air quality monitoring (Government Accountability Office, 2020). This funding level has made it challenging for states and localities to upkeep their air quality monitoring systems. An example of states' and localities' inability to upkeep their air quality monitoring systems is the age of the air quality monitors themselves. Some state agencies interviewed by GAO stated that their air quality monitors were up to 20 years old; however, the air quality monitors were designed for only 7 years of use (Government Accountability Office, 2020).

The passage of The Environmental Justice Hyperlocal Air Quality Monitoring Act and the Public Health Air Quality Act will increase funding to expand our air quality monitoring capacity. There is a need for increased funding for air quality monitoring through the general appropriations process to upkeep and replace aging monitors. Beyond expanding our funding for air quality monitoring there is also a need to end matching requirements for states and local agencies to access air quality monitoring funding. Currently, most federal funding for air quality monitoring requires a 40% match for states and localities (Government Accountability Office, 2020). This can be cost-prohibitive to states and localities that face budget cuts amidst ongoing economic challenges from the COVID-19 pandemic and rising inflation.

The Justice40 initiative is an executive action by the Biden Administration that directs the benefits of 40% of the federal funding on climate change to disadvantaged communities (*Executive Order on Tackling the Climate Crisis at Home and Abroad*, 2021). As part of this initiative, the Council for Environmental Quality created the Climate and Economic Justice Screening Tool (CEJST). The intention of CEJST is to identify "disadvantaged communities" based on environmental and socio-economic data (Council on Environmental Quality, 2022). CEJST utilizes data currently available from the EPA. Currently, the available data often underestimates the burden of air pollution in environmental justice communities (Environmental Integrity Project & Galveston-Houston Association for Smog Prevention, 2004).

There are multiple examples of severe cases where facility explosions go undetected by EPA monitors or the data gathered by the monitors cannot be used to assess health impacts in environmental justice communities. In 2019 there was a fire at the ITC Deer Park Chemical Plant in Harris County, Texas. A study conducted in partnership between Environmental Justice Leadership Forum member, T.E.J.A.S., and Rice University that assessed the impacts of the fire on the surrounding communities, faced numerous obstacles in obtaining high-quality air monitoring data. Monitors from the EPA and the Texas Commission on Environmental Quality (TCEQ) both detected elevated levels of hazardous air pollutants such as benzene and of fine particulate matter (Goldman et al., 2021). However, in this highly industrious area, there tended to be elevated levels of air pollutants outside of the event making it hard to distinguish what was directly related to the fire (Goldman et al., 2021). This is alarming for multiple reasons, firstly that this mostly low-income community of color is experiencing elevated levels of air pollution frequently. Additionally, despite dense monitoring in this industrial region, the monitors are mainly designed "to capture ambient, regional levels of pollution", thus in situations of elevated exposures from point sources, the health impacts of those sources cannot be adequately assessed (Goldman et al., 2021). The study concluded that: "unmeasured harm is still harm: limited or absent data do not indicate minimal or no impacts on community exposure. (Goldman et al., 2021)"

In 2019, there was a refinery explosion in Southern Philadelphia that was completely missed by EPA monitors at the time (McLaughlin et al., 2020). This area of Southern Philadelphia is predominantly Black and working-class (Schmidt, 2022). EPA monitors missing an explosion that released 5,239 pounds of hydrofluoric acid into the environment, underscores the need for these crucial investments in air quality monitors (Brown & Tigue, 2021). Multiple communities surrounding the now-closed Philadelphia Energy Solutions Refinery and larger industrial corridor are not identified in the CEJST for having a high percentile of PM2.5 in the air and are not considered "disadvantaged" for the "clean energy and energy efficiency" category (Council on Environmental Quality, 2022). In order to accurately identify "disadvantaged communities", and thus equitably distribute funds within the Justice40 initiative there must be increased monitoring of air pollution in environmental justice communities.

Environmental justice communities often notice the adverse health outcomes plaguing their community before there is data to identify and validate the source of the problem. The burden of health protection has been placed on environmental justice communities from fundraising for monitors to performing community-based participatory research projects to confirm pollution. The passage of the Environmental Justice Air Quality Monitoring Act and the Public Health Air Quality Act can shift the burden of protecting the environment and human health away from environmental justice communities by providing employment opportunities for affected community members and investing in effective monitoring by the government. Having this information is critical to the health and wellbeing of our communities, and has the opportunity to help identify and thus catalyze clean-ups in our communities.

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Dear Chairman Carper,

Thank you for the opportunity to testify before the Senate Committee on Environment and Public Works Hearing on Air Quality Monitoring, and for allowing me to respond to these questions for the record. Please find below my response to the questions for the record.

1. Please further explain how additional independent air quality monitoring data, which would be provided for through each of the bills examined in the hearing, would help communities better assess their health risks from exposure to air pollution, including air toxics.

   ANSWER: Air quality data is important for real-time decision-making, especially for people that have underlying health conditions that can experience flare ups due to air pollution. For example, in the case of wildfires throughout the West Coast people have used air quality data such as "AirNow" data to determine whether or not to go outside/ wear face masks when outdoors.

2. Mr. Eklund noted in his testimony that industries already have air monitoring stations at their fencelines and in adjacent communities. However, research shows that many fenceline communities do not have accurate air quality monitoring systems in place, especially for air toxics monitoring. Is that true? If yes, please explain the shortcomings of the current system.

   ANSWER: While there are air monitoring systems in place in some fencline areas and adjacent communities, many of these air monitoring systems might not check air quality frequently (daily or more) For example, there are numerous examples of facility explosions that have gone undetected from current air quality monitors. For example, in 2012, there was a refinery explosion at a Chevron facility in Richmond, California. The air quality monitors near the facility were owned by Chevron and the data could not be used by the government.[1] Another example is a 2019 refinery explosion in Southern Philadelphia that was completely missed by EPA monitors at the time.[2] This area of Southern Philadelphia is predominantly Black and working-class.[3] EPA monitors missing

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[1] https://grist.org/climate-energy/a-year-after-a-refinery-explosion-richmond-cali-is-fighting-back/

[2] https://www.reuters.com/article/usa-pollution-airmonitors-specialreport/special-report-u-s-air-monitors-routinely-miss-pollution-even-refinery-explosions-idUSKBN28B4RT

[3] https://stateimpact.npr.org/pennsylvania/2022/01/13/this-is-nonsense-for-real-philly-hits-a-crossroads-of-environmental-justice-at-ex-pes-oil-refinery/

an explosion that released 5,239 pounds of hydrofluoric acid into the environment, underscores the need for these crucial investments in air quality monitors.[4]

3. History has shown that we can reduce air pollution, lower energy prices and grow our economy all at the same time. Yet, history has also shown that we often underestimate the health and economic impacts of air pollution on communities, especially frontline communities. This is especially true for air toxics, which can impact human health years after exposure and which have health impacts that can be difficult to quantify in economic metrics.

   With that in mind, what is your response to Mr. Isaac's claims that reducing mercury and other air toxics in the environment has resulted in few health and economic benefits for Americans and that there is little need to further track such pollution?

   a. Why should we continue to regulate our largest sources of air toxics and why should we better monitor air toxics?

      ANSWER: While there have been reductions in mercury and other air toxics in the environment these reductions are not equitable throughout the United States. Even in the United States, air quality has actually gotten worse in recent years.[5] We should continue to regulate our largest sources of air toxics, to make sure there is compliance of the Clean Air Act and prompt action to protect communities when facilities go out of compliance. Also in regards to cumulative impacts, air quality data is a critical component to understand a communities cumulative pollution burden.[6] There has also been an increase in other environmental and health stressors that contribute to poor health outcomes such as the rise of PFAS[7], microplastics[8], extreme heat[9], gun violence[10], COVID-19[11], etc. Communities that disproportionately face poor air quality, are also more likely to have increased exposure to new contaminants, participate in higher risk workforces and come in contact with violence.

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[4] https://insideclimatenews.org/news/05072021/two-years-after-a-huge-refinery-fire-in-philadelphia-a-new-day-has-come-for-its-long-suffering-neighbors/
[5] https://www.bloomberg.com/news/articles/2019-10-22/u-s-air-quality-was-improving-now-it-s-getting-worse?sref=0lejgNtz#xj4y7vzkg
[6] https://www.mdpi.com/1660-4601/8/5/1441/htm
[7] https://pubs.acs.org/doi/abs/10.1021/acs.estlett.0c00713
[8] https://pubs.acs.org/doi/abs/10.1021/acs.est.9b01517
[9] https://www.tandfonline.com/doi/abs/10.1080/01944363.2021.1977682
[10] https://www.nature.com/articles/s41598-021-98813-z
[11] https://jamanetwork.com/journals/jama/article-abstract/2778361

4. We know that reducing air pollution protects human health, which can lead to reduced medical costs and fewer missed days of work and school. Please elaborate on these benefits and describe any other economic benefits of reducing air pollution. How will investing in our nation's air monitoring system, as is called for in the legislation examined in the hearing, help unleash these benefits?

   ANSWER: Reducing air pollution will lead to improved health outcomes, which has supporting economic benefits such as less missed work days, less ER visits and reduced medical expenditure.[12,13,14] Investments in the air monitoring system would create jobs that citizen scientists should be preferential to receive. Enhancing our air monitoring system would also increase the data available on which specific communities should be targeted for investments in renewable energy and clean transportation investments since they would reap the largest benefit from these investments. Increasing investments in renewable energy and clean transportation in environmental justice would then also lead to more jobs in these communities, as well as improved health outcomes.

5. In an April 2022 article, Mr. Isaac wrote, "Levels of the criteria air pollutants tracked by the U.S. Environmental Protection Agency are now so low they're nearly indistinguishable from natural levels."[15] Do you agree with Mr. Isaac's assessment that there are nearly zero places in the United States where the ambient ozone or particulate pollution levels are indistinguishable from natural levels? If no, please explain.

   a. Are there places in the United States where ambient air pollution levels are rising above unhealthy levels? If yes, please explain.

   ANSWER: I do not agree with Isaac - fenceline and environmental justice communities that tend to be low-income and/ or communities of color have noticeably significant higher levels of ambient ozone and particulate pollution.[16] There is also an increased likelihood of poor air quality days in the future due to more extreme heat days as the climate warms. This will likely occur because extreme heat combined with stagnant air during a heat wave can increase the amount of ozone pollution and particulate pollution.[17]

6. Do Tribes and Tribal governments benefit from the pieces of legislation we examined in this hearing? If so, how?

   ANSWER: Yes, tribes currently have limited air quality monitoring. Tribal communities are environmental justice communities, who greatly suffer from a disproportionately greater burden of air pollution and the associated health

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[12] https://www.epa.gov/sciencematters/links-between-air-pollution-and-childhood-asthma
[13] https://www.aafa.org/media/1633/ethnic-disparities-burden-treatment-asthma-report.pdf
[14] https://pubmed.ncbi.nlm.nih.gov/29323930/
[15] https://www.texaspolicy.com/for-a-cleaner-earth-invest-in-dont-divest-from-fossil-fuels/
[16] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3137995/
[17] https://scied.ucar.edu/learning-zone/air-quality/how-weather-affects-air-quality#:~:text=Heat%20waves%20often%20lead%20to,ozone%20pollution%20and%20particulate%20pollution.

impacts.[18] For example, between the period of 2000 and 2018 while air pollution improved in many parts of the United States it improved to a lesser extent in Tribal communities in comparison to the rest of the United States.[19]

7. What is the most important thing Congress can do to help improve our nation's air quality monitoring system?

   ANSWER: Investment in high quality air monitoring systems in environmental justice communities that allow for a hyperlocal understanding of air quality and can be used to scientifically support environmental justice concerns.

8. Please describe one or two areas of agreement you took away from the hearing. Where did we find common ground on the state and needs of our nation's air quality monitoring system?

   ANSWER: One agreement that I took away from the hearing was that the United States is facing a crisis due to the high cost of energy. I view the solution to our high energy costs as investment in renewable energy, such as solar and wind energy. This would not only decrease high energy costs but also decrease air pollution present in fenceline communities. In regards to the state and needs of our nation's air quality monitoring system, there sadly was little space of agreement, but rather denial from some of the witnesses of the scientific evidence and lived experiences of communities facing poor air quality.

<u>Senator Cardin:</u>

1. In your testimony, you detail the harmful effects of "redlining," especially on communities of color, who are now seeing increased concentrations of air pollution and at risk for worse health outcomes. Neighborhoods were wrongly placed along transportation corridors, near power plant facilities and plastic production factories, creating environmental equities for minority communities. From an environmental justice perspective, can you please highlight how air quality monitoring and data collection make our surface transportation networks more equitable and reduce adverse health outcomes?

   ANSWER: Air quality monitoring and data collection are the first steps in helping to make our surface transportation networks better for communities because it creates baseline data for us to improve upon. When we think of interventions that can help to reduce air pollution in our transportation corridors such as electrification, and greening along highways, data collection allows us to see a change in air quality over time. This helps to validate interventions for further use and replication in other pollution hotspots.

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[18] https://www.epa.gov/indoor-air-quality-iaq/basic-information-about-indoor-air-quality-tribal-partners-program#:~:text=Native%20American%20and%20tribal%20populations,and%20other%20adverse%20health%20effects.
[19] https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2021.306650?journalCode=ajph

> There is also a wide range of adverse health outcomes. In environmental justice communities, asthma rates are higher. Having real-time information on air quality data can help those living in environmental justice communities, especially near transportation corridors make informed decisions. For example, parents might decide to not let their children play outdoors during rush hour traffic since air quality is typically worse than.

I was pleased to see that air quality monitoring was passed in the Inflation Reduction Act. I look forward to any additional ways I can support in the passage and implementation of these important pieces of legislation.

Sincerely,

Dana Johnson

Senior Director of Strategy and Federal Policy at WE ACT for Environmental Justice

Senator CARPER. Ms. Johnson, thank you so much for joining us today.

Now, batting cleanup, we are pleased to welcome Bart Eklund, currently serving as the Senior Technical Expert at Haley and Aldrich. Welcome, Mr. Eklund. We invite you to proceed with your statement. Glad you could be with us. Thank you.

STATEMENT OF BART EKLUND, SENIOR TECHNICAL EXPERT, HALEY AND ALDRICH

Mr. EKLUND. Thank you, Chairman Carper, Ranking Member Capito, distinguished Senators, for the opportunity to speak today.

I concur with the statements that various folks have made about the success in improving air quality over my working lifetime. Some of the reasons for the success of the Clean Air Act for the NAAQS is that we have standards, we agree upon what we are trying to achieve for those six pollutants, and we have reference or equivalent methods so that when people gather data, they used agreed-upon methods, and we don't argue about the data, we argue about what the implications might be.

When it comes to air toxics, we have some additional challenges. We do not have any national standards for air toxics, with the exception of lead. From jurisdiction to jurisdiction, there are differences in what is an acceptable level. If I am doing a study for dry cleaning fluid or arsenic or benzene, what concentrations we have to achieve in California may be different in Illinois may be different in New York. What concentration we have to achieve drives some of our choices on monitoring methodologies.

We don't have any standard methods for some of the air toxics. I know one of the bills calls out ethylene oxide. I developed a method for ethylene oxide 15 years ago. There are a couple other methods out there. There hasn't been methods development done to compare those different approaches to see how they compare, and EPA doesn't necessarily endorse any of them at this point.

When we are looking for monitoring in communities for air toxics, we need to look at the timeframes of interest. Sometimes, we are interested in very short-term exposures, such as during an accidental release or process upset. Sometimes we are interested in lifetime exposure to low levels of carcinogens.

A mistake that is often made is trying to use one measurement method to address all those different objectives. Generally, we wind up needing to fine tune our approach for the specific objective at hand. The trends in the monitoring community have been toward continuous monitoring, and sometimes that is needed, sometimes it is not, but we are generating huge amounts of data now.

The other, I don't know if it is a trend, but there is a lot of enthusiasm for low-cost sensors. There is very little enthusiasm among people like me that are experts in air monitoring for low-cost sensors. They have some pros and cons, obviously, but there are some deficiencies in their accuracy, precision, and sensitivity. I know some of the bills have called out more use of low-cost sensors.

I would suggest, as an alternative, more short-term intensive studies. We have done that many times in the past when we are interested in understanding more about an issue to intensively study it for a shorter period of time with the kinds of equipment that we all have confidence in. That is a potential tradeoff.

I would also point out that we are generating huge amounts of data, millions and millions and millions of data points a year for air quality. Unfortunately, I don't think there is really the funding for review and interpretation of that information. So, for example, EPA has an Urban Air Toxics Monitoring Program. They generate data across the U.S. and urban areas for things like formaldehyde, mercury, benzene, many of the compounds we are interested in.

But they ceased doing reporting of that in 2016. The data is still available, but it is no longer in a usable format for the public. They no longer can see a summary report. There is a lot of reason to do more with the data we have in addition to considering collecting more data.

My final point is, in recent years, I have done a lot of indoor air work. People spend, the typical number you will see is 89 percent of their time indoors. When we are doing indoor air studies, we collect outdoor air samples, but what people are exposed to in that 89 percent of the time they spend is overwhelmingly due to consumer products and other things they have indoors. It is rarely outdoor air being a significant contributor to their overall exposure.

Thank you.

[The prepared statement of Mr. Eklund follows:]

Written Testimony of

Bart Eklund
Senior Technical Expert
Haley & Aldrich
Austin, Texas

Before the
United States Senate
Committee on Environment and Public Works

Legislative hearing to examine S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act; and S. ___, the Public Health Air Quality Act._

July 13, 2022

Chair Carper, ranking member Capito, distinguished members of the United States Senate Committee on Environment and Public Works, thank you for the invitation to speak with you today about air monitoring.

My name is Bart M. Eklund. I am a Senior Technical Expert with Haley & Aldrich, a Massachusetts-based company of environmental and geotechnical engineering consultants. I am a chemist by training and have over 40 years of experience with air quality monitoring. I have over 100 publications: papers in research journals, US government publications, and technical papers in conference proceedings.

I am an expert on air quality issues, in particular those associated with the measurement of air toxics. I have conducted air quality studies on six continents. I started my career working for the Federal Government (specifically the USGS) but have spent most of my time at private, consulting firms. I have been a contractor to the USEPA (e.g., developing guidance for air monitoring at Superfund sites, measuring greenhouse gas emissions from wastewater treatment systems) and the USDOE (e.g., measuring emissions of radioactive gases from landfills, modeling air emissions associated with the disassembly of nuclear weapons). Along with co-workers, I developed sampling and analytical methods and performed numerous air quality studies to characterize worker and community exposures. My experience includes work with various continuous and hi-vol methods and addressing criteria pollutants, particulate matter (TSP, PM_{10}, and $PM_{2.5}$), VOCs, SVOCs, PCBs, dioxins, H_2S, methane, metals and other elements, tritium, radon, pesticides, aldehydes, organic acids, amines, silica, and asbestos. In recent years, I have worked on numerous indoor air studies.

My testimony today is to provide context for the bills under consideration based on my technical expertise and experience with the technical and logistical challenges of air quality monitoring. Very brief overviews of air quality monitoring for regulatory compliance and for air toxics are given below, followed by a discussion of the key elements in developing air monitoring programs, recent trends in air monitoring, and a few observations related to the bills.

Overview of Air Monitoring Programs for Regulatory Compliance –

Under the Clean Air Act (CAA), new or modified facilities may need various types of air permits. The permitting process includes estimating the potential air emissions from the facility and evaluating the effect of these emissions on the local area.

Once operations begin, permitted facilities routinely perform air monitoring to measure the emissions from stacks and other stationary sources. This air monitoring may involve Continuous Emission Monitors (CEMs) to provide automated, continual data or periodic (e.g., annual) stack testing involving manual testing for a few hours at a time. The test results are used to evaluate compliance with permitted levels of air emissions.

The CAA established National Ambient Air Quality Standards (NAAQS) for six so-called criteria pollutants. These include several acid gases, carbon monoxide, particulate matter (dust), and lead. The permitting and on-going air measurements at a given facility address the criteria pollutants, but may also require air monitoring for other, additional chemicals.

Community air monitoring is performed across the US by state, local, and tribal agencies to evaluate compliance with the NAAQS. Meteorological (weather) data are collected at the same time to assist in evaluating the air pollutant monitoring data. These monitoring stations are relatively large, typically requiring a trailer (e.g., 14 ft.) to house racks of equipment, security fencing, and electric power service. Each monitoring location may have >$100,000 of equipment. The attached appendix has a few photographs showing typical monitoring stations.

The air monitoring performed under the CAA, whether inside the fenceline of a facility, or out in the communities, must use standard methods that have been approved by the USEPA. This ensures that data are of known accuracy and known quality. Other, non-approved air monitoring methods may be employed from time to time for informational purposes, but the data generally cannot be used for compliance or enforcement purposes.

The permitting program, with the element of confirmatory air monitoring, set up under the CAA has been a tremendous success. Air quality in the US has substantially improved over the course of my career. The USEPA states that air pollutions levels since 1990 have declined by 79% for carbon monoxide, 85% for lead, 54 to 61% for nitrogen dioxide, 21% for ozone and 91% for sulfur dioxide.[1]

This improvement in air quality across the US has occurred despite significant increases in population, vehicle miles, electricity generation, etc. that otherwise would be expected to worsen

[1] Our Nation's Air 2022 (epa.gov)

air quality. The public perception, however, often is that air quality issues have gotten worse over time.

Overview of Air Monitoring Programs for Air Toxics –

Since the CAA and its amendments were passed, interest has grown in hazardous air pollutants ("air toxics"). Since the 1980's, facilities have been required to provide annual estimates of their toxic releases to the atmosphere. These emission inventories are tracked in the Toxics Release Inventory (TRI) program.

Air monitoring for hazardous air pollutants ("air toxics") is routinely performed in the US. For example, the USEPA operates various national monitoring programs to address air toxics, including the:

- Urban Air Toxics Monitoring Program (UATMP);
- National Air Toxics Trends Stations (NATTS) network; and
- Community-Scale Air Toxics Ambient Monitoring (CSATAM) program.

The most recent report from the USEPA includes results from 53 monitoring sites in approximately 30 urban and rural areas.[2] Other areas of the US were addressed in prior years.

The USEPA also has a Mercury Deposition Network (MDN)[3] which is part of the Clean Air Status and Trends Network (CASNET). Samples are collected weekly at about 80 sites (i.e., about 4,000 samples per year) and analyzed for total mercury. A subset of precipitation samples is analyzed for methyl mercury.

The above programs are only part of the USEPA's monitoring efforts, an overview of which can be found in the recent GAO report.[4]

In addition to the USEPA's efforts, individual facilities or industry consortiums may monitor for air toxics at their fence line or in the neighboring communities. Such monitoring may be voluntary or be called for in their permits. For example, large industry-funded air monitoring networks are present in Texas and Louisiana in areas where chemical and refining facilities are clustered (e.g., Texas City, Beaumont, Lake Charles) or oil & gas production is underway (e.g., Barnett Shale). One of these industry-led networks –The Houston Regional Monitoring network – has been in operation for over 40 years. The fenceline monitoring results over time can be compared with estimated impacts based on permit applications or emission inventories.

A Federal regulatory-driven monitoring effort since 2015 has been the requirement under CAA Section 112(d) for refineries to conduct continuous monitoring for benzene along their fenceline. Samples are collected over two-week time periods using EPA Method 325 and additional

[2] Air Toxics Monitoring National Program Reports | US EPA
[3] 2020as.pdf (wisc.edu)
[4] GAO. Air Pollution – Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System. GAO-21-38. November 2020.

monitoring or corrective actions are required if the fenceline results exceed the criterion for the annual average benzene concentration.

An example of a State-led monitoring requirement for air toxics is California Assembly Bill No. 1647, which requires the owner or operator of a petroleum refinery to install and operate a continuous monitoring system along the facility fenceline. These are often referred to as "Rule 1180" monitoring systems. An extensive list of air pollutants is addressed.

Note that there is less standardization of monitoring methods for air toxics compared with compliance monitoring under the CAA. The USEPA has put forth some methods, such as Method TO-15 for volatile organic compounds (VOCs). But even for Method TO-15, there can be significant differences from lab to lab in terms of which analytes are reported, how sampling devices are cleaned, etc. For air toxics such as ethylene oxide, there may be no consensus approach at this time.

Design of Air Monitoring Programs –

The key elements of design of air monitoring programs are described below. Policy makers specify:

1) Objectives of a program, and
2) Chemicals that are of interest.

The objectives might be to directly measure potential inhalation exposures in the community or might be to make measurements along a facility fenceline as a check of how accurate the annual emission inventory is or how much the air emissions change over time. The next steps are to identify

3) Time frames that are of interest, and
4) What concentrations are acceptable.

In general, community air monitoring is concerned with short-term exposure for highly reactive chemicals (e.g., acid gases, ozone, ammonia) and long-term exposure for air toxics such as lead or benzene. Chemicals may have both short-term and long-term effects, but the levels of concern are far different for the different time frames. The levels of concern for long-term (chronic) exposure may be thousands of times lower than the levels of concern for short-term (acute) exposure.

There are national air quality standards (NAAQS) for six air pollutants and standards (OSHA Permissible Exposure Limits [PELs]) for worker exposure. For the concentration of air toxics (other than lead) in the community, however, there generally are no standards. There may be screening levels or guidance levels, but these do not have the same weight as standards. Furthermore, the acceptable level may vary from State to State based on the local environmental laws (e.g., one state may allow one-in-a-million cancer risk and another state may allow one-in-100,000 cancer risk). In some cases, there also can be differences based on duration of exposure

(24 hour/day vs. 40 hour/week) or land use (rural vs. urban areas). Other design considerations include:

5) Sampling period & frequency

Monitoring may be continuous (e.g., for chemicals with short-term effects) or periodic. The time resolution also may be an issue as well as the sampling duration. For most air toxics, the traditional approach has been to collect 24-hour, time-integrated samples about once per week.

6) Number and location of monitors or sampling devices

Monitors are available that provide data for a given location or along an extended path. The traditional approach has been to collect samples at a given location that is a reasonable worst-case or is representative of a larger area.

7) Monitoring methods

The analytical sensitivity of the method needs to sufficient to address whether the air quality exceeds or does not exceed the acceptable concentrations.

For most criteria pollutants, continuous monitors are available to provide immediate feedback for comparison to the NAAQS. For most air toxics, however, this is not the case. The traditional approach has been to collect samples in the field and ship them to an analytical laboratory for processing and analysis. Using traditional approaches, the key cost elements are the labor to collect the samples and the cost of the off-site analysis. Both are proportional to the number of samples.

Other considerations include, 8) network operations (equipment needs an operator to do regular inspections and maintenance), 9) quality assurance (e.g., third-party audits), and 10) data management, and reporting. Note that continuous measurement methods can produce very large data sets to review, validate, and manage. When the concentrations of interest are very low, more data review is needed to ensure that the chemicals are correctly identified and quantified.

Recent Trends in Air Monitoring –

There have been two notable trends in air monitoring in recent years. First, there has been a trend towards collecting continuous data. Using benzene as an example, traditional monitoring would have collected a 24-hour sample every 6th day at a given location. That yields about 60 data points per year. Many stakeholders were concerned that air emission events might be missed with such intermittent sampling and so continuous methods (such as field gas chromatographs [GCs]) have become more common. Data might be collected every 15 minutes, yielding over 30,000 data points per year (500-times more than previously).

In my experience, stakeholders quickly lose interest in reviewing and evaluating the data because the results tend to be "good news" in that few problems or exceedances are detected. The focus then shifts to getting data during certain short-term, difficult to predict events, such as fires, accidents, and emergency releases.

The second notable trend has been toward use of small, relatively inexpensive sensors to develop a widely distributed air monitoring network. This might entail fixed sensors (e.g., a sensor on every light pole) or community members using their smartphones or other devices to collect data. As expected, the use of citizen-scientists and low-cost sensors has both pros and cons. On the plus side, it can lead to greater community awareness and involvement. There is more potential to identify areas or times where air concentrations differ from the average. But, the sensors are not very accurate compared with USEPA standard methods. False positive results are certainly possible and such false alarms can cause unwarranted concern in the community.

My opinion is that networks of low-cost sensors will prove to have only a very limited role in evaluating and improving air quality.

Observations on the Proposed Bills –

I offer up the following opinions that may be relevant.

1. There is a great deal of existing air monitoring data that may be relevant to the objectives of these bills.

The USEPA air toxics programs previously cited addresses some of the chemicals of interest in today's hearing. For example, the most recent annual report gives data for:

- Chloroprene: 2,934 samples;
- Formaldehyde: 3,157 samples;
- Mercury: 602 dust samples (TSP); and 1,544 inhalable dust samples (PM_{10}).

The detection levels were relatively low and so the data should be useful for purposes of evaluating public health. The USEPA continues to collect this data each year, but stopped publishing annual reports after the 2015-2016 year.

As previously noted, there are thousands of measurements per year for mercury deposition from USEPA's Mercury Deposition Network and over 20 years of data.

The existing monitoring efforts and the resulting data sets are an underutilized resource. There is much information that could be gleaned from the existing data sets. Evaluating the existing data is more cost-effective than generating new data.

2. Existing air toxics monitoring already is skewed towards environmental justice areas.

Monitoring stations operated by individual facilities and industry consortiums that collect air toxics data are located at facility fencelines and in the surrounding communities –

these are the exact locations of interest from an environmental justice (EJ) perspective This may also be true for the USEPA air toxics stations (e.g., UATMP), but I am not aware of any evaluation of monitor siting with respect to EJ.

The NAAQS stations operated by state and local governments, on the other hand, tend to be located in more suburban locales. This was done because ozone was a primary concern and ozone exposure tends to be a suburban issue rather than an issue for the city center or the industrial precincts of a city.

Again, the existing monitoring efforts and data sets are an underutilized resource. The existing data sets can provide some insights into questions such as how much concentrations may vary from location to location and the how much of the total exposure dose is attributable to outdoor air versus exposure to indoor air and during commuting.

3. Continuous air monitoring of various air toxics may not be feasible.

Stakeholders often prefer continuous analyzers that provide real-time data. But for many air toxics (e.g., formaldehyde, ethylene oxide), there may not be any methods that can achieve that goal. Therefore, alternatives may need to be considered (e.g., 24-hour samples analyzed in an off-site analytical laboratory).

In some cases, monitoring approaches have been devised and proof-of-concept testing has been performed. Vendors may make extravagant claims. But if no standard method has been developed and validated, there will be questions about data quality, the degree to which the monitoring can be automated, and the long-term reliability of the equipment for the intended purpose.

There are trade-offs that involve analytical sensitivity, time resolution of the data, how quickly the data are available, the size and cost of the monitoring equipment, and so on. In general, to achieve the very low detection limits needed to evaluate long-term exposure to air toxics, there is a need for large, costly, sophisticated monitoring approaches. An overview of some of the newer monitoring options can be found on the website of the California Air Resources Board (CARB).[5]

Thank you for the opportunity to discuss these issues. I look forward to any answering any questions you may have.

Bart Eklund

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[5] Outline of Measurement Technologies | California Air Resources Board

Appendix – Examples of Air Monitoring Stations

Source: CAMS 15 Site Photographs (texas.gov)

Source: Ambient Air Monitoring Network Review Update (govdelivery.com)

Source: Air Monitoring Equipment Shelters | Shelter One

Senate Committee on Environment and Public Works
Hearing Entitled, *"A Legislative Hearing to Examine S. 1345, the Comprehensive National Mercury Monitoring Act; S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021; and S. ___, the Public Health Air Quality Act."*
July 13, 2022
Questions for the Record for Bart Eklund
Mr. Eklund's Responses in Bold

I appreciate this opportunity to respond to questions about air quality monitoring from Chair Carper, ranking member Capito, and distinguished members of the United States Senate Committee on Environment and Public Works. Thank you for your work to improve our nation's air quality.

Chairman Carper:

1. In an April 2022 article, Mr. Isaac wrote, "Levels of the criteria air pollutants tracked by the U.S. Environmental Protection Agency are now so low they're nearly indistinguishable from natural levels."[1] Do you agree with Mr. Isaac's assessment that there are nearly zero places in the United States where the ambient ozone or particulate pollution levels are indistinguishable from natural levels? If no, please explain.

   It is difficult to determine or know exactly what natural levels of criteria pollutants are in the US.

   I do agree with Mr. Isaac that air pollution has been reduced by nearly 80% since the passage of the Clean Air Act. As I stated in my testimony, the USEPA reports that air pollutions levels since 1990 have declined by 79% for carbon monoxide (CO), 85% for lead (Pb), 54 to 61% for nitrogen dioxide (NO_2), 21% for ozone (O_3) and 91% for sulfur dioxide (SO_2).

   There is more potential for natural emissions to be a significant factor when exceedances of standards are measured, as the air in the US has gotten cleaner and the National Air Ambient Air Quality Standards (NAAQS) have gotten more stringent. There is a protocol for addressing these "exceptional events" so that local areas are not penalized for air pollution that cannot realistically be controlled. For example, wildfire events have led to exceedances of the ozone standard that would not otherwise have occurred (e.g., see: Exceptional Events Submissions Table | Air Quality Analysis | US EPA). But these demonstrations are difficult to prove and almost certainly only account for a portion of the natural contribution.

   The criteria pollutant that poses the most issues in the US in terms of attainment of the national standard is ozone, which is a "secondary" pollutant that forms in the air from chemical reactions involving volatile organic compounds (VOCs) and oxides of nitrogen (NO_x). Natural sources can be significant contributors of VOCs.

[1] https://www.texaspolicy.com/for-a-cleaner-earth-invest-in-dont-divest-from-fossil-fuels/

The USEPA estimates that about 75% of the VOC emissions in the US are from natural sources (USEPA, Integrated Science Assessment for Ozone and Related Photochemical Oxidants. EPA/600/R-20/012. April 2020).

For some other criteria pollutants, such as those formed by combustion processes (i.e., SO_2, NO_x, and CO), most of the emissions are from anthropogenic (man-made) sources. For example, the USEPA estimates that only about 6% of the NO_x emissions are from biogenic (natural) sources.

a. Are there places in the United States where ambient air pollution levels are rising above unhealthy levels? If yes, please explain.

The attainment versus non-attainment status for each of the NAAQS for a given county is the best available answer to this question. Those results are given in the "Green Book" (see: Nonattainment Areas for Criteria Pollutants (Green Book) | US EPA). The overall trend for air quality in the US is improving but there still are counties in the US that are in non-attainment status for one or more of the criteria pollutants. As previously noted, ozone is the criteria pollutant with the most exceedances of the national standard and there also are parts of the US where attainment of the particulate matter (PM) standards is an issue. For CO and NO_x, essentially everywhere in the US is in attainment. For SO_2 or lead (Pb), there are only a few counties that have attainment issues.

2. History has shown that we can reduce air pollution, lower energy prices and grow our economy all at the same time. Yet, history has also shown that we often underestimate the health and economic impacts of air pollution on communities, especially frontline communities. That is especially true for air toxics, which can impact human health years after exposure and which have health impacts that can be difficult to quantify in economic metrics.

   a. With that in mind, what is your response to Mr. Isaac's claims that reducing mercury and other air toxics in the environment has resulted in few health and economic benefits for Americans and that there is little need to further track such pollution?

   b. Why is it important to maintain and update our air quality monitoring system?

I do think we need to continue to monitor and track air toxics. The actual health benefits of reducing air pollution, however, are difficult to quantify. As previously noted, there has been a very large reduction in criteria pollutant emissions in recent decades. The USEPA also recognizes that there is a long-term downward trend in air toxics levels (see: Our Nation's Air 2022 (epa.gov)). If outdoor air quality were strongly correlated with human health, we would expect to see a concurrent improvement in human health of US residents over recent decades. Sadly, that does not appear to be the case. That suggests to me that outdoor air quality has less influence on human health in the US than other factors (e.g., diet, exercise, amount of sleep, tobacco usage, alcohol consumption). Even for air pollution, outdoor air

pollution may not be the most important factor. For example, people spend nearly 90% of their time indoors and the air they breath indoors typically has higher concentrations than outdoor air for many VOCs (see Appendix A).

Economic benefits are outside my area of expertise, but I am skeptical of such estimates no matter who generates them.

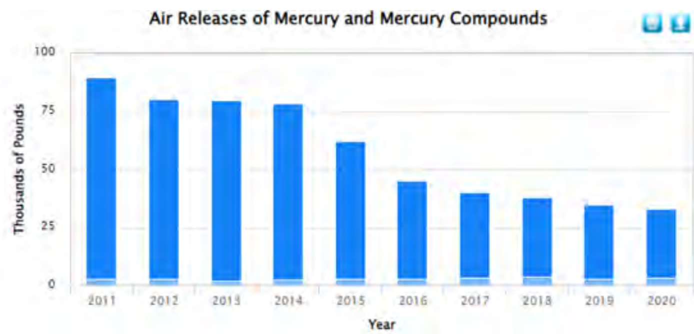
With regard to part B of the question, air quality monitoring is necessary to track how air quality changes over time and to help gauge the effectiveness of regulated and voluntary actions to control or limit air pollution. It is frustrating that the public perception often is that things are getting worse, even though the data clearly shows huge improvements in air quality over time in the US. So, obviously, we could do a better job of informing the public of the data trends.

One of the strengths of the Clean Air Act is that it requires that data be collected using proven and defensible measurement methods. Therefore, there tends to be little argument about the data itself and all stakeholders tend to trust that the numbers are accurate. It is important to maintain and update our air quality monitoring systems to help ensure that valid data are being generated and these data continue to be trusted by stakeholders.

There was talk during the hearing about operators needing to buy spare parts on ebay, etc. Note, however, that the old analyzers being used still meet all the requirements for detection limit, accuracy, etc. It is simply that vendors have newer, similar models of these analyzers (e.g., with better operating software) and may not support the older models. Upgrading monitoring networks with newer analyzers should improve reliability and data capture, but such upgrading is unlikely to have much effect on data quality.

3. Do you support my legislation with Senator Collins, the Comprehensive National Mercury Monitoring Act? If yes, why do you believe a comprehensive system to track mercury in the environment, as is called for in the legislation, is needed?

I am in favor of increased funding for the sciences in general and for air quality monitoring in particular. That said, there are questions about the timeliness of the legislation given that mercury emissions have been decreasing at a significant rate. Per the USEPA, releases of mercury and mercury compounds to air decreased by 64% from 2011 to 2020 and emissions from electric utilities decreased by 88% (see: Mercury Air Releases Trend | US EPA**). I think the benefits of the legislation would have been greater if it had been enacted 10 or 20 years ago.**



The proposed legislation indicates that exposure to mercury occurs largely through the consumption of fish. So, the best way to reduce mercury exposure will continue to be limiting the consumption of fish for the foreseeable future.

4. What, in your view, is the most important thing Congress can do to help improve our nation's air quality monitoring system?

The most important thing Congress can do to help improve our nation's air quality monitoring is to provide adequate funding to the USEPA and the State, local, and tribal organizations that operate the monitoring systems. Beyond that, I think establishing a national database for air quality monitoring data (for both criteria pollutants and for air toxics) would be an important step. The database maintained by the State of Texas would be a template to consider (see: TAMISWeb v5.2.3 - About (texas.gov)).

5. Please describe one or two areas of agreement you took away from the hearing. Where did we find common ground on the state and needs of our nation's air quality monitoring system?

I think there is general agreement that we have made a lot of progress in improving air quality over the last several decades and that air quality monitoring has played an important role. There also appears to be general agreement that the current air quality monitoring infrastructure is aging and additional investment is needed if we are to maintain our current capabilities.

There also may be agreement about the goals of addressing air toxics and environmental justice, though how best to achieve those goals is where there is still debate.

Ranking Member Capito:

1. S. 2476, the Environmental Justice Air Quality Monitoring Act of 2021, requires the EPA Administrator to establish a pilot program for hyperlocal air quality monitoring projects in environmental justice communities. Your testimony seemed to indicate that many air toxics monitoring stations operated by individual facilities and industry consortia are already located in environmental justice communities, and that the existing data sets can provide some insights into questions of how much pollutant concentrations may vary from location to location. Could you please comment on the spatial variability in air quality impacts in environmental justice communities?

   There is a distinction between monitoring sites for criteria pollutants (NOx, SO_2, CO, O_3, etc.) and monitoring sites for air toxics such as benzene and 1,3-butadiene. The criteria pollutant sites are intended to measure regional air quality, to provide feedback on whether emission sources need to be reduced, whether controls are effective, etc. They do not necessarily reflect contributions from small or non-industrial emission sources that may impact a specific small area. For many air toxics (e.g., VOCs), on the other hand, monitoring is typically done at the fenceline of facilities and the fenceline monitors are placed to measure the greatest potential impacts in neighborhoods near industrial facilities. For VOCs, existing data should already represent worst-case values and collecting data across more locations is unlikely to change risk evaluations or decision making.

   Senator Markey provided a study by Liu, et al. from 2021 that evaluated disparities in air pollution exposure in the US by race/ethnicity and income based on data from 1990 to 2010. They looked at criteria pollutants but did not address air toxics. The findings are that:

   - **There is no difference in exposures to ozone (O_3) for whites versus blacks versus Hispanics versus Asians. That is important, because, as previously indicated, ozone is the criteria pollutant for which there are the most areas with non-attainment. That finding is not unexpected, because ozone is more of a suburban pollution issue than an issue for industrial areas or central cities.**
   - **For SO_2, CO, and PM_{10}, the average exposure among the various groups is similar for all groups. More importantly, the values for those three pollutants appear to be low for all groups relative to the standards (NAAQS).**
   - **For fine particulate ($PM_{2.5}$), there is a little less than 10% variability in exposure from group to group.**
   - **The pollutant that stands out in the Liu study is nitrogen dioxide (NO_2), for which there are relatively large percentage differences in exposure from group to group.**

   Senator Markey also provided a summary of an Aclima study from the Bay Area where mobile monitoring found that concentrations can vary up to 800% from one end of a block to the next. Note that this result is only for NO_2.

I believe what the data are telling us is that minority groups live in neighborhoods or areas with more vehicle exhaust. That may be due to closer proximity to highways and/or more vehicle use and/or more older, poorly maintained vehicles (which account for a disproportionate share of total vehicle emissions).

Air quality scientists know that air emissions get diluted as they move downwind and that spatial variability decreases with distance. If there is 800% spatial variability over short distances, that must mean that the emission sources are very close by. And if there is that much spatial variability, it is likely there would also be a great deal of temporal variability. If so, the average concentrations over time in the area would tend to converge (i.e., the 800% variability would not persist).

We should have realistic expectations about what future studies will demonstrate. There will not be 800% spatial variability over short distances for industrial emissions. There will not be that level of spatial variability for air toxics from industrial sources. Further reductions in air emissions from refineries, chemical plants, and petrochemical plants will not have a significant effect on the disparity in NO_2 exposures for environmental justice communities.

2. During the hearing, concerns were raised regarding the accuracy of low-cost air monitoring sensors. Could you speak to the accuracy – or inaccuracy – of low-cost air quality sensors, especially by non-experts?

If the goal is to better address emissions of air toxics and the effect of industrial pollution on environmental justice areas, networks of low-cost sensors for gaseous criteria pollutants (e.g., NO_2) are not a good approach.

There are hundreds of low-cost sensors available for air quality monitoring. Independent evaluations of these sensors against reference measurements generally find that the low-cost sensors are unstable and often affected by atmospheric conditions. Dust monitors tend to perform better than monitors for gases.

The relatively poor performance under field conditions is particularly true for NO_2 sensors. A European iSCAPE project reported that NO_2 sensors have excellent performance in the laboratory ($R^2 > 0.9$), but under field conditions the performance significantly deteriorates ($R^2 < 0.2$). The authors indicate that it is necessary to account for ozone, NO, temperature, humidity, and aging when interpreting the results, with ozone being especially problematic. In California, the South Coast Air Quality Management District (SCAQMD) has been testing various low-cost sensors and found similar results for NO_2 sensors: very strong correlations with reference monitors in the laboratory ($R^2>0.98$) but only moderate correlations in the field ($R^2\sim0.50$).

The above results are for monitoring performed by experts. There can be additional issues when non-experts perform the monitoring. Nordic researchers involved with citizen science projects state that maintaining high data quality in

large, long-term low-cost sensor networks risks becoming very costly and time consuming.

A short summary is attached as Appendix B that provides more detail and references for the above statements.

3. In light of these concerns, how useful would information from low-cost sensors be for monitoring criteria pollutants under the National Ambient Air Quality Standards? Could the volume of data distract from more valuable measurements?

   In general, I do not think widespread use of low-cost sensors for monitoring criteria pollutants is a good idea. Whatever useful information that is generated will be hard to identify amidst the deluge of data of questionable accuracy and validity.

   As I stated in my oral testimony before the committee, if we want to better understand spatial variability, I think a better option would be to perform short-term, intensive studies using more robust and reliable monitoring equipment.

4. The Public Health Air Quality Act of 2022, S. 4510, appears to be highly prescriptive on emissions monitoring – requiring the purchase of specific types of monitoring devices, fenceline monitoring at certain facilities, as well as stringent maintenance requirements. Are the maintenance requirements included in the Public Health Air Quality Monitoring Act reasonable and appropriate?

   I do not think the language in S.4510 regarding maintenance is appropriate.

   The Bill does not define what is a maintenance check, but it specifies that one be performed at least once every 180 days. This does seem overly prescriptive. In general, maintenance is performed on an as-needed basis along with some routine preventative maintenance performed on a regular basis (e.g., annually). In reality, what is important is that the data quality be checked on a regular basis. This can be done daily if the data can be remotely accessed. For sites without automated data downloading, an operator should visit the site on a regular basis (e.g., weekly) to ensure the systems are performing acceptably.

   S.4510 indicates that a maintenance check also must be performed whenever requested by a member of the public. I think a better approach would be that data, maintenance records, operating logs, etc. be made available to the public (either upon request or via publicly accessible records).

   The Bill does not address performance or systems audits by 3rd parties. In my experience, such audits are an effective way to help ensure that valid data are being generated and that potential maintenance issues are identified.

   S.4510 specifies that systems yield "reliable data not less than 95 percent of the time." That level of data capture is possible but a more realistic target would be 85 or 90%. Data capture for a given monitor cannot be 100%, because the monitor is off-line for daily calibration checks, maintenance, and any audits that are

performed. Data capture also is reduced if there is loss of electric power to the monitoring site. Battery back-up power typically is available for data storage, but it is not feasible to use battery power (or solar power or wind power) to operate the air conditioning or heating that often is necessary. Air monitors will not generate valid data if they are not operated within a certain temperature range.

5. If someone – who is not an air quality monitoring or technical expert – was handed raw air quality monitoring data in a spreadsheet, would they be able to understand what that data means and what does that mean for accurate risk communication?

Air monitoring results can be difficult for non-specialists to interpret, even if those persons are scientists and engineers.

There is a human tendency to assume that large values are more significant than small values (this is a type of cognitive bias). If we report a measured value as 3,000 ng/m^3, many people will assume that level likely represents a problem. If we report a measured value as 0.003 mg/m^3, many people will assume that level is probably safe. In reality, the two measurements are the same, all we have done is use different units to report the same result.

One common error made by the public and others is to compare apples to oranges, such as comparing a value measured over a short period of time to a standard or guideline based on a much longer period of time. For example, it is not appropriate to compare an instantaneous or 1-minute value for NO_2 to its annual standard.

Doctors face a similar challenge and most medical results are reported along with a typical or normal range of results to help the patient interpret the results. A patient getting a result showing they have 4 mmol/L of potassium in their blood need only compare their result to the stated normal range to see if there likely is an issue or not. Unfortunately, we do not have a similar option in air quality monitoring. What is normal or typical may depend on which direction the wind is blowing or on the time of year or the amount of sunshine.

Senator Inhofe:

1. In your testimony, you mentioned that the evaluation of underutilized data from existing monitoring efforts is much more cost effective than generating new data. Is there a point where additional air quality monitoring data becomes less useful?

   There is always a point of diminishing returns. There is greater value in adding one more measurement to a small data set than adding one more measurement to a large data set.

   There is a tendency in air quality monitoring to continue to make the same measurements at the same frequency, year after year. We could do a better job of taking into account the data that has already been generated in determining what to do next. This is sometimes referred to as using Bayesian logic. For carcinogens, where we are interested in the average concentration over time, it might be useful to initially collect samples every 6th day when we have no data on the topic. But once we have several years of data, it might be more cost-effective to collect samples every 12th day or even every 30th day. The long-term trend in air quality monitoring, however, is to move toward continuous monitoring which is the opposite of what logic would suggest for this example.

Appendix A

Comparison of Typical Measured Values in Indoor Air and Outdoor Air

Chemical	% Detection	Indoor Air (ug/m3)	% Detection	Outdoor Air (ug/m3)	I/O
Benzene	94	0.617	100	0.58	1.06
Toluene	100	2.24	100	1.06	2.12
Ethylbenzene	100	0.30	99.8	0.17	1.73
m-/p-Xylene	100	0.810	99.9	0.43	1.87
o-Xylene	100	0.319	99.4	0.19	1.67
Styrene	87	0.183	74.3	0.06	2.86
1,2,4-Trimethylbenzene	97	0.313	97.7	0.18	1.77
Tetrachloroethylene	64	0.173	78.3	0.081	2.13
1,2-Dichloroethane	79	0.113	93.4	0.08	1.40
Chloroform	92	0.151	98	0.13	1.19

Values shown are median values. Data are from following studies:

Rago, R., A. Rezendes, J. Peters, K. Chatterton, and A. Kammari. Indoor Air Background Levels of Volatile Organic Compounds and Air-Phase Petroleum Hydrocarbons in Office Buildings and Schools. Groundwater Monitoring & Remediation. 2021.

USEPA. 2015-2016 National Monitoring Programs, Annual Report (UATMP, NATTS, and CSATAM. July 2018.

All Indoor/Outdoor (I/O) ratios are >1, indicating that all indoor air concentrations are higher than outdoor air concentrations.

Indoor air data are for schools and offices. Measured concentrations in single-family residential buildings would be expected to be higher, especially for houses with attached garages.

Appendix B

Overview of Low-Cost Sensors for Air Quality Monitoring

The readily available literature on low-cost sensors was reviewed and the results are summarized below. Particular emphasis was given to sensors for nitrogen dioxide (NO_2), given that the bills under consideration call for more NO_2 monitoring based on studies of spatial variability in air quality concentrations that have shown greater variability for NO_2 compared with other criteria pollutants.

There are hundreds of low-cost sensors available. Independent evaluations of these sensors against reference measurements generally find that the low-cost sensors are unstable and often affected by atmospheric conditions (Karagulian, et al., 2019). Others report similar findings. For example, Kang, et al., (2022) reviewed 112 studies and say that low-cost sensors exhibit improved performance in stable environmental settings. Kureshi, et al. (2022) also point out issues with temperature and humidity, along with sensitivity issues and instability, and address calibration issues. Watne, et al. (2021) address data quality issues and state that maintaining high data quality in large, long-term low-cost sensor networks risks becoming very costly and time consuming.

The relatively poor performance under field conditions is particularly true for NO_2 sensors. Rai and Kumar (2017) report that NO_2 sensors have excellent performance in the laboratory ($R^2 > 0.9$), but under field conditions the performance significantly deteriorates ($R^2 < 0.2$). The authors indicate that it is necessary to account for ozone, NO, temperature, humidity, and aging with ozone being especially problematic.

The USEPA notes that there are currently no standard testing protocols, metrics, or targets to evaluate the performance of low-cost air sensors uniformly. They have started addressing this for $PM_{2.5}$ and ozone (Duvall, et al., 2021a, b).

The South Coast Air Quality Management District (SCAQMD) has been testing various low-cost sensors and publishing their results on-line (see: **Evaluations (aqmd.gov)**). SCAQMD has developed its own testing protocols (SCAQMD, 2016) and published summary reports for testing of two NO_2 sensors. Aerooqual sensors showed very strong correlations with reference monitors in the laboratory (R2>0.98) but only moderate correlations in the field (R^2~0.50). Even in the laboratory studies, the sensors showed low accuracy. Ozone was identified as an interferent. Igienair sensors had moderate accuracy. The sensors also had very strong correlations with reference monitors in the laboratory (R2>0.99) but only moderate correlations in the field (R^2 of 0.53-0.58).

It should be noted that low-cost sensors for particulate matter have shown more promise than low-cost sensors for gaseous pollutants. For example, Wang (2020) did a long-term study near the UCLA campus and compared indoor and outdoor $PM_{2.5}$ levels. Researchers report better results for the number of particles detected rather than the measured mass (deSouza, et al., 2020).

Additional results from specific studies are discussed below.

Ahn, et al. (2020) evaluated 264 low-cost dust sensors in short duration tests in a test chamber. They defined the highest class of sensors as those that could achieve an accuracy of +/-20% compared with a reference method. This level of accuracy was met by only 16% of the sensors for PM_{10} and 26% of the sensors for $PM_{2.5}$. More than one-third (36%) of the sensors were off by more than 50% for PM_{10}.

Bauerova, et al. (2020) compared the performance of various low-cost sensors with reference methods over a one-year period at a field site. The concluded that the SO_2, NO_2, and CO sensors were "*inappropriate due to their weak measurement quality or data inconsistency within sensor pairs.*" The sensor accuracy was affected by temperature, relatively humidity, and interfering gases. For NO_2 and ozone, they found that temperature could affect the zero value by +/-50 ppb. In other words, they might read 50 ppb at times when no pollutant was actually present.

Gabel,et al. (2022) evaluated very low-cost sensors at a field site for 4-8 months. They evaluated both electrochemical sensors and metal oxide sensors for gases and optical particle counters for particulate matter. Both electrochemical and method oxide sensors for NO_2 had poor performance. The NO_2 sensors "*showed no capability to measure the given concentrations…*" and had correlations that were close to zero.

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Watne ÅK, Linden J, Willhelmsson J, Fridén H, Gustafsson M and Castell N. Tackling Data Quality When Using Low-Cost Air Quality Sensors in Citizen Science Projects. Front. Environ. Sci., Vol. 9. October 2021.

Senator CARPER. Thank you very, very much.

Senator Capito has to head out for another responsibility here in a second, but she is going to be asking questions. I think I will turn it over next to Senator Whitehouse. I will probably go right after her, so Senator Capito.

Senator CAPITO. Thank you, and thank you all for being here. Mr. Eklund, let me ask you if you can explain in really general terms, because I know you are a technical expert, the difference between monitors that are used to regulate criteria for air pollutants, and then air toxics. Is there a difference there?

Mr. EKLUND. Certainly. For criteria pollutants, they are largely the combustion products for things like vehicle use and burning coal. We are interested in short-term exposure, so we have monitors that give us time resolution of a few seconds or a few minutes.

For air toxics, we are often interested in lifetime exposure, because of the potential for them being cancer causing. In those cases, we don't need that same time resolution, but we need to get very, very sensitive results. So as a previous witness pointed out, we may be collecting a sample and shipping it off to a lab and getting the answer back in a matter of weeks, rather than instantaneously.

Senator CAPITO. We have heard testimony that there are gaps, and some of these bills are aimed at trying to fill gaps. You mentioned enormous amounts of data that EPA is generating, or has, collects, and then we are hearing all these gaps.

I am curious to know, why did EPA stop publishing the data in 2016, that you could extrapolate for regular people like me to be able to see what it going on, rather than to have to dig deep, and what gaps would you say there are in light of the testimony that you have heard before you?

Mr. EKLUND. I can't speak to EPA's——

Senator CAPITO. You don't know?

Mr. EKLUND. I don't know.

Senator CAPITO. OK.

Mr. EKLUND. In terms of gaps, there are emerging pollutants.

Senator CAPITO. What would be an example of an emerging pollutant?

Mr. EKLUND. Well, PFAS is one, but also some of the things that were listed in Senator Duckworth's bill: ethylene oxide, formaldehyde. One of the issues is that the methods that we use to look at things like around a refinery aren't good tools for those chemicals. Each of those chemicals presents some challenges from an analytical chemistry standpoint, and we wind up needing to spend a lot of money and effort to get data for one chemical at a time, as opposed to some of the existing methods that allow us to look at dozens or hundreds of chemicals with a single sample.

Senator CAPITO. OK. Mr. Isaac, I want to ask you about the Permian Basin, because domestic air emissions, including ground-level ozone, have fallen significantly over the past few decades, meaning our Country has much cleaner air, but that has not stopped this Administration from moving forward with plans to redesignate your area, the Permian Basin, as being in nonattainment with the ozone standard. How would a finding of nonattainment with the ozone standard impact what goes on in the Permian Basin, and how do you interpret their interpretation?

Mr. ISAAC. Their interpretation is wrong. The EPA nonattainment areas should be based on vehicular traffic, and they are looking at remote areas where there is no vehicular traffic. You are looking at one of the largest areas of production for oil and gas in this Country, and so it would be absolutely catastrophic to put EPA nonattainment, and that is why our Governor, Governor Abbott, has come out full throttle against this and will work diligently to make sure that this is not implemented over the Permian Basin, whether it is Texas or New Mexico.

But that energy that we are producing is really providing the fuel for this Country and the rest of the world, and quite honestly, we need to be increasing production. We need to get the financial industry off of the backs of the oil and gas companies and the fossil fuel producers in this Country. We need to get them to quit discriminating against responsible American energy producers. We need to get the government to get out of the way and get off the backs of these responsible energy producers so that we can be helping people that are facing troubles in Sri Lanka, in Germany, in France, and the Netherlands, and Ghana and South Africa that are just being crushed by energy poverty because they have adopted these policies to decarbonize their governments, their countries, which does nothing to improve the environment, but does everything to increase the cost of energy. It is just another assault on the oil and gas industry.

Senator CAPITO. Thank you. We have heard that, and we have stated, both of us, and you all have as well, that the mercury levels have come way, way down over the last 20 to 30 years. Consistent with everybody's testimony is that the reason that we have any issues with this, I wouldn't say any, but issues with this is because of what goes on in China. I am curious to know, does China monitor their mercury emissions? Mr. Eklund, do you know?

Mr. EKLUND. No, I don't know, but I would be surprised if they do.

Mr. ISAAC. I do know they have the pollution control technology, they just don't utilize it. I have often said that there are, of all the technology the Chinese steal from us, it would be nice if they would utilize our pollution control technology. They don't. We are world leaders in clean air, and that impacts, as I said in our testimony, over 80 percent of the mercury deposits in the U.S. today come from foreign sources, and over half of that is from Asia.

Senator CAPITO. Thank you.

Senator CARPER. Senator Capito, thanks so much for joining us. I look forward to seeing you on the floor in a little bit.

I am going to ask unanimous consent to submit for the record letters and statements of support for today's legislative hearing. These letters come from environmental organizations, environmental justice groups, public health advocates, including a July 12th, 2022 letter from the American Lung Association in support of all three pieces of legislation we are examining today.

[The referenced information was not submitted at the time of print.]

Senator CARPER. I believe a series of votes have just started on the Senate floor. We will have to be out of here in less than 30 minutes. I am going to ask questions next, and I will yield to a Marine friend of mine, I am a Navy guy, different uniform, same team, and I will yield to Senator Sullivan next, and Senator Whitehouse is back. He will be following Senator Sullivan. OK.

My question, let me just start off with a quick statement. My colleagues have heard me say this more times than they want to remember, Mr. Isaac, but there is an old saying that says where you sit helps determine where you stand on a particular issue. I don't sit in Delaware, but I live in Delaware. I have lived there forever since I got out of the Navy a million years ago at the end of the Vietnam War when I moved there.

My State is sinking. We are the lowest-lying State in America. We are sinking. The seas around us are rising. Up and down the east coast, you find similar situations. Although our colleagues from Louisiana remind me from time to time, both Republicans, that in their State, that they lose about every hundred minutes, a piece of land the size of a football field. During the course of this hearing, they are going to lose, in Louisiana, enough land for two football fields, and it is going off into the sea.

We have wildfires across the Country as big as my State. There is stuff going on here. There are reasons why we are still concerned about reducing carbon emissions, as you know. The challenge for us, and the opportunity for us, going back to what Ms. Johnson said, she was talking about diesel bus emissions.

One of the things that Senator Sullivan and I focus on is how do we cleanup, do good things for our planet, for air, water, and so forth, and create economic opportunity at the same time? One of the things that, this is the committee that helped write the Bipartisan Infrastructure Bill and reported out unanimously both the Surface Transportation piece and all the water legislation.

We are proud of the work that we did. We also provide a lot of opportunity to address, through electric vehicles and buses, reducing bus pollution, diesel emissions and that sort of thing. There is a lot of opportunity for economic development and job creation, as well, so we are focused on both sides of that.

In terms of questions, I will start with Ms. Fallon. Ms. Fallon, are you still with us?

Ms. FALLON. Yes, Senator.

Senator CARPER. Good, good. Mercury is a dangerous air toxic, as we know, that persists and bioaccumulates in the environment long after its release, meaning it gets more dangerous over time.

Unlike particulate matter and ozone pollution, mercury air pollution is more dangerous when it settles into our waterways and our food than when it is in the air, yet we have significant data gaps in knowing how much mercury is present in our environment at one time. For example, as you mentioned in your testimony, it has been a decade since EPA last compiled State mercury fish consumption advisories.

The question, Ms. Fallon, is this: how is the mercury monitoring authorized and the Comprehensive National Mercury Monitoring Act different? How is it different from EPA's current air toxics monitoring programs, and why is this new type of mercury monitoring necessary to better protect health?

Ms. FALLON. Thank you for that question. Currently, as you said, as you rightly said, mercury is not just an air pollution problem. While mercury levels, specifically mercury emissions, have gone down, the amount of mercury deposited to watersheds has not, and may be increasing. The funding is currently to measure that deposition being pieced together from State agencies, universities, non-profit organizations.

We don't have dedicated Federal funding to measure mercury deposition, and we are down to 82 sites that measure mercury deposition. There have been about 90 others that were online at one point or another. As the patterns of where mercury is coming from changes, it is particularly notable that we lack Federal funding for measuring mercury deposition in Western States.

So, with the influx of mercury from emissions in China, it is really important that we are able to document mercury deposition in those Western States. Given the fishery and the Gulf States, it is equally important that we measure mercury deposition there. We shouldn't take the fact that mercury emissions in the U.S. are declining to mean that the mercury problem has been solved.

Senator CARPER. Thanks very much. A quick question, and a quick answer, I would ask from Ms. Johnson. You explained in your testimony how vulnerable populations like children, like seniors, and pregnant women are more sensitive to the effects of air pollution, especially if they live in low-income communities or communities of color.

Do you believe that the three pieces of legislation before us today complement one another to address the deficiencies of our current air monitoring systems and adequately protect vulnerable communities? Why should Congress, through these bills and other legislative action, continue to invest in air monitoring? I ask you to be succinct in responding to that question. Go ahead, Ms. Johnson.

Ms. JOHNSON. Yes, thank you for your question, Chair Carper.

I absolutely believe that the three pieces of legislation work well to address the issue of air pollution in our communities. I think that people living in an environmental justice community oftentimes notice the adverse health outcomes plaguing their community before data is available to validate that source.

I think the burden of health protection has been placed on people living in communities, whether it is fundraising for monitors or performing community-based participatory research, and the passage of these bills, the Environmental Justice Air Quality Monitoring Act and the Public Health Air Quality Act, as well as the bill focused on mercury, can shift the burden of protecting communities, protecting the environment away from residents and place that burden on our agencies and departments that have that responsibility.

I think it also, as was mentioned earlier, can provide economic opportunities for individuals. We talked about the age of the monitors that we currently have in place and a need for us to do robust maintenance and care for them, and we believe that those are opportunities, economic opportunities, that are available for individuals to be trained, to have jobs, as well as to have entrepreneurial opportunities in that space.

Senator CARPER. That was good. Thanks very much.

Senator Sullivan is next, followed by Senator Whitehouse. Senator Padilla will be coming back after that; he will be next. OK, Senator Sullivan, welcome. Good to see you.

Senator SULLIVAN. Thank you, Mr. Chairman. You, too.

Mr. Isaac, Mr. Eklund, I want to followup on Mr. Isaac's discussions on the energy sector and the importance in terms of jobs, national security, economic security, prices at the pump. I couldn't agree with you more that this Administration has undertaken a full assault on these sectors.

One thing, though, that never gets talked about, I am from Alaska. I was the Commissioner of Natural Resources and Energy in Alaska. We have the highest environmental standards on production of any place in the world, in the world, by far. It is not even a close call, but that goes for America in general. I think Alaska is the highest.

But can you just comment on that, because a lot of people don't know that. When we produce oil and gas in Texas and Alaska, New Mexico, by the way, New Mexico is just cranking. Deb Haaland, Martin Heinrich, their State, boy, do they crank on oil and gas. They get special treatment by the Biden Administration. Almost half the Federal permits, half the Federal permits issued by the Biden Administration go to one State. Not Texas, not Alaska, they try to shut my State down every day.

New Mexico; I think it would be a great hearing to have, why is New Mexico getting all this special treatment for oil and gas? Maybe it is the Secretary of the Interior. Maybe it is the Senior Senator, but who knows. I am digressing here. It is an issue I am a little hot and bothered about.

Do we have higher standards than, say, Russia, Saudi Arabia, Venezuela, Iran, where the President is going around begging for more oil production? Do we, and shouldn't that matter?

Mr. ISAAC. Absolutely, Senator. The National Energy Technology Lab issued a report. You could take natural gas produced in this Country, you export, you produce it, you pipe it, you liquefy it, and then you put it on a ship and you transport it around the world, and you can get that gas to Europe and the India with greater than 40 percent fewer life cycle emissions than getting the same gas just piped from Russia.

Senator SULLIVAN. From Russia, 40 percent. Yes.

Mr. ISAAC. You are absolutely right, yes.

Senator SULLIVAN. Greater than, Venezuela is 18 times higher in terms of pollution, including air, than U.S. energy production. Isn't that true as well?

Mr. ISAAC. That is absolutely correct.

Senator SULLIVAN. OK.

Mr. ISAAC. We are world leaders in environmental protection.

Senator SULLIVAN. But that never gets out. When they come after the energy sector, oh, you guys are horrible. We are the leader in the world, aren't we?

Mr. ISAAC. Yes, we are.

Senator SULLIVAN. Let me show you another chart that is really important. I bring this out a lot. By the way, all the national media has fact-checked this because they hate it, but it happens to be true. Even they have to admit it is true.

This is a chart of CO_2 emissions since 2005, OK? That is the United States. We have reduced CO_2 emissions by almost 15 percent. There is China; there is India, through the roof. Why do you think that happened?

Mr. ISAAC. It is technology, and it is environmental leadership.

Senator SULLIVAN. Technology, and it is also the revolution and the production of natural gas in America, correct?

Mr. ISAAC. Yes.

Senator SULLIVAN. Because it is clean-burning, relative to other sources. We moved off coal, and we went to the production of natural gas.

Mr. ISAAC. I am glad you brought up CO_2, because I am ingesting higher concentrations that what is prevalent in the atmosphere, and I am not spontaneously combusting, so we can't demonize CO_2. It is necessary for life on Earth.

Senator SULLIVAN. My point is, if other countries had the profile that we do, don't you think the global emissions problem would make significant, if China and India had our profile, wouldn't that be good for global emissions around the world?

Mr. ISAAC. Oh, absolutely.

Senator SULLIVAN. Does everybody, Mr. Eklund, do you agree with that?

Mr. EKLUND. I think that is pretty obvious, yes.

Senator SULLIVAN. OK. Ms. Fallon, do you agree with that?

Ms. FALLON. Could you repeat your question, please?

Senator CARPER. Try to make it really short.

Senator SULLIVAN. I am going to be out of time here.

I want to ask, Ms. Johnson, I want to ask one final question. It is a really important one for me. I have brought this chart up a lot, too. This is a chart about life expectancy in my State, in America. Dark blue, even purple, is the most life expectancy, increases from 1980 to 2014.

Unfortunately, in America, there are a couple areas you look, orange, red, yellow, the life expectancy in America decreases. It is mostly the places where there is opioid challenges.

Alaska has had the biggest life expectancy increases of any place in the Country, almost 13 years. What is remarkable about this, and the reason it happened, is because resource development happened. That is the North Slope of Alaska, Northwest Arctic Borough, Aleutian Island Chain with the Magnuson-Stevens Act. That is fisheries, that is oil, gas, mining.

My question is, this Administration likes to talk a lot about environmental justice, environmental equity, but when it comes to Alaska Natives, they don't count. They don't count, because they try to shut down resource development projects in these parts of my State that will not only hurt people, it is a matter of life and death. Thirteen years life expectancy increase.

So when people talk about environmental justice and environmental equity, Ms. Johnson, shouldn't they also include the Alaska Native people who are communities of color, who are often targeted by the Biden Administration, not helped, and to promote policies that actually increase life expectancy?

Senator CARPER. Ms. Johnson, I am going to ask you to be succinct in responding to that question.

Senator SULLIVAN. Yes, that is my question.

Senator CARPER. Three more folks to ask questions, and then we have to go vote. Ms. Johnson, very briefly, please. Thank you.

Ms. JOHNSON. Yes. I will note that there are indigenous tribes in Alaska, and they are considered environmental justice communities. So I would make the assumption that when one is talking about Native Alaskans, one could also be talking about an environmental justice community.

Senator SULLIVAN. Good. Thank you very much. Thank you, Mr. Chairman.

Senator CARPER. Thank you, Senator Sullivan.

Senator Whitehouse, please. Thanks for coming back, Sheldon.

Senator WHITEHOUSE. Thanks. I love following Senator Sullivan, because I get the chance to point out that his graph does not include methane and is based on coal-to-gas transition that has unleased enormous amounts of excess methane, and it is not based on percentage, which is interesting, because the U.S. has been the biggest carbon dioxide emitter. It is based on raw emissions.

So yes, we have a bigger number because we are a bigger emitter. I think that is what the fact-checking shows.

Mr. Isaac, the Texas Public Policy Foundation has received funding from the fossil fuel billionaire Koch operation, from ExxonMobil, Chevron, Conoco-Phillips, Devon Energy and other fossil fuel companies. Is that correct?

Mr. ISAAC. If that is public knowledge. I don't keep track of who our donors are, but I know that we are supported by over close to 10,000 people across the United States that believe in liberty, free enterprise and personal responsibility.

Senator WHITEHOUSE. Here is what TPPF's former vice president said about the organization producing industry-friendly research and advocacy in exchange for donations from industries that would financially benefit from the industry-friendly policies. The fundraising involved approaching corporations, wealthy businessmen and corporate-funded foundations with a pitch described as "We think this is beneficial to your industry and would you consider providing us with a non-profit contribution? Here is the timeline for the completion of the research, the parameters of the research are this, we expect it to result in some savings or outsourcing."

I would like to put this article from the Texas Observer into the record.

Senator CARPER. Without objection.

[The referenced information was not submitted at the time of print.]

Senator WHITEHOUSE. Mr. Isaac, in 2020, the most recent year for which we have your TPPF 990 form, TPPF reported receiving over $17 million in donations, correct?

Mr. ISAAC. That is correct. That is my understanding.

Senator WHITEHOUSE. How much of that comes from entities connected to the fossil fuel industry?

Mr. ISAAC. I am not advised.

Senator WHITEHOUSE. You really don't know that that funding comes from the fossil fuel industry?

Mr. ISAAC. I am going to say it comes 100 percent from people that benefit from fossil fuels.

[Laughter.]

Senator WHITEHOUSE. Yes, I bet they do.

I am assuming that you are a fan of and familiar with the economist Milton Friedman, the godfather of conservative libertarianism.

Mr. ISAAC. Yes.

Senator WHITEHOUSE. In fact, TPPF honored Dr. Friedman at a commemorative event for the important role he played in promoting economic freedom in the United States, correct?

Mr. ISAAC. I believe so, yes.

Senator WHITEHOUSE. Are you aware that Dr. Friedman supported pricing of emissions, pollution pricing, indeed said it was the best way to deal with pollution, and he considered pollution to be a market failure? Is that correct?

Mr. ISAAC. I am not advised of his comments on pollution pricing.

Senator WHITEHOUSE. Is this being the one area where TPPF doesn't follow Friedman's principles related to the fossil fuel donors of TPPF?

Mr. ISAAC. I would say that we are proud of our American achievement and having the cleanest air on record, and we are world leaders in environmental protection.

Senator WHITEHOUSE. We, meaning?

Mr. ISAAC. The foundation. The foundation is absolutely proud of our Country and the clean air that we have, the safest, we are No. 1 when it comes to access to clean and safe drinking water. There is almost a billion people on the face of the earth that have no access to electricity.

Senator WHITEHOUSE. We keep trying to improve that, and your industry keeps trying to oppose us, and you work for the industry.

You cite a Bloomberg article in your testimony saying that the average household paid $5,200 more a year because of inflation, much of it from gas price hikes by big oil, which sets gas prices. At the same time, the International Monetary Fund estimates that damages associated with fossil fuel combustion to people's healthy, property, lives, amount to approximately $640 billion in 2020, which works out per household to almost exactly $5,200. That hits those households every year, not just when inflation surges, correct?

Mr. ISAAC. Yes, I believe those are referring to statistical lives, and that is flawed, much like the U.N. IPCC climate model.

Senator WHITEHOUSE. So you disagree with that?

Mr. ISAAC. Yes.

Senator WHITEHOUSE. How much is the Ike Dike going to cost to protect the Texas coast from future hurricanes? Is it $31 billion?

Mr. ISAAC. I am not sure of the cost of the Ike Dike. The only levee that I am aware of was built around Galveston.

Senator WHITEHOUSE. How much is the damage from Hurricane Harvey? Is it $125 billion?

Mr. ISAAC. I am not advised.

Senator WHITEHOUSE. Ninety-one percent of families in the Houston area with flood insurance policies projected to see their rates go up due to increasing weather events like Hurricane Harvey?

Mr. ISAAC. I would say it is due to extreme insurance companies that are no longer making funds available to the fossil fuel industry or the timber industry in this Country as well as financial institutions discriminating——

Senator WHITEHOUSE. How do they make funds available to the fossil fuel industry?

Mr. ISAAC. If you are limiting access to insurance policies——

Senator WHITEHOUSE. Hold on. Hold on. Hear my question. This is home insurance I am talking about.

Mr. ISAAC. Yes.

Senator WHITEHOUSE. You are talking about business insurance.

Mr. ISAAC. Correct.

Senator WHITEHOUSE. OK. Just wanted to be clear about that. I would like to put into the record the article about the increased cost to Houston families from flooding.

Senator CARPER. Without objection.

[The referenced information was not submitted at the time of print.]

Senator WHITEHOUSE. In other States, Florida, average homeowner's insurance premiums up 55 percent in the last 3 years due largely to increased hurricanes and flooding. California, more than 350,000 home and business owners saw property and casualty properties dropped because of more frequent and severe wildfires. Cargill's executive director has stated that climate change could reduce grain yields in the U.S. by 14 percent by mid-century and 42, 42 precent by late century.

What effect on prices would a 42 percent reduction in midwestern grain yields have, Mr. Isaac?

Mr. ISAAC. I think the key word there is could. What we are seeing is climate is absolutely changing and man is having an impact on it. But over the last 100 years we have seen around a 90 percent——

Senator WHITEHOUSE. And a 42 percent reduction in supply would have an effect on price, would it not?

Mr. ISAAC. It could. Could.

Senator WHITEHOUSE. Thank you. My time is expired.

Senator CARPER. Thank you very much.

Now we have Senator Kelly.

Senator KELLY. Thank you, Mr. Chairman. Thank you to everybody who is testifying today.

Mr. Eklund, I want to ask you about emission reduction credits and what flexibilities currently do or could exist under the Clean Air Act. As you know, under the Clean Air Act, any new manufacturing or development must identify emission offsets through emission reduction credits. These credits are traditionally created by installing pollution controls at factories or at generation facilities.

In Arizona, where we do not have a legacy of heavy polluting industries, finding sources of emission reduction credits from traditional sources is challenging. This has led Maricopa County, the largest county in Arizona, to explore opportunities to create nontraditional credits from offsets from the transportation sector or improving efficiencies in refrigeration technologies. But they have encountered challenges working with EPA Region Nine, given limitations of the Clean Air Act.

Mr. Eklund, do you believe that there are opportunities in the Clean Air Act legislation that we are considering today or another legislation to give EPA the additional ability to help localities create non-traditional emission reduction credits?

Mr. EKLUND. I am not an expert in that topic, but I think we all would agree that EPA should have flexibility to reach goals that are agreed upon by non-traditional methods, if necessary, for those kinds of situations like you described.

Senator KELLY. Yes. So this is getting rather challenging for Arizona. If you could, after the hearing today, if there is any other information you can get on this topic, and would work with my office, I would appreciate that.

Ms. Fallon is testifying remotely. Ms. Fallon, thank you as well for being here today. Your testimony and that of several other of our witnesses has focused on the potential benefits that could come from the deployment of small, low-cost sensors to help localities monitor air quality in more locations and at a lower cost. Yet some have raised concerns that this technology has not been fully proven out and in some cases, it creates false positives, which can push a community into non-compliance.

Ms. Fallon, do you believe that the new, small, low-cost sensors are able to perform at the same level or before than existing level, or better than existing air quality management tools?

Ms. FALLON. Thank you, Senator. That is a bit outside my specific area of expertise, so we can certainly get back to you with more details. But in general, innovations in air quality monitoring are pretty commonplace. As new methods are adopted and new equipment is used over time, they are often co-located and coupled with the conventional methods for a period of time. So that through a pilot project, for example, we learn how to calibrate and better use new equipment.

So innovation in air quality monitoring is important and should be funded so that we can continuously improve our measurement of air quality.

Senator KELLY. I would appreciate your getting back to us because there have been a number of cases where this has created false positive situations. Mr. Eklund, if you would like to comment?

Mr. EKLUND. The low-cost sensors cannot be used for enforcement or compliance purposes, because they don't have the capabilities to do that. So we can put them out for informational purposes, but when we have put them side by side with EPA reference or equivalent methods, they don't perform very well. That is why I was making the case for alternative approaches like short-term intensive studies using more robust methods than relying on low-cost sensors to gain that knowledge about how pollution might bury them on a local scale.

Senator KELLY. Yes, I am all in favor of game-changing technology. We just need to make sure it is ready for widespread use.

Thank you, Mr. Eklund, Ms. Fallon, and I yield back.

Senator CARPER. Senator Markey, have you voted? Senator Markey. I have not voted.

Senator CARPER. Senator Padilla, have you voted? Would you mind if Senator Markey goes ahead and speaks, asks his question? Are you able to do that? That would be helpful. Thanks very much.

Senator MARKEY. Thank you, Senator Padilla.

Just a few years ago, Chelsea, Massachusetts, a major industrial hub with some of the highest rates of asthma in the United States, the most elevated rates of lung disease, did not have any permanent air quality monitors, while nearby Boston had three. I am proud that we were able to get some monitors deployed in Chelsea.

But we have a lot more work to do to correct our patchwork approach to pollution measurements within affected communities. Ambient air quality monitors are critical tools to get baseline air quality measurements on a regional average.

But we also need to understand that the air quality issues that can vary substantially from neighborhood to neighborhood are very real. Communities like Chelsea or Springfield or Lawrence deserve real-time data on a block-by-block basis in order to make day to day decisions about public health risks, as well as long-term decisions about siting infrastructure.

Ms. Fallon, do you agree that hyper-local monitors are helpful and provide additional data to regional ambient air monitors that will help us really to target the areas that need the most help?

Ms. FALLON. Yes, Senator, I do agree with that. As you have mentioned, a lot of the existing monitoring provides regional average information. We can have very strong gradients in air pollution exposure and air quality.

So we need to begin to better understand how people are affected who live close to these sources such as people who live in Chelsea and hyper-local monitoring is the way to get there.

Senator MARKEY. Thank you. Because the national average or the State average doesn't tell us anything about Chelsea. Because you only get the average from the extremes. So the suburbs, they are great. But you have to identify the Chelseas to know where the protections are in need of being placed. We can't manage what we don't measure. We have to use the best available technology to make the best possible decisions.

That is why I introduced the Technology Assessment for Air Quality Management Act, in addition to the Environmental Justice Air Quality Monitoring Act. This legislation would help the EPA annually update and expand its online air quality toolbox with the best available monitoring technology and connect the toolbox with environmental justice mapping and screening tools.

It is 2022. We have new, advanced technology that can fill critical hyper-local data gaps. But today's communities aren't reaping the benefits of today's monitors. We need to pass the Environmental Justice Air Quality Monitoring Act in order to provide EPA with the resources to kickstart hyper-local monitoring programs in environmental justice communities across the Nation.

Ms. Johnson, do you agree that it is important that communities have access to air quality data that lets them know how healthy the air is in their neighborhood, especially for neighborhoods that have historically been redlined or afflicted with higher levels of pollution?

Ms. JOHNSON. Yes, thank you for the question, Senator Markey, and your leadership on this issue. We do believe that it is important for communities to have this air quality data. We believe that they are already with citizen science projects identifying pollution in their communities and this gives us an opportunity to match real time data, real time information with the lived experiences that people are having on the ground.

It also helps to address, as you noted in your comments, how communities have been redlined and how we have centralized pollution. While we may have seen improvements in air quality at a national level, this does give us the opportunity to really drill down and at a hyper-local level be able to quantify and qualify the experiences that people are having.

Senator MARKEY. I thank you so much. You also, I hope, believe that it is important to provide people on the front lines with jobs and training to work on community air monitoring issues. Do you agree with that?

Ms. JOHNSON. Yes, absolutely. As I noted earlier, this is an opportunity for us to train those who are under-employed or unemployed in a new skill set. It is an opportunity to give folks entrepreneurial possibilities, in sort of managing and monitoring the upkeep of these systems and technologies. So we do think it is a great opportunity and WE ACT does have experience in training and developing people in these areas.

Senator MARKEY. Thank you, Ms. Johnson. Thank you, Mr. Chairman. Thank you to Senator Padilla for your indulgence.

Senator CARPER. Thanks for coming back.

Senator Padilla, thank you for joining us again.

Senator PADILLA. Thank you, Mr. Chairman. I want to thank you for holding this hearing on the bills to improve air quality monitoring. All three of the bills that we are talking about today will improve our air monitoring network, which is desperately needed to improve public health and access to clean air in our communities.

California is no stranger to polluted air. Going b ack to 1955, 15 years before the Clean Air Act and before the creation of California's own Air Resources Board, the city of Los Angeles, where I was born and raised, experienced the single smoggiest day in its history. I know firsthand what that is like. When I was a kid growing up in Los Angeles, I remember the smog days when we were sent home from school early due to the devastating air quality.

We have come a long way in improving air quality and clean air access for our communities. But California's clean air gains have not necessarily been equitable throughout the State. I won't go into the entire history of redlining, but I think the results are devastatingly clear in many California communities.

I will give an initial example. In the East Bay area in California, redlined neighborhoods in Berkley and Oakland, among others, were closer in proximity to polluting industries and further harmed by major highways that separated communities and increased exposure to pollution.

Data shows that even today, people in those areas disproportionately suffer from higher levels of nitrogen dioxide pollution which in turn increases rates of childhood asthma. A study from 2019 that focused on eight California cities found that residents of historically redlined neighborhoods were twice as likely to visit emergency rooms for asthma.

So my first question is for Ms. Johnson. Ms. Johnson, how would the Environmental Justice Air Quality Monitoring Act help redlined neighborhoods, specifically like those in the East Bay, achieve the same air quality gains that non-redlined communities have enjoyed?

Ms. JOHNSON. Thank you for your question, Senator. I think there are examples of hyper-local air quality monitoring projects in California that give us an idea of the benefits that we can gain from these bills. One is a pollution monitoring project that was designed to increase youth literacy around air quality issues. But what it really found was that as it followed youth in their day-to-day activities, it found that their exposure at home and at school to transportation pollution was higher than expected because of the path that they needed to take to walk back and forth between those two places.

When we think about a project that the NRDC, The Environmental Group and Google engaged in it really showed that people living in a redlined community have a higher percentage of exposure to pollution that is eight times that of any other area. So I think our ability to really be able to capture this data will be the step, the first step or an additional step, in the path that we need to be able to actually bring corrective action to these communities that will improve air quality.

Senator PADILLA. Thank you. I want to piggyback on the question and topic raised by Senator Markey about hyper-local monitoring, which you just acknowledged once again. We have been working together with Senator Duckworth as well on an item.

I will preface it with highlighting once again the tool developed in California known as CalEnviroScreen, that helps identify communities with the most significant pollution burden. Part of the innovation of CalEnviroScreen is how it maps communities that are impacted by multiple sources of pollution, not just each source in isolation. It collects data on over 20 indicators to help California policymakers identify disadvantaged communities so we can better target climate investments.

We are working, as I mentioned, with my colleagues as well as the Council on Environmental Quality to make recommendations for how to improve the Federal climate and economic justice screening tool, and we hope that the recommendations, which are based on lessons learned from California, can be used to improve both the Federal tools and the States that have similar tools.

Ms. Johnson, how is CalEnviroScreen unique in its use of air quality data? How would the legislation that we are focused on today help improve California's tool and the Federal tools at CEQ and EPA?

Senator CARPER. Ms. Johnson, I am going to ask you to answer very briefly. Time has expired on the floor. Answer that very briefly and we will ask you to answer it more completely for the record. Go ahead, Ms. Johnson.

Ms. JOHNSON. The CalEnviroScreen is unique in that it uses satellite data and pairs that with other sensor technologies. It is a process for that tool, had a robust community engagement complement to it. When we think about the climate and economic justice screening tool, married with other data sets, as noted in these pieces of legislation today, we do think that that community engagement, the use of satellite data and other data sets will really go a long way in ensuring that we are able to direct benefits to communities that have been most impacted by redlining and air pollution.

Senator CARPER. Good. AI am going to ask you to hold it at that.

Again, Senator Padilla, thanks so much for coming back. I want to thank all of our witnesses for being with us. I want to thank Senator Capito. I want to thank the other colleagues who joined us here. There is going to be much interest in this issue, more than I even expected. We are delighted with the kind of participation that we have had.

I want to thank our staffs on both sides of the aisle for the work they have done on this, and especially our witnesses. Our Nation's air quality monitoring networks face some real challenges, but I think we have some opportunities within those challenges to address them through the legislative solutions we have talked about today and discussed today.

Before we adjourn, a little bit of housekeeping. Senators will be allowed to submit written questions for the record through the close of business on Wednesday, July 27th, 2022. We will compile those questions, send them to our witnesses, and ask our witnesses to reply by August 10th, 2022.

One of the questions I am going to ask for the record is for the witnesses, having a diverse panel like this ensures that there is not a lot of unanimity. But one of the things I will be asking you to do is maybe to come back and share with us, each of you, what may be an area or two that we have talked about today with respect to improving the quality of air, where do we agree. Not just where do we disagree, where do we agree. That is what I always look for.

With that, it is a wrap. Thank you all so much. Great to be with you. This hearing is adjourned.

[Whereupon, at 12:13 p.m., the hearing was adjourned.]

[Additional material submitted for the record follows:]

II

117TH CONGRESS
1ST SESSION

S. 1345

To establish a national mercury monitoring program, and for other purposes.

IN THE SENATE OF THE UNITED STATES

APRIL 22, 2021

Ms. COLLINS (for herself and Mr. CARPER) introduced the following bill; which was read twice and referred to the Committee on Environment and Public Works

A BILL

To establish a national mercury monitoring program, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Comprehensive National Mercury Monitoring Act".

SEC. 2. FINDINGS.

Congress finds that—

(1) mercury is a potent neurotoxin of significant ecological and public health concern;

(2) it is estimated that approximately 100,000 to 200,000 children born each year in the United States are exposed to levels of mercury in the womb that are high enough to impair neurological development;

(3) based on estimates from the Centers for Disease Control and Prevention, between 2000 and 2010, between 2 and 6 percent of women in the United States of childbearing age have exceeded blood mercury levels determined to be safe by the Environmental Protection Agency;

(4) exposure to mercury occurs largely by the consumption of contaminated fish, but fish and shellfish are important sources of dietary protein and micronutrients, and a healthy fishing resource is important to the economy of the United States;

(5) in most locations, the primary route for mercury input to aquatic ecosystems is atmospheric emissions, transport, and deposition;

(6) existing broad-scale data sets are important but insufficient to track changes in mercury levels in the environment over time, test model predictions, and assess the impact of changing mercury emissions and deposition; and

(7) a comprehensive national mercury monitoring network to accurately quantify regional and national changes in atmospheric mercury deposition, ecosystem contamination, and bioaccumulation of mercury in fish and wildlife in response to changes in mercury emissions would help policy makers, scientists, and the public to better understand the sources, consequences, and trends of mercury pollution in the United States.

SEC. 3. DEFINITIONS.

In this Act:

(1) ADMINISTRATOR.—The term "Administrator" means the Administrator of the Environmental Protection Agency.

(2) ADVISORY COMMITTEE.—The term "Advisory Committee" means the Mercury Monitoring Advisory Committee established under section 5(a).

(3) ANCILLARY MEASURE.—The term "ancillary measure" means a measure that is used to understand the impact and interpret results of measurements under the program.

(4) ECOREGION.—The term "ecoregion" means a large area of land and water that contains a geographically distinct assemblage of natural commu-

nities, including similar land forms, climate, ecological processes, and vegetation.

(5) MERCURY EXPORT.—The term "mercury export" means mercury transport from a watershed to the corresponding body of water, or from 1 body of water to another body of water (such as from a lake to a river), generally expressed as—

(A) mass per unit of time;

(B) mass per unit of watershed; or

(C) area of the water body per unit of time.

(6) MERCURY FLUX.—The term "mercury flux" means the rate of transfer of mercury between ecosystem components (such as between water and air or land and air) or between portions of ecosystem components, expressed in terms of—

(A) mass per unit of time; or

(B) mass per unit of area of land or water per unit of time.

(7) PROGRAM.—The term "program" means the national mercury monitoring program established under section 4(a).

(8) SURFACE SEDIMENT.—The term "surface sediment" means sediment in the uppermost 2 centi-

meters of a lakebed, riverbed, estuary, or coastal area.

SEC. 4. MONITORING PROGRAM.

(a) ESTABLISHMENT.—

(1) IN GENERAL.—The Administrator, in consultation with the Director of the United States Fish and Wildlife Service, the Director of the United States Geological Survey, the Director of the National Park Service, the Administrator of the National Oceanic and Atmospheric Administration, and the heads of other appropriate Federal agencies, shall establish a national mercury monitoring program.

(2) PURPOSE.—The purpose of the program is to track—

(A) long-term trends in atmospheric mercury concentrations and deposition; and

(B) mercury levels in watersheds, surface water, and fish and wildlife in terrestrial, freshwater, coastal, and marine ecosystems in response to changing mercury emissions over time.

(3) MONITORING SITES.—

(A) IN GENERAL.—In carrying out paragraph (1), not later than 1 year after the date of enactment of this Act and in coordination with the Advisory Committee, the Administrator shall select multiple monitoring sites representing multiple ecoregions and associated coastal waters of the United States.

(B) LOCATIONS.—Locations of monitoring sites shall include—

(i) units of the National Park System;

(ii) units of the National Wildlife Refuge System;

(iii) units of the National Estuarine Research Reserve System;

(iv) human communities with highly exposed and vulnerable populations; and

(v) sensitive ecological areas in which substantive changes are expected to result from changes in domestic or international mercury emissions.

(C) COLOCATION.—Monitoring sites shall be co-located with sites from other long-term environmental monitoring programs, where practicable, including sites associated with the National Ecological Observatory Network, the Long Term Ecological Research Network, and the National Atmospheric Deposition Program.

(D) Monitoring protocols.—Not later than 1 year after the date of enactment of this Act, the Administrator, in coordination with the Advisory Committee, shall establish and publish standardized measurement protocols for the program.

(4) International cooperation.—To the maximum extent practicable, the program shall be compatible with similar international efforts, including the Arctic Monitoring and Assessment Programme, the Global Earth Observation System of Systems, and the monitoring associated with the effectiveness evaluation of the Minamata Convention on Mercury, adopted October 10, 2013 (TIAS 17–816), which entered into force on August 16, 2017.

(5) Data collection and distribution.—Not later than 1 year after the date of enactment of this Act, the Administrator, in coordination with the Advisory Committee, shall establish—

(A) a centralized database for existing and newly collected environmental mercury data that can be freely accessed on the Internet; and

(B) assurance and quality standards for the database under subparagraph (A).

(b) Functions.—

(1) IN GENERAL.—Under the program, the Administrator, in consultation with the appropriate Federal agencies and the Advisory Committee, shall at a minimum carry out monitoring described in paragraphs (2) through (4) at the locations selected under subsection (a)(3).

(2) AIR AND WATERSHEDS.—The program, in association with the National Atmospheric Deposition Program, shall monitor long-term changes in mercury levels and important ancillary measures in the air, including—

(A) the measurement and recording of wet mercury deposition;

(B) an estimation of—

(i) dry mercury deposition (such as litter mercury deposition or estimates of mercury accumulation in vegetation through eddy covariance measurements);

(ii) mercury flux; and

(iii) mercury export; and

(C) the measurement of stable isotopes of mercury and ancillary measurements to fully understand the transport, cycling, and transformations of mercury through ecosystems.

(3) WATER AND SOIL CHEMISTRY.—The program, in association with the WaterWatch Program established by the United States Geological Survey, shall monitor long-term changes in mercury and methyl mercury levels and important ancillary measures in the water and soil or sediments, including—

(A) extraction and analysis of soil and sediment cores;

(B) measurement and recording of total mercury and methyl mercury concentration in surface sediments; and

(C) measurement and recording of total mercury and methyl mercury concentration in surface waters.

(4) AQUATIC AND TERRESTRIAL ORGANISMS.—The program, in association with the United States Fish and Wildlife Service and the Inventory and Monitoring Division of the National Park Service, shall monitor long-term changes in mercury and methyl mercury levels and important ancillary measures in marine, freshwater, and terrestrial organisms, including—

(A) measurement and recording of total mercury and methyl mercury concentrations in—

(i) invertebrates;

(ii) yearling or lower trophic level fish; and

(iii) commercially, recreationally, or conservation relevant fish; and

(B) measurement and recording of total mercury concentrations in—

(i) selected insect- and fish-eating birds; and

(ii) selected insect- and fish-eating mammals.

SEC. 5. ADVISORY COMMITTEE.

(a) ESTABLISHMENT.—The Administrator, in consultation with the Director of the United States Fish and Wildlife Service, the Director of the United States Geological Survey, the Director of the National Park Service, the Administrator of the National Oceanic and Atmospheric Administration, and the heads of other appropriate Federal agencies, shall establish a scientific advisory committee, to be known as the "Mercury Monitoring Advisory Committee", to advise the Administrator and those Federal agencies on the establishment, site selection, measurement, recording protocols, and operation of the program.

(b) MEMBERSHIP.—The Advisory Committee shall consist of scientists who are not employees of the Federal Government, including—

(1) 3 scientists appointed by the Administrator;

(2) 2 scientists appointed by the Director of the United States Fish and Wildlife Service;

(3) 2 scientists appointed by the Director of the United States Geological Survey;

(4) 2 scientists appointed by the Director of the National Park Service; and

(5) 2 scientists appointed by the Administrator of the National Oceanic and Atmospheric Administration.

SEC. 6. REPORTS AND PUBLIC DISCLOSURE.

(a) REPORTS.—Not later than 2 years after the date of enactment of this Act and every 2 years thereafter, the Administrator shall submit to Congress a report on the program, including data on relevant temporal trends and spatial gradients in mercury contamination in the environment.

(b) ASSESSMENT.—Not less frequently than once every 4 years, the report required under subsection (a) shall include an assessment of mercury deposition rates that need to be achieved in order to prevent adverse human and ecological effects.

(c) AVAILABILITY OF DATA.—The Administrator shall make all data obtained under this Act available to the public through a dedicated website and on written request.

SEC. 7. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to carry out this Act—

(1) $37,000,000 for fiscal year 2022;

(2) $29,000,000 for fiscal year 2023; and

(3) $29,000,000 for fiscal year 2024.

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II

117TH CONGRESS
1ST SESSION

S. 2476

To require the Administrator of the Environmental Protection Agency to establish a pilot program for hyperlocal air quality monitoring projects in environmental justice communities, and for other purposes.

IN THE SENATE OF THE UNITED STATES

JULY 27, 2021

Mr. MARKEY (for himself, Mrs. GILLIBRAND, Mr. PADILLA, Mr. DURBIN, Mr. BOOKER, Ms. SMITH, Mr. SANDERS, and Ms. DUCKWORTH) introduced the following bill; which was read twice and referred to the Committee on Environment and Public Works

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A BILL

To require the Administrator of the Environmental Protection Agency to establish a pilot program for hyperlocal air quality monitoring projects in environmental justice communities, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Environmental Justice Air Quality Monitoring Act of 2021".

SEC. 2. FINDINGS.

Congress finds that—

(1) air pollution inflicts disproportionate harm on Black people, Indigenous people, and People of Color;

(2) air quality can vary up to 800 percent from block to block within a single neighborhood;

(3) it is possible to identify and attribute sources of pollution based on fingerprint analysis of multiple pollutants; and

(4) existing methods that are prescribed for basin-wide air quality monitoring—

(A) are cost-prohibitive for monitoring community-scale air quality; and

(B) do not, as of the date of enactment of this Act, measure the intrinsic variability of persistently poor air quality in environmental justice communities at the neighborhood block level.

SEC. 3. DEFINITIONS.

In this Act:

(1) ADMINISTRATOR.—The term "Administrator" means the Administrator of the Environmental Protection Agency.

(2) AIR POLLUTANT.—The term "air pollutant" means—

(A) a criteria pollutant for which there are national ambient air quality standards under section 109 of the Clean Air Act (42 U.S.C. 7409);

(B) a hazardous air pollutant (as defined in section 112(a) of that Act (42 U.S.C. 7412(a))); and

(C) a greenhouse gas.

(3) ELIGIBLE HYPERLOCAL AIR QUALITY DATA PROVIDER.—The term "eligible hyperlocal air quality data provider" means an organization with the demonstrated ability to deploy hyperlocal air quality monitoring systems in support of State, local, or Tribal air agencies.

(4) ENVIRONMENTAL JUSTICE.—The term "environmental justice" means the fair treatment and meaningful involvement of all people, regardless of race, color, culture, natural origin, or income, in the development, implementation, and enforcement of environmental laws (including regulations) and policies to ensure that each person enjoys—

(A) the same degree of protection from environmental and health hazards; and

(B) equal access to any Federal agency action relating to the development, implementation, and enforcement of environmental laws (including regulations) and policies for the purpose of having a healthy environment in which to live, learn, work, and recreate.

(5) ENVIRONMENTAL JUSTICE COMMUNITY.—The term "environmental justice community" means a community with significant representation of communities of color, low-income communities, or Tribal and Indigenous communities that experiences, or is at risk of experiencing, higher or more adverse human health or environmental effects, as compared to other communities.

(6) GREENHOUSE GAS.—The term "greenhouse gas" means any of the following:

(A) Carbon dioxide.

(B) Methane.

(C) Nitrous oxide.

(D) Hydrofluorocarbons.

(E) Perfluorocarbons.

(F) Sulfur hexafluoride.

(7) HYPERLOCAL AIR QUALITY MONITORING SYSTEM.—The term "hyperlocal air quality monitoring system" means a method of monitoring ambient air quality and greenhouse gases and detecting the presence of air pollutants that—

(A) yields frequently repeated, ongoing measurements of air pollutants at a block-level resolution; and

(B) identifies hotspots of persistent elevated levels of air pollutants localized to, and caused by the characteristics of, a specific geographic location.

(8) NONPROFIT ORGANIZATION.—The term "nonprofit organization" means an organization described in section 501(c)(3) of the Internal Revenue Code of 1986 and exempt from taxation under section 501(a) of that Code.

(9) PILOT PROGRAM.—The term "pilot program" means the pilot program established under section 4(a).

SEC. 4. PILOT PROGRAM FOR HYPERLOCAL AIR QUALITY MONITORING PROJECTS IN ENVIRONMENTAL JUSTICE COMMUNITIES.

(a) ESTABLISHMENT.—Subject to the availability of appropriations, the Administrator shall carry out a pilot program to award, on a competitive basis, grants or contracts to State, local, and Tribal air agencies, in partnership with local nonprofit organizations or eligible hyperlocal air quality data providers, to carry out projects described in subsection (b) for hyperlocal air quality monitoring systems in environmental justice communities.

(b) PROJECTS.—A State, local, or Tribal air agency that receives a grant or contract under the pilot program shall use amounts received under the grant or contract to carry out an air quality monitoring project within a geographical region specified by the State, local, or Tribal air agency—

(1) to monitor air quality at a level of discreteness capable of monitoring an area that is the smaller of—

(A) a block; and

(B) a 100-meter radius;

(2) to identify areas of persistent elevated air pollution levels above a relevant background level;

(3) to regularly monitor air quality using monitoring technology that meets the data quality objectives of the Environmental Protection Agency, which may, in the determination of the Administrator, include a requirement that the technology qualify as a Federal Reference Method or a Federal Equivalent Method;

(4) to resolve changes in ambient levels of relevant air pollutants;

(5) to generate equity maps by geographical area, including generating maps using such variables as demographic data relating to race, ethnicity, and income level; and

(6) to report hyperlocal air quality data and mapping tools to—

(A) community residents through an online platform to increase public awareness and engagement; and

(B) relevant local, State, Tribal, and Federal air pollution managers to inform management decisions, such as the placement or relocation of stationary air pollution monitors, transportation or land use planning, investments in mitigating air pollution sources, and other planning decisions.

(c) PROJECT SELECTION.—

(1) APPLICATIONS.—A State, local, or Tribal air agency seeking a grant or contract under the pilot program shall submit to the Administrator an application at such time, in such manner, and containing such information as the Administrator may require.

(2) PRIORITIZATION.—In selecting projects to receive grants or contracts under the pilot program,

the Administrator shall give priority to projects that—

(A) would be carried out in areas with high rates of illness associated with exposure to air pollution, as determined by the Administrator, including childhood asthma, adult asthma, chronic obstructive pulmonary disease, heart disease, chronic bronchitis, and cancer;

(B) seek to identify pollution sources through multipollutant analysis when relevant;

(C) would be able to assess pollution burdens on sensitive individuals who may be at greater risk of adverse health effects from exposure to the air pollutants to be monitored as compared to the general population; and

(D) would promote—

(i) public access and transparency of data; and

(ii) proactive outreach for community engagement and awareness.

(3) EQUITABLE FUNDING DISTRIBUTION.—A State, local, or Tribal air agency that receives a grant or contract under the pilot program shall ensure that air quality monitoring projects deployed using amounts from the grant or contract—

(A) provide full-time, salaried employment opportunities, with benefits, to local residents of environmental justice communities, which may include employment or training for positions such as—

(i) air quality monitoring device installation, maintenance, and calibration technicians;

(ii) data scientists, atmospheric scientists, chemists, epidemiologists, and social scientists;

(iii) software developers, engineers, and interface designers;

(iv) community engagement and communications and outreach specialists;

(v) air quality monitor operators;

(vi) environmental justice organizer; and

(vii) environmental health advocate; and

(B) direct not less than 40 percent of the amount received from the grant or contract toward the employment opportunities described in subparagraph (A).

(d) DURATION.—A project carried out using a grant or contract awarded under the pilot program may not exceed 5 years in duration.

(e) EVALUATION METRICS.—To evaluate the effectiveness of the pilot program, the Administrator shall establish, based on the project requirements described in paragraphs (1) through (6) of subsection (b), metrics and reporting requirements for grant recipients.

(f) REPORTS.—

(1) ANNUAL REPORTS.—Not later than 180 days after the end of each fiscal year in which the Administrator carries out the pilot program, the Administrator shall submit to Congress a report on the results of the pilot program for the previous fiscal year, which shall include, with respect to the fiscal year covered by the report—

(A) a description of each project awarded a grant or contract under the pilot program;

(B) a description of the evaluation metrics established under subsection (e);

(C) the results of and the insights developed from the monitoring carried out under projects for which grants or contracts were awarded under the pilot program; and

(D) whether the Administrator proposes to continue air quality monitoring at the locations monitored by projects for which those grants or contracts were awarded.

(2) FINAL REPORT.—Not later than 180 days after the date on which the final project carried out using a grant or contract awarded under the pilot program is completed, the Administrator shall submit to Congress a report that describes the results of the pilot program, which shall include—

(A) a description of the pilot program;

(B) a description of the air quality monitoring data collected under projects that received grants or contracts under the pilot program;

(C) an assessment of the effectiveness of the pilot program using the evaluation metrics established under subsection (e) and information received from the reporting requirements established under that subsection;

(D) a description of the cost of the pilot program, including an estimate of the cost of making the pilot program permanent;

(E) an estimate of the cost of expanding the pilot program to monitor air quality in air basins that are adjacent to air basins for which air quality was monitored under projects that received grants or contracts under the pilot program; and

(F) such recommendations for legislation, regulation, or administrative action as the Administrator considers appropriate, including recommendations for—

(i) reducing air pollution burdens in identified hotspots; and

(ii) extending the pilot program or making the pilot program permanent.

(g) AUTHORIZATION OF APPROPRIATIONS.—

(1) IN GENERAL.—There is authorized to be appropriated to the Administrator $100,000,000 for each of fiscal years 2022 through 2027 to carry out the pilot program.

(2) SUPPLEMENT, NOT SUPPLANT.—Amounts made available under paragraph (1) shall supplement, and not supplant, other amounts made available to address harms resulting from air pollution.

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117TH CONGRESS
2D SESSION

S. ______

To protect clean air and public health by expanding fenceline and ambient air monitoring and access to air quality information for communities affected by air pollution, to require hazardous air pollutant monitoring at the fenceline of facilities whose emissions are linked to local health threats, to ensure the Environmental Protection Agency promulgates rules that require hazardous air pollutant data measurement and electronic submission at fencelines and stacks of industrial source categories, to expand and strengthen the national ambient air quality monitoring network, to deploy air sensors in communities affected by air pollution, and for other purposes.

IN THE SENATE OF THE UNITED STATES

Ms. DUCKWORTH introduced the following bill; which was read twice and referred to the Committee on ______________

A BILL

To protect clean air and public health by expanding fenceline and ambient air monitoring and access to air quality information for communities affected by air pollution, to require hazardous air pollutant monitoring at the fenceline of facilities whose emissions are linked to local health threats, to ensure the Environmental Protection Agency promulgates rules that require hazardous air pollutant data measurement and electronic submission at fencelines and stacks of industrial source categories, to expand and strengthen the national ambient air quality monitoring network, to deploy air sensors in communities affected by air pollution, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Public Health Air Quality Act of 2022".

SEC. 2. DEFINITIONS.

In this Act:

(1) ADMINISTRATOR.—The term "Administrator" means the Administrator of the Environmental Protection Agency.

(2) ACCIDENTAL RELEASE.—The term "accidental release" has the meaning given the term in section 112(r)(2) of the Clean Air Act (42 U.S.C. 7412(r)(2)).

(3) AREA SOURCE; EXISTING SOURCE; HAZARDOUS AIR POLLUTANT; MAJOR SOURCE; NEW SOURCE; STATIONARY SOURCE.—Except as otherwise provided, the terms "area source", "existing source", "hazardous air pollutant", "major source", "new source", and "stationary source" have the meanings given the terms in section 112(a) of the Clean Air Act (42 U.S.C. 7412(a)).

(4) EMISSIONS MEASUREMENT SYSTEM.—The term "emissions measurement system" means a set

of monitors, testing equipment, tools, and processes employed at a facility to measure emissions from direct and fugitive points at a source or facility or at the source's or facility's fenceline that employs Environmental Protection Agency-approved or promulgated test methods for all measured pollutants for which a method is available.

(5) FEDERAL EQUIVALENT METHOD; FEDERAL REFERENCE METHOD.—The terms "Federal equivalent method" and "Federal reference method" have the meanings given to such terms in section 53.1 of title 40, Code of Federal Regulations (or to the same or substantially similar terms in successor regulations).

(6) METHOD 325A.—The term "Method 325A" means the most current version of the test method 325A published by the Environmental Protection Agency.

(7) METHOD 325B.—The term "Method 325B" means the most current version of the test method 325B published by the Environmental Protection Agency.

(8) METHOD TO–15A.—The term "Method TO–15A" means the most current version of the test

method TO–15 (including TO–15A) published by the Environmental Protection Agency.

(9) NATIONAL AMBIENT AIR QUALITY STANDARD.—The term "national ambient air quality standard" means a national ambient air quality standard established under section 109 of the Clean Air Act (42 U.S.C. 7409).

(10) NCORE; SLAMS.—The terms "NCore" and "SLAMS" have the meaning given those terms in section 58.1 of title 40, Code of Federal Regulations (as in effect on the date of enactment of this Act).

(11) REAL-TIME.—The term "real-time" means the actual or near actual time during which pollutant levels occur at or near the property boundary of a facility or in a nearby community.

(12) SOURCE.—The term "source" means a source as such term is used in the Clean Air Act (42 U.S.C. 7401 et seq.).

SEC. 3. HEALTH EMERGENCY AIR TOXICS MONITORING NETWORK.

(a) MONITORING.—

(1) IN GENERAL.—

(A) PROGRAM.—The Administrator shall carry out a program to administer or conduct, pursuant to authority provided under the Clean

Air Act (42 U.S.C. 7401 et seq.), including sections 103 and 114 of that Act (42 U.S.C. 7403, 7414), emissions measurement and quantification, including the best available form of fenceline monitoring of stationary sources of hazardous air pollutants that are on the list developed under subsection (c), including through expansion of the National Air Toxics Trends Station network or through creating a new network, as appropriate.

(B) TIMING.—The Administrator shall begin implementation of the program under subparagraph (A) not later than 18 months after the date of enactment of this Act.

(2) MONITORING PERIOD.—

(A) IN GENERAL.—The Administrator shall maintain the monitoring required under paragraph (1) for a period of not less than 6 years after the date on which the monitoring required under that paragraph is first carried out.

(B) SUBSEQUENT MONITORING.—After the 6-year period described in subparagraph (A), the Administrator shall maintain the emissions measurement and quantification program under paragraph (1), consistent with this section, through—

(i) maintaining monitors at all or some sources under the program under paragraph (1); and

(ii) adding or moving monitors under the program under paragraph (1) to additional sources, following the process for substitution of sources in subsection (g).

(C) SHORTENED PERIOD.—If the Administrator determines that 6 years of monitoring, as required by subparagraph (A), is not necessary to protect public health or assure compliance at the source or the facility involved, the Administrator may decrease or end the monitoring after at least 3 years of monitoring has occurred.

(D) ADDITIONAL INSPECTIONS AND TESTING.—In addition to fenceline monitoring under the program under this subsection, the Administrator shall use the Administrator's full authority to inspect and require emission testing at sources at or inside the facility involved to the extent necessary to identify and address the emissions crossing the fenceline.

(b) PUBLICATION OF RESULTS.—

(1) IN GENERAL.—The Administrator shall publish and maintain the plans for and the results of all measurements, including fenceline monitoring, conducted under the program under subsection (a)(1) on the website of the Environmental Protection Agency—

(A) in a highly accessible format;

(B) in multiple languages; and

(C) for a period of at least 6 years.

(2) IMMEDIATE AVAILABILITY.—The Administrator shall ensure that the monitoring data described in paragraph (1) is made publicly available under that paragraph as expeditiously as practicable, and not later than 7 days after electronic submission, which shall be not later than one month after the date of collection of such data.

(c) LIST OF SOURCES.—

(1) DEVELOPMENT.—

(A) IN GENERAL.—Not later than 270 days after the date of enactment of this Act, the Administrator shall publish, after public notice and comment, a list of stationary sources of hazardous air pollutants that, subject to subparagraph (B), includes—

(i) at least 45 of the sources listed—

(I) as high-priority facilities in Appendix A of the report of the Office of Inspector General of the Environmental Protection Agency numbered 20–N–0128 and dated March 31, 2020; or

(II) as contributing to high cancer risk at the census block level in Appendix C of the report of the Office of Inspector General of the Environmental Protection Agency numbered 21–P–0129 and dated May 6, 2021; and

(ii) at least 55 other major sources or area sources that meet the criteria described in paragraph (2).

(B) SUBSTITUTION.—

(i) IN GENERAL.—If the Administrator determines that a source described in subparagraph (A)(i) no longer contributes to high health risks or impacts, the Administrator shall—

(I) cease to include that source in the list under subparagraph (A); and

(II) include instead an additional major source or area source described in subparagraph (A)(ii) to ensure that the list under subparagraph (A) includes not less than 100 high-priority sources.

(ii) DESCRIPTION OF REASONS.—The Administrator shall publish in the Federal Register—

(I) any determination to make a substitution under clause (i); and

(II) an explanation of the reasons for any such determination demonstrating, based on monitoring data or other reliable information, that the substitution is likely to ensure that monitoring under this section occurs at the sources causing or contributing to the highest potential health risks or other impacts from hazardous air pollution.

(iii) REQUIREMENT.—The Administrator may include an additional major source or area source under clause (i)(II) only if the Administrator determines that the source is, or is likely to be, contributing local health risks or impacts that are equivalent to, or greater than, those of the source for which the new source is being substituted.

(2) CRITERIA.—The Administrator may include a major source or area source described in clause (ii) of paragraph (1)(A) on the list described in that paragraph only if the source—

(A) emits at least 1 of the pollutants described in paragraph (3);

(B) is—

(i) located in, or within 3 miles of, a census tract with—

(I) a cancer risk of at least 100-in-1,000,000; or

(II) a chronic non-cancer hazard index that is greater than 1; or

(ii) in a source category with—

(I) a cancer risk that is at least 50-in-1,000,000 for the individual most exposed to emissions from the source category;

(II) a total organ-specific hazard index for chronic non-cancer risk that is greater than 1; or

(III) an acute risk hazard quotient that is greater than 1; and

(C)(i) is classified in 1 or more of North American Industry Classification System codes 322, 324, 325, 326, 331, 332, 339, 424, and 562;

(ii)(I) is required to prepare and implement a risk management plan pursuant to section 112(r) of the Clean Air Act (42 U.S.C. 7412(r)); and

(II) has had an accidental release required to be reported during the previous 5-year period pursuant to sections 68.42 and 68.195 of title 40, Code of Federal Regulations (as in effect on the date of enactment of this Act); or

(iii) is determined by the Administrator to be a high priority source or facility for emissions measurement because the emissions of the source or facility are causing or contributing to, or have the potential to cause or contribute to, serious health risks or impacts.

(3) POLLUTANTS.—The pollutants described in this paragraph are—

(A) ethylene oxide, CAS 75218;

(B) chloroprene, CAS 126998;

(C) benzene, CAS 71432;

(D) 1,3–butadiene, CAS 106990;

(E) formaldehyde, CAS 50000;

(F) acetaldehyde, CAS 75070;

(G) lead compounds;

(H) arsenic compounds;

(I) cadmium compounds;

(J) nickel compounds;

(K) manganese compounds;

(L) any other hazardous air pollutant included in the list described in section 112(b) of the Clean Air Act (42 U.S.C. 7412(b)) that the Administrator determines, after public notice and comment, the emissions of which—

(i) are, or may be contributing to, serious health risks; and

(ii) warrant emissions quantification and measurement; and

(M) any pollutant that is a precursor to atmospheric photochemical production of any other pollutant on such list.

(4) USE OF RISK ASSESSMENTS.—In carrying out this subsection, the Administrator shall—

(A) use—

(i) the Environmental Protection Agency's latest evaluations and methods of compiling and evaluating information about risks from air toxics, or the most recent Air Toxics Screening Assessment or other current evaluation or report by the Environmental Protection Agency providing similar information about cancer and noncancer risks from hazardous air pollution based on measured or modeled emissions;

(ii) the Risk-Screening Environmental Indicators model of the Administrator;

(iii) a prior health risk assessment that was performed by the Administrator for the applicable source or source category; or

(iv) a new health risk assessment performed by the Administrator that—

(I) follows the best available science (including the most recent guidance from the National Academy of Sciences); and

(II) considers, to the greatest extent practicable, with respect to the applicable source or facility—

(aa) cumulative risks and impacts;

(bb) increased vulnerability that results from socioeconomic disparities;

(cc) multiple source exposure; and

(dd) exposure in utero, in childhood, and through the age of 85; and

(B) consider—

(i) the most recent emission tests available to the Administrator or received by the Environmental Protection Agency in public comment; and

(ii) any fenceline or ambient monitoring data for which an Environmental Protection Agency-approved data quality check has been performed.

(d) METHODS AND TECHNOLOGIES.—

(1) IN GENERAL.—Except as provided in paragraph (3), in carrying out the program under subsection (a), the Administrator shall, for each stationary source on the list published under subsection (c)(1), employ an emissions measurement system to monitor the pollutants described in subsection (c)(3) emitted by the stationary source, including at least—

(A) the most current Environmental Protection Agency-approved or promulgated emission test or monitoring method, including Methods 325A, 325B, and TO–15 or the most current and best available version of such methods approved or promulgated by the Environmental Protection Agency; or

(B) for each stationary source described in paragraph (2), the best available method for continuous, real-time measurement of air pollutant concentrations.

(2) STATIONARY SOURCES DESCRIBED.—A stationary source referred to in paragraph (1)(B) is—

(A) not less than each of the 20 stationary sources on the list published under subsection (c)(1) that—

(i) emits the greatest volume of pollutants described in subsection (c)(3); or

(ii) causes the greatest health risk, based on the emissions of the pollutants described in subsection (c)(3) individually, as a group, or cumulatively, based on—

(I)(aa) the Environmental Protection Agency's latest evaluations and methods of compiling and evaluating information about risks from air toxics, or the most recent Air Toxics Screening Assessment or other current evaluation or report by the Environmental Protection Agency providing similar information about cancer and noncancer risks from hazardous air pollution based on measured or modeled emissions;

(bb) the Risk-Screening Environmental Indicators model of the Administrator;

(cc) a prior health risk assessment that was performed by the Administrator for the applicable source or source category; or (dd) a new health risk assessment performed by the Administrator that—

(AA) follows the best available science (including the most recent guidance from the National Academy of Sciences); and

(BB) considers, to the greatest extent practicable, with respect to the applicable source or facility, cumulative risks and impacts, increased vulnerability that results from socioeconomic disparities, multiple source exposure, and exposure in utero, in childhood, and through the age of 85; and

(II) the most recent emission tests available to the Environmental Protection Agency or received in public comment, and any fenceline or ambient monitoring data for which an Environmental Protection Agency-approved data quality check has been performed; and

(B) any other stationary source on the list published under subsection (c)(1) that is regulated under section 112(r)(7) of the Clean Air Act (42 U.S.C. 7412(r)(7)) and has had an accidental release or incident that is required to be reported during the previous 5-year period under such section 112(r)(7) (42 U.S.C. 7412(r)(7)); and

(C) any other stationary source on the list published under subsection (c)(1) for which application of the methods described in subparagraph (A) alone will not be sufficient to monitor and report the pollutants described in subsection (c)(3) that are emitted by that stationary source.

(3) UPDATES.—

(A) APPROVED OR PROMULGATED METHODS.—The Administrator shall—

(i) not later than 270 days after the date of enactment of this Act, review and, after public notice and comment, update each approved or promulgated test method described in this section to add as many of the pollutants described in subsection (c)(3) as possible; and

(ii) otherwise strengthen the test methods described in clause (i) to support effective hazardous air pollutant measurement and the full implementation of this Act.

(B) NEW TEST METHODS.—

(i) IN GENERAL.—Not later than 18 months after the date of enactment of this Act, the Administrator shall approve or promulgate, as applicable, any new test methods that are necessary to ensure effective fenceline monitoring of all pollutants and sources described in this section, including—

(I) at least 1 method that represents the best and most accurate form of continuous, real-time fenceline monitoring; and

(II) at least 1 method that represents the best and most accurate form of multimetal monitoring.

(ii) UPDATES REQUIRED.—Not less frequently than once every 10 years, the Administrator shall review and, if necessary, after public notice and comment, strengthen or add new test methods that meet the requirements under clause (i), which shall be based on—

(I) the best available monitoring technologies; and

(II) the advice of staff of the Environmental Protection Agency responsible for enforcement of this Act and other monitoring experts.

(e) MONITOR PLACEMENT AND MAINTENANCE.—

(1) IN GENERAL.—The Administrator shall, after public notice and comment, place and maintain, or ensure placement and regular maintenance of, all monitors required under this section to ensure effective and reliable emissions measurement pursuant to this section.

(2) MAINTENANCE CHECK.—The maintenance required under paragraph (1) shall include a maintenance check of the monitor not less frequently than once every 180 days, unless—

(A) the test method used by the monitor requires a maintenance check more frequently; or

(B) a maintenance check is requested by a member of the public.

(3) PUBLIC INPUT.—The Administrator shall, after public notice and comment, create a process for the public—

(A) to track the maintenance of monitors under this subsection; and

(B) request a maintenance check of a monitor.

(f) REPORT.—Not later than 6 years after the date of enactment of this Act, and not less frequently than every 6 years thereafter, the Administrator shall submit to the Congress and post publicly on the website of the Environmental Protection Agency a report describing the results of the program carried out under subsection (a), which shall include—

(1) the results of emissions measurement implemented under that program;

(2) any actions of the Administrator taken based on that emissions measurement data or program; and

(3) whether the Administrator proposes—

(A) to continue emissions measurements at any or all of the stationary sources on the list published under subsection (c)(1); or

(B) to implement emissions measurements of any additional stationary sources as determined under subsection (g).

(g) DETERMINATION REGARDING ADDITIONAL SOURCES.—Not later than 6 years after the date of enactment of this Act, and not less frequently than every 6 years thereafter, the Administrator shall—

(1) after public notice and comment, make a determination of whether to add or remove sources to the list published under subsection (c)(1)—

(A) to ensure compliance of such stationary sources with existing emission standards under section 112 of the Clean Air Act (42 U.S.C. 7412);

(B) to prevent and detect accidental releases;

(C) to protect the health of the communities most exposed to the emissions of hazardous air pollutants from such stationary sources to the greatest extent possible; or

(D) to ensure the 100 highest-priority sources or facilities, based on the best available science and the most current data on health risks and impacts, have emissions measurement systems in place for pollutants required to be monitored under this section; and

(2) publish a determination under paragraph (1) in the Federal Register.

(h) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section $146,000,000 for the period of fiscal years 2023 and 2024.

SEC. 4. COMMUNITY AIR TOXICS MONITORING.

(a) REGULATIONS.—Not later than 2 years after the date of enactment of this Act, the Administrator shall promulgate regulations pursuant to authority provided by the Clean Air Act, which may include subsections (d), (f), and (r) of section 112, section 113, and section 114 of the Clean Air Act (42 U.S.C. 7412, 7413, 7414), for each source category described in subsection (b), that—

(1) require all sources in the source category to implement, not later than 1 year after the promulgation of the regulations, the best available form of emissions measurement, including continuous emissions monitoring and fenceline monitoring, to ensure compliance with the emission standards for hazardous air pollutants;

(2) for facilities in the source category that are required to submit risk management plans under

section 112(r)(7) of that Act (42 U.S.C. 7412(r)(7)), require each facility to implement—

(A) continuous, real-time monitoring to provide for effective emergency response and provide information to prevent future releases; and

(B) emissions measurement, including fenceline monitoring, to provide for effective emergency response and provide information to prevent future releases;

(3) subject to subsection (e), establish a corrective action level at the fenceline for at least the top 3 hazardous air pollutants that drive the cancer, chronic non-cancer, or acute risk for the source category;

(4) if any applicable corrective action level under paragraph (3) is exceeded, require—

(A) a root cause analysis;

(B) full remedial action to resolve the exceedance and protect the most exposed or most vulnerable individuals potentially affected by the exceedance; and

(C) a public report that a violation of the Clean Air Act (42 U.S.C. 7401 et seq.) has occurred; and

(5) treat any requirement imposed by the regulations under this section as a requirement under section 112 of the Clean Air Act (42 U.S.C. 7412) that is enforceable under section 113 of such Act (42 U.S.C. 7413).

(b) SOURCE CATEGORIES.—The source categories described in this subsection shall include—

(1) each category or subcategory of major sources or area sources that—

(A) contains—

(i) at least 1 of the stationary sources of hazardous air pollutants that are on the list published under section 3(c);

(ii) major sources or area sources identified in the most recent National Emissions Inventory of the Environmental Protection Agency as emitting a pollutant described in section 3(c)(3);

(iii) petroleum, chemical, petrochemical, or plastics manufacturing sources, marine vessel loading operations, or other sources that are classified in 1 or more of North American Industry Classification System codes 322, 324, 325, 326, 331, 332, 339, 424, and 562; or

(iv) any other major source of fugitive hazardous air pollutant emissions for which the Environmental Protection Agency is subject to a court-ordered or statutory deadline, engaged in a reconsideration proceeding, or subject to a court remand (or is likely within the 2-year period beginning on the date of enactment of this Act to become subject to such an obligation or action) to review and determine whether to revise the emissions standards that apply to that major source; or

(B) contains any stationary source that—

(i) is regulated under section 112(r)(7) of the Clean Air Act (42 U.S.C. 7412(r)(7)); and

(ii) has had an accidental release or incident that is required to be reported during the previous 5-year period under such section 112(r) (42 U.S.C. 7412(r)) and the regulations thereunder; and

(2) any other source category for which the Administrator determines that requiring fenceline monitoring would benefit public health or welfare.

(c) DETERMINATION OF BEST AVAILABLE FORM OF MONITORING.—

(1) IN GENERAL.—The Administrator, in consultation with the Office of Air and Radiation, the Office of Enforcement and Compliance Assurance, the Office of Environmental Justice, and the Office of Research and Development, shall, for purposes of the regulations promulgated pursuant to subsection (a)—

(A) determine the best available form of emissions measurement, including continuous emissions monitoring and fenceline monitoring; and

(B) ensure the methods required under the regulations are at least as stringent as the most current Environmental Protection Agency-approved or promulgated emission test or monitoring method, including Methods 325A, 325B, and TO–15 (or the most current and best available version of such methods approved or promulgated by the Environmental Protection Agency).

(2) REQUIREMENT.—In carrying out paragraph (1)(B), the Administrator shall ensure that 1 or more of the methods described in or promulgated

under section 3 or subsection (d) (including multimetal monitoring) is included in the regulations promulgated pursuant to subsection (a) if that method is the best available method for 1 or more of the pollutants for which monitoring is required under this section.

(d) METHODS AND TECHNOLOGIES.—

(1) IN GENERAL.—For all stationary sources in the source categories described in subsection (b), as the best available fenceline monitoring method for those source categories, the Administrator may, in the regulations promulgated pursuant to subsection (a)—

(A) require application, implementation, or employment of optical remote sensing technology to provide real-time measurements of air pollutant concentrations along an open-path; or

(B) provide an explanation of why application, implementation, or employment of 1 or more of the technologies described in subparagraph (A) is not necessary—

(i) to ensure compliance with the emission standards established under the regulations promulgated pursuant to subsection (d), (f), or (r) of section 112 of the

Clean Air Act (42 U.S.C. 7412), as applicable; or

(ii) to protect the public health, to prevent accidental releases, or to provide for effective emergency response.

(2) MULTIPLE-SOURCE OR FACILITY COMPLEXES.—

(A) DEFINITION OF MULTIPLE-SOURCE OR FACILITY COMPLEX.—In this paragraph, the term "multiple-source or facility complex" means 1 or more stationary sources co-located at the same site.

(B) MULTIPLE-SOURCE OR FACILITY COMPLEX MONITORING.—In the regulations promulgated pursuant to subsection (a), the Administrator shall ensure that the best available form of monitoring for a multiple-source or facility complex that contains not less than 2 stationary sources in 1 or more of North American Industry Classification System codes 324, 325, and 326, or a related chemical or petrochemical sector, may be at least a combination of—

(i) real-time, open-path monitoring; and

(ii) Method 325A and Method 325B.

(C) REQUIREMENT.—In carrying out subparagraph (B), the Administrator may consider whether any other multiple-source or facility complexes should be required to employ the combined monitoring methods described in that subparagraph.

(e) PRECAUTIONARY APPROACH.—In promulgating the corrective action level for each of the hazardous air pollutants described in subsection (a)(3), the Administrator shall—

(1) consider the best available science;

(2) take a precautionary approach to ensure that the owner or operator of the source or facility reduces the emissions of the source or facility to prevent harm if the measured concentration at the fenceline would, or is likely to—

(A) increase harm to public health or safety (including through an increased health risk); or

(B) reach a level that may result in short-term, long-term, or chronic human exposure to air pollution (including any fetal exposure that begins in utero) that increases the risk of—

(i) health harms resulting from odors, irritation, sensitizing effects, or any combination of those harms;

(ii) disease (including cancer and other illnesses); or

(iii) death; and

(3) take into account the aggregate and cumulative emissions and health risks from the facility, including multiple source categories, as applicable, to ensure full health protection from the entire facility.

(f) MAINTENANCE AND PUBLIC REPORTING.—

(1) IN GENERAL.—In the regulations promulgated under subsection (a), the Administrator shall ensure that—

(A) the owners or operators of sources subject to the requirements of this section—

(i) perform regular inspections and maintenance of all measured equipment required under this section; and

(ii) submit regular reports to the Administrator that—

(I) include the measured emissions data collected by that emissions measurement equipment;

(II) describe the status of that measurement equipment; and

(III) contain a detailed explanation of the circumstances surrounding a delay in collecting or missing data;

(B) the emissions measurement system required under this section is continuous and yields reliable data not less than 95 percent of the time, without any regulatory exemption or extension; and

(C) any problem with the fenceline monitoring equipment required under this section is repaired within 2 days of discovering the problem.

(2) VIOLATION.—In the regulations promulgated under subsection (a), the Administrator shall—

(A) require the owner or operator of a stationary source subject to such regulations to report, with respect to such source, at least semiannually—

(i) all exceedances of any corrective action level; and

(ii) all corrective action planned and taken; and

(B) for purposes of imposing penalties, treat each day on which a violation of a reporting requirement under subparagraph (A) continues as a separate violation.

(3) PUBLIC REPORTING.—

(A) IN GENERAL.—The Administrator shall make available on the website of the Environmental Protection Agency, in an accessible format that includes multiple languages—

(i) all emissions measurement plans and reports required under this section;

(ii) all emissions measurement data collected by monitoring equipment required under this section; and

(iii) an option to sign up for community-wide or source-specific alerts that alert the user if the emissions concentrations measured pursuant to clause (i) or (ii), as applicable, exceed—

(I) a health reference level of the Administrator;

(II) a health reference level approved by the Administrator; or

(III) the applicable corrective action level under subsection (a)(3).

(B) PUBLIC NOTICE AND COMMENT.—The Administrator shall provide notice and receive public comment on the format and accessibility of the information required under subparagraph (A).

(C) PUBLICATION.—The Administrator shall publicize the information required under subparagraph (A) in each community that contains a source regulated under this section through not less than 2 of the most widely viewed local media formats for members of that community that live nearest the regulated source.

(g) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section $50,000,000 for the period of fiscal years 2023 and 2024.

SEC. 5. NAAQS MONITORING NETWORK.

(a) DEPLOYMENT OF NCORE MULTIPOLLUTANT MONITORING STATIONS.—The Administrator shall require the deployment of 80 additional NCore multipollutant monitoring stations.

(b) DEADLINE.—Not later than 3 years after the date of enactment of this Act, the Administrator shall ensure that all NCore multipollutant monitoring stations required to be deployed under subsection (a) are—

(1) installed and integrated into the air quality monitoring system established pursuant to sections 110(a)(2)(B) and 319 of the Clean Air Act (42 U.S.C. 7410(a)(2)(B), 7619); and

(2) after installation, operated and maintained on a continuing basis.

(c) MONITORING RESULTS.—Monitoring results from NCore multipollutant stations deployed pursuant to subsection (a) shall be used for—

(1) assessments of the compliance of areas with national ambient air quality standards;

(2) integrated science assessments in reviews of national ambient air quality standards promulgated under section 109 of the Clean Air Act (42 U.S.C. 7409);

(3) evaluating disparities of pollution exposures within metropolitan areas; and

(4) such other purposes as the Administrator determines will promote the protection of public health from air pollution.

(d) LOCATIONS.—

(1) VULNERABLE POPULATIONS.—The Administrator shall ensure that not less than 40 of the

NCore multipollutant monitoring stations required under subsection (a)—

(A) are not limited to metropolitan statistical areas with populations of 50,000 or greater; and

(B) are sited in census tracts that each meet 1 or more of the following criteria, with the specific site selected consistent with Appendix D to part 58 of title 40, Code of Federal Regulations (as in effect on the date of enactment of this Act):

(i) The rates of childhood asthma, adult asthma, chronic obstructive pulmonary disease, heart disease, or cancer are at least 5 percent higher than the national average for that condition in the census tract.

(ii) The percentage of people living below the poverty level, that are above age 18 without a high school diploma, or that are unemployed, is higher than the national average in the census tract.

(iii) Two or more major sources (as defined in section 501 of the Clean Air Act (42 U.S.C. 7661)) are located within the census tract or adjacent census tracts combined.

(iv) There is a higher-than-national-average population in the census tract of vulnerable or sensitive individuals who may be at greater risk than the general population of adverse health effects from exposure to 1 or more air pollutants for which national ambient air quality standards have been established pursuant to section 109 of the Clean Air Act (42 U.S.C. 7409).

(2) SITING DETERMINATIONS.—In determining and approving sites for NCore multipollutant monitoring stations required under subsection (a), the Administrator shall—

(A) invite proposals from or on behalf of residents of any community for the siting of the stations in that community, which may include inviting proposals through regional or virtual meetings;

(B) prioritize siting of the stations in census tracts or counties that the Administrator determines should be prioritized for siting based on—

(i) the potential for the levels of 1 or more air pollutants to be monitored by the stations to reach or exceed the level of the applicable national ambient air quality standard established pursuant to section 109 of the Clean Air Act (42 U.S.C. 7409);

(ii) the number of people who live, work, or recreate in the area or areas for which monitoring by the stations is reasonably anticipated to be representative with respect to air quality and the proportion of those people who are at higher risk than the general population of adverse health effects from the air pollutants monitored;

(iii) the lack or inadequacy of existing air quality monitors for providing representative air quality data for the affected area or areas for the pollutants to be measured by the station; and

(iv) the current designation of the area in which the monitoring station would be located as unclassifiable or in attainment for 1 or more of the pollutants to be monitored by that station; and

(C) prior to making siting determinations—

(i) provide public notice of proposed siting locations—

(I) in the Federal Register;

(II) by email to persons who have requested notice of proposed siting determinations;

(III) by news release; and

(IV) by posting on the public website of the Environmental Protection Agency; and

(ii) provide an opportunity for public comment for not less than 30 days after the date of publication of the notice required under clause (i) in the Federal Register.

(3) RELIANCE ON HYBRID METHODS.—In determining under paragraph (2)(B)(i) the potential for an air pollutant to reach or exceed the level of the applicable standard, the Administrator may rely on hybrid methods that combine information from multiple sources, including monitors, sensors, modeling, and satellites.

(e) ADDITIONAL AMBIENT MONITORS.—

(1) IN GENERAL.—The Administrator shall deploy not fewer than 100 Federal reference method monitors or Federal equivalent method monitors for 1 or more air pollutants for which national ambient air quality standards have been established pursuant to section 109 of the Clean Air Act (42 U.S.C. 7409) in areas—

(A) that are unmonitored or undermonitored, as determined by the Administrator; and

(B) within which the Administrator determines, after public notice and comment, that adding those monitors is warranted—

(i) to detect whether the area is in nonattainment of the applicable national ambient air quality standards; and

(ii) to improve the publicly available data on air quality for 1 or more of those air pollutants (or precursors to those air pollutants).

(2) SITING DETERMINATIONS.—In approving sites for new Federal reference method monitors or Federal equivalent method monitors required under this subsection, the Administrator shall prioritize siting of the stations in census tracts or counties in accordance with subsection (d)(2)(B).

(3) RELATION TO PREVIOUSLY DEPLOYED OR PLANNED MONITORS.—The Federal reference method monitors required under this subsection shall be in addition to, and not in lieu of, any monitors already deployed or planned for deployment by the Administrator, any State, any other governmental entity, or any other entity prior to the date of enactment of this Act.

(f) REPORT.—Not later than 2 years after the date of enactment of this Act, the Administrator shall—

(1) in coordination with the States, complete an assessment, which includes public input, on the status of all ambient air quality monitors that are part of Federal, State, or local networks and used for determining compliance with national ambient air quality standards; and

(2) submit to Congress and make available on the public website of the Environmental Protection Agency a report that includes—

(A) a list of all monitors identified under paragraph (1); and

(B) a schedule and plan to restore or replace all monitors included in the list under subparagraph (A) to full operation not later than 16 months of the date of enactment of this Act, except that the schedule and plan shall not apply to monitors—

(i) that have been discontinued in accordance with section 58.14(c) of title 40, Code of Federal Regulations (as in effect on the date of enactment of this Act); and

(ii)(I) for which such discontinuation is not subject to a judicial challenge; or

(II) for which a judicial challenge described in subclause (I) has been fully resolved by a settlement or order that authorizes discontinuation of such monitor.

(g) DESIGNATIONS.—Not later than 2 years after the date on which data is received from a monitor sited pursuant to this section that demonstrates that an area that is designated pursuant to section 107(d)(1) of the Clean Air Act (42 U.S.C. 7407(d)(1)) by the Administrator as in attainment or unclassifiable for an air pollutant is in violation of the applicable national ambient air quality standard, the Administrator shall redesignate pursuant to section 107(d)(3) of such Act (42 U.S.C. 7407(d)(3)) that area as in nonattainment for that pollutant unless the designation is otherwise precluded under this Act.

(h) SATELLITE MONITORING.—

(1) SATELLITE MONITORING DATA.—

(A) PROVISION OF SATELLITE DATA.—The Administrator may consult with the Administrator of the National Aeronautics and Space Administration regarding data from the satellites of the National Aeronautics and Space Administration for use in calculating design values under any national ambient air quality standards for PM_{10} and $PM_{2.5}$.

(B) REGULATIONS REQUIRED.—The Administrator may promulgate regulations to specify procedures (including any modeling techniques) for using data described in subparagraph (A) in combination with information from multiple sources, including monitors and modeling, to calculate the expected number of exceedances per year and the design values for PM_{10} and $PM_{2.5}$ for purposes of determining compliance or noncompliance with the national ambient air quality standards for those pollutants.

(2) NATIONAL ACADEMY OF SCIENCES REPORT.—

(A) IN GENERAL.—The Administrator may enter into an arrangement with the National Academy of Sciences under which the National

Academy of Sciences agrees to submit a report that describes the actions necessary, including new science and satellite assets to enable the contribution of satellite monitoring to the calculation of design values and nonattainment determinations under any national ambient air quality standards for ozone, oxides of nitrogen, and oxides of sulfur established pursuant to section 109 of the Clean Air Act (42 U.S.C. 7409).

(B) REGULATIONS REQUIRED.—

(i) IN GENERAL.—Not later than December 31, 2023, the Administrator, in coordination with the Administrator of the National Aeronautics and Space Administration and the Administrator of the National Oceanic and Atmospheric Administration, shall promulgate regulations that provide a plan for the use of satellite monitoring data in calculating design values for the pollutants described in subparagraph (A).

(ii) REQUIREMENT.—Not later than January 1, 2027, the Administrator shall implement the plan required by clause (i) and provide for use of satellite data in calculating design values for the pollutants described in subparagraph (A).

(3) DEFINITION.—For purposes of this subsection, the term "design value" means, for each pollutant, the air quality statistic the Administrator defines in part 50 (including appendices) of title 40, Code of Federal Regulations, for comparison with the relevant national ambient air quality standard established under section 109 of the Clean Air Act (42 U.S.C. 7409), regardless of whether the regulation (including appendices) in part 50 of title 40, Code of Federal Regulations, uses the term "design value".

(i) MONITORING PLANS.—Notwithstanding any other provision of law, the Administrator may not approve a State monitoring plan under section 58.10 of title 40, Code of Federal Regulations (or successor regulations), unless—

(1) the State provided, with respect to the State monitoring plan—

(A) public notice;

(B) not less than 45 days for public comment; and

(C) an opportunity for public hearing; and

(2) the Administrator—

(A) proposes in the Federal Register to approve or disapprove of the State monitoring plan;

(B) provides not less than 45 days for public comment on the proposal described in subparagraph (A); and

(C) publishes in the Federal Register the final action on the proposal described in subparagraph (A).

(j) FUNDING.—

(1) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section $75,000,000 for fiscal year 2023.

(2) USES.—The Administrator—

(A) may use the amounts made available to carry out this section—

(i) to directly deploy new or replacement NCore multipollutant monitoring stations required under subsection (a); or

(ii) to make grants under section 103 or 105 of the Clean Air Act (42 U.S.C. 7403, 7405) to State and local governments for deployment and operation of the

NCore multipollutant monitoring stations required under subsection (a); and

(B) shall use not less than 5 percent, but not more than 10 percent, of the amounts made available to carry out this section to perform the maintenance and repairs necessary to restore to operation NCore multipollutant monitoring stations that are—

(i) as of the date of enactment of this Act, nonoperational; and

(ii) located in areas that are designated as in nonattainment of national ambient air quality standards under section 109 of the Clean Air Act (42 U.S.C. 7409) for ozone or particulate matter.

SEC. 6. SENSOR MONITORING.

(a) DEPLOYMENT OF AIR QUALITY SENSORS.—

(1) IN GENERAL.—Not later than 2 years after the date of enactment of this Act, the Administrator—

(A) shall deploy, in accordance with the prioritization criteria described in section 5(d)(2), not fewer than 1,000 air quality sensors, each of which shall cost not more than $5,000;

(B) shall deploy such air quality sensors in clusters of not fewer than 5 in each of the census tracts or counties selected;

(C) before determining and approving sites for such air quality sensors, shall invite, through public notice and other means designed to reach communities disproportionately impacted by air pollution, proposals from or on behalf of residents of any community for the sites; and

(D) may contract with State and local air pollution control agencies to conduct sensor monitoring and report the results.

(2) REQUIREMENT.—In carrying out paragraph (1), the Administrator shall select sensors for deployment that—

(A) are available on the market at the time of purchase;

(B) the Administrator determines will provide data of sufficient accuracy to provide a reasonable basis for determining whether the location in which the sensor is sited is or may be at risk of exceeding the applicable national ambient air quality standard established pursuant to section 109 of the Clean Air Act (42 U.S.C. 7409); and

(C) are the lowest cost available that meet the criteria of subparagraph (B).

(3) EXCEPTION TO COST LIMITATION.—Notwithstanding paragraph (1), if the Administrator determines in writing that a sensor model to measure a particular pollutant is not available on the market at a price at or below $5,000 each, the Administrator may spend an amount above $5,000 to acquire such sensor model so long as the Administrator complies with subparagraphs (B) and (C) of paragraph (2).

(b) POLLUTANTS.—

(1) IN GENERAL.—Each air quality sensor deployed pursuant to subsection (a) shall measure ozone, $PM_{2.5}$, oxides of nitrogen, or sulfur dioxide.

(2) DETERMINATION.—The Administrator shall determine which pollutant or air pollutants an air quality sensor deployed pursuant to subsection (a) shall monitor based on the pollution sources affecting the area in which the sensor is to be deployed.

(c) DETERMINATION AND INSTALLATION.—

(1) IN GENERAL.—Not later than 18 months after the date on which an air quality sensor de-

ployed pursuant to subsection (a) has been monitoring air quality data for 1 year, the Administrator shall determine whether data from the air quality sensors deployed in the applicable census tract or county shows air pollution levels over the 1-year period ending on the date of the determination that reached 98 percent of the level of the national ambient air quality standard under section 109 of the Clean Air Act (42 U.S.C. 7409) for any air pollutant.

(2) REQUIREMENT.—If the Administrator makes a determination under paragraph (1) that an air pollutant described in subsection (b)(1) met the threshold described in that paragraph, the Administrator shall, not later 180 days after the date of the determination, ensure that Federal reference method monitors or Federal equivalent method monitors are installed and in operation within that census tract or county for each pollutant that met the threshold.

(3) EXCEPTIONS.—The Administrator shall waive the requirement of paragraph (2) if the Administrator finds, within the 180-day period described in such paragraph, and after providing notice and an opportunity for public comment, that based on clear and convincing evidence—

(A) the measurements from the sensor or sensors supporting the determination described in paragraph (2) were so inaccurate as to provide no reasonable basis for finding that levels of the relevant pollutant reached 98 percent of the level of the national ambient air quality standard under section 109 of the Clean Air Act (42 U.S.C. 7409) for the relevant pollutant; or

(B) complementary data, such as information on the ambient matric, meteorology, measurements from other nearby sensors or ambient monitors, modeling, satellite data, or other relevant and reliable information, demonstrate that levels of the relevant pollutant could not have plausibly reached 98 percent of the level of such standard.

(d) REPORT.—Not later than 1 year after the date of enactment of this Act, and not less frequently than every 6 years thereafter, the Administrator shall report on additional areas of decision-making where data from low-cost air quality sensors may be relevant and useful.

(e) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section $6,000,000.

SEC. 7. DATA REQUIREMENT.

To the extent practicable, the Administrator shall integrate the data collected through the programs established under this Act into the EJSCREEN mapping tool of the Environmental Protection Agency or a relevant, similar mapping and screening tool.