



Particulate Matter: Spotlight on Health Protection

Symposium Summary: Health Effects and Exposures and Risk

October 28, 2019



**BAY AREA AIR QUALITY
MANAGEMENT DISTRICT**

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Executive Summary

On October 28, 2019, the Bay Area Air Quality Management District (Air District) convened a symposium, at the request of its Advisory Council, to obtain input from leading experts on the best available science concerning impacts of particulate matter (PM). The morning panel focused on PM health effects; the afternoon panel focused on PM exposure and risk. After hearing from national and state air quality experts on the panels and from community members during public comment periods, the Advisory Council drafted the following Sense of the Advisory Council statement:

The current PM standards are not adequately health protective. Further reductions in particulate matter will realize additional health benefits. We ask the Air District staff to bring forward with urgency options within the legal authority of the Air District that would further limit PM exposure, especially in high-risk communities.

This consensus was reached upon consideration of information presented by the panelists and public commenters demonstrating: adverse health effects of PM, including mortality, at concentrations below the current standard; disproportionate burden of PM exposure and risk on disadvantaged communities, including those within the Air District; and emerging evidence of the health impact of ultrafine particles (UFP) and wildfires, both of which are understudied.

PM Health Effects

Draft PM ISA. Jason Sacks, Project Lead on the Particulate Matter Integrated Science Assessment (PM ISA) and Senior Epidemiologist at the Environmental Protection Agency's (EPA) National Center for Environmental Assessment, reviewed the structure and findings of the Draft PM ISA (<https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter>). His presentation demonstrated that PM causes more health problems than previously known, at lower concentrations than previously known, and disproportionately affects vulnerable populations. In particular, the Draft PM ISA found new causal or likely-to-be causal associations between nervous system effects and long-term exposure to PM_{2.5} and, independently, to the portion of PM_{2.5} considered to be ultrafine particles (UFP), and between cancer and long-term exposure to PM_{2.5}. Children and non-white populations are at increased risk of adverse health effects of PM, and there is no evidence of a concentration threshold below which effects are not observed.

Mechanisms of PM impact. Advisory Council Vice Chair Michael Kleinman, Professor of Environmental Toxicology at UC Irvine and Co-Director of the Air Pollution Health Effects Laboratory, focused on the formation, composition, and mechanistic health effects of PM and new insights from his research concerning the toxicity of PM. He discussed how the connection between PM and health effects can be traced mechanistically, with oxidative stress from biological reactions to PM leading to inflammation, cell death, and cardiovascular events. He

also discussed how the toxicity of PM may be attributable to its coating rather than its core, although metals in the core can also produce health effects.

PM burdens and wildfire impacts. Dr. John Balmes, Professor of Medicine at UC San Francisco, Professor of Environmental Health Sciences at UC Berkeley, and Director of the Northern California Center for Occupational and Environmental Health, covered numerous topics associated with particulate matter including sources, effects, challenges with UFP, disproportionate burdens of exposure, and wildfire impacts. His presentation demonstrated that PM exposure leads to a wide range of health problems and disproportionately affects low-income communities and people of color, who suffer cumulative impacts from multiple exposures and disadvantages. In California, exposure to wildfire smoke is associated with increases in health care utilization for both respiratory and cardiovascular problems.

Independent PM Review Panel. Christopher Frey, Chair of the Independent Particulate Matter Review Panel and Glenn E. Futrell Distinguished Professor of Environmental Engineering at North Carolina State University, explained how recent changes to the review process for the federal National Ambient Air Quality Standards (NAAQS) led to the formation of the Independent Particulate Matter Review Panel. He summarized the conclusions of that panel:

- The scientific evidence for PM_{2.5} health effects is robust.
- The current PM_{2.5} standards are not adequately protective of public health.
- The annual standard should be lowered to 10 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) to 8 $\mu\text{g}/\text{m}^3$ (versus the current 12 $\mu\text{g}/\text{m}^3$ standard).
- The 24-hour standard should be lowered to 30 $\mu\text{g}/\text{m}^3$ to 25 $\mu\text{g}/\text{m}^3$ (versus current 35 $\mu\text{g}/\text{m}^3$ standard).
- These changes would save thousands of lives.
- The PM₁₀ standard should be adjusted downward consistent with these changes.
- There appears to be no threshold; lower levels would produce still greater benefits.
- For African Americans, the relative risk of health impacts from PM is three times higher than for the U.S. as a whole.

PM Exposures and Risks

OEHHA research. Lauren Zeise, Director of the California Office of Environmental Health Hazard Assessment (OEHHA) and Leading Developer of CalEnviroScreen, described some of OEHHA's current research efforts to understand the relationships between specific PM sources and community health outcomes. After explaining that there is great variability in the relationship between PM concentration and health risk, she discussed how OEHHA is conducting biomonitoring studies to track whether biomarkers indicate reductions in risk following reduced air pollution concentrations. These data, along with indoor air samples, questionnaires, activity diaries, and information from GPS trackers, will be combined with source pollution mapping data to determine how exposures are occurring. Dr. Zeise also demonstrated that wildfires are causing PM standards to be exceeded for both 24-hour and annual averages. OEHHA is presently investigating relationships between the 2017 Northern California Wildfires and

numerous health outcomes in the area including respiratory, cardiovascular, and neurological problems.

Silver buckshot, not silver bullet. Julian Marshall, Kiely Endowed Professor of Civil & Environmental Engineering and Adjunct Professor of Global Health at the University of Washington, described an approach to reducing health risks from PM involving combined analysis of sources of emissions, concentrations at geographical locations, levels of exposure to different sources of emissions, and racial and income disparities affecting environmental justice. Because PM comes from many sources, he concluded that reducing PM exposure requires many strategies, describing this approach as “silver buckshot, not a silver bullet.” With respect to health risks from PM, he demonstrated that income matters, and race matters, but race matters more than income. To get the most “bang for the buck” on health impacts, he argued that interventions should focus on areas where high impact from PM meets high inequity in terms of environmental justice.

Draft PM Policy Assessment. Scott Jenkins, Project Lead on the EPA’s review of National Ambient Air Quality Standards for PM and Senior Environmental Health Scientist in EPA’s Office of Air Quality Planning and Standards, presented an overview of the approach and conclusions of the EPA’s Draft PM Policy Assessment completed in response to the Draft PM ISA. The PM Policy Assessment featured a risk assessment indicating that thousands of lives per year in the U.S. could be saved if annual average PM_{2.5} concentrations are reduced. The assessment included an argument for revising the annual PM_{2.5} standard downward based on the science, as well as a discussion of how retaining the current standard could be justified by placing very little weight on the epidemiological evidence and risk assessment and greater weight on the uncertainties and limitations of the data.

West Oakland Community Action Plan. Phil Martien, Director of Assessment, Inventory, & Modeling for the Air District, described the analysis conducted for the recently completed West Oakland Community Action Plan, the first in a series of community emissions reduction programs that the Air District is developing in response to California’s Assembly Bill 617 legislation (AB 617). Per the community’s requests, the study took a hyperlocal approach, modeling block-by-block exposures. Disparate exposure levels were seen within West Oakland: the cleanest blocks are experiencing on average 3 µg/m³ lower PM concentrations than the most polluted blocks. Sources of PM also differed, with some areas experiencing PM_{2.5} emissions primarily from street traffic and others experiencing the greatest proportion of PM_{2.5} emissions from highways or permitted sources. The West Oakland Community Action Plan demonstrates how hyperlocal modeling can be accomplished, but also highlights the need for other agencies to act, such as California Air Resources Board (CARB), the City of Oakland, and the Port of Oakland, in order to reach community emissions reduction targets.

Public comment

Public comment was taken during two designated periods during the event. The general sentiment expressed by many commenters was, “We need action, not more discussion.”

Several people spoke about their personal experiences with toxic emissions in their neighborhoods. The disproportionate impact of air pollution on disadvantaged communities was a central point of focus.

Discussion and Deliberation

The discussion between the Advisory Council and the morning panel focused on cost considerations and the appropriateness of a “no safe level” stance, and broached the topic of recommending Air District priorities, which led to further discussion regarding the monitoring of ultrafine particles. The discussion between the Advisory Council and the afternoon panel was brief and comprised of one question concerning margin of safety considerations in the Draft Policy Assessment (which Dr. Jenkins clarified was the exclusive domain of the EPA Administrator).

The Advisory Council’s deliberation followed, resulting in the Sense of the Advisory Council statement presented above. Advisory Council members also expressed interest in further exploring the potential for:

- Treating PM as a toxic;
- Monitoring ultrafine particles;
- Encouraging the State of California to adopt stricter PM standards;
- Ensuring local permits are consistent with the PM standard supported by the science;
- Disaggregating solutions with climate co-benefits, solutions unrelated to climate strategies, and emergencies;
- Identifying strategies to maximize impact or “bang for the buck”; and
- Creating an Air District Implementation Plan.

Next Steps

The Advisory Council will reconvene on December 9, 2019. During that meeting, in response to the Advisory Council’s requests, the Air District will present on its current activities to reduce PM exposures, including monitoring of ultrafine particles. It will also discuss additional “options within the legal authority of the Air District that would limit PM exposure, especially in high-risk communities,” in accordance with the Sense of the Advisory Council, in order to inform the Advisory Council’s advice to the Air District’s Board of Directors. The Advisory Council is expected to receive and comment on this symposium summary document during the December 9 meeting.

Planning continues for a second PM symposium focused on community and other stakeholder input and engagement; the event will take place in Spring 2020.

Background

On October 28, 2019, the Bay Area Air Quality Management District (Air District) convened a symposium, at the request of its Advisory Council (Council), in order to obtain input from leading experts on the best available science concerning health effects of particulate matter (PM). Serving as an official meeting of the Advisory Council, which advises and consults with the Air District's Board of Directors and Executive Officer on technical and policy matters, the symposium sought to discuss:

PM Health Effects

- what health effects are observed from PM exposure, including exceptionally high acute PM exposures (e.g., wildfire smoke);
- what biological systems are affected and by what mechanisms;
- what population groups are most at risk; and
- what uncertainties are most relevant.

PM Exposure and Risk

- what the emission sources are that contribute to PM;
- what exposures to airborne PM occur and to whom;
- what health risks are posed by those PM exposures; and
- what subset of sources contribute most to PM risk, particularly in the most highly impacted communities.

The symposium followed several relevant policy developments at the state and federal levels. In California, Assembly Bill 617 passed in 2017 directing the California Air Resources Board and all local air districts to protect communities disproportionately impacted by air pollution. Implementation in the Bay Area Air Quality Management District to date includes the development of a community-led plan for air quality improvement in West Oakland (adopted by the Air District's Board of Directors in October 2019) and an air quality monitoring program for the Richmond area (underway).

At the federal level, staff of the Environmental Protection Agency (EPA) released a Draft Integrated Science Assessment (ISA) for Particulate Matter (PM) in October 2018, followed by a Draft PM Policy Assessment regarding the standard-setting implications of the PM ISA in September 2019. These drafts were submitted for review to the Clean Air Scientific Advisory Committee (CASAC), which provides advice to the EPA Administrator on the setting of national ambient air quality standards. Additionally, a separate, independent response to both EPA draft documents was released in October 2019 by the Independent Particulate Matter Review Panel, whose members served previously on the CASAC PM Review Panel until their dismissal in October 2018 by EPA Administrator Andrew Wheeler.

The timing of the symposium also coincided with the outbreak of the Kincade Fire in Sonoma County and associated evacuations. Additionally, widespread power outages within the Air

District's jurisdiction were intentionally executed by Pacific Gas & Electric (PG&E) as wildfire prevention measures given the dry conditions and high winds. This crisis formed a backdrop to the proceedings.

Particulate matter experts presenting at the event included the lead authors of the EPA PM ISA (Jason Sacks), the EPA PM Policy Assessment (Dr. Scott Jenkins), the Independent Review Panel document (Professor Christopher Frey), and the West Oakland Community Action Plan (Dr. Phil Martien). They were joined by Independent Particulate Matter Review Panel Members Professor Michael Kleinman and Dr. John Balmes, Director of the California Office of Environment Health Hazard Assessment Dr. Lauren Zeise, and University of Washington Professor Julian Marshall. These speakers were organized into a morning panel focused on PM health effects and an afternoon panel focused on PM exposure and risks.

The event, which was open to the public, included two public comment periods. The midday lunch break featured a keynote address by former EPA Administrator Gina McCarthy, who also answered questions from community attendees.

The morning and afternoon panels were each followed by joint discussions between the Advisory Council members and panelists. The event concluded with a brief Advisory Council deliberation.

The event was shared live via webcast, the video archive of which can be viewed at http://baha.granicus.com/MediaPlayer.php?clip_id=6194.

Morning Panel: PM Health Effects

Current State of Particulate Matter Science: Particulate Matter Integrated Science Assessment (Working Draft Conclusions)

Jason Sacks

Project Lead, Particulate Matter Integrated Science Assessment (PM ISA)
Senior Epidemiologist, National Center for Environmental Assessment, EPA

<i>Main takeaway</i>	PM causes more health problems than previously known, at lower concentrations than previously known, and disproportionately affects vulnerable populations.
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Presentation Summary

Mr. Sacks reviewed the structure and findings of the initial draft of the EPA’s recent Particulate Matter Integrated Science Assessment (PM ISA), which aims to provide an updated review of the science in order to assist federal rulemaking. The Draft PM ISA addresses the question:

“Is there an independent effect of PM on health and welfare at relevant ambient concentrations?”

The PM ISA drafters reviewed the body of new research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

The Draft PM ISA can be found at <https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter>.

Health effects. The Draft PM ISA found new causal or likely-to-be causal associations between:

- Nervous system effects and long-term exposure to PM_{2.5} and, independently, to the portion of PM_{2.5} considered to be ultrafine particles (UFP)
- Cancer and long-term exposure to PM_{2.5}

The science also confirmed and strengthened the evidence of previously known causal or likely-to-be-causal associations between respiratory, cardiovascular, and mortality effects of both short- and long-term exposure to PM_{2.5}. Additional PM exposure associations with metabolic and reproductive effects suggested causality but did not meet the strict criteria for “causal” or “likely-to-be-causal,” often due to a limited quantity of data.

At-risk populations. Children and non-white populations are at increased risk of adverse health effects of PM. Further evidence regarded as “suggestive” points to increased health risk for people with low socioeconomic status, overweight and obese populations, people with pre-existing cardiovascular and respiratory disease, and people with certain genetic variants.

Chemical components of PM. The evidence does not indicate that any one specific chemical component of PM is a disproportionate concern over others.

Advisory Council Q&A with Panelist

No threshold. Council Member Rudolph inquired whether any evidence supported a threshold concentration value below which health effects from PM_{2.5} could not be observed. The panelist responded that there does not appear to be any such threshold.

Changes to health effect determinations. Chair Hayes requested further clarification on the new findings from the ISA since 2009, which are outlined above and in Slide 15 of the presentations.

Relevance of animal studies concerning UFP. Council Member Solomon asked if there was any reason to question whether results seen in animal studies concerning UFP would be consistent with human health effects. The panelist replied that the inconsistency was in the size of the particles considered to be UFP. There has not been a consistent metric or definition for UFP, which has limited the ability to draw conclusions.

Publication bias. Council Member Borenstein inquired whether studies with null results were being published; if not, there may be a concern that the presentation represented only the fraction of research that observed positive associations with health effects. The panelist clarified that this concern drove the decision to focus on multi-city studies in order to ensure that null results would be incorporated.

Wildfires and sub-daily exposures. Given the Kincade Fire that was burning at the time of the event, Chair Hayes inquired about the influence of sub-daily exposures to high levels of PM. The panelist responded that there are some controlled human exposure studies that would be equivalent to a person walking along a busy road, during which some changes in cardiac and lung function have been observed, but sub-daily studies are scarce and he was not aware of research that would be directly relevant to wildfire exposures.

Particulate Matter: A Complex Mixture that Affects Health

Michael Kleinman

Professor of Environmental Toxicology, University of California, Irvine
Co-Director, Air Pollution Health Effects Laboratory

Professor Kleinman is also Vice Chair of the Air District's Advisory Council.

<i>Main takeaways</i>	PM can be mechanistically and causally linked to cardiovascular health effects. The toxicity of PM may be more attributable to its coating than its core, although metals in the core can also produce health effects.
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Presentation Summary

Professor Kleinman's presentation focused on the formation, composition, and mechanistic health effects of PM and new insights from his research concerning the toxicity of PM.

Basic PM process. A key source of PM is the combustion of fossil fuels. After these fuels break down during combustion, they cool, become radicalized, and agglomerate. Additional chemicals adhere to these particles and can form highly toxic compounds that may include contaminants such as chlorine, bromine, and metals. When these particles are inhaled and enter the respiratory tract, they can react with proteins and fluids in the lungs and release highly reactive free radicals, causing chemical imbalances throughout the body. If these free radicals overwhelm the body's antioxidant self-protection capabilities, the process can result in inflammation, cell death, and organ failure. Because oxidative stress can oxidize lipids in the blood, it can also lead to the development of atherosclerotic plaque and coagulation factors that can contribute to cardiovascular events such as stroke and heart attack.

"The icing, not the cake." Professor Kleinman's laboratory experimented with removing the organic coating from ambient air particles to which animals were exposed to determine whether, in the words of Chair Hayes, the problem was "the icing or the cake." They found that stripping the particles of their organic coating appeared to mitigate their toxicity.

Additional key points:

- Data limitations concerning chemical components. PM_{2.5} total mass is regarded as a more relevant concern than specific components within it, but this may be due to the much smaller database available for chemical components than for PM_{2.5} as a category.
- Measurement challenges. Ultrafine particles are difficult to measure and monitor because they have almost no mass.
- Risks for California. Sunlight, which is plentiful in California, is involved in the formation of pollutants. In addition to PM, health is also affected by air pollutants such as ozone, which is a strong oxidant. The combined effects of PM and ozone, which can be

experienced in the same day, may cause high levels of oxidative stress. Additionally, Professor Kleinman's research indicates that particles formed on warmer days result in worse health effects than those formed on cooler days, which portends additional problems in an era of climate change.

Advisory Council Q&A with Panelist

Incomplete combustion and control technology. Council Member Long inquired whether UFP resulted from incomplete combustion and whether newer technologies were effective in controlling their formation. The panelist responded that to his knowledge all combustion resulted in the formation of ultrafine particles (along with other particles). He noted that although modern diesel engine afterburner controls denuded particles in a manner similar to his animal toxicology experiments, they also produced high amounts of UFP.

Greenhouse gas impacts. Council Member Rudolph asked whether the process of stripping components from PM would change the release of carbon dioxide from combustion, emphasizing that "climate change is the greatest existential threat to human health right now." She questioned whether targeting the toxicity of the results of combustion should be a goal rather than trying to reduce combustion itself in order to reduce greenhouse gas emissions. The panelist shared his view that in the short-term "we can improve public health by mitigating what we're making right now," while in the long-term pursuing strategies to reduce reliance on fossil fuels.

Particulate Matter Health Effects: What Do We Know and What Do We Still Need to Know?

John Balmes, M.D.

Professor of Medicine, UC San Francisco

Professor of Environmental Health Sciences, UC Berkeley

Director, Northern California Center for Occupational and Environmental Health

<i>Main takeaways</i>	PM exposure leads to a wide range of health problems and disproportionately affects low-income communities and people of color, who suffer cumulative impacts from multiple exposures and disadvantages. In California, exposure to wildfire smoke is associated with increases in health care utilization for both respiratory and cardiovascular problems.
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Presentation Summary

Dr. Balmes covered numerous topics associated with particulate matter (PM) including sources, effects, challenges with UFP, disproportionate burdens of exposure, and wildfire impacts.

Sources of PM. PM derives not only from combustion particles, but also from crustal and biological sources; for example, road dust is a significant source of PM. Dust particles may carry biological components that can cause health effects.

Health effects. In addition to re-emphasizing the health effects covered in Mr. Sacks' and Professor Kleinman's presentations, Dr. Balmes further noted:

- the smaller the particle, the farther it travels into the body, with some PM particles small enough to enter the bloodstream and even cross the blood-brain barrier;
- PM_{2.5} is associated with increased risk of metabolic effects, including diabetes;
- fetal PM_{2.5} exposures can result in low birth weight, pre-term birth, and changes in gene expression; and
- brain inflammation from PM can affect both ends of the life spectrum - neurodevelopment and neurodegeneration.

Challenges with UFP. As mentioned by previous presenters, because UFP is not regulated independently from other PM_{2.5}, there is limited monitoring, which presents challenges for epidemiological research, although toxicological studies suggest UFP is a high-risk hazard. Further, innovations designed to reduce climate change impacts, such as gasoline direct injection, can result in higher UFP emissions.

Disproportionate burdens and cumulative impacts. People of color and people with low socioeconomic status are more likely to be exposed to PM, and the risk from these exposures is compounded by the lack of health-promoting resources in these communities such as health

care, fresh produce, and green spaces. Dr. Balmes shared the example of Richmond, CA, which is within the Air District's jurisdiction. People living in the Liberty/Atchison Villages in Richmond are next to the railyard, near the freeway, next to the General Chemical Corporation (which recently had a serious accident), and downwind from the Chevron Refinery. Stating, "This cumulative risk concept is something that we need to be including in our thinking about air quality management," Dr. Balmes also noted that the Air District is a leader in this regard.

Wildfires. While acknowledging that "we need to know more than we currently do," Dr. Balmes asserted that there is a well-known association between wildfires and increased health care utilization for people with respiratory conditions such as asthma and chronic obstructive pulmonary disease. Additionally, a recent California study associates wildfire smoke with cardiovascular events including heart attack, stroke, and heart failure.

Advisory Council Q&A with Panelist

Wildfire contribution to cumulative impact. Council Member Rudolph asked whether wildfires should be understood as an additional layer of cumulative impact. The panelist responded that although he hadn't considered that framing, it was accurate, as people with lower socioeconomic status are those most likely to be without the means to relocate during wildfires. Rural agricultural workers are one example of a community that may be working outdoors despite poor air quality from wildfires. Council Member Rudolph asked whether it was accurate to say, "It's even more important to reduce our baseline exposures because we know these acute exposures are going to be happening more frequently" due to climate change, or if the two issues of baseline and acute exposures should not be viewed as interrelated. The panelist asserted that Council Member Rudolph's statement was accurate.

Bay Area studies? Referring to slide 76, which mapped Los Angeles county data comparing the distribution of non-white people and people living in poverty alongside the distribution of cumulative air quality hazard, Council Member Solomon asked whether the same analysis could be performed for the Bay Area. The panelist replied that although he was not aware of such an analysis having been performed, it should be possible. He indicated that he would speak with an expert he believed to be capable of executing the task.

Recent Developments in the Scientific Review of the National Ambient Air Quality Standards for Particulate Matter

Christopher Frey

Chair, Independent Particulate Matter Review Panel

Glenn E. Futrell Distinguished Professor of Environmental Engineering, North Carolina State University

<i>Main takeaways</i>	The federal administration truncated the National Ambient Air Quality Standard science review process and purged the Clean Air Scientific Advisory Committee (CASAC) and the supporting CASAC PM Review Panel of critical scientific expertise. The scientists who were dismissed from the CASAC PM Review Panel continued their review work independently and found that the current PM standards are insufficient to protect public health.
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Presentation Summary

Professor Frey explained how recent changes to the review process for the federal National Ambient Air Quality Standards led to the formation of the Independent Particulate Matter Review Panel. He then summarized the conclusions of that panel, which he leads.

Federal PM Review

Process: The scientific review process that for four decades involved an iterative sequence of assessments flowing from science to policy has been severely abridged. Notably, the EPA’s PM Policy Assessment (PA) must now be finalized without reviewing the EPA’s final PM Integrated Science Assessment (ISA). Additionally, members of the Clean Air Scientific Advisory Committee (CASAC) PM Review Panel were dismissed, leaving the current CASAC without, by its own admission, the necessary expertise to respond to the documents. Acknowledging the good work accomplished by EPA staff in completing the Draft PM ISA and Draft PM PA in difficult circumstances, Professor Frey emphasized the need for the Air District “to look elsewhere than the EPA’s Chartered Clean Air Scientific Advisory Committee” for guidance on PM science review.

Findings: As of October 25, 2019, the remaining six CASAC members were split 4-2 on their national ambient air quality standards (NAAQS) recommendations, with the majority supporting retaining all current standards.

Independent Particulate Matter (PM) Review Panel

Process: Led by Professor Frey, the scientists that were dismissed from the CASAC PM Review Panel continued to meet, without compensation, to complete the public service to which they had committed as CASAC PM Review Panel members. With logistical support from the Union of

Concerned Scientists, the Independent PM Review Panel met for two days in October 2019 and developed a consensus report that was sent to the EPA Administrator. The report and the video-recorded proceedings can be accessed at <https://ucsusa.org/meeting-independent-particulate-matter-review-panel>.

Findings: The scientific evidence for PM_{2.5} health effects is robust. The current PM_{2.5} standards “are not protective of public health, not even close.”

- The annual standard should be lowered to 10 µg/m³ to 8 µg/m³ (versus the current 12 µg/m³ standard)
- The 24-hour standard should be lowered to 30 µg/m³ to 25 µg/m³ (versus the current 35 µg/m³ standard)
- These changes would save thousands of lives
- The PM₁₀ standard should be adjusted downward consistent with these changes
- There appears to be no threshold; lower levels would produce still greater benefits
- For African Americans, the relative risk of health impacts from PM is three times higher than for the U.S. population as a whole

See Slides 102 and 103 for Professor Frey’s rapid-fire answers to questions posed by the Air District.

Advisory Council Q&A with Panelist

Response to Independent PM Review Panel. Council Member Long asked whether the Independent PM Review Panel received a response from the EPA Administrator or had been mentioned in the press. The panelist replied that the Administrator had not responded, but may not yet have received the report. However, the Independent PM Review Panel also submitted their report as public comment to CASAC, and several CASAC members referred to the report during their deliberations on October 25, 2019. There has been some press coverage of the Independent PM Review Panel, for example in the *Guardian* and *Rolling Stone*.

Safety at 8 µg. Council Member Solomon expressed the concern that, if there is no threshold below which health effects cannot be observed, 8 µg/m³ cannot be regarded as safe, particularly for vulnerable individuals. The panelist replied that the recommendation is given within the policy context of national ambient air quality standards (NAAQS) and is intended to support a standard that could withstand judicial review. The number is based on the available science, which focuses on ambient air pollution levels observed in epidemiological studies. The Clean Air Act requires that the standards protect public health “allowing an adequate margin of safety,” which should protect the general population and at-risk groups, but will not necessarily protect every individual.

The post-presentation Q&A segued into the general discussion between the Advisory Council and the PM Health Effects panel. This discussion is described in the following section.

PM Health Effects: Discussion Summary

The discussion between the Advisory Council and the morning panel focused on cost considerations and the appropriateness of a “no safe level” stance and broached the topic of recommending Air District priorities, which led to further discussion regarding UFP.

Cost considerations and appropriateness of “no safe level” language. Council Member Borenstein expressed discomfort with the language of “no safe level” of PM, emphasizing the need to assess the costs, including health costs, of implementing more stringent standards and using the analogy of motor vehicles to demonstrate that all areas of safety concern must accept some risks. Professor Frey responded that the U.S. Supreme Court’s interpretation of the Clean Air Act expressly forbids cost considerations in setting National Ambient Air Quality Standards and stated that voluntary activities such as driving should not be equated to the involuntary act of breathing. He also clarified that the conclusion “there is no evidence of a threshold” is not in itself an argument for banning all particulate emissions. Dr. Balmes addressed the topic from his perspective as a physician member of the California Air Resources Board (CARB). He clarified that whereas CARB does consider economic impacts, the Independent PM Review Panel, following the procedures that had until recently governed CASAC, was restricted from mingling health and economic concerns. He also emphasized that while the most precautionary stance would consider levels below $8 \mu\text{g}/\text{m}^3$, the lack of data on lower levels of exposure makes it appropriate to recommend $8 \mu\text{g}/\text{m}^3$ for a present limit. In response to a question from Council Member Solomon, Professor Frey clarified that this $8 \mu\text{g}/\text{m}^3$ recommendation did take into consideration the increased sensitivity to pollution impacts of African American populations.

Recommending Air District priorities. Chair Hayes asked for guidance in identifying the most important areas of focus for the Air District, given the science and the particular challenges for the area, including wildfires. Dr. Balmes emphasized the need for community-level monitoring in accordance with AB 617 to identify air pollution “hot spots” and hypothesized that black carbon, a form of PM, may be a vital concern for these communities. He also expressed support for monitoring ultrafine particles (UFP) and collecting epidemiological data concerning wildfires. Council Member Long emphasized the need for a strategic plan.

Ultrafine particles. The discussion of UFP continued with Mr. Sacks underscoring that while animal toxicological studies show effects of UFP, little is known about UFP’s effects on the human population. One challenge for such research is that particles emitted as UFP may not stay in that size range. He further noted that UFP are contained within $\text{PM}_{2.5}$ and efforts to control $\text{PM}_{2.5}$ therefore may also bring down UFP concentrations. In response to Chair Hayes’ requests for guidance regarding UFP, Professor Frey suggested establishing monitoring stations in carefully selected locations as a long-term strategy and public education/consumer ratings regarding automobile ventilation and filtration systems as more immediate tactics. Professor Kleinman noted that there may be an opportunity for regulation to stimulate innovation with respect to decreasing UFP emissions and that the European Union already requires vehicles to share “particle numbers” regarding in-cabin air quality.

Afternoon Panel: PM Exposure and Risk

Exposure and Risk Panel Particulate Matter: Spotlight on Health

Lauren Zeise

Director, California Office of Environmental Health Hazard Assessment
Leading Developer, CalEnviroScreen

<i>Main takeaways</i>	There is a high degree of variability among individuals in the relationship between PM exposure concentration and health risk. OEHHA is pursuing research to determine the most important sources of air pollution with respect to health effects. Wildfires are causing PM standards to be exceeded for both 24-hour and annual averages.
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Presentation Summary

After explaining how health risks from PM can vary, OEHHA Director Zeise described some of OEHHA’s current research to understand the relationships between specific PM sources and community health outcomes. She also shared some initial data on PM levels from wildfire.

Variability. There is a high degree of variability in concentration-response relationships relating PM exposure concentration to resulting health risks, due to multiple factors including:

- variable individual vulnerability (e.g., health status, genetic factors, demographic factors)
- variable doses at a given concentration (e.g., breathing rates, other physiological factors)
- variable concentrations within a location (e.g., in West Oakland, can be five times higher)

Given this variability, one way to get the most “bang for the buck” is to focus on improving air quality in communities with the highest exposures and highest vulnerabilities.

Current research at OEHHA. Several relevant studies are underway in alignment with AB 617 that will provide valuable input to PM risk management efforts. A key feature of these studies is biomonitoring to determine whether biomarkers indicate reductions in health risk following reduced air pollution concentrations. For example, the East Bay Diesel Exposure Project is a pilot study measuring exposure to diesel exhaust among community residents. This project collects urine samples in addition to indoor air samples, questionnaires, activity diaries, and information from GPS trackers. These data collected from residents will be combined with source pollution mapping data to determine how exposures are occurring.

Wildfires. PM concentrations during the 2017 Napa Wildfire reached 24-hour averages close to 200 µg/m³ and one-hour averages above 300 µg/m³ in some areas. In West Oakland, wildfire

impacts on PM have driven annual averages above the national standard, to 12.9 $\mu\text{g}/\text{m}^3$ in 2017 and 14.4 $\mu\text{g}/\text{m}^3$ in 2018. OEHHA is presently investigating relationships between the Napa Wildfire and numerous health outcomes in the area including respiratory, cardiovascular, and neurological problems.

Advisory Council Q&A with Panelist

Wildfire research outcomes. Chair Hayes asked if any preliminary health outcome results could be shared from the Napa Fire study, to which the panelist replied that she could not yet share results but expected to do so in the near future. Chair Hayes also asked if OEHHA would be including other years in the study. The panelist replied that while the Napa Fire study is a stand-alone project, the OEHHA epidemiology team has also been involved in a study of primates (macaques) in captivity that tracks outcomes to exposure to wildfires that occurred in 2008. This natural experiment of mother-infant pairs indicates that the exposure resulted in impacts on lung function and immunological markers. Chair Hayes remarked that such findings were consistent with studies in Southern California indicating issues with lung function in children.

Communicating importance of sub-daily exposures. Council Member Borenstein introduced the topic of communicating with the public about risks and precautions, citing the example of a group of teenage girls, presumably a high school track team, who were running, outdoors, while a nearby wildfire caused the air quality index (AQI) to be over 150. The panelist agreed that there is a need for more effective communication strategies and highlighted the misconception that filtration masks allow the wearers to safely exercise outdoors. She referenced a forthcoming meeting in Sacramento in April that will bring together representatives from OEHHA, EPA, Center for Disease Control (CDC), National Institute of Health (NIH), and other agencies to specifically discuss how to advise the public with respect to filtration.

Approaching PM as a non-threshold contaminant. Council Member Solomon inquired about the process for quantifying risk if PM is approached as a non-threshold contaminant. The panelist replied that while it was a difficult task that would involve creating estimates of risk that would differ across communities, it can be done and she anticipates that “working together we can come up with approaches to implement pretty soon.”

Location- and source-specific strategies: Consider impact, marginal impact, and environmental justice

Julian Marshall

Kiely Endowed Professor, Civil & Environmental Engineering, University of Washington
Adjunct Professor, Global Health, University of Washington

<i>Main takeaways</i>	Reducing PM requires many strategies: “silver buckshot, not a silver bullet.” With respect to risks, income matters and race matters, but race matters more than income. To get the most “bang for the buck” on health impacts, focus on areas where high impact meets high inequity.
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Presentation Summary

Professor Marshall described an approach to reducing health risks from PM involving combined analysis of sources of emissions, concentrations at locations, levels of exposure to different sources of emissions, and racial and income disparities affecting environmental justice.

Many sources of PM. PM_{2.5} comes from many sources, and not only from primary emissions but also through formation of PM_{2.5} in the atmosphere from other compounds. No one single source is dominant. At the national level, several sources make up a substantial fraction of emissions, including fuel combustion, agriculture, road dust, and residential wood burning. However, there are many other meaningful contributors and therefore tackling PM_{2.5} will require multiple strategies.

Intake fraction in California. When the levels of emissions from different sources are combined with the percentage of those emissions that are inhaled, relative contributions to exposure can more clearly be seen. In California, industrial emissions and on-road mobile sources are particularly high contributors to PM_{2.5} exposure. Importantly, this conceptualization makes clear that emissions reductions are not all equal in impact. For example, reducing one ton of emissions from on-road mobile sources will have greater impact than reducing one ton of emissions from industrial sources because the former category has a higher intake fraction.

Race and income disparities. In California, white people and wealthier people are least exposed to pollution, and the racial difference is more predictive than the income difference. Looking at patterns of consumption, it is also evident that white people are the greatest consumers of the products of polluting activities despite being the least exposed to the resulting pollution.

Mobile measurements and low-emission zones. Dr. Marshall described mobile PM measurement technology as “really promising” for identifying local pollution hotspots and pointed to Google and Aclima as innovators. He also described the policy tool of “low-emission zones” that have been used around the world, although not yet in the U.S., to reduce risks for

vulnerable populations subjected to high PM concentrations. Even if some polluting activity relocates outside the zone, positive health outcomes can still be achieved with this strategy.

Advisory Council Q&A with Panelist

How much pollution comes from local sources? Council Member Long inquired how much of the contaminant load in West Oakland (depicted in the panelist’s slide showing the results of mobile measurement) could be attributed to local versus regional sources. The panelist replied that the study did not investigate sources and deferred to Phil Martien, the final presenting panelist, to address the question of local versus regional contamination affecting West Oakland. (Dr. Martien’s presentation revealed that the majority of PM_{2.5} in West Oakland comes from regional sources; see Slide 198.)

Air District authority. In response to the panelist’s question about the Air District’s powers, Council Member Borenstein clarified that the Air District regulates stationary but not mobile sources and does not have the power to impose prices or taxes. Although the Air District does impose fines on a limited basis, these can only recover the costs of doing business, and emitters are not required to assume the costs of pollution below the standard. He went on to advocate for the Air District to “lobby Sacramento” for the authority to impose prices to help overcome a situation he described as “trying to make policy with one arm tied behind our back.”

Other beneficiaries of polluting activities. Referring to the panelist’s analysis of the drivers of pollution, which focused on consumption, Council Member Borenstein commented that additional beneficiaries of polluting activities should be considered: shareholders and workers.

Review of the National Ambient Air Quality Standards for Particulate Matter: Overview of the Draft Policy Assessment

Scott Jenkins

Project Lead, EPA review of National Ambient Air Quality Standards for PM
Senior Environmental Health Scientist, Office of Air Quality Planning and Standards, EPA

<i>Main takeaways</i>	New studies available since the previous NAAQS review strengthen evidence of serious PM_{2.5} health effects, including premature death, and add additional health concerns. Available scientific information calls into question the adequacy of the public health protection afforded by current standards. Risk assessment results show that reducing PM to alternative standard levels below the current standards would achieve significant additional health benefits, including thousands of lives spared per year in the U.S. Alternatively, retaining the current standards would require placing "little weight" on that information.
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Presentation Summary

Dr. Jenkins presented an overview of the approach and conclusions of the EPA's [Draft PM Policy Assessment](#) completed in response to the agency's Draft PM Integrated Science Assessment. He explained that the PM Policy Assessment is intended to serve as a bridge between science and rulemaking, which is expected to take place by the end of 2020. The assessment included an argument for revising the annual PM_{2.5} standard downward based on the science, as well as a discussion of how retaining the current standard could be justified by placing little weight on the epidemiological evidence and risk assessment and greater weight on the uncertainties and limitations of the data.

Focus on "typical" exposures. The NAAQS review process focuses on exposures that represent the middle of the U.S. air quality distribution curve, rather than its extremes. In most U.S. locations, the annual standard is the controlling standard. Epidemiological data is not very informative with respect to the impact of 24-hour exposures on the upper end of the concentration distribution curve, and sub-daily (2-hour) controlled human exposure studies correspond to concentrations considered to be outside the typical distribution curve. The implication of this focus is that the review does not inform analysis of conditions analogous to those occurring during California wildfires.

Pseudo-design values and hybrid modeling. The review examined health effects seen in areas for which PM monitoring data could be used to calculate whether the area's air quality would have met the current standards. This "pseudo-design value" approach approximated the design value statistics used to describe air quality relative to the NAAQS. The review also examined

hybrid modeling studies that incorporated not only air quality monitoring but also a range of other data including satellite imagery and land use and transportation information.

Risk Assessment. The risk assessment considered likely mortality outcomes if national air quality was to “just meet” the current $12 \mu\text{g}/\text{m}^3$ standard in comparison to “just meeting” 11, 10, and $9 \mu\text{g}/\text{m}^3$. Although estimates differed according to the study being used and whether a primary or secondary PM-based modeling approach was employed, the overall implication was that thousands of lives would be spared at lower concentrations.

Conclusions. The Draft PM Policy Assessment states that “The available scientific information can reasonably be viewed as calling into question the adequacy of the public health protection afforded by the current annual and 24-hour primary $\text{PM}_{2.5}$ standards.” This conclusion relies on the long-standing body of health evidence, strengthened in the latest review, and risk assessments indicating that current standards allow for thousands of $\text{PM}_{2.5}$ -associated deaths per year at concentrations above $10 \mu\text{g}/\text{m}^3$. However, the assessment also states that a conclusion that current standards are sufficient could be reached if very little weight is placed on the large body of epidemiological evidence, particularly the newly available studies regarding lower concentrations, and more weight is placed on uncertainties in the literature.

Advisory Council Q&A with Panelist

Wildfires excluding Bay Area from risk assessment. Chair Hayes asked for clarification on why the Bay Area was not included in the risk assessment. The panelist responded that the assessment aimed to simulate impact from anthropogenic sources, so the focus was on areas for which that adjustment could reliably be done using available data. The implication appeared to be that it was difficult to disentangle wildfire effects from anthropogenic effects.

Lessons for areas controlled by 24-hour standard? Given that the focus of the Draft PM Policy Assessment was on areas in which the annual standard is controlling, Chair Hayes asked what the Air District, which experiences 24-hour concentrations well above the standard during wildfires, should take away from the analysis. The panelist acknowledged that the epidemiology driving the assessment is focused on the middle of the air quality distribution and does not offer many insights for areas experiencing very high 24-hour and sub-daily concentrations.

Deaths from air pollution. Referring to Slide 155, Chair Hayes asked how the review process determines acceptable risk in terms of $\text{PM}_{2.5}$ -associated deaths. The panelist responded that the estimates of $\text{PM}_{2.5}$ -related deaths are not meant to be read as absolute numbers but rather used as a basis for comparison between outcomes at different concentration levels to indicate the magnitude of public health impact. He further noted that risk assessments have not historically been the drivers of decisions regarding NAAQS. Council Member Solomon asked if lower concentrations had also been considered in the risk assessment. The panelist replied that they had, and that estimated deaths are reduced by 10-15% for each $1 \mu\text{g}/\text{m}^3$ reduction.

PM thresholds? Council Member Borenstein asked if the panelist had seen any evidence of a PM threshold. The panelist replied that he had not. However, he explained that there may be thresholds for individuals that cannot be seen in population-level studies.

Targeting Particulate Matter: West Oakland Community Emissions Reduction Program

Phil Martien

Director, Assessment, Inventory, & Modeling, Bay Area Air Quality Management District
Project Lead, Technical Assessment of AB 617 West Oakland Community Action Plan

<i>Main takeaways</i>	In response to California’s AB 617 and in collaboration with communities, the Bay Area Air Quality Management District is implementing community-specific emissions reductions programs. The West Oakland plan demonstrates how hyperlocal modeling can be accomplished, but other agencies will also need to act in order to reach emissions reduction targets.
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Presentation Summary

Dr. Martien described the analysis conducted for the recently completed [West Oakland Community Action Plan](#), the first in a series of community emissions reduction programs that the Air District is developing in response to California’s AB 617 legislation.

Response to AB 617. California’s Assembly Bill 617 mandates a statewide program to address long-standing air pollution concerns in disadvantaged communities. The Air District has committed to work collaboratively with disadvantaged communities experiencing disproportionately high levels of air pollution. The first year of implementation focused on Richmond and West Oakland; Richmond requires more measurements to be collected, but West Oakland had a large amount of data and was able to launch directly into planning an emissions reduction program. Beginning in year two, Air District efforts will expand to six more communities: Vallejo, the Pittsburg-Bay Point Area, Eastern San Francisco, the East Oakland-San Leandro Area, Tri-Valley, and San Jose.

Approach to West Oakland. West Oakland was chosen as the first implementation site both because its population experiences high socioeconomic burdens alongside low air quality and because West Oakland has a well-established and experienced community group, the West Oakland Environmental Indicators Project, that was able to guide the process in collaboration with the Air District. The study employed a hybrid modeling approach that first accounted for pollution originating outside the area in order to then zero in on local sources. In response to community requests, the study took a hyperlocal approach, modeling block-by-block exposures. Seven local impact zones were identified using data from specially equipped Google Street View vehicles. Sources modeled comprised the Port of Oakland, railyards and trains, vehicles on freeways and streets, truck-related businesses, and permitted stationary sources.

Results. Although the Port of Oakland was the primary contributor to diesel PM emissions, PM_{2.5} showed a more distributed source allocation, with highway, street, port, and permitted sources all contributing significantly to PM_{2.5} levels. However, approximately 34% of PM_{2.5} came

from sources not included in the model, such as construction, restaurants, and residential wood burning. For each zone, the proportional contributions of the different sources were calculated, with different allocations evident for each zone. For example, 60% of modeled PM_{2.5} could be attributed to street traffic in Zone 3, whereas street traffic made up only 28% of PM_{2.5} emissions in Zones 1 and 2. Disparate exposure levels were seen within the studied West Oakland zones: the cleanest blocks are experiencing on average 3 µg/m³ lower PM concentrations than the most polluted blocks.

Action priorities. The West Oakland Community Action Plan established the goal of bringing all zones to average levels for the area by 2025 and to the level of today's cleanest residential West Oakland neighborhood by 2030. However, it is important to note that most of the pollution experienced in West Oakland comes from regional sources outside the West Oakland local area, and most of the local pollution sources are outside the Air District's jurisdiction. That said, priorities for decreasing exposures from local sources center on addressing sources with higher shares of modeled impact, which include heavy-duty trucks and harbor craft for diesel PM and road dust and passenger vehicles for PM_{2.5}.

Advisory Council Q&A with Panelist

West Oakland levels in comparison to other District areas. Council Member Rudolph asked how the "average" and "cleanest" levels in West Oakland that were set as targets compare to air pollution levels elsewhere in the Air District. The panelist responded that he does not have that information because other areas have not yet been assessed. However, he asserted that differences in pollution levels between West Oakland other parts of the Air District are likely to be driven by local impacts, so addressing disparities within the Air District can be accomplished by considering local pollution sources.

Electric vehicles and road dust. Council Member Rudolph pointed out that if road dust is a significant concern in terms of PM_{2.5} exposure, then solutions like electric vehicles will not address that problem. The panelist agreed.

Capturing unrecorded emissions. Council Member Rudolph asked whether further analysis would be conducted to better understand the PM_{2.5} contributors that were not accounted for in the study. The panelist indicated that expanding the list of modeled sources was among the "homework activities" for the Air District team developing further AB 617 action plans.

Translating findings into action. Council Member Long asked for clarification on how the information presented would be translated into concrete actions to improve air quality in West Oakland. The panelist acknowledged the challenge of the Air District's limited jurisdiction and asserted that the West Oakland community had a "realistic perspective" on what can be done. He described the West Oakland Community Action Plan (which calls for the implementation of strategies by the City of Oakland, Port of Oakland, Caltrans, CARB, PG&E, and others in addition to the Air District) as "a starting point."

PM Exposure and Risks: Discussion Summary

Because the event was running long and Advisory Council members had addressed their questions to the individual panelists, the discussion between the Advisory Council and the afternoon panel was brief.

Margin of safety. Vice Chair Kleinman asked for clarification on whether the risk assessment within the Draft PM Policy Assessment considered margin of safety for particulate matter. Dr. Jenkins responded that the risk assessment does not address margin of safety because the concept of safety rests solely within the judgement of the EPA Administrator.

Public Comment

Public comment was taken during two designated periods during the event. A list of the commenters during those periods follows the summary. Questions were also addressed to the lunchtime keynote speaker, former EPA Administrator Gina McCarthy.

Comment Summary

The general sentiment expressed by many commenters was, “We need action, not more discussion.” Several people spoke about their personal experiences with toxic emissions in their neighborhoods. The disproportionate impact of air pollution on disadvantaged communities is a central point of focus.

Additional themes that emerged in public comment:

Physicians. A group of physicians expressed their position that they are not able to protect the health of their patients due to air pollution, particularly children with asthma. They emphasized the return on investment from improving air quality.

African American communities. Two attendees who addressed Gina McCarthy during her keynote speech focused on the challenges of African American communities in the Air District relative to cumulative impacts of air pollution problems and the need for education, training, and investment in environmental health.

Refineries. Several speakers expressed concerns about refineries in the Air District, both with respect to air pollution and the need to reduce or eliminate reliance on fossil fuels.

Mobile-source increases from stationary permits. A speaker from East Oakland highlighted air quality challenges from a local crematorium, not only from its direct emissions but also from diesel trucks making frequent deliveries.

Climate change. Concerns about climate change aspects of air pollution were emphasized in addition to the need to address immediate health issues.

Community representation. The suggestion was made to form a community advisory board for the Air District “with teeth,” i.e., with the power to make and enact decisions.

List of commenters

PUBLIC COMMENT ON AGENDA MATTERS (ITEM 3)

Dr. Ashley McClure, California Climate Health Now

Sarah Schear, California Climate Health Now

PUBLIC COMMENT ON NON-AGENDA MATTERS (ITEM 7)

Katherine Funes, Rose Foundation for the Communities and the Environment

Jed Holtzman, 350 Bay Area

Jan Warren, Interfaith Climate Action Network of Contra Costa County

Dr. Amanda Millstein, California Climate Health Now

Dr. Cynthia Mahoney, California Climate Health Now

Sarah Schear, California Climate Health Now

Maureen Brennan, Rodeo citizen

Charles Davidson, Sunflower Alliance

Ken Szutu, Citizen's Air Monitoring Network

Margie Lewis, Communities for a Better Environment

Steve Nadel, Sunflower Alliance

Advisory Council Deliberation

The symposium concluded with the Advisory Council's deliberation regarding the implications of the information presented. The Advisory Council arrived at the following Sense of the Advisory Council statement:

The current standard is not adequately health protective. Further reductions in particulate matter will realize additional health benefits. We ask the Air District staff to bring forward with urgency options within the legal authority of the Air District that would limit PM exposure, especially in high-risk communities.

Council Member Borenstein reflected the sentiment of the Advisory Council in stating, "We need more science, and we should act."

Additionally, Advisory Council members expressed interest in further exploring the potential for:

Treating PM as a toxic. Council Member Solomon stated that the lack of evidence for a threshold for PM health effects argues for treatment of PM as a linear, non-threshold toxic in the same manner as other toxic air contaminants and carcinogens.

Monitoring ultrafine particles. Council Member Solomon indicated support for continuing monitoring of ultrafine particles in the Bay Area or increasing monitoring if the costs are not unreasonable. The Air District's Deputy Air Pollution Control Officer Greg Nudd proposed that the Air District present to the Advisory Council regarding the UFP monitoring that is already occurring in order to better inform the Advisory Council's recommendations.

Encouraging the State of California to adopt stricter PM standards. Acknowledging that the District does not have the authority to set ambient air standards, Vice Chair Kleinman suggested that those present in the room should encourage the State to adopt stricter PM standards.

Ensuring local permits are consistent with PM standards supported by the science. Vice Chair Kleinman stated that because local permits and emission requirements for stationary sources are the specific purview of the Air District, the Advisory Council should focus on advising the Board on how the Air District could make those determinations consistent with improved ambient air standards.

Disaggregating solutions with climate co-benefits, solutions unrelated to climate strategies, and emergencies. Council Member Long argued for separately approaching three different categories of strategies for addressing PM: 1) strategies that reduce particulate matter as a co-benefit of addressing climate change, such as making engines more efficient and decarbonizing electricity; 2) strategies regarding issues such as road dust that are independent of climate

action (given that more efficient or electric cars still produce brake, tire, and road dust); and 3) emergencies including wildfires and explosions at permitted sites.

Bang for the buck. Council Member Long stressed the need to identify strategies with the greatest potential for impact and to track the outcomes of the strategies that are implemented.

Air District Implementation Plan. Vice Chair Kleinman stated the need for an Air District Implementation Plan in accordance with cleaner air standards. Chair Hayes expressed interest in the idea of an Air District Implementation Plan but stated that he was not yet ready to endorse the strategy and needed to gain a better understanding of what it would entail.

Next Steps

Three primary action items emerged from the first PM symposium:

1. **Air District delivery of presentations** to the Advisory Council on the Air District's current activities and capabilities to monitor ultrafine particles and to address PM exposures;
2. **Advisory Council discussion and deliberation** on these current and potential activities in light of the information presented at the October 28 symposium and summarized in this document; and
3. **Planning for a second symposium** for Spring 2020 to focus on community and other stakeholder input and engagement concerning PM exposures and health risks.

The Advisory Council will reconvene on **December 9, 2019**.

During that meeting, in response to the Advisory Council's requests, the Air District will present on its current activities to reduce PM exposures, including monitoring of ultrafine particles. It will also discuss additional "options within the legal authority of the Air District that would limit PM exposure, especially in high-risk communities," in accordance with the Sense of the Advisory Council, in order to inform the Advisory Council's advice to the Board.

The Advisory Council is expected to receive and comment on this symposium summary document during the December 9 meeting.

Planning for the Spring 2020 event continues with input from community representatives and other stakeholders.