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TN #:	241475
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DOCKETED

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Project Title:	SJ2
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Comment Received From: Ada E. MÃ¡rquez
Submitted On: 2/8/2022
Docket Number: 19-SPPE-04

Ada E MÃ¡rquez Comments - CEQA Comment Letter Appendix A Ref (2 of 8)

Additional submitted attachment is included below.

Air Pollution Contributes to Multiple Diseases

The *Lancet* Commission on pollution and health, Lancet, October 2017

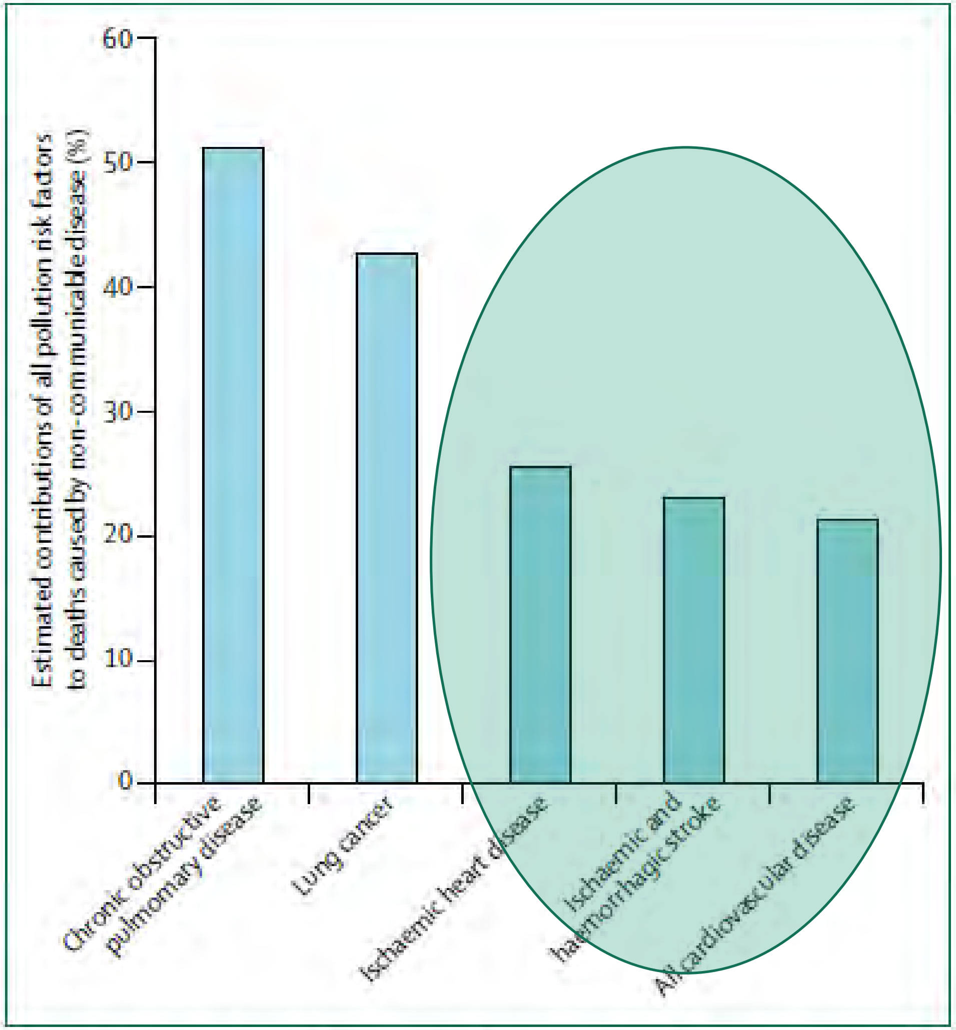
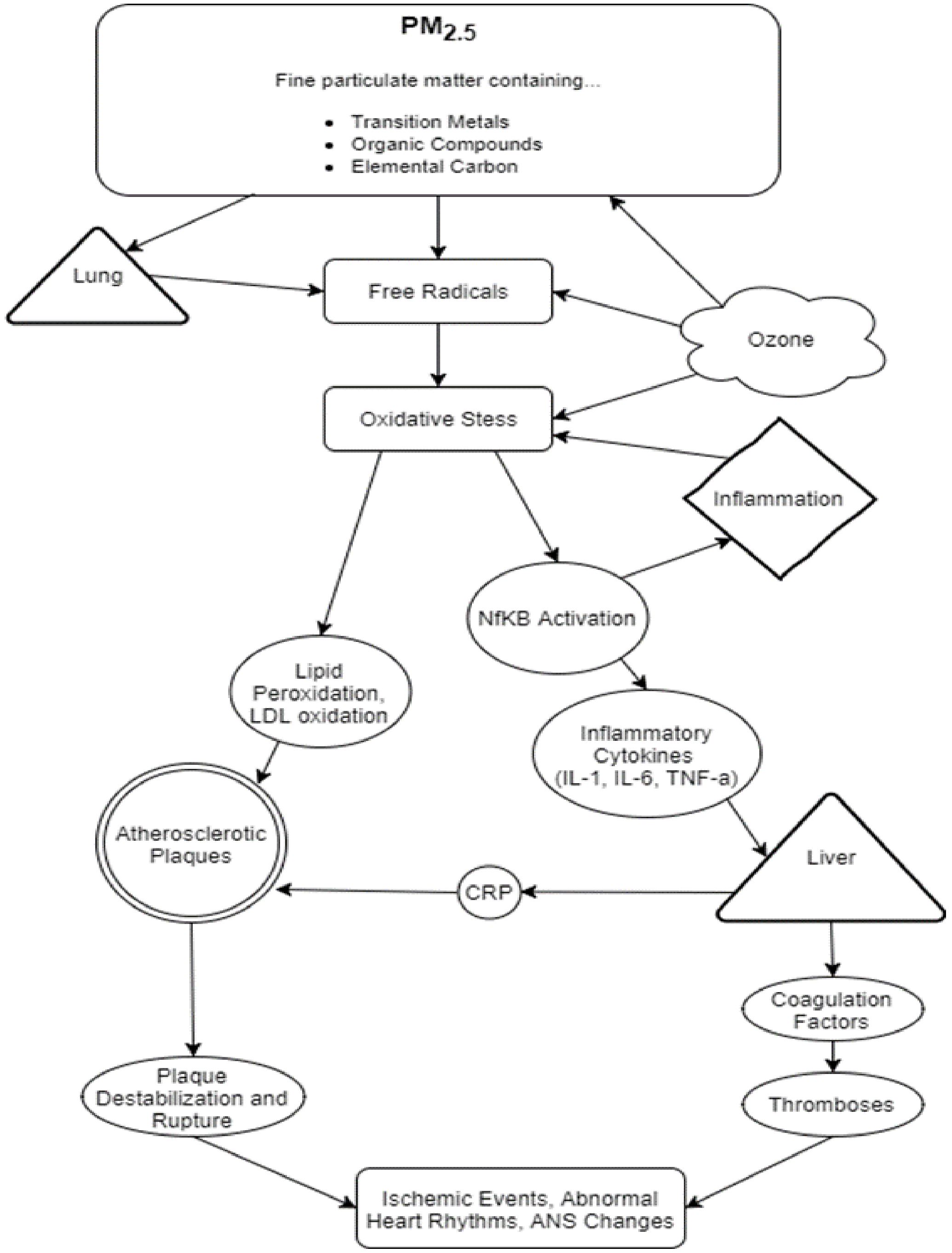


Figure 6: Estimated contributions of all pollution risk factors to deaths caused by non-communicable diseases, 2015

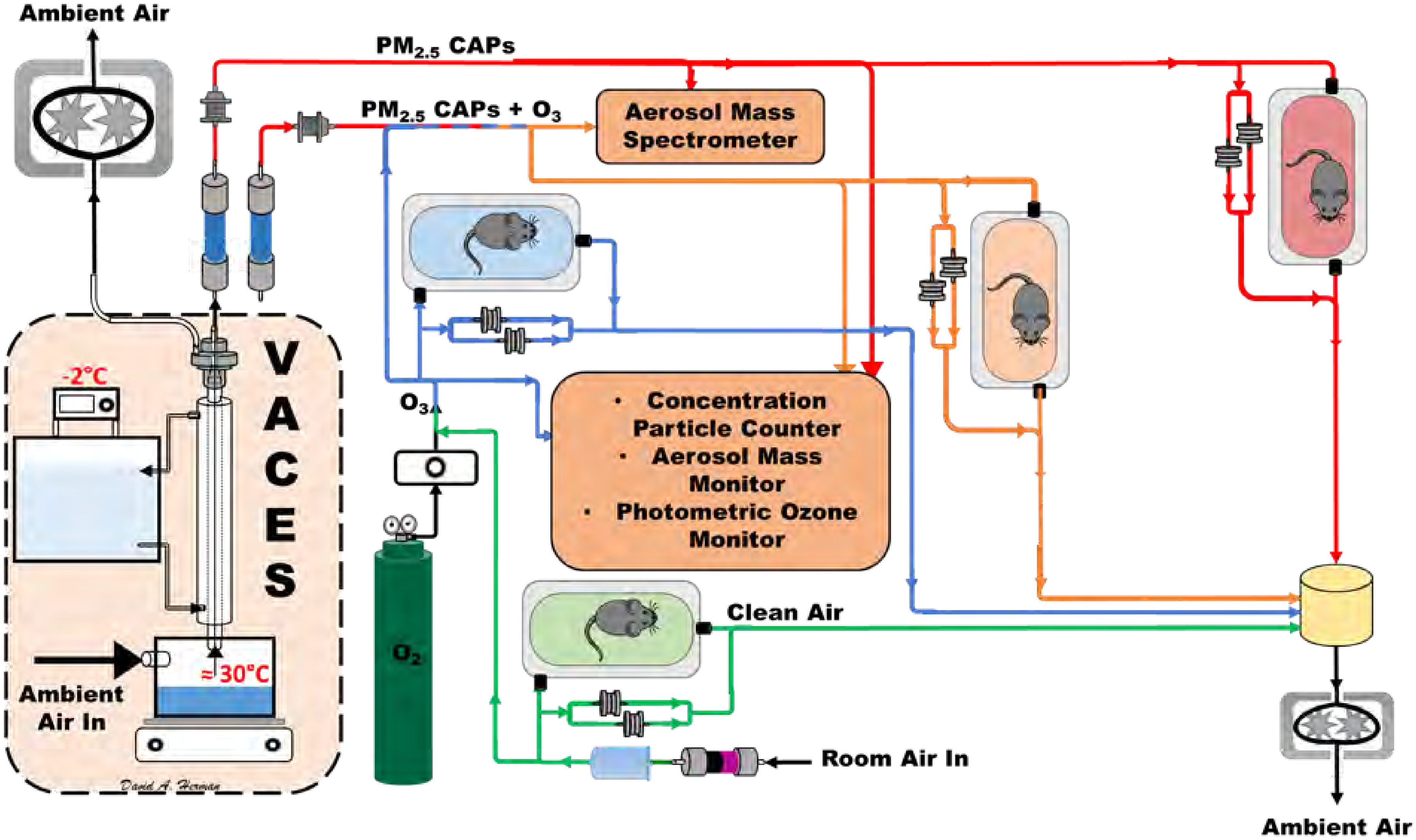
GBD Study, 2016.[42]

C81

A Mechanistic Framework for PM2.5 Effects Leading to Cardiovascular Disease



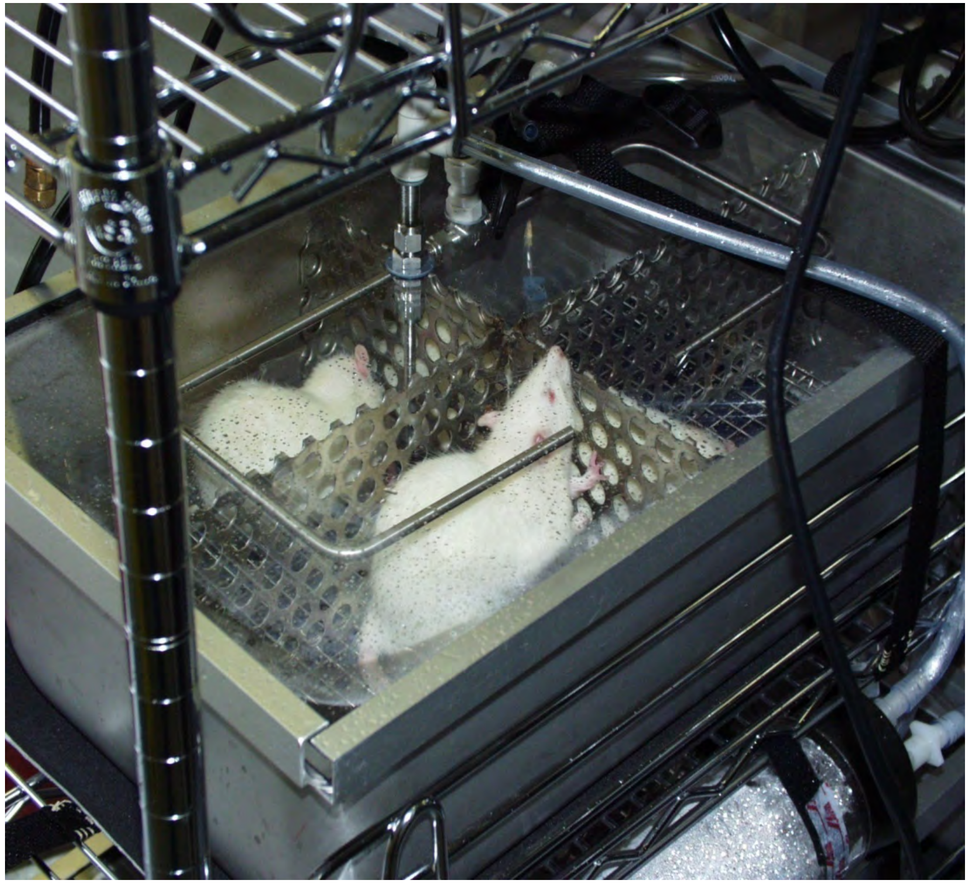
We can examine the health effects of specific pollutants using controlled exposures and help understand the mechanisms by which PM causes or worsens cardiovascular diseases.



C83

Rats or Mice Can Be Exposed to Purified Air or CAPs in Sealed Chambers

The Sealed Chambers Can Be Placed Onto Racks to Facilitate Transport



ECG and Blood Pressure Telemetry Devices can be Implanted to provide physiology data before, during and after exposures.

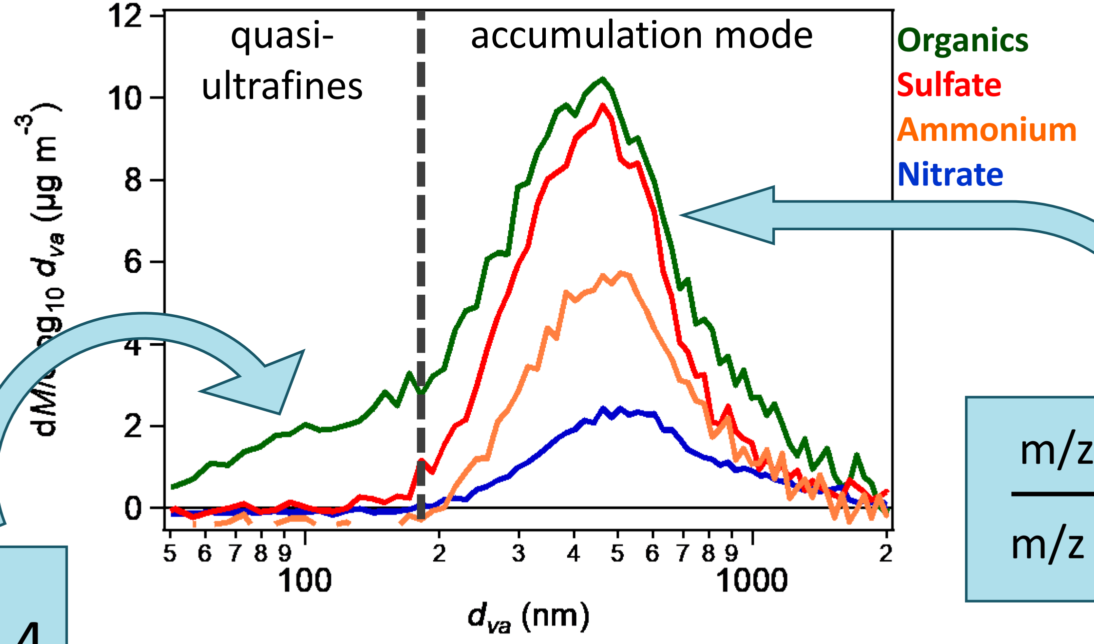
Exposure Protocol

- ApoE-/- mice were surgically implanted with ECG telemetry devices.
- Mice were exposed 5 hr per day (8AM to 1 PM) 4 days per week for 8 weeks at UC Irvine and were housed in filtered air-supplied caging systems between exposures.
- ECG data were monitored during exposures and while the mice were in housing (21 hr / day).
- All animal protocols were approved by the Institutional Animal Care and Use Committee.

What Happens When You Denude Quasi-Ultrafine CAPs (d_p < 180 nm)?

- Particle number and mass are reduced.
- Refractory constituents, such as heavy metals and elemental carbon, were only marginally affected by heating.
- Labile species such as total and water soluble organic carbon and PAHs showed progressive loss in concentration with increase in TD temperature.

Health-related characteristics of Ultrafine PM



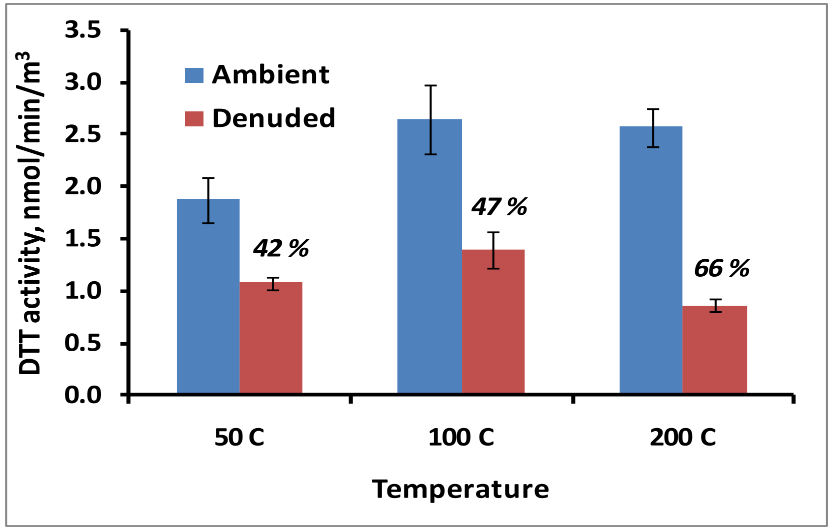
larger particles
oxygenated

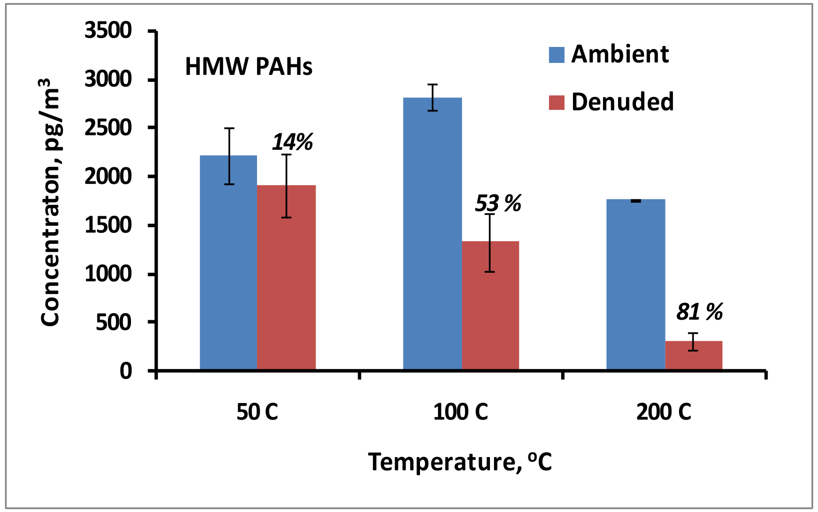
$$\frac{m/z\ 44\ (CO_2^+)}{m/z\ 55\ (C_4H_7^+)} \cong 4$$

ultrafines
less oxygenated
(to denuder)

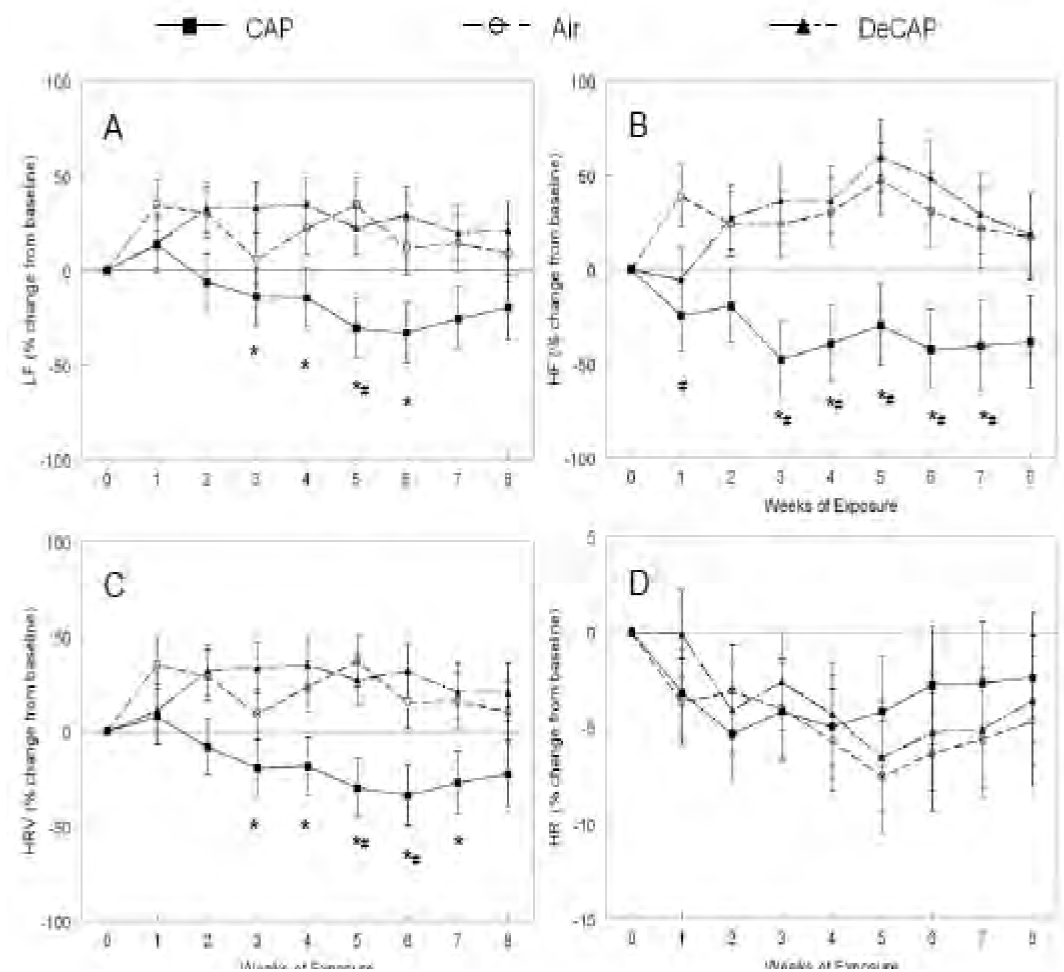
$$\frac{m/z\ 44\ (CO_2^+)}{m/z\ 55\ (C_4H_7^+)} \cong 0.4$$

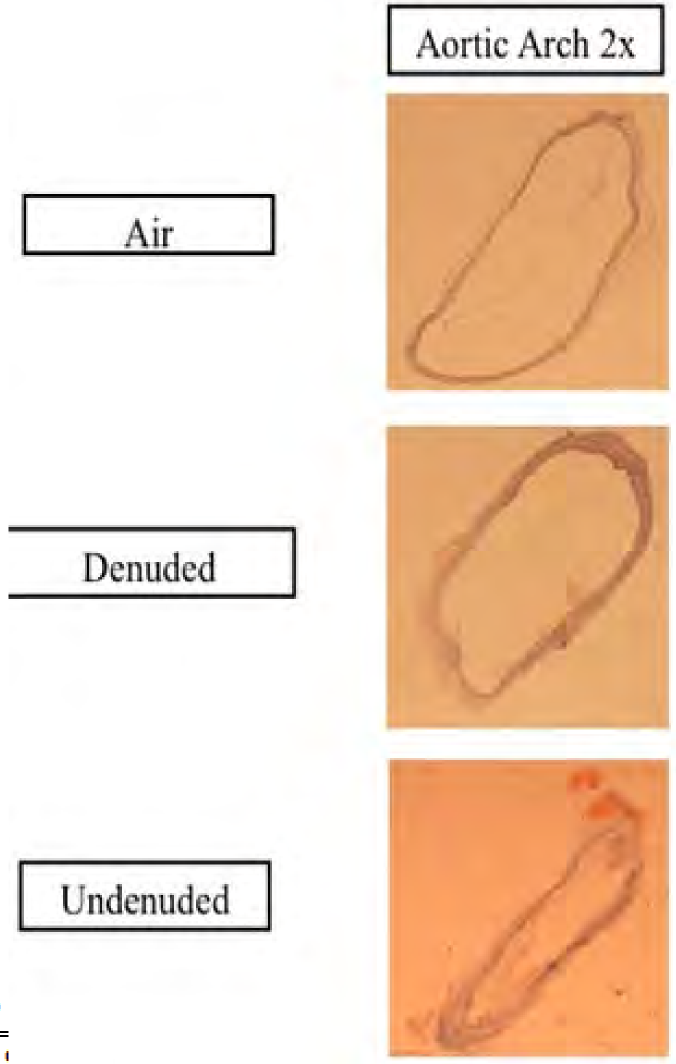
When you denude the UFP





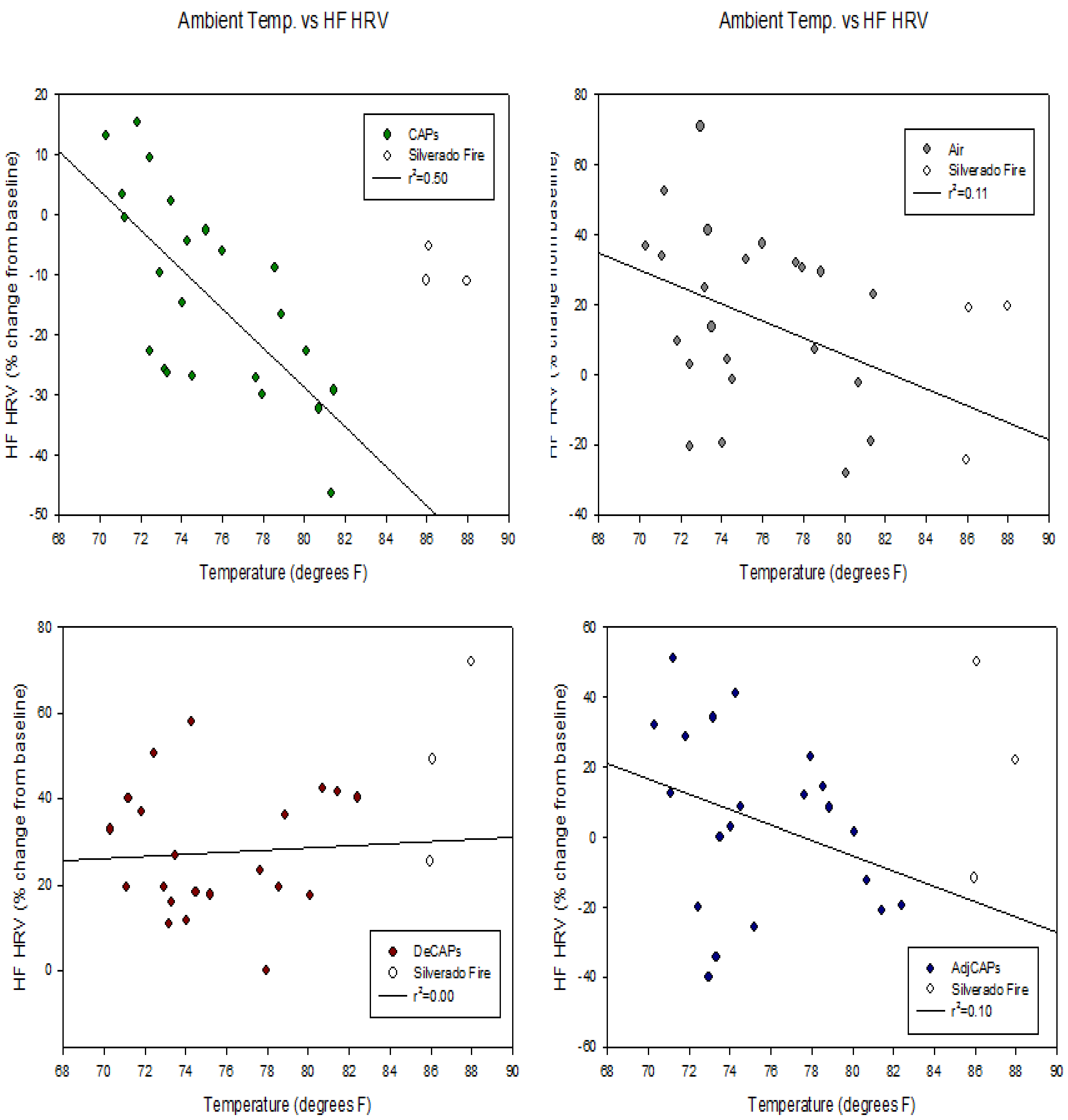
Removing the Organic Constituents From Ambient UFP Blocks CV Effects





	Air	CAP	deCAP
Plaque Size (% area of plaque in of total lumen CS)	14.5 ± 6.3	29.9 ± 10.0*	2.3 ± 0.
Lipid Accumulation (% area of lipid in total tissue CS)	5.1 ± 3.3	8.9 ± 2.4,#	2.2 ± 0.3
Lipid Peroxidation (nM MDA/mg protein)	134 ± 29	218 ± 32*,**	141 ± 17

C88



These data show an association between ambient temperature and toxicity measured using heart rate variability (HRV).

The composition of the particles, which determines particle toxicity, is a function of atmospheric chemical reactivity, which is dependent on temperature and photochemical processes.

Conclusions

- PM exposures can exacerbate lung disease, heart disease and cancer
- UFP and PM2.5 contain toxic components and carcinogens
- Children, elderly and Individuals with pre-existing lung and heart conditions are at elevated risk
- The human studies and the toxicology studies support the premise that PM can be mechanistically and causally linked to cardiovascular health effects.

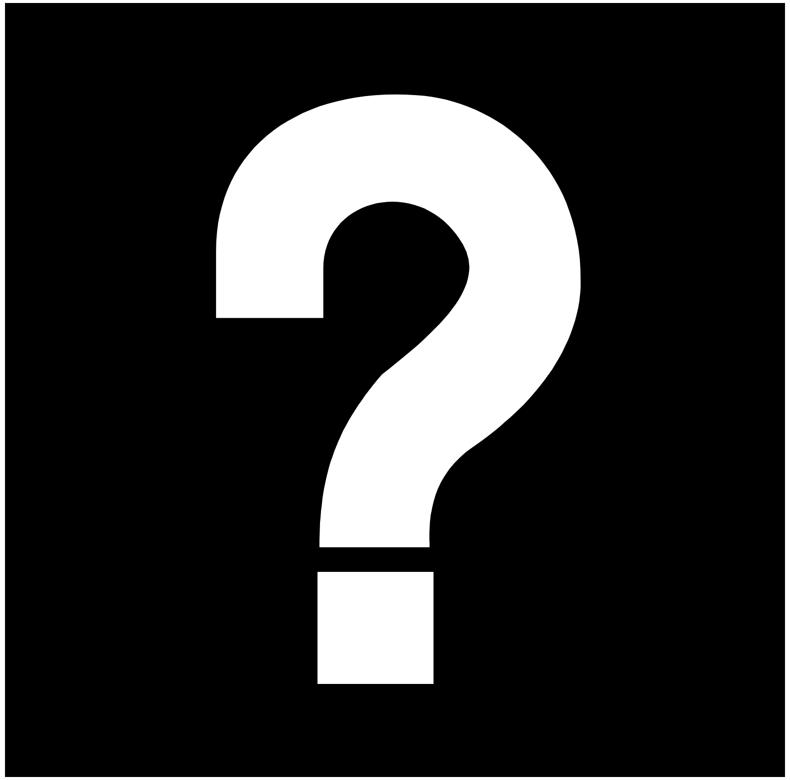
Funding Sources

- Research using advanced instrumentation (AMS and SMPS) was through AirUCI and funded by the National Science Foundation

Moving the AMS is a group effort!

Health studies at are currently sponsored by the California Air Resources Board, the South Coast Air Quality Management District and the NIEHS

Questions and Discussion



Particulate Matter:

Spotlight on Health Protection

Bay Area Air Quality Management District

C93

John R. Balmes, M.D.

- Professor of Medicine at UC San Francisco
- Professor of Environmental Health Sciences in the School of Public Health at UC Berkeley
- Director of the Northern California Center for Occupational and Environmental Health
- Authored over 300 papers on occupational and environmental health-related topics
- Physician Member of the California Air Resources Board

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

John R. Balmes, MD

University of California,

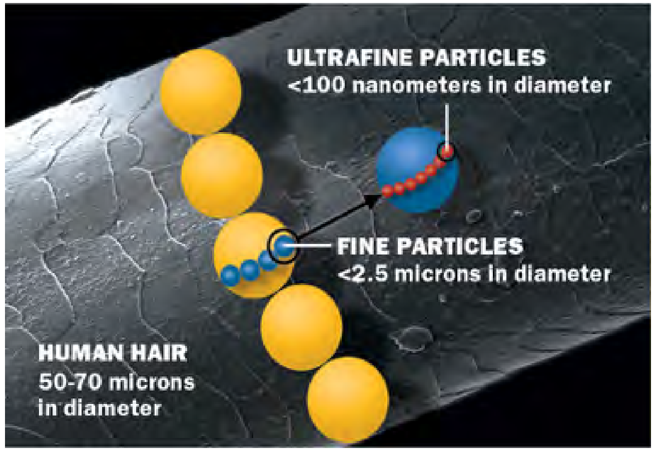
San Francisco and Berkeley

Outline

- Particulate Pollution
  – What Do We Know
  – New Evidence
- Exposure Inequality
  – Cumulative Risk
- Wildfire PM
  – Cardiovascular Risk

Ambient Particulate Matter (PM)

- PM is a mixture, including particles of differing origin (combustion, crustal, biological) and varying size.
- Multiple sources
  - Ultrafines ($PM_{<0.1}$): Fuel (including biomass) combustion
  - $PM_{2.5}$: Fuel (including biomass) combustion
  - $PM_{10-2.5}$: Road dust, crustal, and biological material



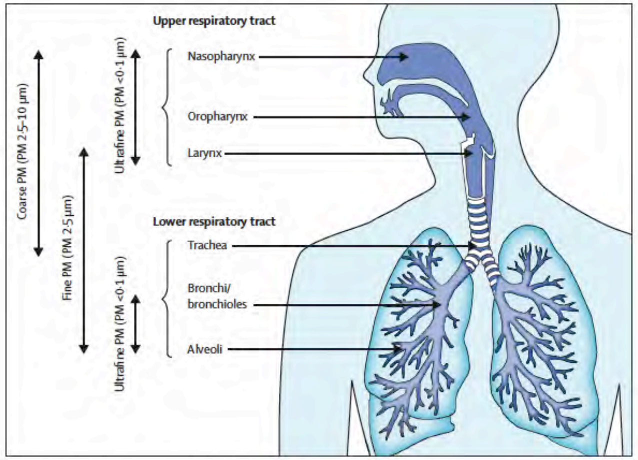


Figure 4: Compartmental deposition of particulate matter

Particulate Matter: Health Effects

- Asthma
  - Exacerbation
  - New-onset
- Decreased lung function growth
- Mortality
  - Ischemic heart disease
- Lung cancer

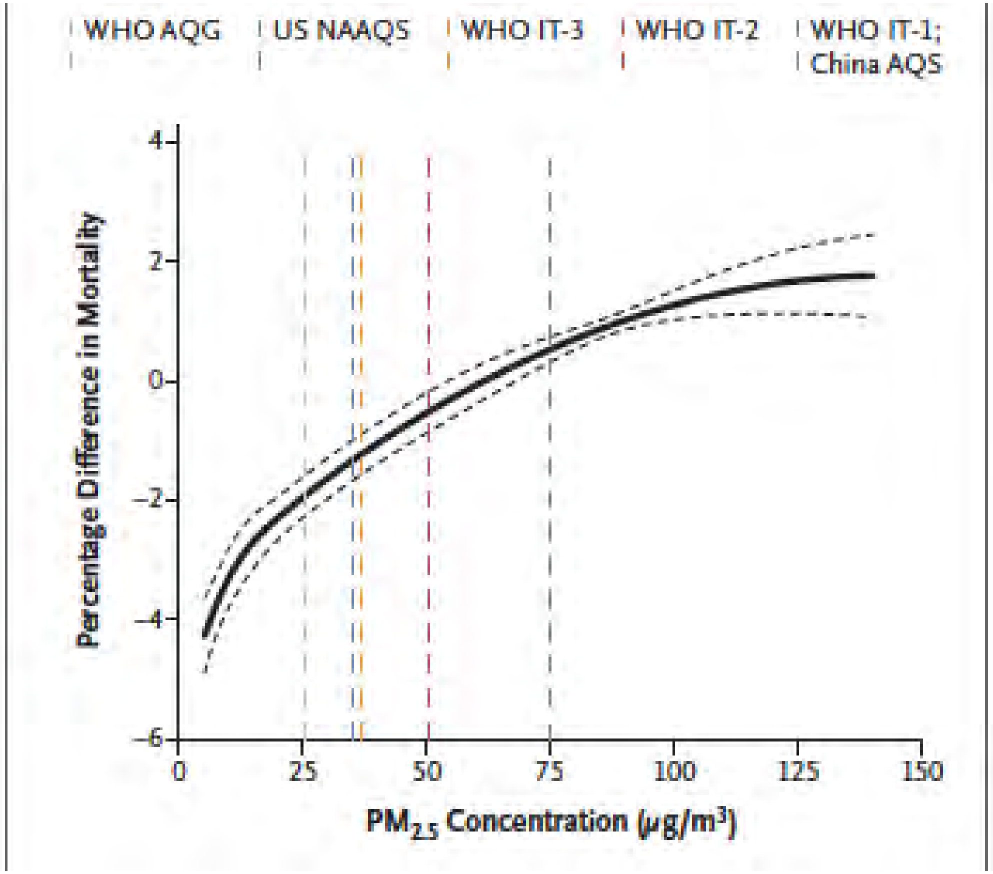
Key Questions

- Are current PM standards sufficiently protective?
  -- No margin of safety
- How has the PM health evidence been strengthened?
  – New evidence of mortality effect at levels below the current NAAQS

The NEW ENGLAND JOURNAL of MEDICINE

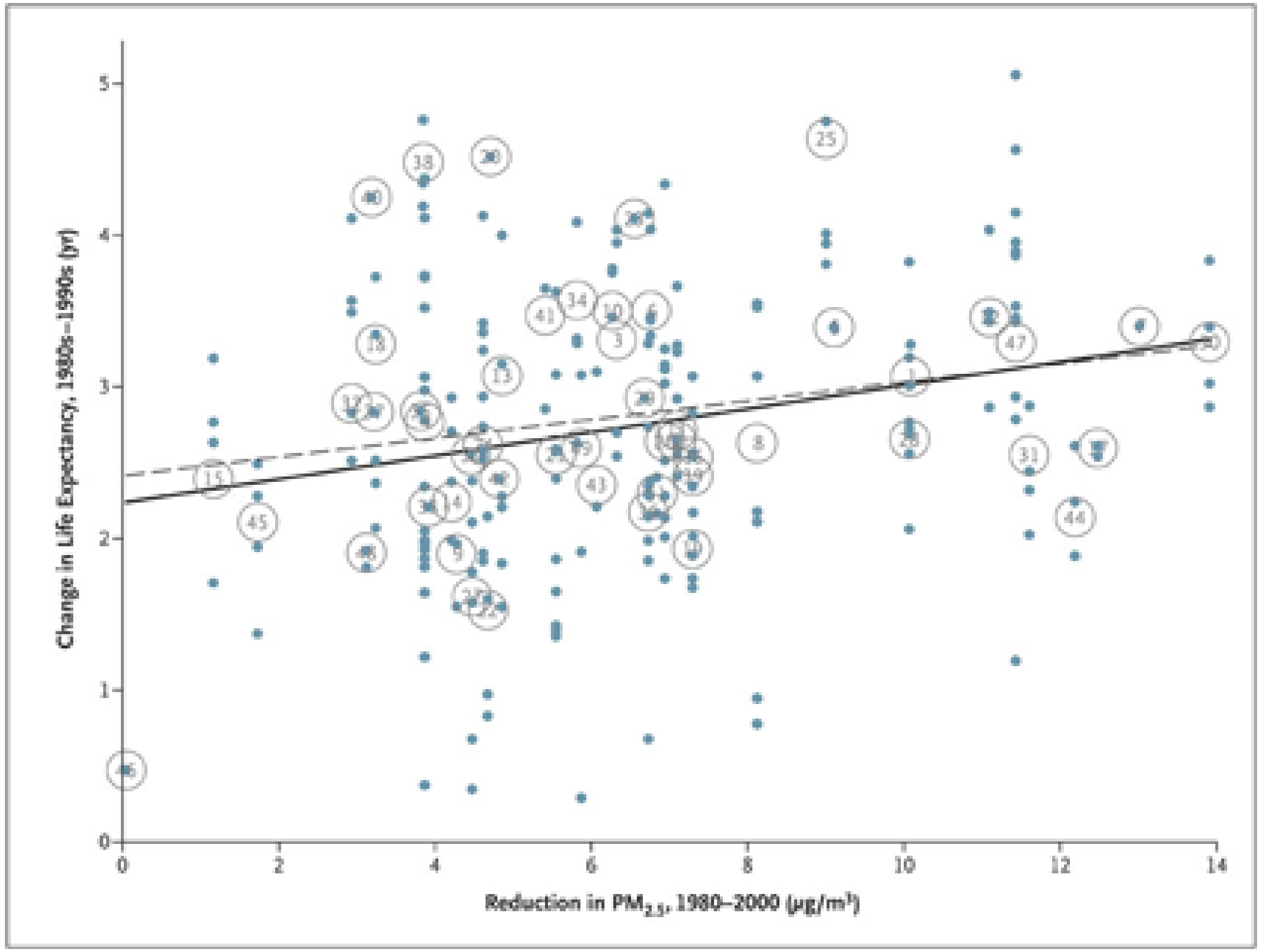
ESTABLISHED IN 1812 AUGUST 22, 2019 VOL. 381 NO. 8

Ambient Particulate Air Pollution and Daily Mortality in 652 Cities



C100

Fine-Particulate Air Pollution and Life Expectancy in the United States

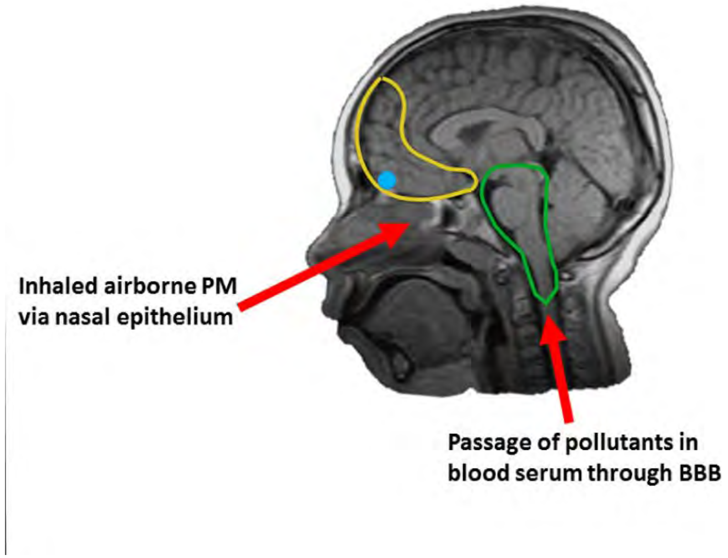


Pope et al. N Engl J Med 2009;360:376-386.

C101

Key Questions

- What new health effects are now recognized?
  – Adverse birth outcomes
  – Metabolic effects
  – Neurological effects



What is role of ultrafine particles (UFP)?

- UFP (PM<0.1μm) are generated both as primary emissions from combustion processes and as secondary products of atmospheric chemistry
- Toxicological studies suggest UFP are a high-risk hazard, but epidemiological data are sparse because there is no monitoring network

Key Questions

- Are there "new" sensitive groups?
  - Children
  - People of color and low SES
- How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?

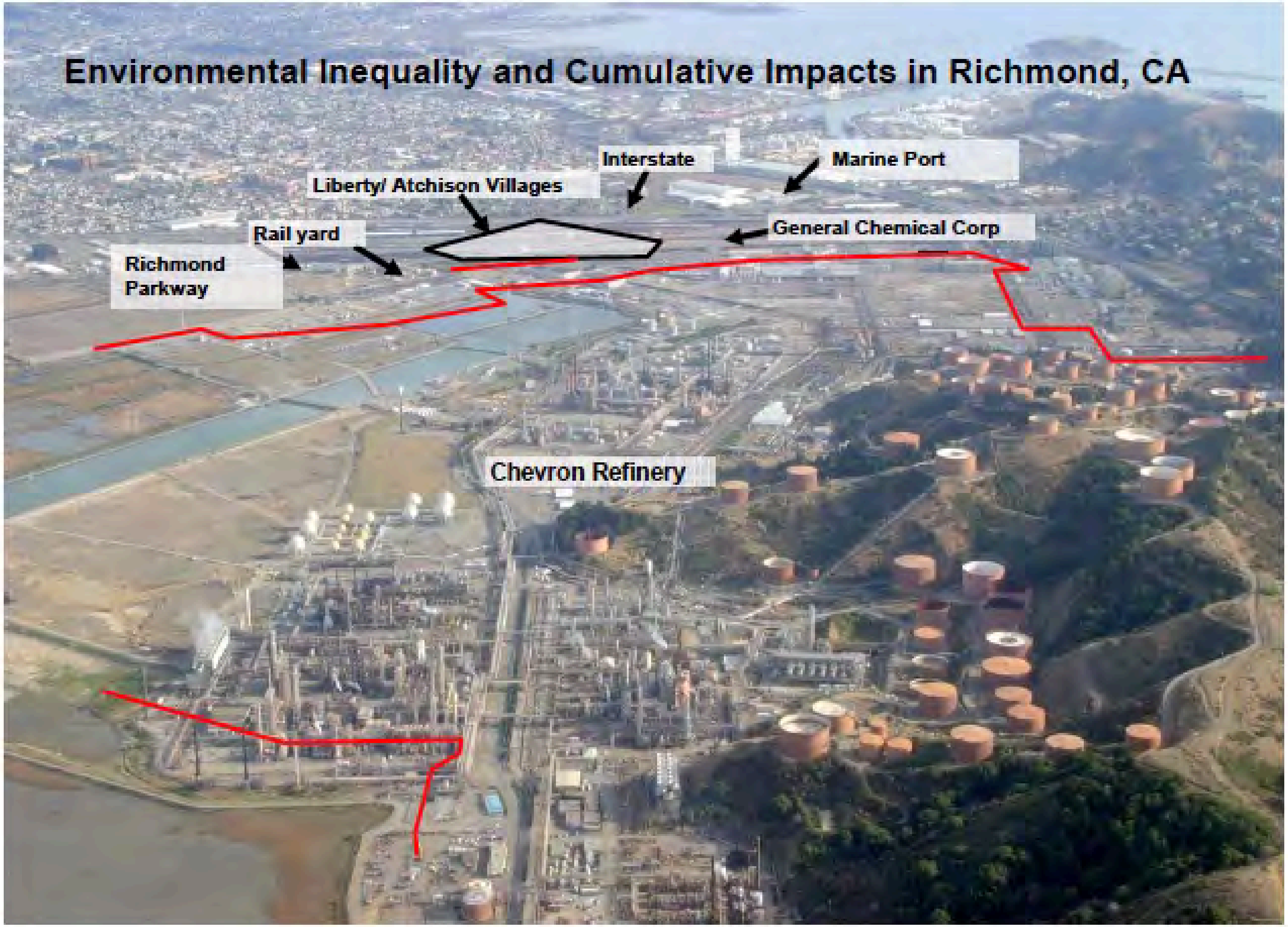
Demographics of Children Living Near Freeways

– Children of color 3x more likely to live near high traffic density in California

Gunier et al., California Dept of Health Services, 2003

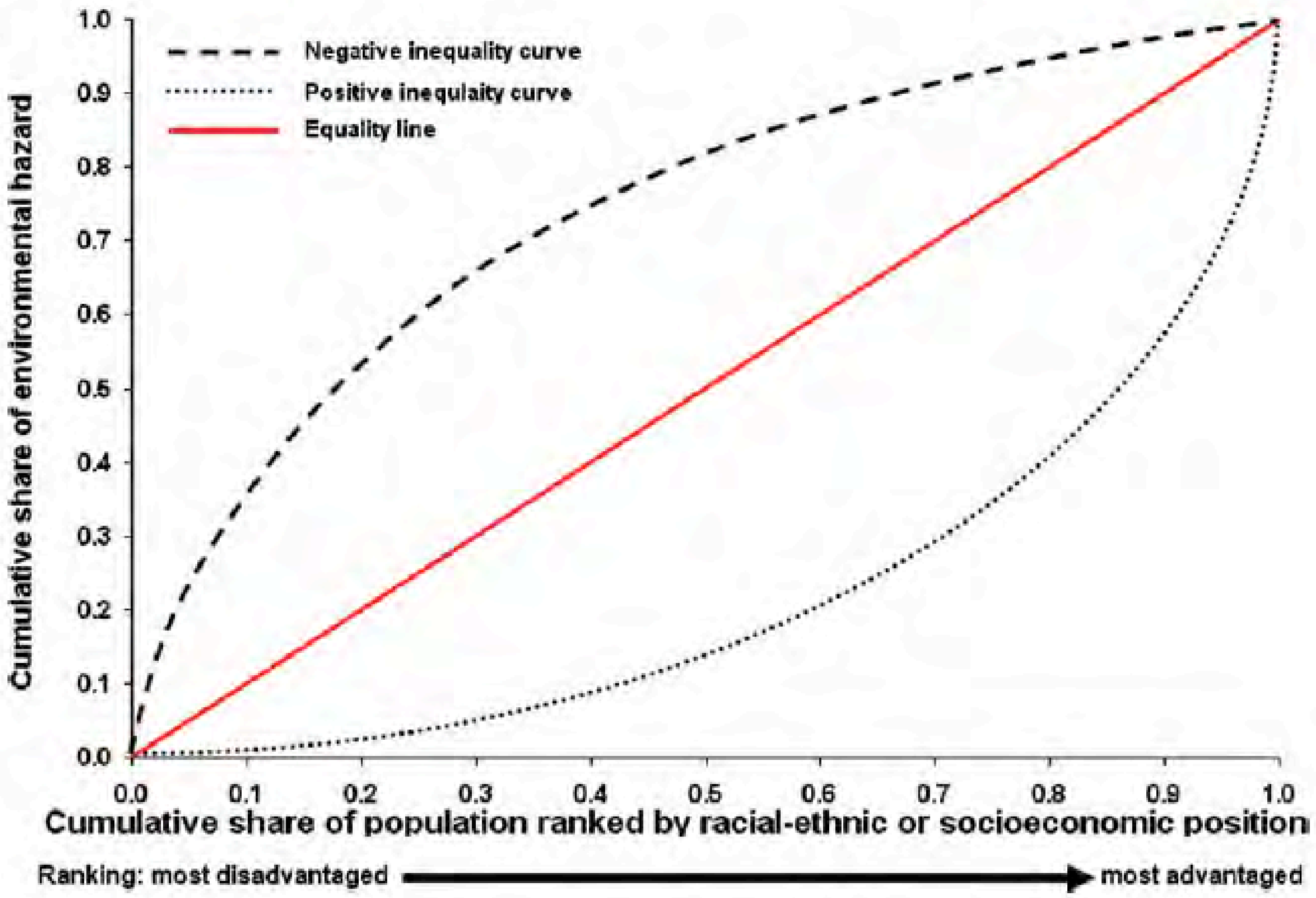
– Schools near busy roads have a disproportionate number of children who are economically disadvantaged and non-white

RS Green et al, Environ Health Perspect 2004;112:61.

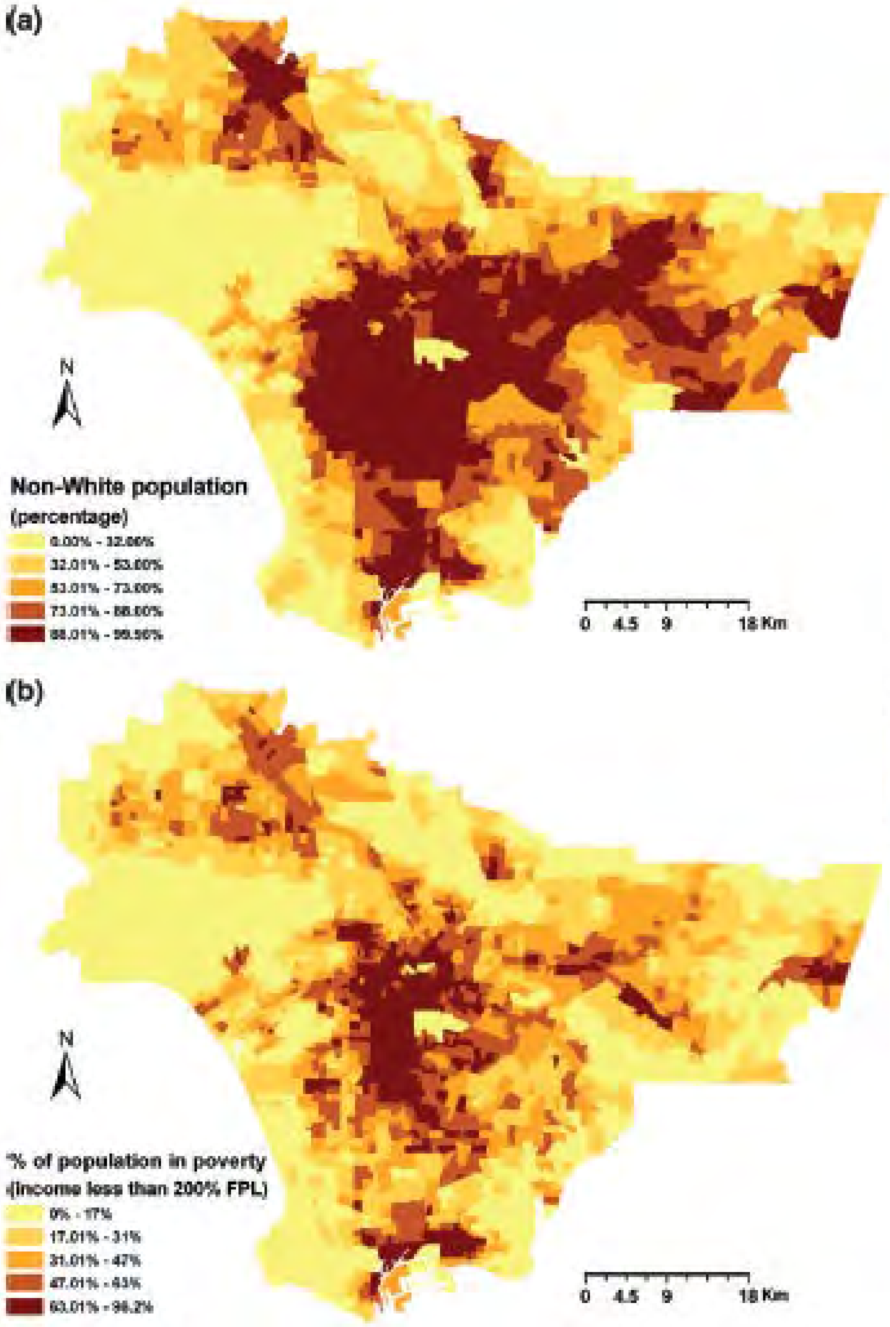

Environmental Inequality and Cumulative Impacts in Richmond, CA
Interstate
Marine Port
Liberty/ Atchison Villages
Rail yard
General Chemical Corp
Richmond Parkway
Chevron Refinery

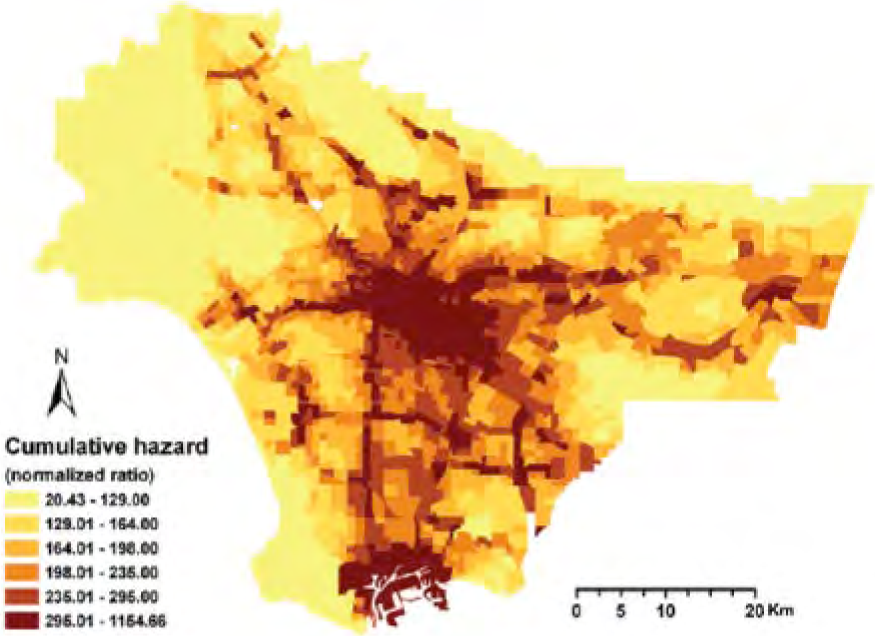
C106

Inequality Curve



Environ Sci Technol 2009;43:7626–34.





Environ Sci Technol 2009;43:7626–34.

Cumulative Risk

- People of color and low SES have
  - Greater exposures to outdoor partculate pollution
  - Disproportionate proximity to polluting land uses and toxic emissions
- Poor communities have more health-damaging factors and less health-promoting amenities
  - Less access to healthy food and health care
  - Less green space and recreational programs
  - Poor quality housing and greater violence

Key Questions

- What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

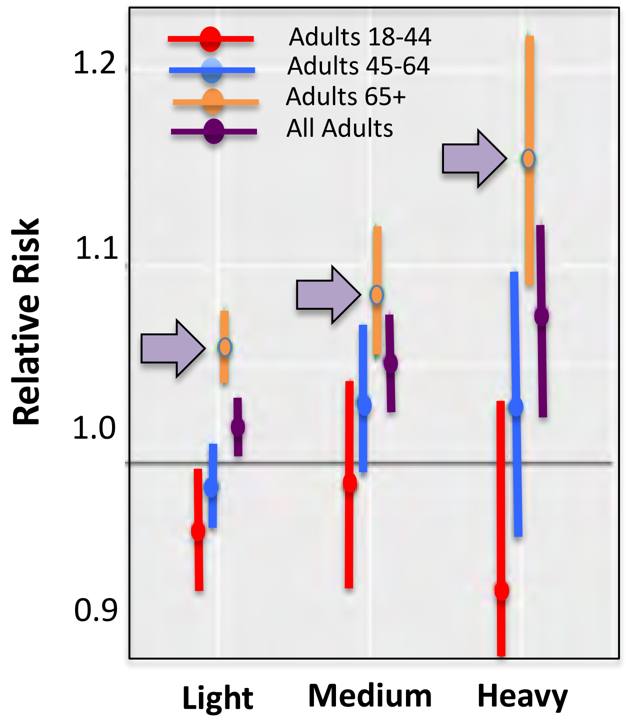
Clear evidence of an association between wildfire smoke and respiratory health

- Asthma exacerbations significantly associated with higher wildfire smoke ***in nearly every study***
- Exacerbations of chronic obstructive pulmonary disease (COPD) significantly associated with higher wildfire smoke in most studies
- Growing evidence of a link between wildfire smoke and respiratory infections (pneumonia, bronchitis)

Wildfire-$PM_{2.5}$ Increases Heart Attack & Stroke

- ***Wildfire-$PM_{2.5}$ associated with heart attacks and strokes for all adults, particularly for those over 65 years old***
- ***Increase in risk the day after exposure:***
  - All cardiovascular, 12%
  - Heart attack, 42%
  - Heart failure, 16%
  - Stroke, 22%
  - All respiratory causes, 18%
  - Abnormal heart rhythm, 24%
    (on the same day as exposure)

All Cardiovascular Causes



80

Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al.
JAHA April 11, 2018

Slide credit: Wayne Cascio

C112

Thank you

Particulate Matter:
Spotlight on Health Protection

H. Christopher Frey, Ph.D., F. A&WMA, F. SRA

- Glenn E. Futrell Distinguished University Professor of Environmental Engineering in the Department of Civil, Construction, and Environmental Engineering at North Carolina State University
- Adjunct professor in the Division of the Environment and Sustainability at the Hong Kong University of Science and Technology
- Fellow of the Air & Waste Management Association and of the Society for Risk Analysis
- Ph.D. in Engineering and Public Policy from Carnegie Mellon

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

H. Christopher Frey
frey@ncsu.edu

NC STATE UNIVERSITY

Department of Civil, Construction & Environmental Engineering
North Carolina State University
Raleigh, NC 27695

Presented at:
Particulate Matter: Spotlight on Health Protection
Bay Area Air Quality Management District
San Francisco, CA

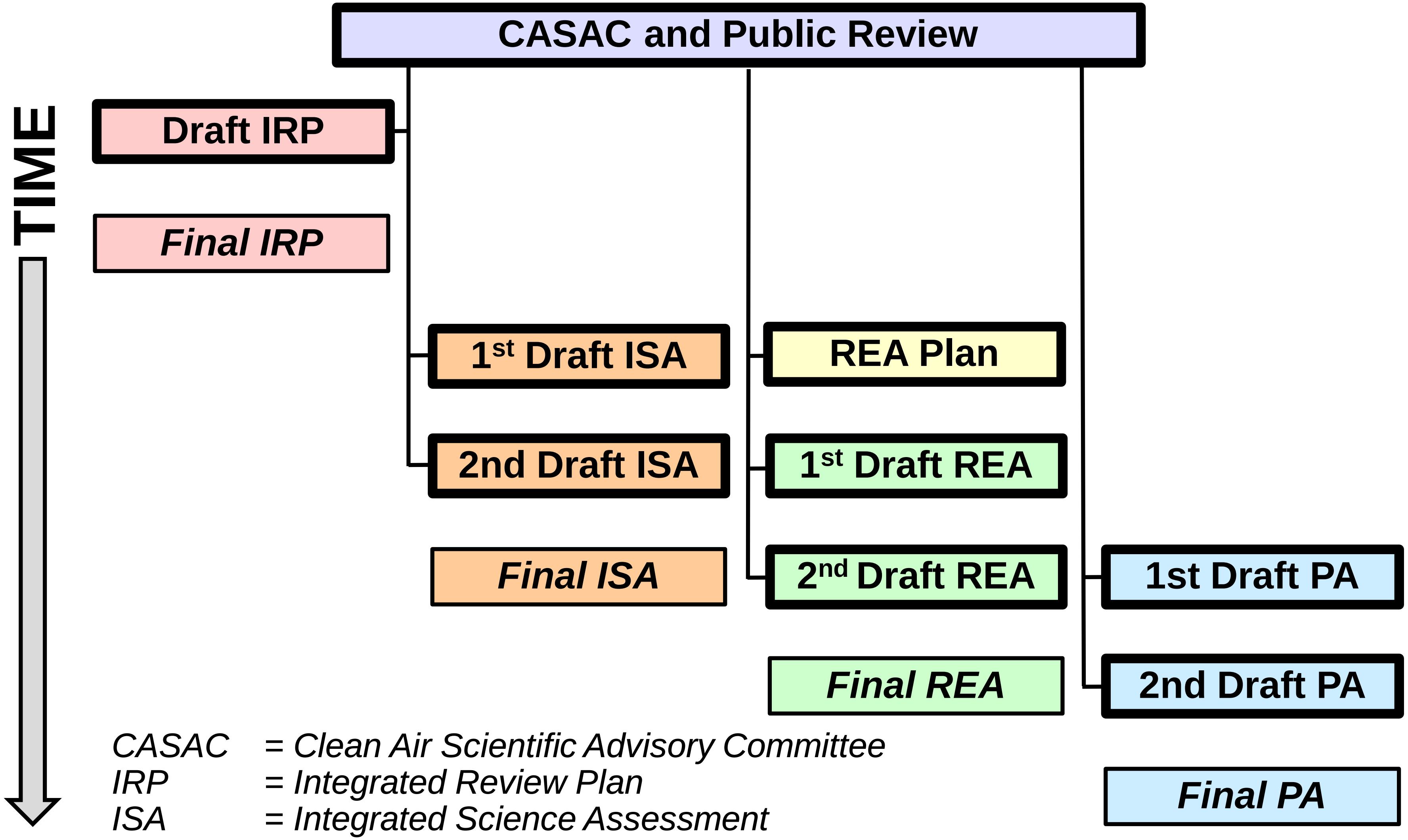
October 28, 2019

C116

Key Points

- The National Ambient Air Quality Standard (NAAQS) Science Review Process Worked Well Until 2017
- EPA Administrators Pruitt and Wheeler Have Broken the Process
- Particulate Matter Science Review By the EPA Clean Air Scientific Advisory Committee (CASAC) is Highly Deficient: Appropriate to Look Elsewhere
- Disbanded CASAC PM Review Panel Reconvened Itself
- Key Findings of the Independent Particulate Matter Review Panel

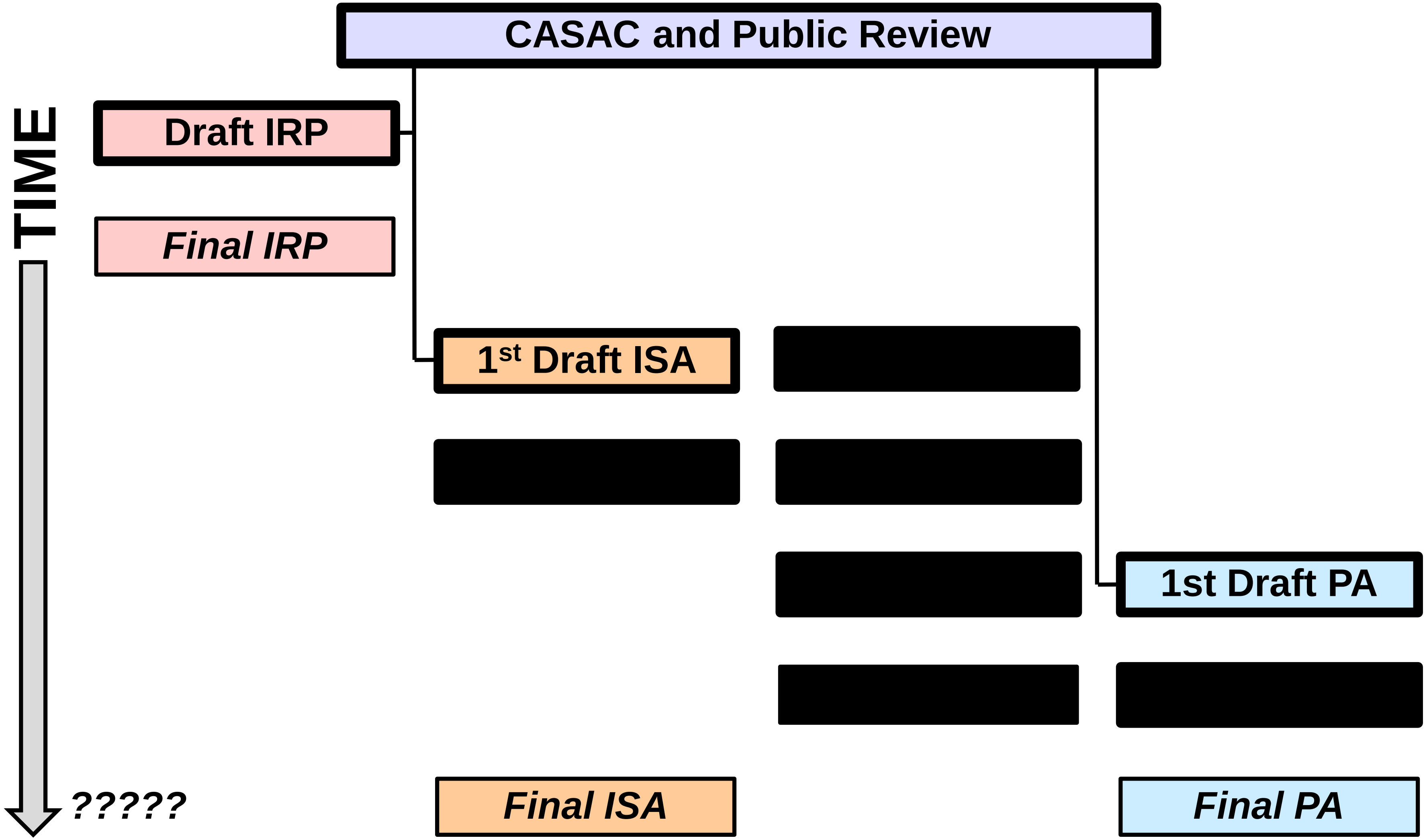
Generic "Full" National Ambient Air Quality Standard (NAAQS) Science Review from Document Perspective



CASAC = Clean Air Scientific Advisory Committee
IRP = Integrated Review Plan
ISA = Integrated Science Assessment
REA = Risk and Exposure Assessment
PA = Policy Assessment

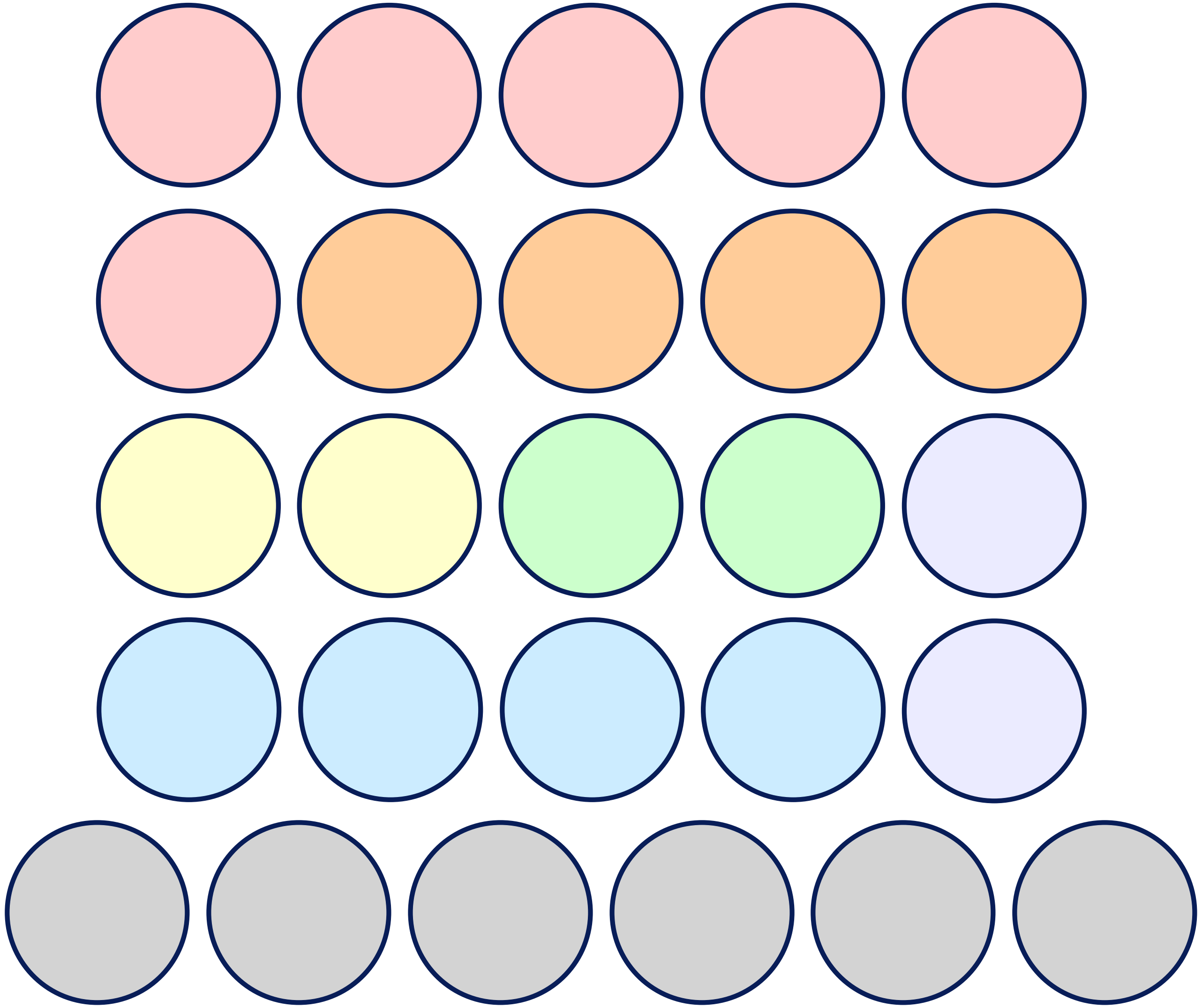
C118

Pruitt/Wheeler (P/W) Particulate Matter NAAQS Science Review from Document Perspective

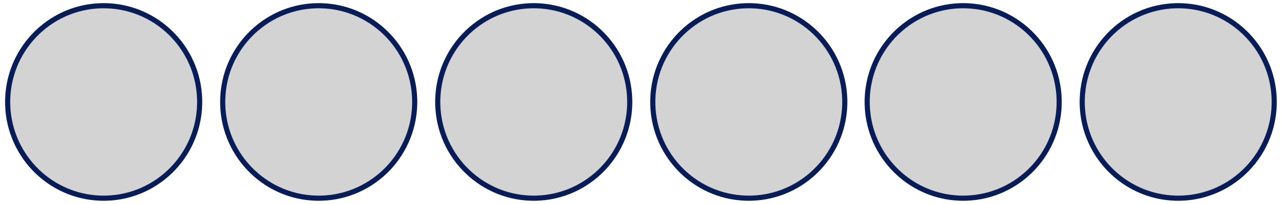


C119

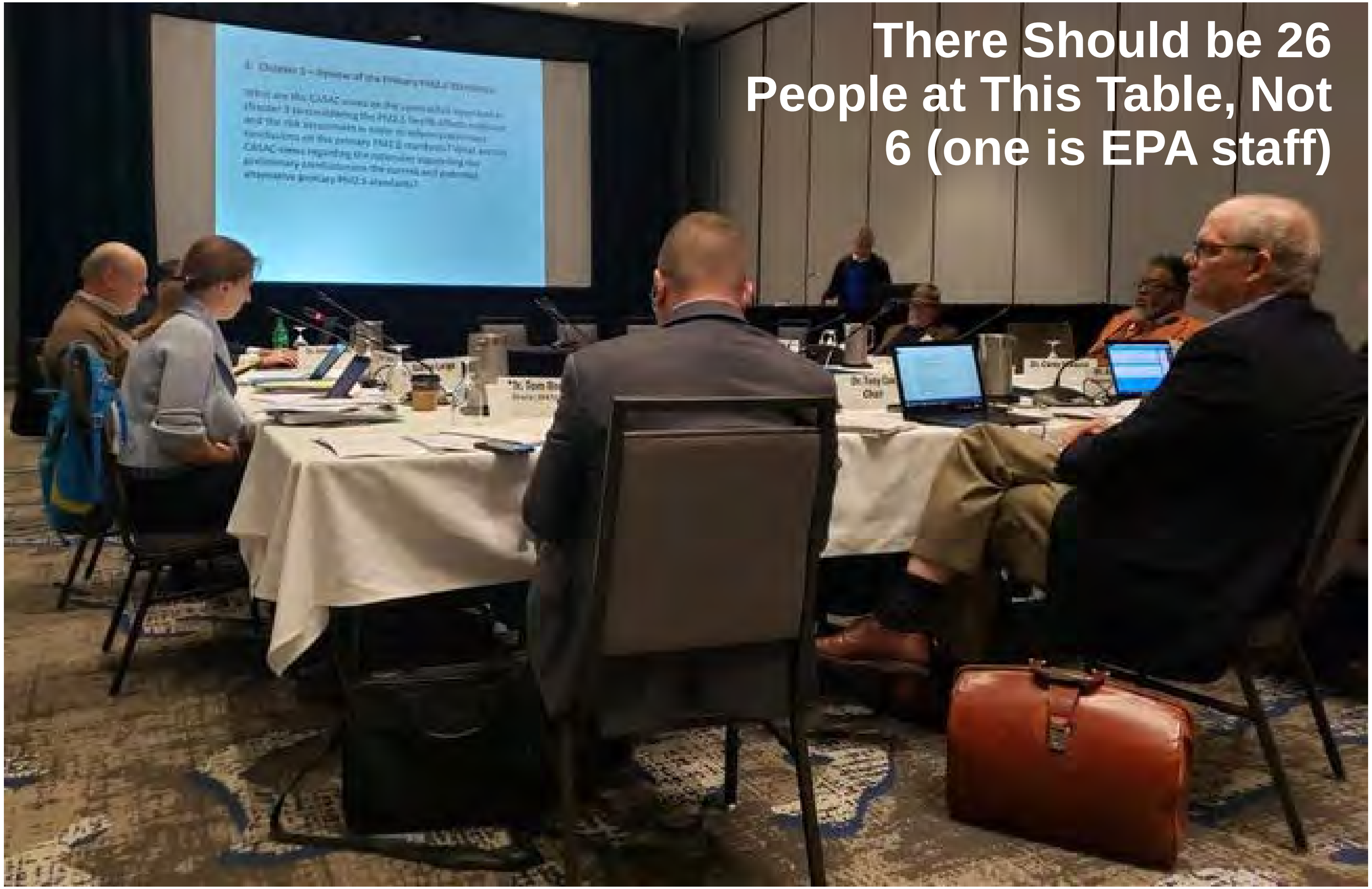
2015 EPA CASAC Particulate Matter Review Panel (26)



Pruitt/Wheeler EPA CASAC Particulate Matter Review Panel (6 last week, 7 by statute)



The Latest from CASAC, as of 2:25 pm Friday, October 25, 2019



The Latest from CASAC, as of 2:25 pm Friday, October 25, 2019

- CASAC is split 4-2:
  - Four recommend keeping all current standards (primary $PM_{2.5}$, coarse PM, secondary $PM_{2.5}$) as is.
  - Rationales offered for keeping the annual primary $PM_{2.5}$ standard are ill-informed or inappropriate, given the state of the science, lack of needed expertise and obvious lack of understanding of the statutory mandate of the Clean Air Act.

Independent Particulate Matter Review Panel

- Formerly the CASAC PM Review Panel
- Disbanded October 10, 2018
- Met October 10, 2019 to October 11, 2019 in Crystal City, VA
- Follow-up Teleconference October 18, 2019 to finalize report

C124

Independent Particulate Matter Review Panel

- **Dr. H. Christopher Frey**, Chair, North Carolina State University
- **Dr. Peter Adams**, Carnegie Mellon University
- **Dr. John L. Adgate**, Colorado School of Public Health
- **Mr. George Allen**, NESCAUM
- **Dr. John Balmes**, University of California at San Francisco
- **Dr. Kevin Boyle**, Virginia Tech
- **Dr. Judith Chow**, Desert Research Institute
- **Dr. Douglas W. Dockery**, Harvard T.H. Chan School of Public Health
- **Mr. Dirk Felton**, NY State Dept. of Environmental Conservation
- **Dr. Terry Gordon**, New York University School of Medicine
- **Dr. Jack Harkema**, Michigan State University
- **Dr. Joel Kaufman**, University of Washington
- **Dr. Patrick Kinney**, Boston University School of Public Health
- **Dr. Michael T. Kleinman**, University of California at Irvine
- **Dr. Rob McConnell**, University of Southern California
- **Mr. Richard Poirot**, Independent Consultant
- **Dr. Lianne Sheppard**, University of Washington
- **Dr. Jeremy Sarnat**, Rollins School of Public Health, Emory University
- **Dr. Barbara Turpin**, University of North Carolina at Chapel Hill
- **Dr. Ronald Wyzga**, Retired, Electric Power Research Institute

Independent Particulate Matter Review Panel

- Followed the same process and procedures as we did formerly as the CASAC PM Review Panel
- Developed a letter to the EPA Administrator and Consensus Responses to EPA Charge Questions on the Draft Policy Assessment
- Submitted our report to CASAC, the docket, and the Administrator
- **ucsusa.org/pmpanel**

C126

Acknowledgment of EPA Staff

- The Panel finds that the EPA staff in the Office of Air Quality Planning and Standards have undertaken a good faith effort to produce a first draft of the PA.
- This draft was produced under extenuating, unprecedented, and inappropriate constraints.
- **The Panel commends the staff for this effort.**

C127

Causality Determinations

- The **weight of evidence framework for causality determination** that is applied by EPA **is an appropriate and well-vetted tool** for drawing causal conclusions.
- The epidemiologic **evidence**, supported by evidence from controlled human studies and toxicological studies, **supports the ‘causal’ and ‘likely to be causal’ determinations** that are the focus of the draft PA.
- “The epidemiologic **evidence** provides strong scientific **support for recommendations** regarding current and alternative standard levels.”
- **Arguments to retain the current primary $PM_{2.5}$ standards** “would require disregard of the epidemiological evidence,” and “are not scientifically justified and **are specious**.”

C128

Major Findings: Fine Particle Standards

- The current primary fine particle ($PM_{2.5}$) annual and 24-hour standards are **not protective of public health**.
- Retain current indicators, averaging times, and forms.
- The **annual** standard should **be 10 $\mu g/m^3$ to 8 $\mu g/m^3$** (versus 12 $\mu g/m^3$ now).
- The **24-hour** standard should be **30 $\mu g/m^3$ to 25 $\mu g/m^3$** (versus 35 $\mu g/m^3$ now).
- **Consistent epidemiological evidence** from multiple multi-city studies, **augmented with** evidence from **single-city studies**, at policy-relevant **ambient concentrations** in areas with design values at and **below the levels of the current standards.**
- **Supported** by research from **experimental models** in animals and humans and by **accountability studies**

C129

Major Findings: Fine Particle Standards

- A motivation for strengthening the 24-hour $PM_{2.5}$ standard is high 24-hour to annual ratios related to **residential wood combustion** in some areas.
- Panel notes **growing frequency and severity of so-called “wildfires.”**

C130

Accounting for Limitations

- The Panel considered in detail uncertainties and limitations of available epidemiologic evidence, such as:
  - Use of linear, multipollutant models
  - Possibility that co-pollutants may be effect modifiers rather than confounders
  - Confounding by individual characteristics has been considered and evaluated
  - No rationale or empirical support for confounding by temperature in annual studies
- Consistency among **multiple multicity models**, for which there is variability in relative ambient **mixtures of co-pollutants**, **population demographics**, **climatic zones**, and distributions of **housing characteristics**, supports the **robustness** of their results.

C131

Recommended Range for Annual $PM_{2.5}$ Standard

- At **10 µg/m³** there is a **very high degree of scientific confidence** in the relationship between exposure to fine particles and **adverse effects**.
- The risk is **linear** with **no threshold** below the current standard down to an annual level of 8 µg/m³ or lower.
- The Panel finds that there is **not sufficient scientific certainty below 8 µg/m³ to support a lower recommendation.**

C132

Other Issues: At Risk Groups

- Di et al. (2017a) chronic Medicare study shows that the relative risk for African Americans is three times higher than that of the entire population (hazard ratio of 1.21 per 10 μg/m^3 increase in $PM_{2.5}$).

C133

BAAQMD's Questions

- Are current PM standards sufficiently protective? **Emphatic NO – definitely not for $PM_{2.5}$.**
- How has the PM health evidence been strengthened? **Better "exposure" models, much larger study populations at much lower levels than before.**
- What new health effects are now recognized? **Strengthening of some causality determinations, but largely the focus is still premature mortality, respiratory morbidity, and cardiovascular morbidity.**
- New endpoints like cancer and central nervous system effects? **Opinions differ.**
- New sensitive groups, like children and lower socioeconomic status, SES, populations? **Growing recognition of "at risk" groups.**
- Are all types of PM equal? **Probably not.** Or, are some more dangerous than others? **Probably. But, more work needed. No components are as yet 'exonerated.'**
- How severe are PM health risks? **Premature mortality is severe.**
- What additional health benefits can be achieved by further reducing PM to below current standards? **Difficult to quantify with certainty but on the order of tens of thousands of deaths nationally.**

C134

BAAQMD's Questions

- How important are short-term PM events, like wildfires? **Not well-known scientifically but of concern for potential or anticipated effects**. **Research recommended.**
- How should we weight them in comparison with ongoing day-to-day PM levels? **No simple answer. Depends… can they be controlled? If so, how? Via a state implementation plan? And would you slap non-attainment on an area just devastated by a wildfire?**
- How important are ultrafine particles, UFPs? **Current evidence of adverse effects is generally weak but there is concern for potential or anticipated effects. Need more monitoring to support more epidemiological studies**. **Panel recommends a UFP FRM for this purpose.**
- Should we consider more than just PM mass? *(meaning particle number concentration?)* **In research, absolutely. In regulation, too soon, unless one takes a very precautionary, highly risk-averse decision approach.**
- Which is most protective, an annual average target or a 24-hour average one? Or, a sub-daily average? **For most parts of the country, annual can offer protection also for 24-hour averages. For other parts, not so. Panel comments on this. Health data on sub-daily is too limited as yet to support a standard at the national level, but Panel has recommendations to look at this further**.

C135

Next Steps

- CASAC will release its draft report on the draft PM Policy Assessment within a few weeks.
- CASAC will meet on December 3, 2019 to review and likely finalize its report to the Administrator
- Opportunity for public comment in writing beforehand and oral comment at the meeting.
- *CASAC will review the draft ISA and draft PA for Ozone at the Dec 3-6, 2019 meeting*.

Key Points

- The NAAQS Science Review Process Worked Well Until 2017
- EPA Administrators Pruitt and Wheeler Have Broken the Process
- Particulate Matter Science Review By CASAC is Highly Deficient: Appropriate to Look Elsewhere
- Disbanded CASAC PM Review Panel Reconvened Itself
- Key Findings of the Independent Particulate Matter Review Panel

Acknowledgments

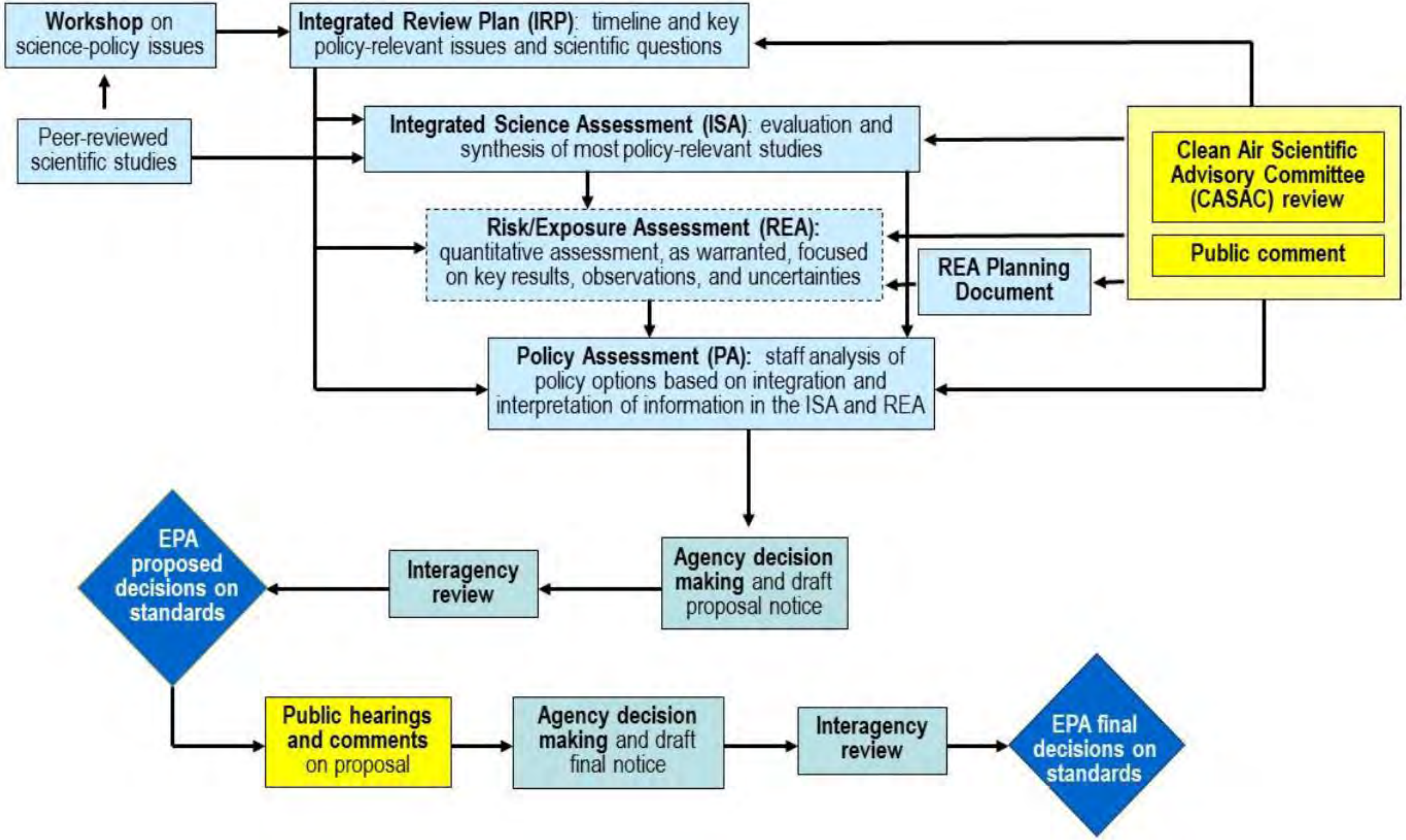
- Members of the Independent Particulate Matter Review Panel.
- Union of Concerned Scientists hosted the October 2019 meetings of the Panel. Special thank you to Dr. Gretchen Goldman.
- Mr. Chris Zarba acted in the role of a designated officer for the panel.
- Mr. John Bachmann and Mr. Steven Silverman provided technical and legal clarifications, respectively.
- This presentation has not been reviewed or approved by anyone. The author is solely responsible for its content.

frey@ncsu.edu

Report of the Independent Particulate Matter Review Panel is at:

ucsusa.org/pmpanel

Overview of EPA's Process for Reviewing National Ambient Air Quality Standards, 2016



C140

Generic "Full" NAAQS Science Review from CASAC and Public Perspective

CASAC Meeting*	Topic
1 & 2	Draft Integrated Review Plan
3 & 4	1st Draft Integrated Science Assessment Risk & Exposure Assessment Plan
5 & 6	2nd Draft Integrated Science Assessment 1st Draft Risk & Exposure Assessments
7 & 8	2nd Draft Risk & Exposure Assessments 1st Draft Policy Assessment
9 & 10	2nd Draft Policy Assessment

*Meetings 1, 2, 4, 6, 8, 10 by teleconference; Meetings 3, 5, 7, 9 face-to-face
Public Comment at EVERY meeting (10 opportunities)

C141

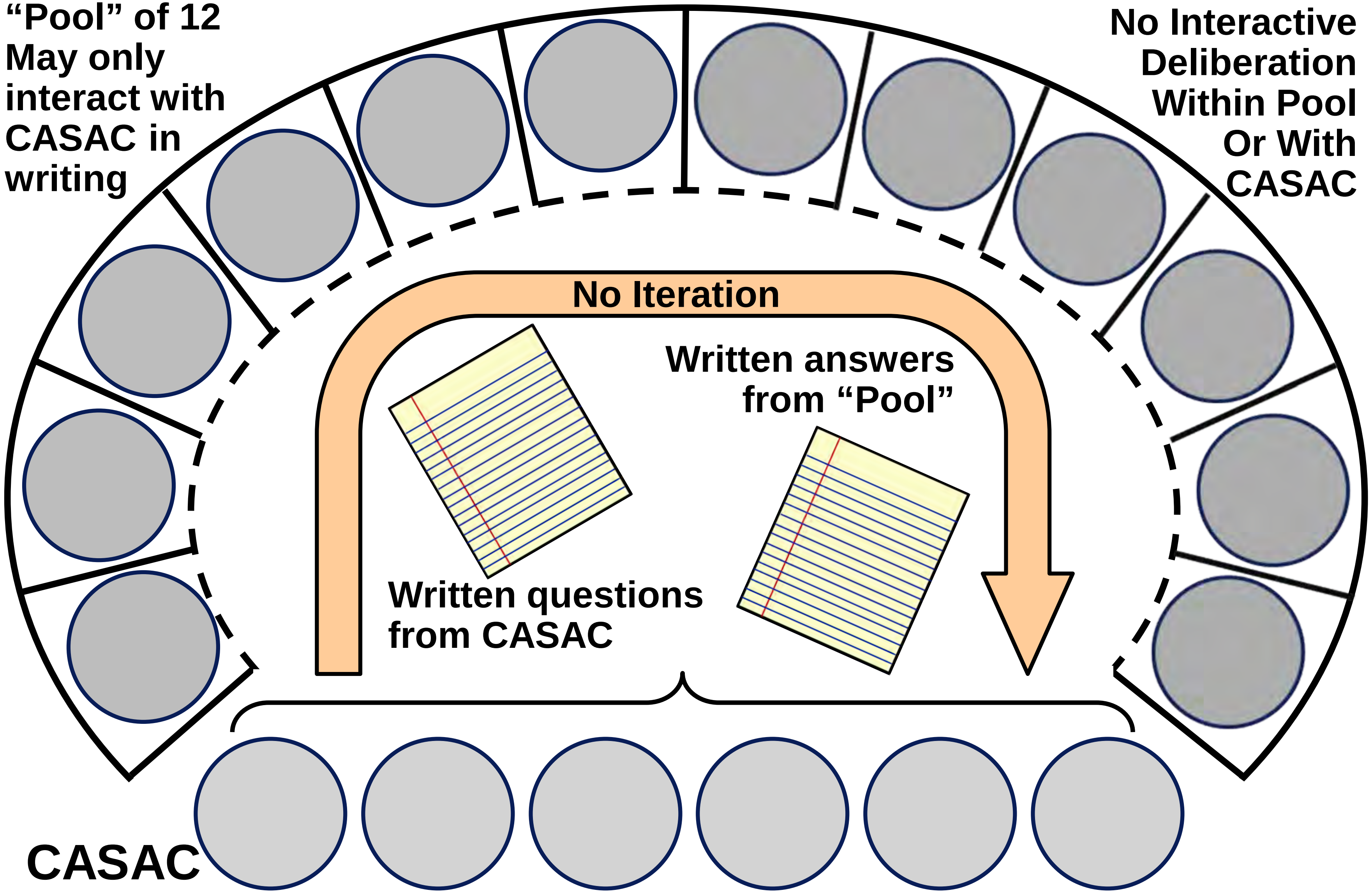
Pruitt/Wheeler (P/W) Particulate Matter NAAQS Science Review from CASAC and Public Perspective

CASAC Meeting*	Topic	
1 & 2	Draft Integrated Review Plan	*2016 Before P/W*
3 & 4	1st Draft Integrated Science Assessment [redacted]	
[redacted]	[redacted]	
5 & 6	[redacted] 1st Draft Policy Assessment	
[redacted]	[redacted]	

*Meetings 1, 2, 4, 6 by teleconference; Meetings 3, 5 face-to-face
Public Comment at EVERY meeting (6 opportunities) [Only 4 in P/W era]

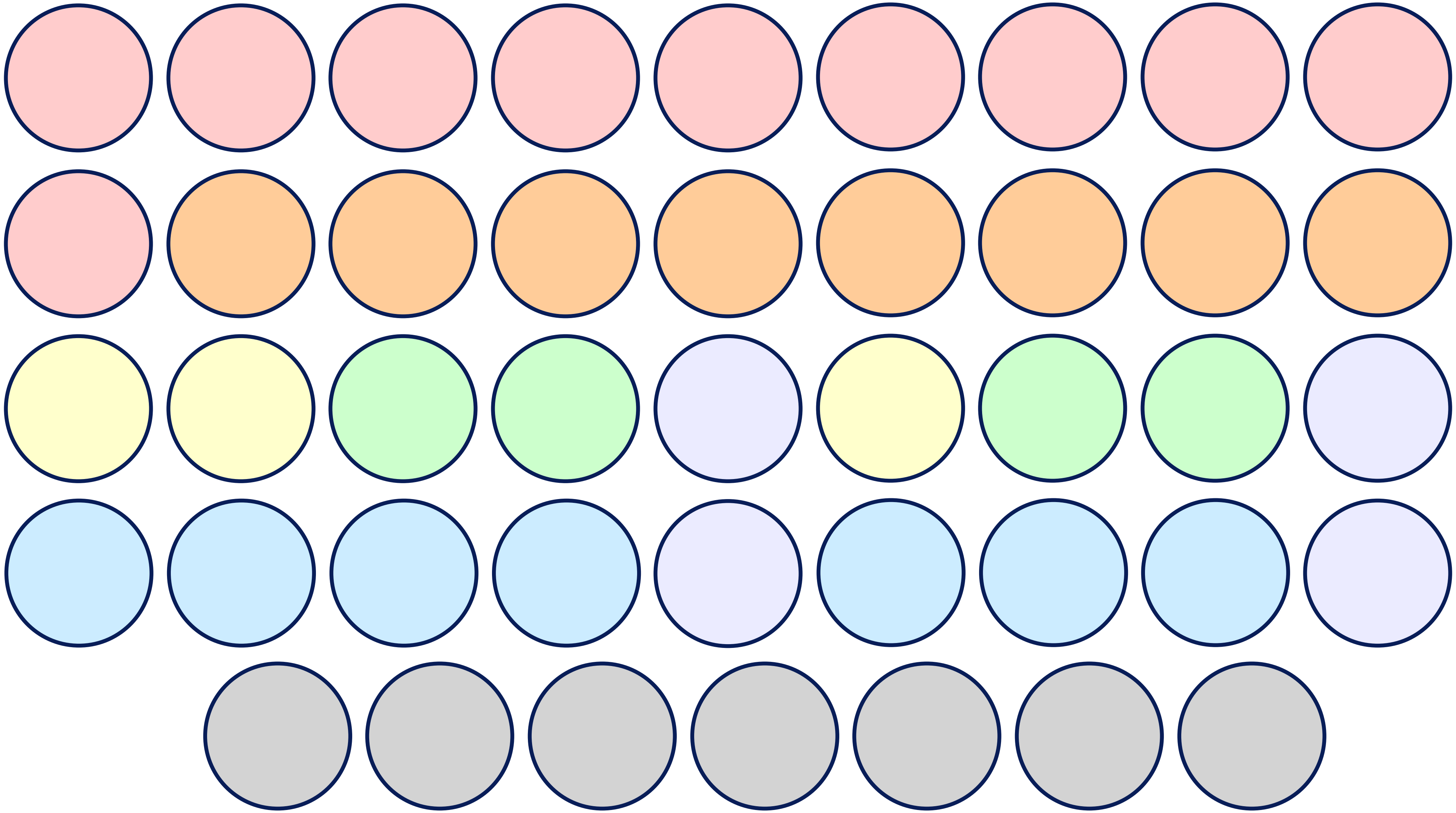
C142

Wheeler Ad Hoc "Pool" of External Consultants for PM and O_3 Reviews



C143

Typical Pre-Pruitt/Wheeler CASAC for PM and O_3 Reviews: CASAC Augmented with PM and O3 Panels



C144

Report of the Independent Particulate Matter Review Panel

- ucsusa.org/pmpanel
- 11 page letter (5 pages of text)
- Attachment A: Panel Roster (2 pages)
- Attachment B: Consensus Responses (43 pages)
- Attachment C: Individual Member Comments (117 pages)
- Attachment D: History, Membership Criteria, and Administrative Procedures of the Panel
- Attachment E: Panel Member Biosketches

Major Findings: Coarse PM

- Coarse PM (PM_{10} as an indicator for $PM_{10-2.5}$)
  - Retain current indicator, form, and averaging time (24-hour)
  - Current level of protection should at least be maintained
  - Need to revise downward with downward revision of 24-hour $PM_{2.5}$ standard.
  - Should move to $PM_{10-2.5}$ as the indicator in the next review.

C146

Major Findings: Visibility

- Welfare (Secondary) Standards
  - Current annual standard has no effect (15 $\mu g/m^3$ vs. 12 $\mu g/m^3$ for primary $PM_{2.5}$ standard.
  - Annual should at least match primary annual.
  - 24-hour standard is not adequate to protect against visibility effects
  - A second draft of the PA should identify and analyze alternatives
  - Panel offers recommendations regarding alternative indicators, averaging times, forms, and levels to be considered.

C147

Process Issues (Overview, Examples)

- Since 2017, the Panel finds that the EPA has made unwarranted changes to the CASAC and the NAAQS review process.
- Detailed recommendations to reverse the unwarranted changes are in the consensus responses.
- A second draft of the ISA should be reviewed by CASAC and the public, and the ISA should be finalized, prior to release of a second external review draft of the PA
- The CASAC PM Review Panel should be reappointed to provide CASAC with the expertise it needs.

New Federal Reference Methods Needed

- The Panel recommends that Federal Reference Methods be developed for Ultrafine Particles and Black Carbon
- FRMs for UFP and BC should be deployed to collect data need for health studies and for baselines

C149

Break

Particulate Matter:
Spotlight on Health Protection




Advisory Council Discussion with Health Effects Panel

Discussion Questions

Are current PM standards sufficiently health protective?

Are some species of PM more dangerous than others?

What is role of ultrafine particles (UFPs)?

How should air quality targets be set? Should form of target expand to account for more than just mass?

How should we include draft PM ISA's new "likely-causal" health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?

What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

Lunch

Keynote – Gina McCarthy

Particulate Matter:
Spotlight on Health Protection

Particulate Matter:
Spotlight on Health Protection

Bay Area Air Quality Management District

C154

Gina McCarthy

- Former EPA Administrator
- Finalized the Clean Power Plan and the Clean Water Rule
- Professor of the Practice of Public Health in the Department of Environmental Health at Harvard T.H. Chan School of Public Health
- Director of the Center for Climate, Health, and the Global Environmental
- Member of the Board of Directors of the Energy Foundation and Ceres
- M.Sc. in Environmental Health Engineering, Planning and Policy from Tuft’s University

Particulate Matter:

Spotlight on Health Protection




Exposure and Risk

Lauren Zeise, Ph.D.

- Appointed by Gov. Brown as Director of the California Office of Environmental Health Hazard Assessment in December 2016
- Former Chief of the cancer unit at the California Department of Health Services
- Leading role in OEHHA’s development of CalEnviroScreen
- Co-led the team that developed the hazard trait regulation for California’s Safer Consumer Products program
- Member, fellow, former editor, and former councilor of the Society for Risk Analysis
- 2008 recipient of the Society’s Outstanding Risk Practitioner Award
- Ph.D. from Harvard University

Exposure and Risk Panel

Particulate Matter: Spotlight on Health

Bay Area Air Quality Management District

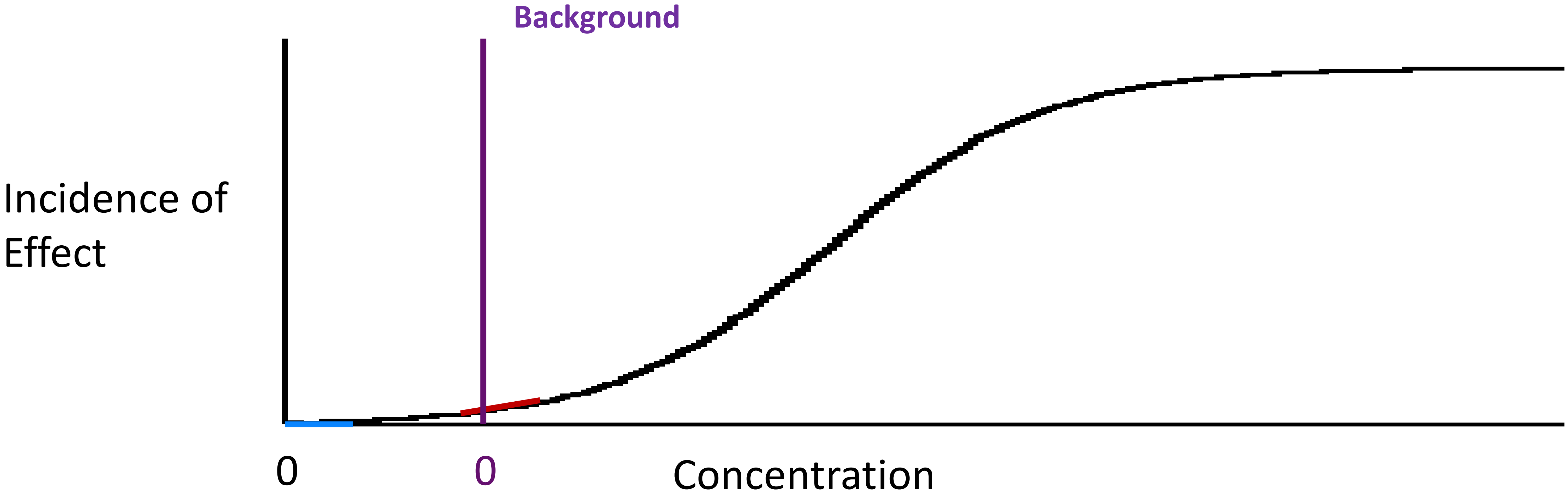
October 28, 2019

Lauren Zeise

California Environmental Protection Agency

Office of Environmental Health Hazard Assessment

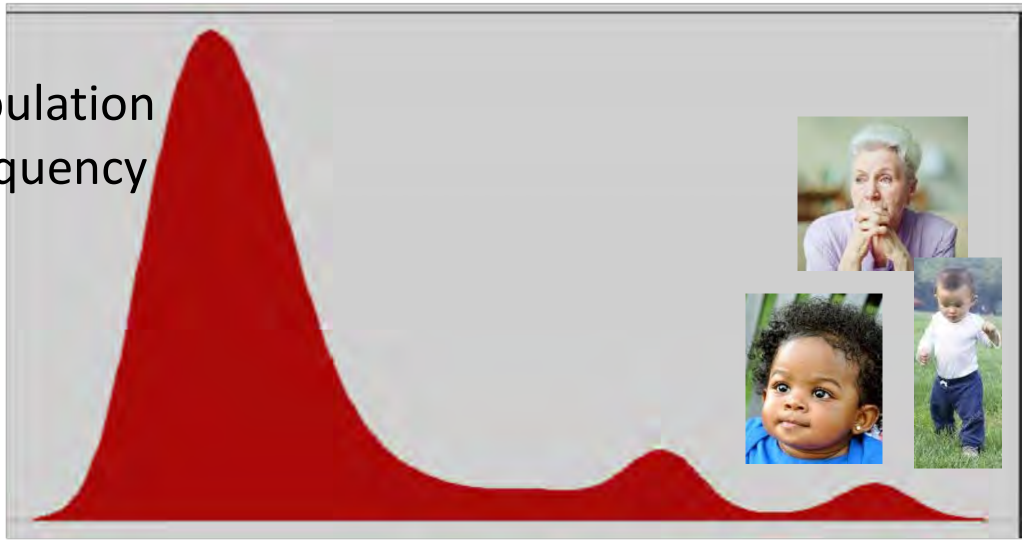
Population Concentration-Response Relationships



Variability Underlying Concentration Response Observations

Variable Risk at a Given Dose

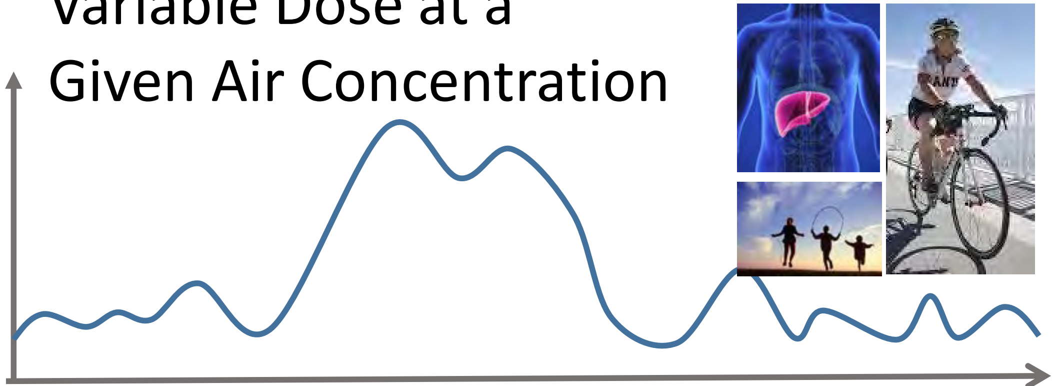
Population Frequency



Increasing Risk

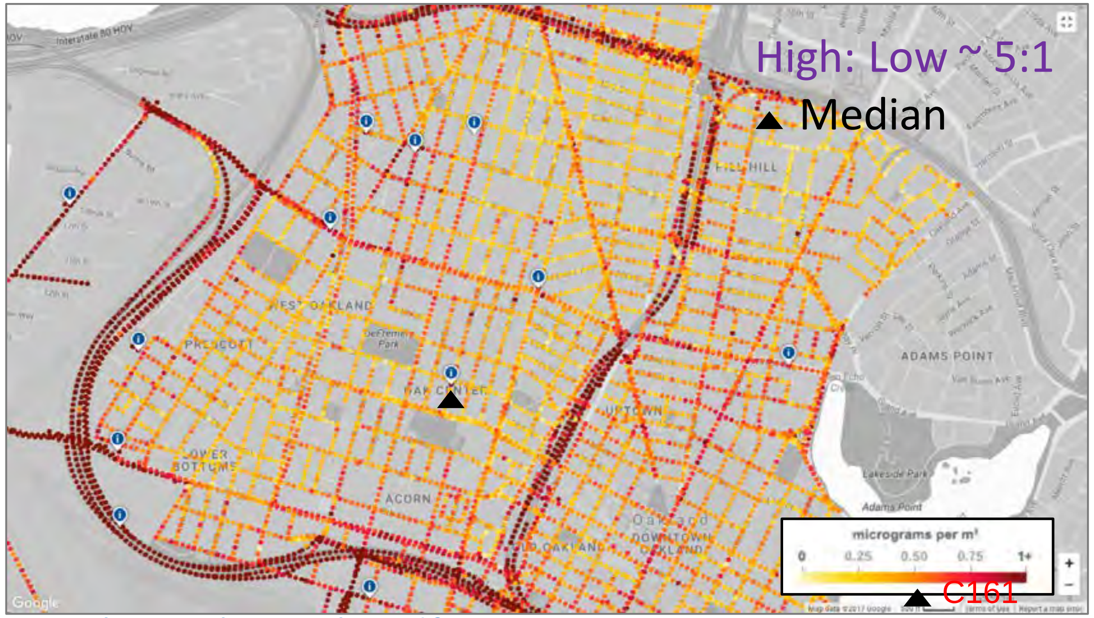
Variable Dose at a Given Air Concentration

Population Frequency

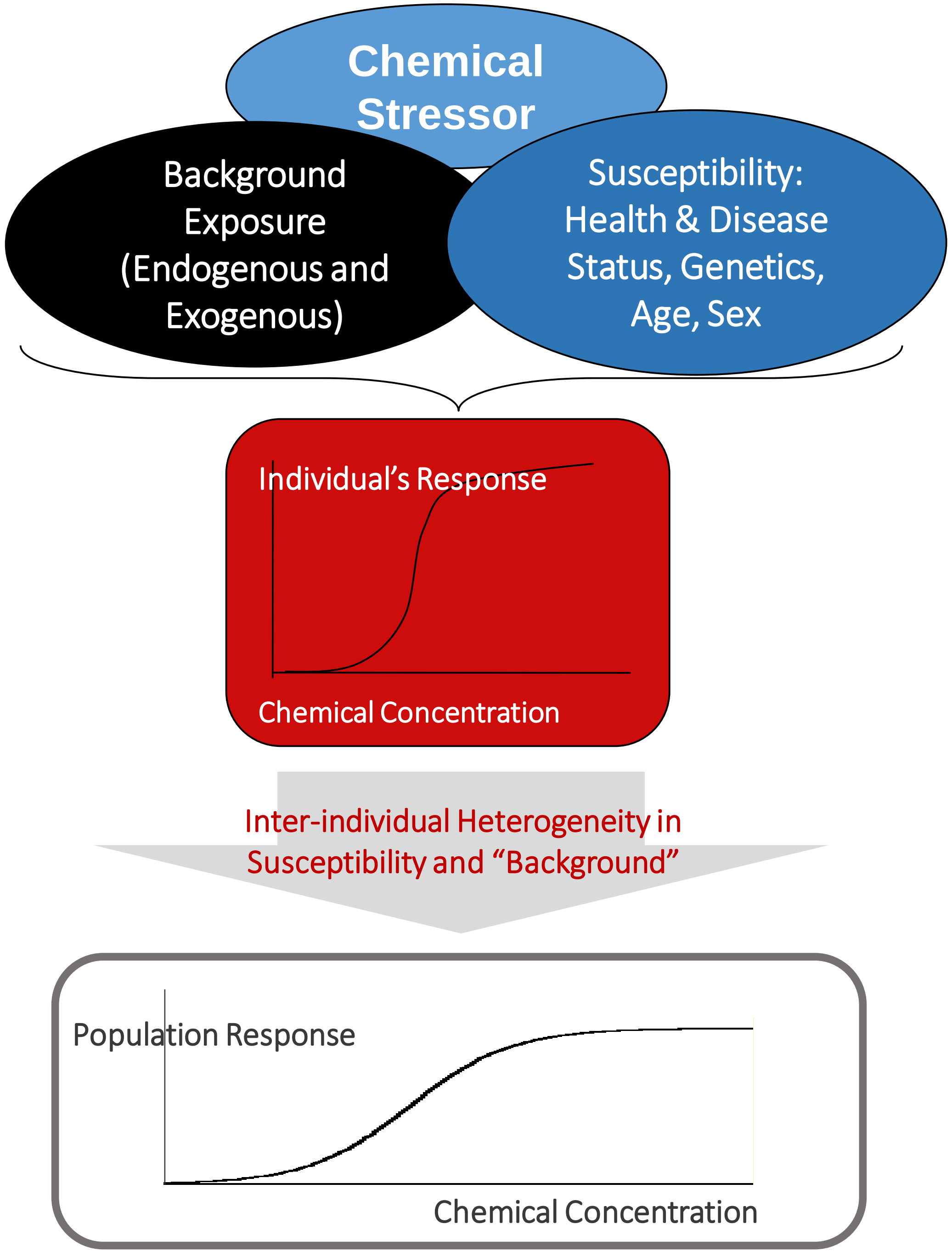


Increasing Dose

Variable Concentration with Location



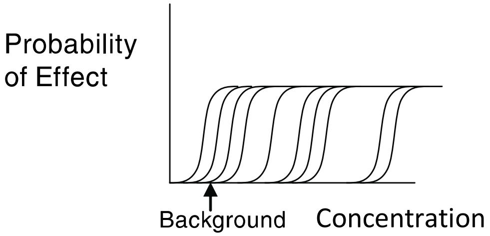
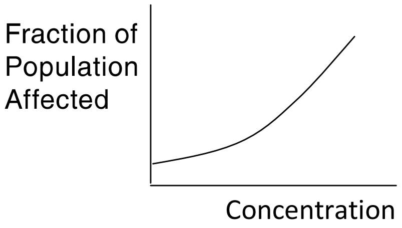
Sarah Vogel svogel@edf.org



Considerations for Interventions

- Risk determined by individual's biologic make-up, health status, endogenous and exogenous exposures that affect toxic chemical process
- Differences among people in these factors affect the shape of the concentration response curve

Individual vs Population Concentration-Response

<table>
<tr><th></th><th>Individual level</th><th>Population Level</th></tr>
<tr><td>1. An individual's:
Nonlinear
The population:
Linear</td><td>
</td><td>
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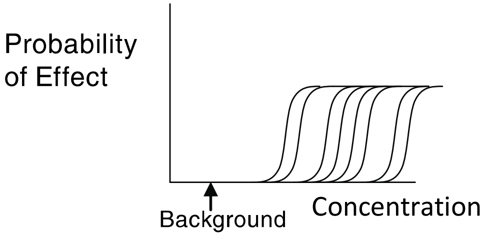
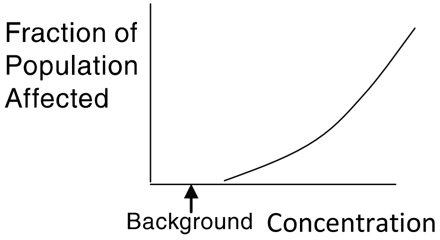
The population:
Nonlinear</td><td>
</td><td>
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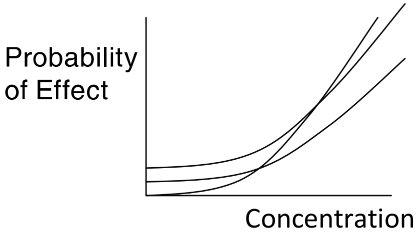
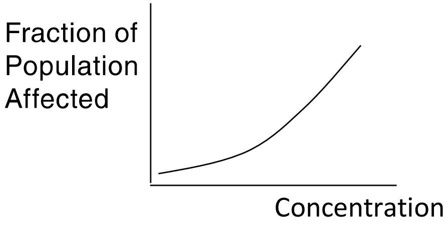
Linear
The population:
Linear</td><td>
</td><td>
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East Bay Diesel Exposure Project

- Measure exposures to diesel exhaust in East Bay community residents
  - ➢ Biomonitoring – urine (1-Nitropyrene metabolites)
  - ➢ Dust in home
  - ➢ Indoor Air (1-Nitropyrene, Black carbon with real-time sensor)
- Measure in child-parent pairs to evaluate exposure patterns within family and across ages
- Collect urine & air samples at two time points to look at seasonal differences
  - ➢ 25 families: one urine sample at end of 4 day periods
  - ➢ 15 families: daily urine samples x 4 days
- Collect information related to sources and activities
  - ➢ Exposure questionnaire
  - ➢ GPS data loggers – every 5 minutes
  - ➢ Activity diaries

C164

BIOMONITORING CALIFORNIA

cerch Center for Environmental Research & Children's Health

OEHHA

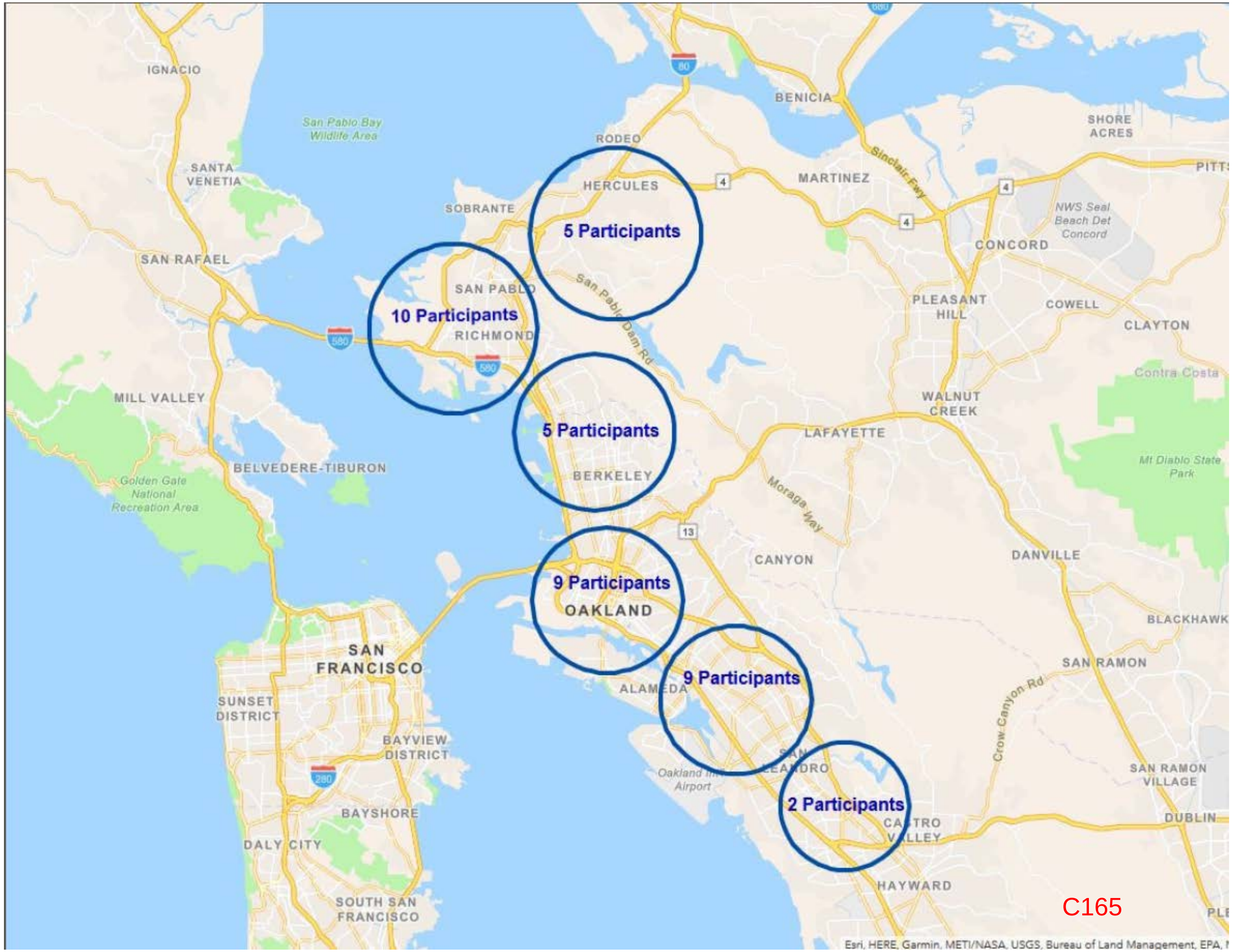
Berkeley UNIVERSITY OF CALIFORNIA

CDPH California Department of Public Health

UNIVERSITY of WASHINGTON

EBDEP Participant Locations

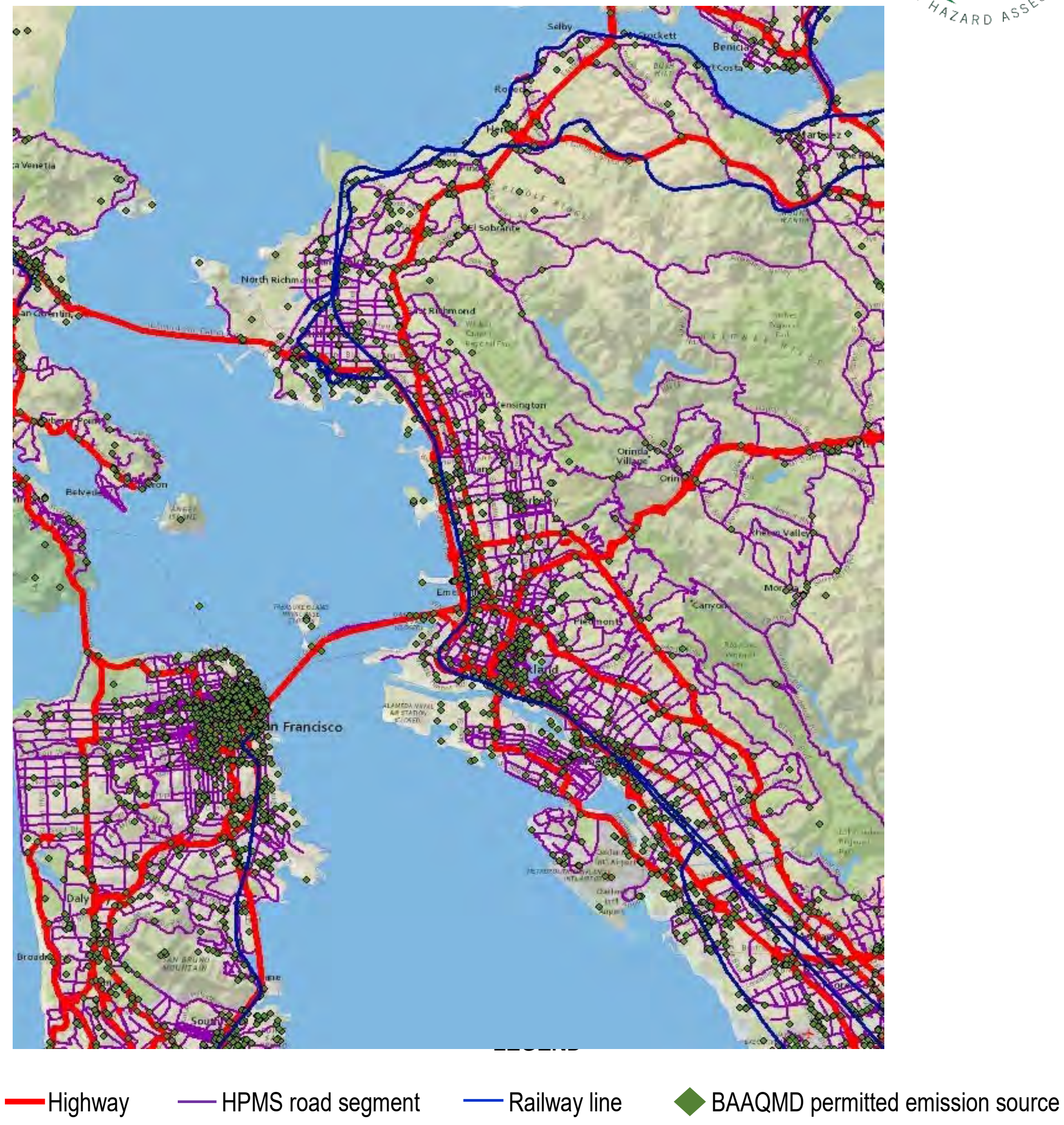
- East Bay
- Neighborhoods with a range of diesel exhaust exposure, based on:
  - ➢ CalEnviroScreen's diesel particulate matter indicator (based on CARB data)
  - ➢ Diesel truck traffic patterns
  - ➢ Local air pollution mapping



C165

GIS Diesel Source Layers and Maps

- Permitted stationary emission sources (BAAQMD)
- Railway lines and railway road crossings
- Caltrans Truck Network
- Caltrans Bottlenecks (highway congestion)
- AC Transit and Amtrak bus routes and stops
- Major roads
- Industrial land use zoning maps (county)
- Highway Performance Monitoring System traffic data
- California ports



Complementary Pilot Air Quality Study

- Measure ambient air concentrations of black carbon and selected PAHs in areas of Richmond relevant to EBDEP
- Conduct field sampling for several days during periods of moderate and high pollution
- Analyze results to:
  - Compare levels across location and time
  - Examine patterns for possible clues on sources

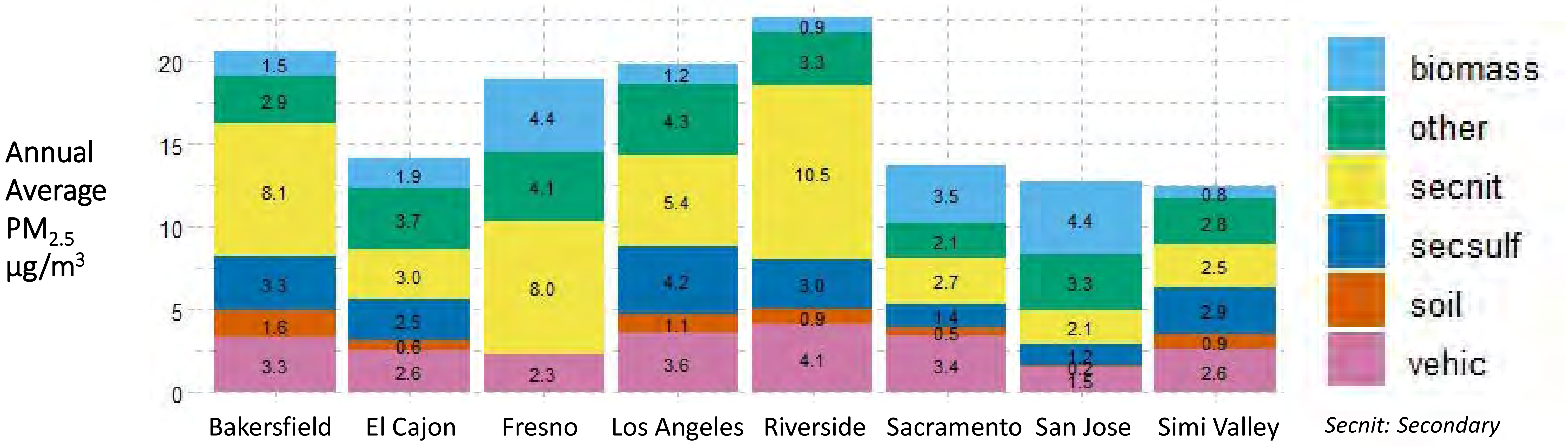
Berkeley UNIVERSITY OF CALIFORNIA

Principal Investigator: Betsey Noth, UC Berkeley
OEHHA funded

OEHHA Biomonitoring to Support AB 617

- Directly measure exposure to a chemical(s) of concern
- Establish baseline exposures prior to reduction efforts
- Examine exposures associated with a specific source(s) in the community, and/or
- Evaluate the effectiveness of exposure reduction efforts

Estimated $PM_{2.5}$ Source Contribution by Monitoring Site



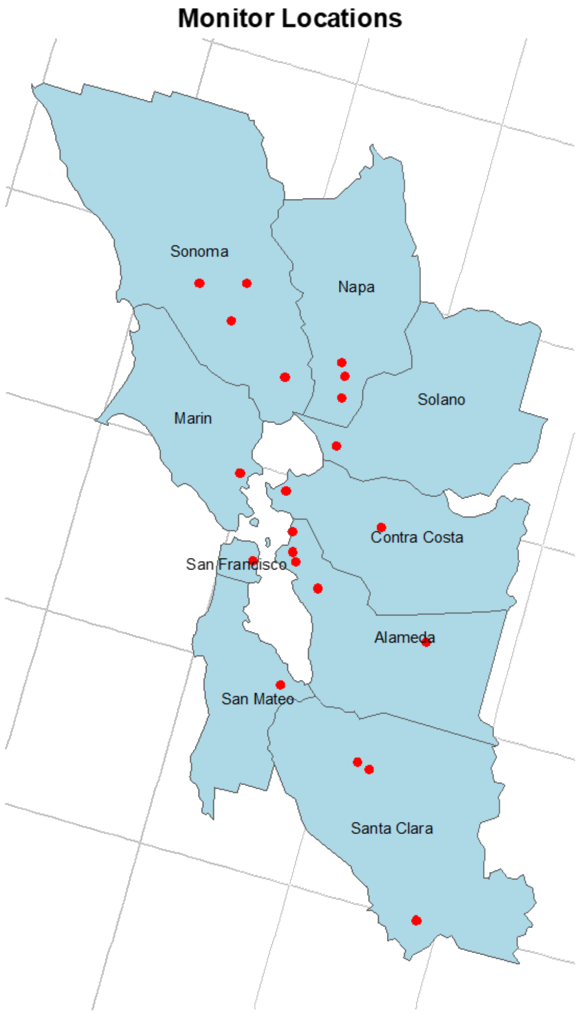
Secnit: Secondary Ammonium Nitrate
Secsulf: Secondary Ammonium Sulfate

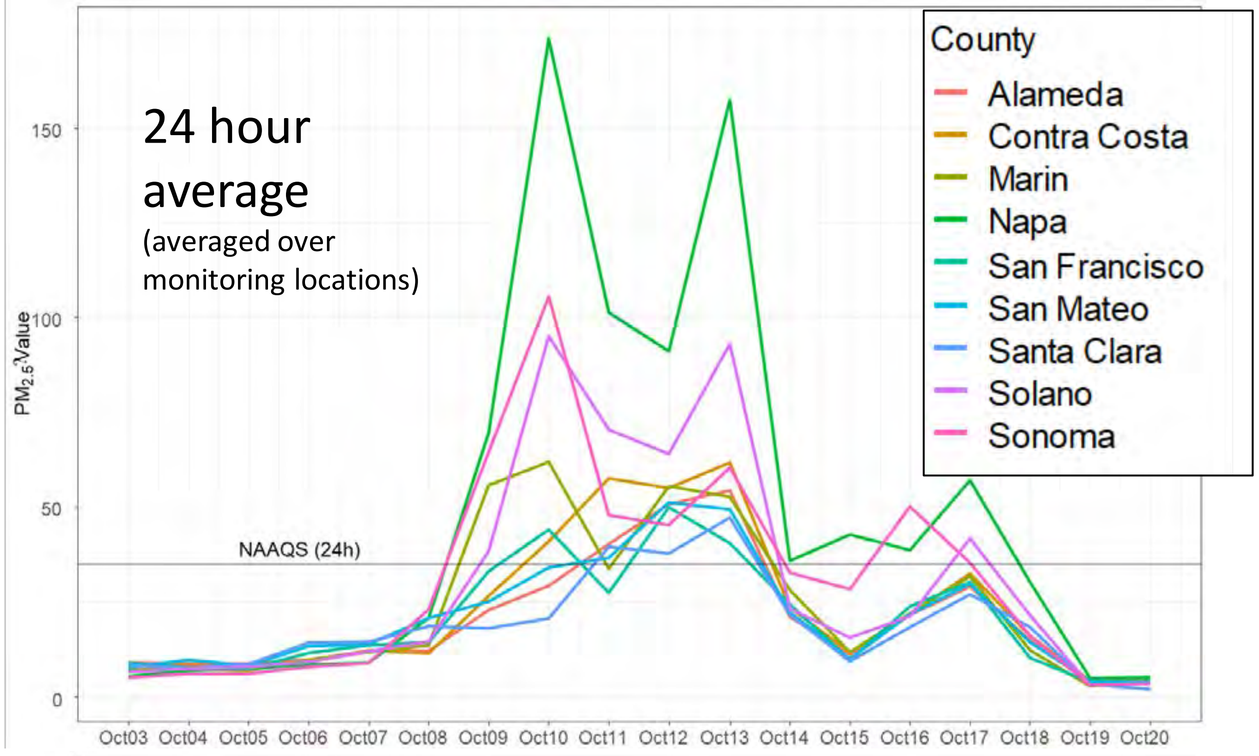
Source	Marker Constituents
Biomass	EC, OC, K
Secondary Ammonium Nitrate	NO_3^-, NH_4^+
Secondary Ammonium Sulfate	$SO_4^=$, NH_4^+
Resuspended Soil	Al, Si, Ca, Fe, Ti
Vehicular Emissions	EC, OC, Fe, Cu, Zn

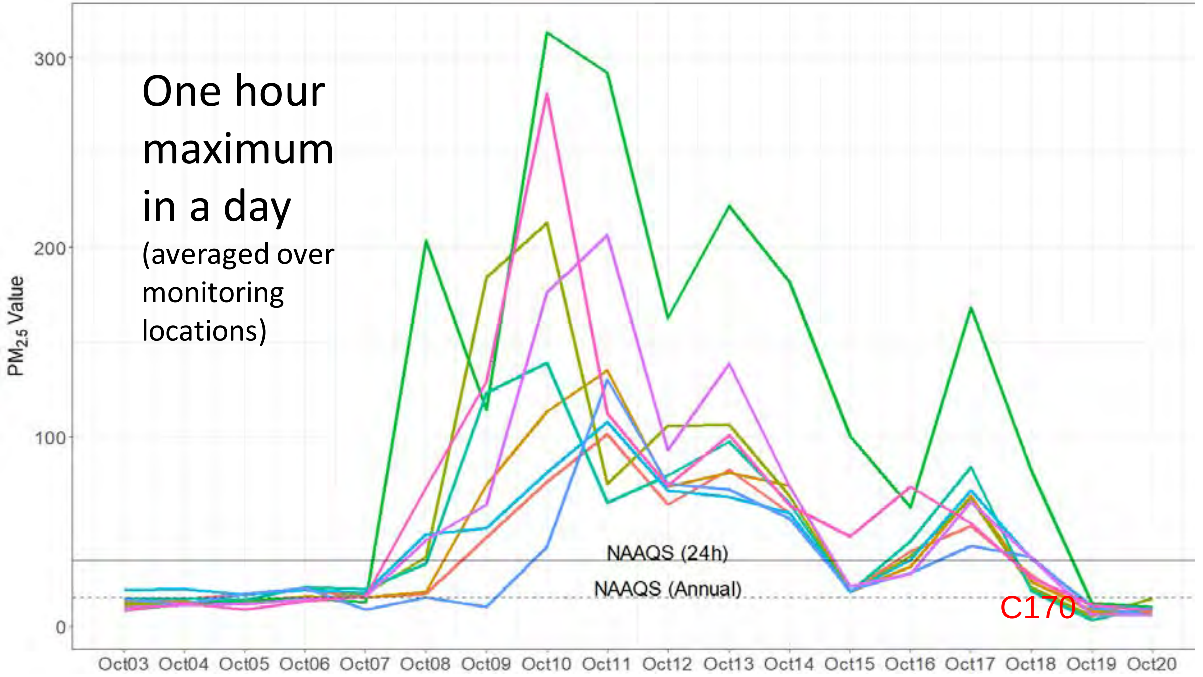
$PM_{2.5}$ in Bay Area During 2017 Napa Wildfire

Health Outcomes Being Investigated

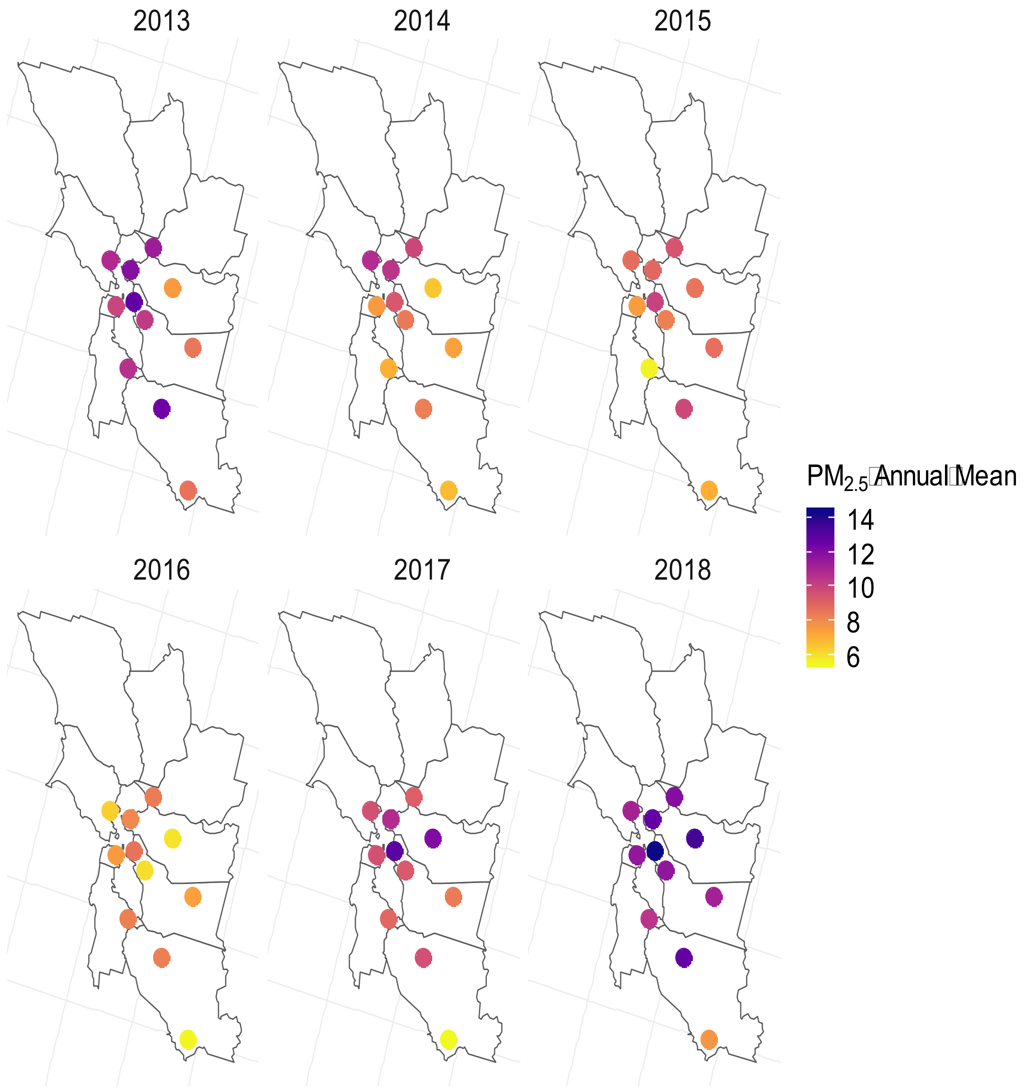
- Cardiovascular Disease
- Ischemic Heart Disease
- Acute Myocardial Infarction
- Dysrhythmia
- Cerebrovascular Disease
- Transient Ischemic Attack
- Peripheral Vascular Disease
- Diabetes
- Respiratory Disease
- Asthma/Wheeze
- Pneumonia
- Chronic Lower Respiratory Disease
- Acute Upper Respiratory Infection
- Mental/Behavioral Disorders



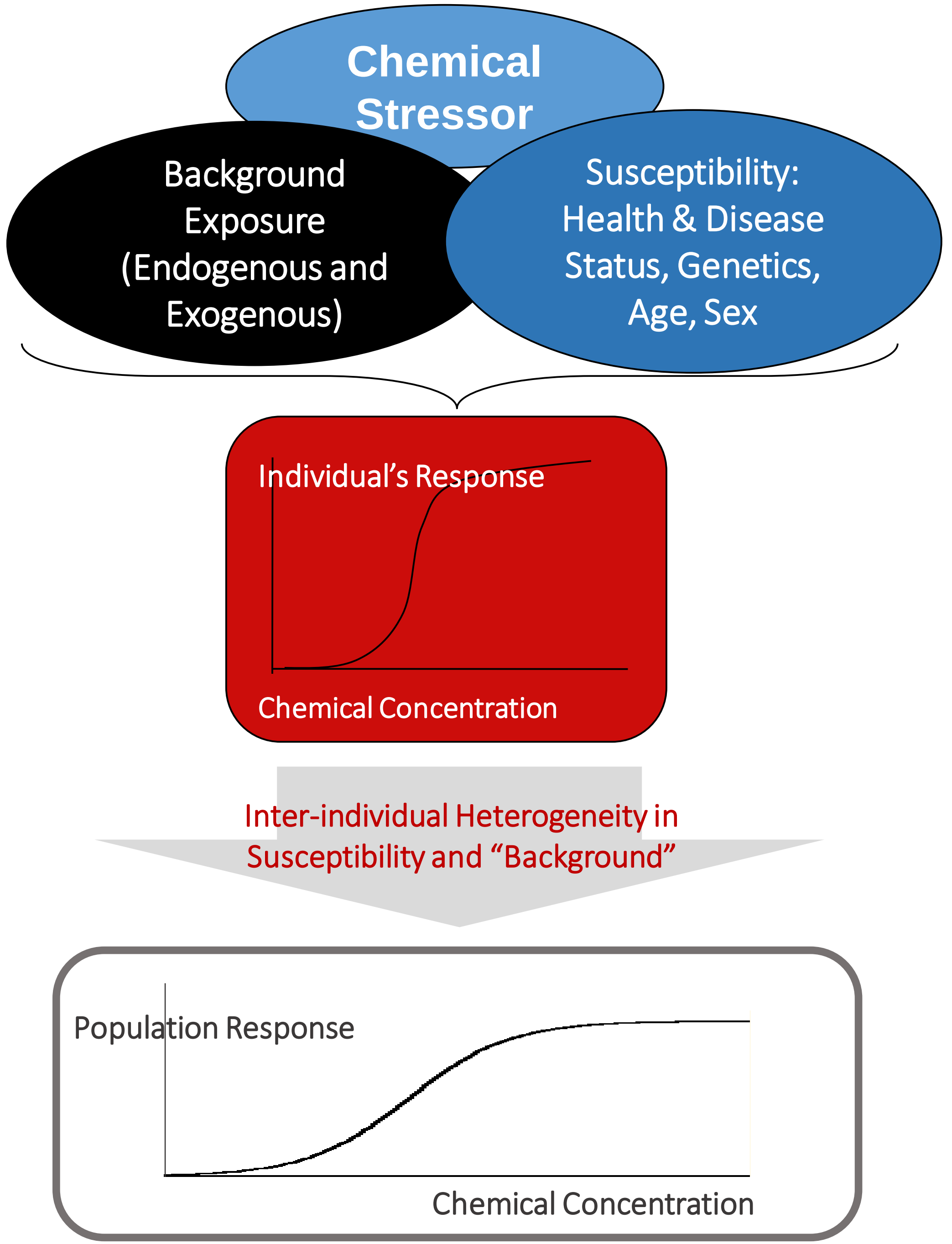




Wildfire Affects Annual Average of $PM_{2.5}$



- Wildfire PM adds to underlying "baseline"
- Monitor in West Oakland:
  - 2017: 12.9 µg/m³
  - 2018: 14.4 µg/m³


Chemical Stressor
Background Exposure (Endogenous and Exogenous)
Susceptibility: Health & Disease Status, Genetics, Age, Sex
Individual's Response
Chemical Concentration
Inter-individual Heterogeneity in Susceptibility and "Background"
Population Response
Chemical Concentration

Acknowledgements

- OEHHA Community Health and Environmental Impacts Section: Rupa Basu, Keita Ebisu, et al.
- OEHHA Safer Alternatives Assessment and Biomonitoring Section: Sara Hoover, Russ Bartlett, Duyen Kauffman et al.

Particulate Matter:

Spotlight on Health Protection

Julian Marshall, Ph.D.

- Kiely Endowed Professor of Environmental Engineering at University of Washington with a focus on air quality management
- Founded and runs the Grand Challenges Impact Lab, a UW study abroad program in Bangalore, India
- Associate Editor for Environmental Health Perspectives and Development Engineering
- Published over 100 peer-reviewed journal articles
- Ph.D. in Energy and Resources from UC Berkeley

Particulate Matter:
Spotlight on Health Protection

Scott Jenkins, Ph.D.

- Senior Environmental Health Scientist in EPA's Office of Air Quality Planning and Standards (OAQPS)
- Currently leading EPA’s review of the National Ambien Air Quality Standards (NAAQS) for Particulate Matter (PM)
- Howard Hughes Postdoctoral Research Fellow in the Department of Cell Biology at Duke University
- Ph.D. in Behavioral Neuroscience from the University of Alabama at Birmingham

REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER

OVERVIEW OF THE DRAFT POLICY ASSESSMENT

Scott Jenkins
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards

Presentation to the Bay Area Air Quality Management District

October 28, 2019

Outline of Presentation

- Overview of the standards, process and schedule
- Key information and analyses in draft Policy Assessment
- Preliminary conclusions on the primary $PM_{2.5}$ standards

C179

Current PM Standards Under Review

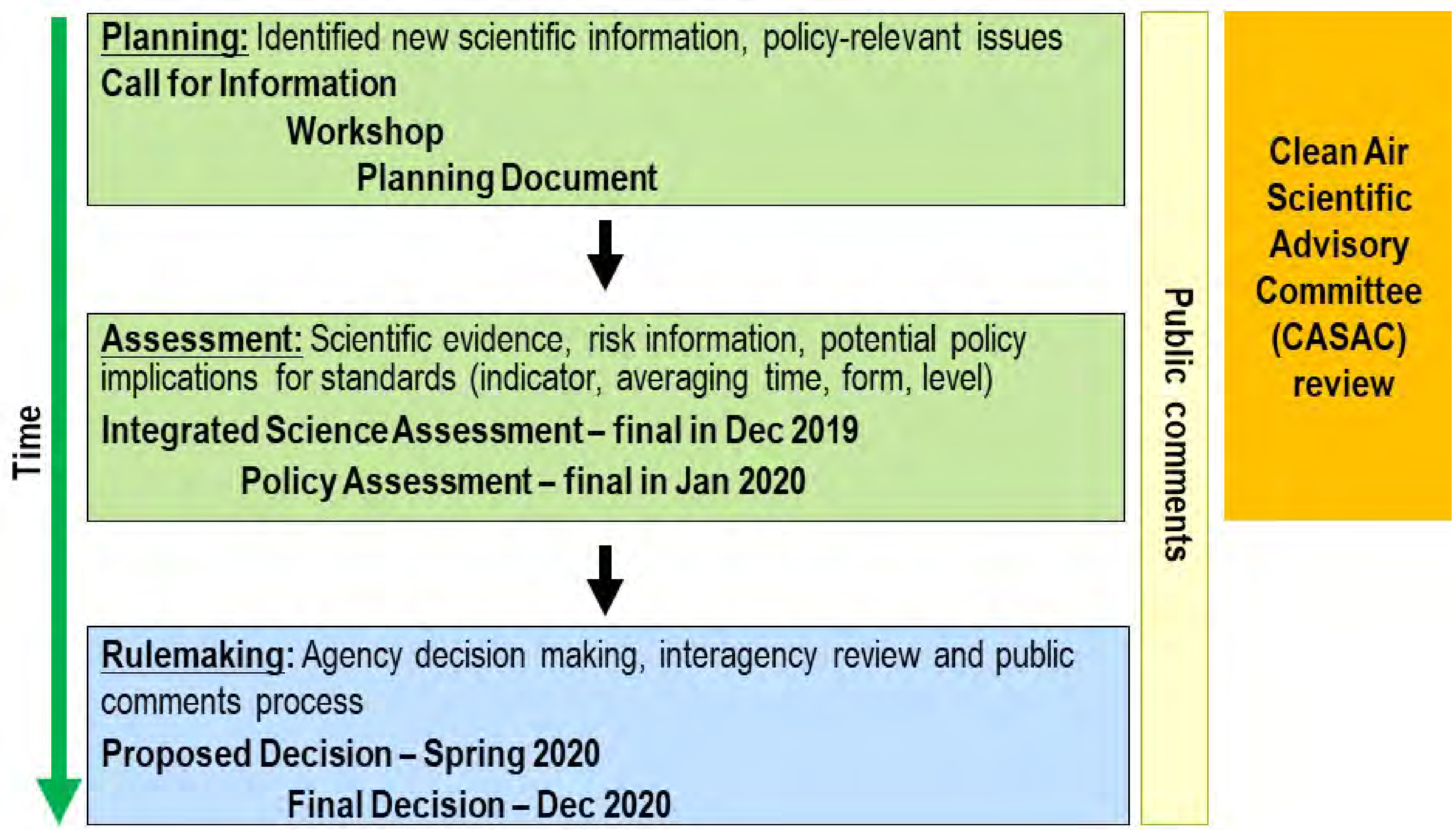
Current Standards – Last Review Completed in 2012*					Decisions in 2012 Review
Indicator	Averaging Time	Primary/Secondary	Level	Form	
$PM_{2.5}$	Annual	Primary	12.0 µg/m^3	Annual arithmetic mean, averaged over 3 years	Revised level from 15 to 12 µg/m^3**
		Secondary	15.0 µg/m^3		Retained**
	24-hour	Primary and Secondary	35 µg/m^3	98th percentile, averaged over 3 years	Retained
PM_{10}	24-hour	Primary and Secondary	150 µg/m^3	Not to be exceeded more than once per year on average over a 3-year period	Retained

*Prior to 2012, PM NAAQS were reviewed and revised several times – established in 1971 (total suspended particulate – TSP) and revised in 1987 (set PM_{10}), 1997 (set $PM_{2.5}$), 2006 (revised $PM_{2.5}$, PM_{10})

**EPA eliminated spatial averaging for the annual standards

C180

Process and Anticipated Schedule for This Review of the PM NAAQS



C181

Evaluating Primary $PM_{2.5}$ Standards: Summary of Approach

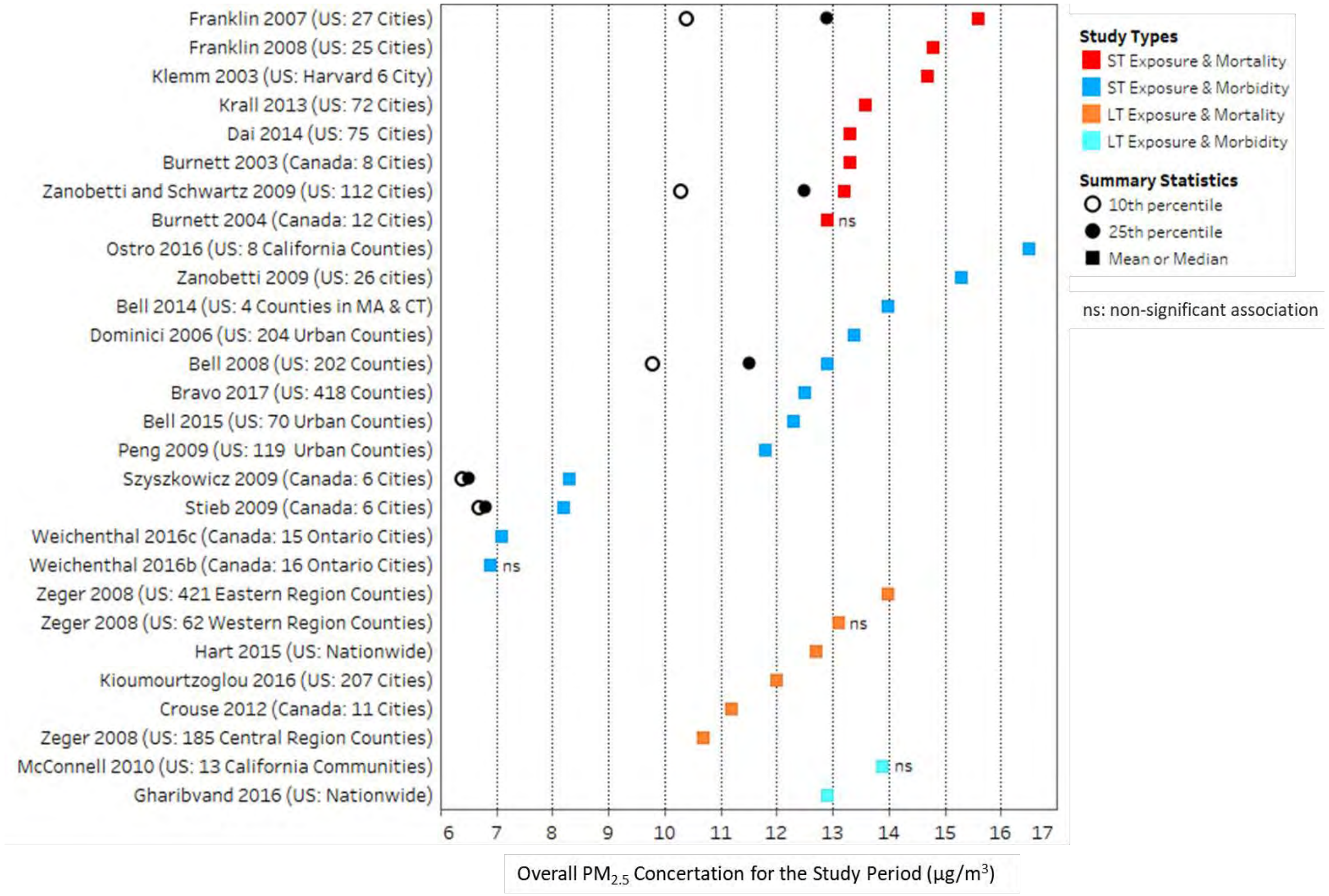
- The **annual** $PM_{2.5}$ **standard** is viewed as the principle means of providing public health protection against the bulk of the distribution of short- and long-term $PM_{2.5}$ exposures
- In previous reviews, conclusions on the annual $PM_{2.5}$ standard have been informed by consideration of the $PM_{2.5}$ air quality distributions associated with mortality or morbidity in epidemiologic studies
  - The current level of 12.0 $\mu g/m^3$ was set below the overall means of the long- and short-term $PM_{2.5}$ exposure estimates in key studies
- In this review, the draft PA characterizes those distributions by identifying overall means of $PM_{2.5}$ exposure estimates, concentrations corresponding to the lower quartiles of data (when available), and study-area metrics similar to design values (pseudo-design values)
- The **24-hour** $PM_{2.5}$ **standard**, with its 98^{th} percentile form, is viewed as a means of providing protection against short-term exposures to peak $PM_{2.5}$ concentrations, such as can occur in areas with strong contributions from local or seasonal sources, even when mean $PM_{2.5}$ concentrations remain relatively low
- Controlled human exposure studies provide evidence for health effects following single, short-term $PM_{2.5}$ exposures to concentrations that typically correspond to upper end of the $PM_{2.5}$ air quality distribution in the U.S. (i.e., “peak” concentrations – see additional slides)

C182

$PM_{2.5}$ Concentrations in Epidemiologic Studies

- Overall mean concentrations reflect study averages of daily or annual $PM_{2.5}$ exposures – bulk of data generally occurs around overall means
- Key studies consistently reporting positive and statistically significant associations have overall mean $PM_{2.5}$ concentrations > 8.0 $\mu g/m^3$
- In studies with data available, 75% of health events occurred in areas with mean $PM_{2.5}$ concentrations ≥ 11.5 $\mu g/m^3$ (U.S. studies) or 6.5 $\mu g/m^3$ (Canadian studies)

Monitored $PM_{2.5}$ concentrations*



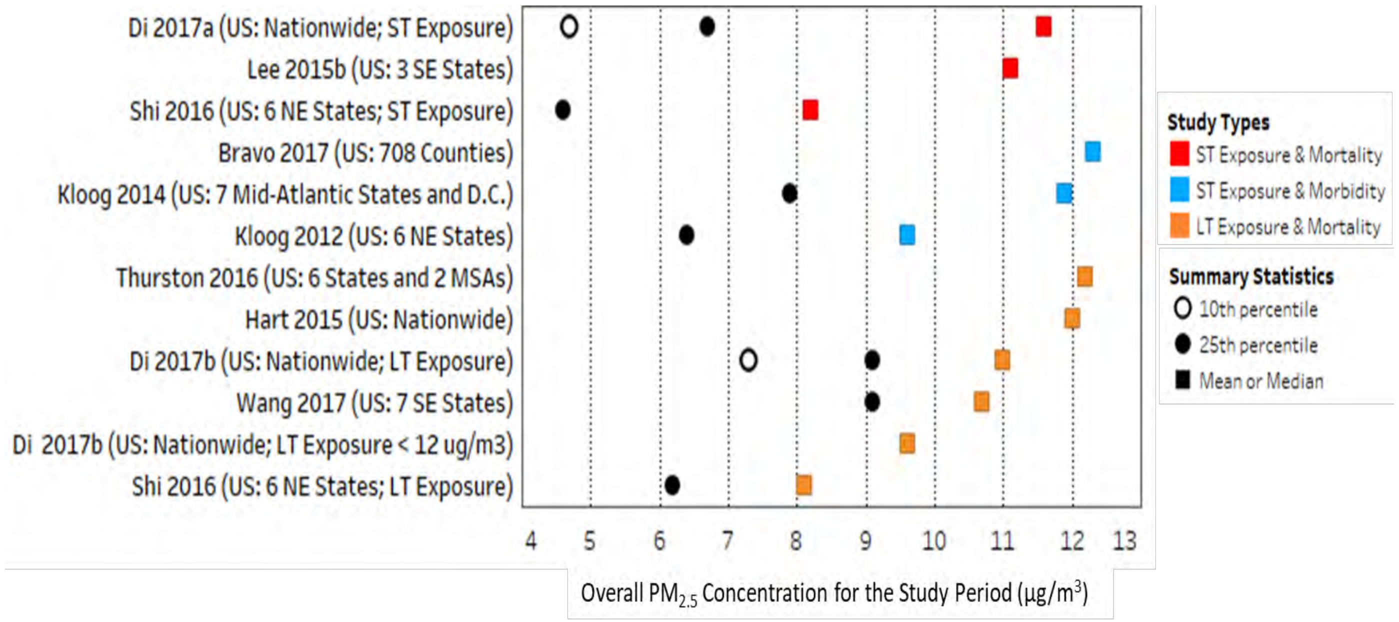
*Colored squares reflect overall study-reported mean (or median) $PM_{2.5}$ concentrations. Circles reflect the mean $PM_{2.5}$ concentrations corresponding to the 25th (filled) and 10th (open) percentiles of health events.

C183

$PM_{2.5}$ Concentrations in Epidemiologic Studies (Continued)

- Many new studies have used hybrid modeling approaches to estimate $PM_{2.5}$ exposures in monitored and unmonitored locations
- Approaches use information from multiple sources, potentially including satellites and models, in addition to ground-based monitors
- All of these key studies report positive and statistically significant associations and have overall mean $PM_{2.5}$ concentrations > 8.0 $\mu g/m^3$
- In most studies with data available, 75% of exposures (or deaths) are at predicted ambient $PM_{2.5}$ concentrations > 6.0 $\mu g/m^3$

Hybrid Model-Predicted $PM_{2.5}$ Concentrations



Uncertainties in using this information to inform conclusions on standards include:

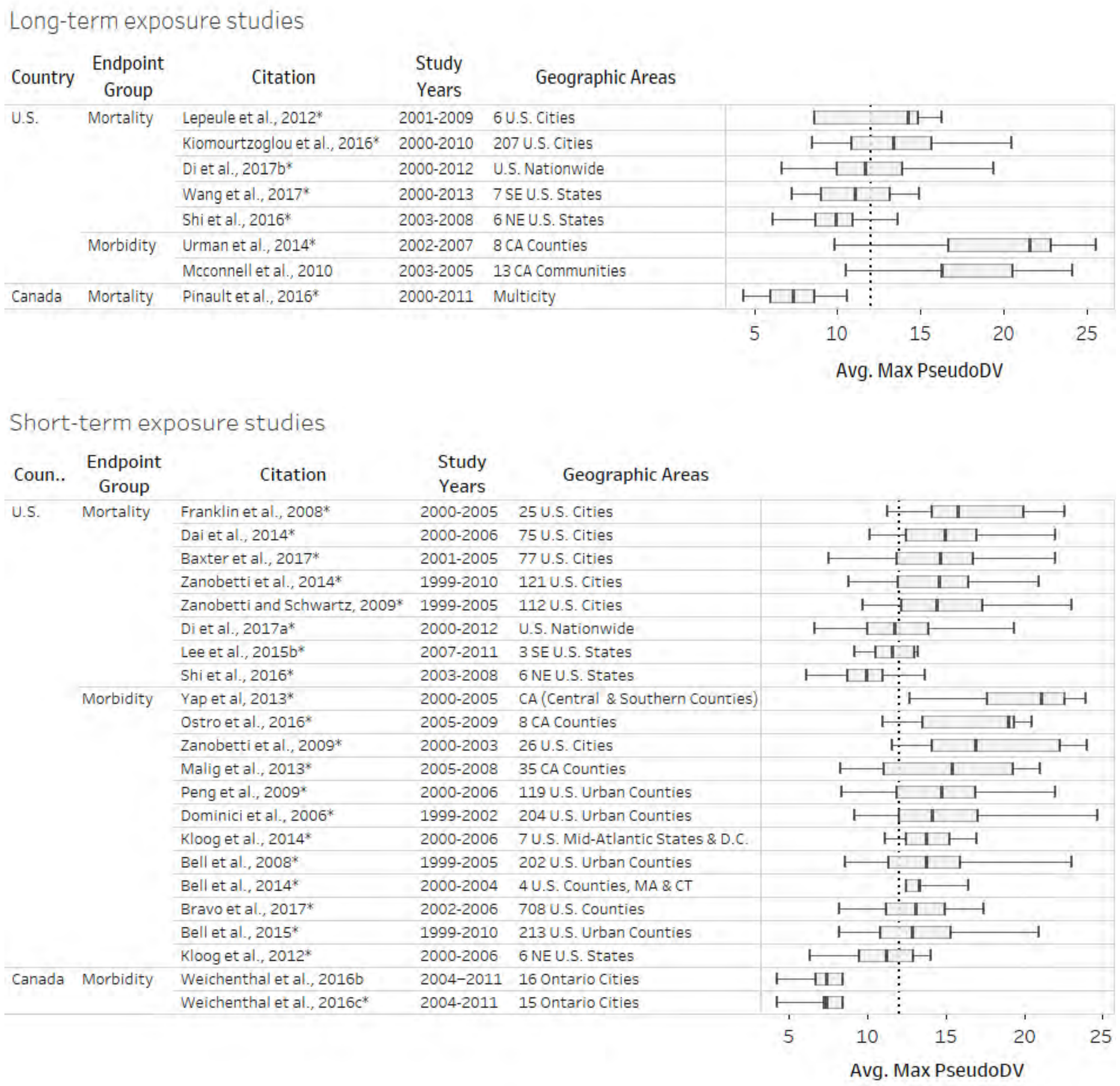
- Mean and lower quartile concentrations are not the same as those used by the EPA to compare with standard levels
- Studies have not identified a threshold concentration below which associations do not occur
- Hybrid model performance varies by location, with factors contributing to poorer performance (e.g., sparse monitoring) often coinciding with relatively low ambient $PM_{2.5}$ concentrations

*Colored squares reflect overall study-reported mean $PM_{2.5}$ concentrations. Circles reflect the mean $PM_{2.5}$ concentrations corresponding to the 25th (filled) and 10th (open) percentiles of exposures or deaths.

C184

$PM_{2.5}$ Annual Pseudo-Design Values in Locations of Key Studies

- The draft PA also identifies monitor-based metrics – similar to design values – in study locations (annual and 24-hr pseudo-design values)
- For most of the 29 key studies evaluated, ≥ about 25% of study area health events/populations were in locations that generally would have met both standards during study periods
- For 9 key studies, > 50% of study area health events/populations were in such locations
- For 4 key studies, > 75% of study area health events/populations were in such locations
- Uncertainties include:
  - Many studies examine a mix of locations and time periods meeting and violating standards
  - Values are not available in unmonitored areas
  - Values do not reflect current near-road monitoring requirements

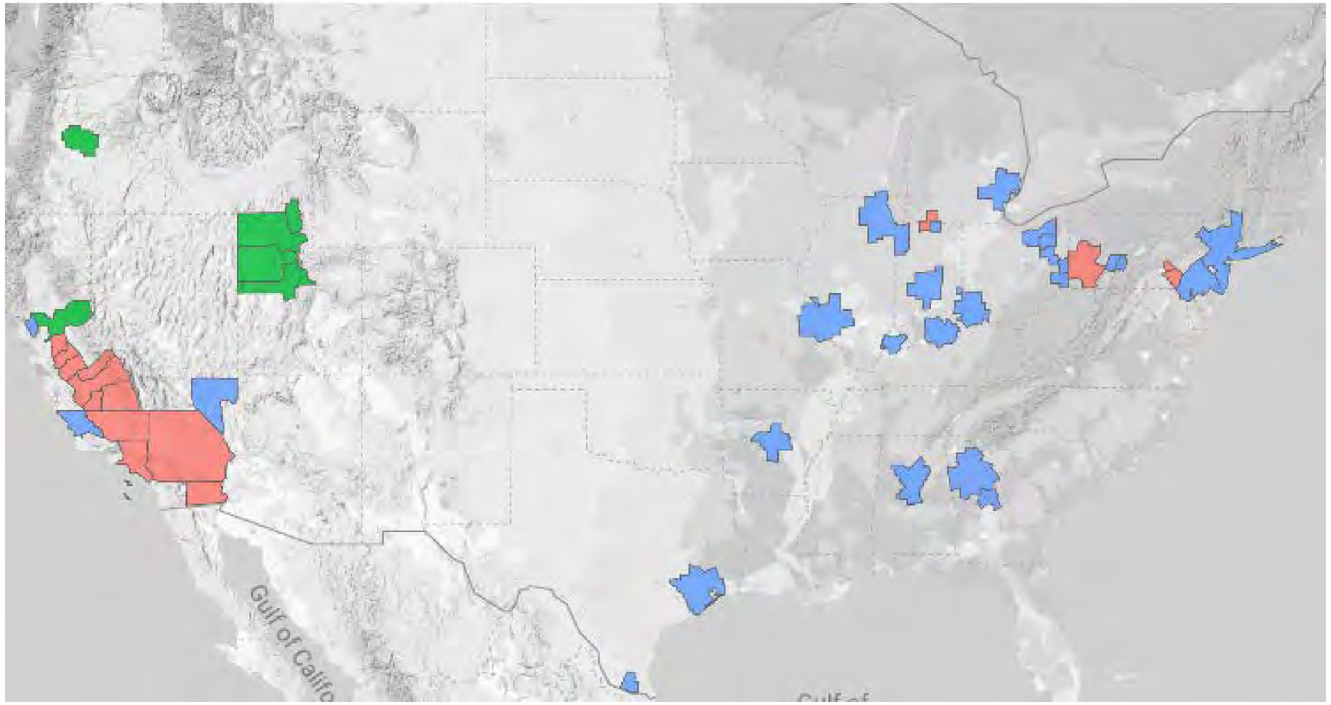


C185

 * Whiskers correspond to 5th and 95th percentiles, boxes correspond to 25th and 75th percentiles, central vertical lines correspond to 50th percentiles

$PM_{2.5}$ Risk Assessment

- Examined $PM_{2.5}$-associated mortality risk in 47 urban study areas
- Assessed current standards; alternative annual standards with levels of 11.0, 10.0, and 9.0 µg/m^3; alternative 24-hour standard with a level of 30 µg/m^3
- 2015 analysis year
- Examined two approaches to adjusting air quality
  - Focus on primary PM
  - Focus on secondary PM



47 urban study areas (population ≥ 30 years: ~60M)

- 30 annual-controlling (population ≥ 30 years: ~50M)
- 11 daily-controlling (population ≥ 30 years: ~4M)
- 6 mixed (population ≥ 30 years: ~5M)

Above 10 annual and 30 daily
Above 30 daily
Above 10 annual

C186

Summary of Risk Estimates

Estimates of $PM_{2.5}$-associated deaths in the full set of 47 study areas

Endpoint	Study	Air quality simulation approach*	Current Standad Absolute Risk (12/35 µg/m^3)	CS (12/35) % of baseline**	Alternative Standard Absolute Risk: Alternative Annual (10 µg/m^3)	Alternative Standard Absolute Risk: Alternative 24-hr (30 µg/m^3)
Long-term exposure related mortality						
Ischemic Heart Disease	Jerrett 2016	Pri-PM	16,500 (12,600-20,300)	14.1	14,400 (11,000-17,700)	16,400 (12,500-20,000)
		Sec-PM	16,800 (12,800-20,500)	14.3	14,200 (10,900-17,500)	16,500 (12,600-20,200)
	Pope 2015	Pri-PM	15,600 (11,600-19,400)	13.3	13,600 (10,100-17,000)	15,400 (11,500-19,200)
		Sec-PM	15,800 (11,800-19,600)	13.4	13,400 (9,970-16,700)	15,600 (11,600-19,400)
All-cause	Di 2017	Pri-PM	46,200 (45,000-47,500)	8.4	40,300 (39,200-41,400)	45,700 (44,500-47,000)
		Sec-PM	46,900 (45,600-48,200)	8.5	39,700 (38,600-40,800)	46,200 (44,900-47,500)
	Pope 2015	Pri-PM	51,300 (41,000-61,400)	7.1	44,700 (35,700-53,500)	50,700 (40,500-60,700)
		Sec-PM	52,100 (41,600-62,300)	7.2	44,000 (35,100-52,700)	51,300 (41,000-61,400)
	Thurston 2015	Pri-PM	13,500 (2,360-24,200)	3.2	11,700 (2,050-21,100)	13,300 (2,330-24,000)
		Sec-PM	13,700 (2,400-24,600)	3.2	11,500 (2,010-20,700)	13,500 (2,360-24,200)
Lung cancer	Turner 2016	Pri-PM	3,890 (1,240-6,360)	8.9	3,390 (1,080-5,560)	3,850 (1,230-6,300)
		Sec-PM	3,950 (1,260-6,460)	9.1	3,330 (1,060-5,470)	3,890 (1,240-6,370)
Short-term exposure related mortality						
All cause	Baxter 2017	Pri-PM	2,490 (983-4,000)	0.4	2,160 (850-3,460)	2,460 (970-3,950)
		Sec-PM	2,530 (998-4,060)	0.4	2,120 (837-3,400)	2,490 (982-3,990)
	Ito 2013	Pri-PM	1,180 (-16-2,370)	0.2	1,020 (-14-2,050)	1,160 (-16-2,340)
		Sec-PM	1,200 (-16-2,400)	0.2	1,000 (-14-2,020)	1,180 (-16-2,370)
	Zanobetti 2014	Pri-PM	3,810 (2,530-5,080)	0.7	3,300 (2,190-4,400)	3,760 (2,500-5,020)
		Sec-PM	3,870 (2,570-5,160)	0.7	3,250 (2,160-4,330)	3,810 (2,530-5,070)

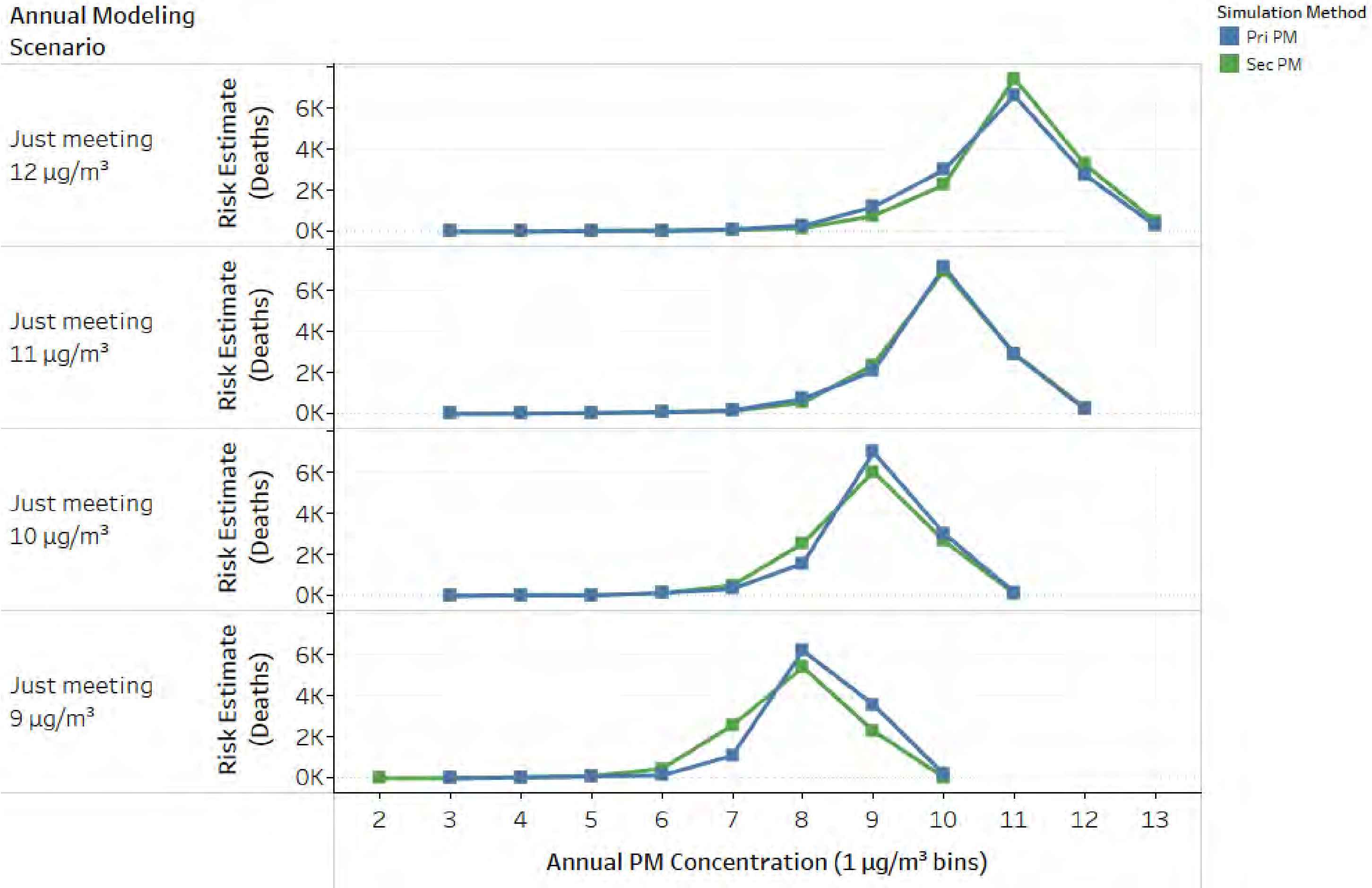
* Pri-PM (primary PM-based modeling approach), Sec-PM (secondary PM-based modeling approach)

** CS denotes the current standard.

C187

Summary of Risk Estimates (Continued)

Distributions of estimated risks in the 30 study areas where the annual standard is controlling*



Uncertainty in risk estimates results from uncertainties in the underlying epidemiologic studies, in the air quality adjustments, and in the application of study and air quality information to develop quantitative estimates of $PM_{2.5}$-associated mortality risks

*Estimates of ischemic heart disease deaths associated with long-term $PM_{2.5}$ exposures for air quality adjusted to simulate "just meeting" the current and alternative primary standards (based on Jerrett et al., 2016)

C188

Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards

- 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 $PM_{2.5}$ standards
- Basis for this preliminary conclusion:
  - Long-standing body of health evidence, strengthened in this review, supporting relationships between $PM_{2.5}$ exposures and various outcomes, including mortality and serious morbidity effects
  - Recent U.S. and Canadian epidemiologic studies reporting positive and statistically significant health effect associations for $PM_{2.5}$ air quality likely to be allowed by the current standards
  - Analyses of pseudo-design values indicating substantial portions of study area health events/populations in locations with air quality likely to have met the current $PM_{2.5}$ standards
  - Risk assessment estimates that the current primary standards could allow thousands of $PM_{2.5}$-associated deaths per year – most at annual average $PM_{2.5}$ concentrations from 10 to 12 $\mu g/m^3$ (well within the range of overall mean concentrations in key epidemiologic studies)

C189

Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards (Continued)

- In contrast, a conclusion that the current primary $PM_{2.5}$ standards do provide adequate health protection would place little weight on the epidemiologic evidence or the risk assessment
- Such a conclusion would place greater weight on uncertainties and limitations, including:
  - Increasing uncertainty in the biological pathways through which $PM_{2.5}$ exposures could cause serious health effects as the ambient concentrations being considered fall farther below the $PM_{2.5}$ exposure concentrations shown to cause effects in experimental studies
  - Increasing uncertainty in the potential public health impacts of air quality improvements as the ambient concentrations being considered fall farther below those present in accountability studies that document improving health with declining $PM_{2.5}$
    - Accountability studies evaluate air quality improvements with “starting” mean $PM_{2.5}$ concentrations (i.e., prior to the reductions evaluated) from ~13 to > 20 $\mu g/m^3$
  - Uncertainty in the risk assessment results from uncertainties in the underlying epidemiologic studies, in the air quality adjustments, and in the application of study and air quality information to develop quantitative estimates of $PM_{2.5}$-associated mortality risks

C190

Preliminary Conclusions on the Annual Standard Level

- If consideration is given to revising the primary $PM_{2.5}$ standards to increase public health protection, it would be appropriate to focus on lowering the level of the annual standard
- Support for particular levels depends on the weight placed on various aspects of the science and uncertainties
- For example, a level as low as 10.0 $\mu g/m^3$ could be considered if weight is placed on:
  - Setting a standard to maintain mean $PM_{2.5}$ concentrations below those in most key U.S. epidemiologic studies
  - Setting the standard level at or below the pseudo-design values corresponding to about the 50th percentiles of study area health event/populations in key U.S. studies
  - Setting a standard estimated to reduce $PM_{2.5}$-associated health risks, such that a substantial portion of the risk reduction is estimated at annual average $PM_{2.5}$ concentrations ≥ ~8 $\mu g/m^3$
- A level below 10.0 $\mu g/m^3$, potentially as low as 8.0 $\mu g/m^3$, could be supported to the extent more weight is placed on $PM_{2.5}$ health effect associations and estimated risks at lower concentrations and less weight is placed on uncertainties at lower concentrations

C191

Preliminary Conclusions on the 24-Hour Standard Level

- Purpose of the 24-hour standard is to provide protection against the short-term exposures to peak $PM_{2.5}$ concentrations, such as those that can occur in areas with strong contributions from local or seasonal sources even when overall mean concentrations remain relatively low
- In considering potential support for additional protection against short-term exposures to "peak" concentrations, we focus on the evidence from key epidemiologic studies and human clinical studies
  - Key epidemiologic studies do not indicate that $PM_{2.5}$ health effect associations are driven disproportionately by peak concentrations
  - Human clinical studies report effects following single short-term $PM_{2.5}$ exposures, but these studies generally examine exposures well above those measured in areas meeting the current standards
- Thus, the evidence provides little support for the need to provide additional protection against short-term peak concentrations in areas meeting the current 24-hour standard and the current, or revised (i.e., with a lower level), annual standard

C192

Additional Information

Two-Hour $PM_{2.5}$ Concentrations

- In human clinical studies, statistically significant effects on one or more indicators of cardiovascular function are often, though not always, reported following 2-hour exposures to average $PM_{2.5}$ concentrations at and above about 120 μg/m^3
- There is less consistent evidence for effects following exposures to lower concentrations

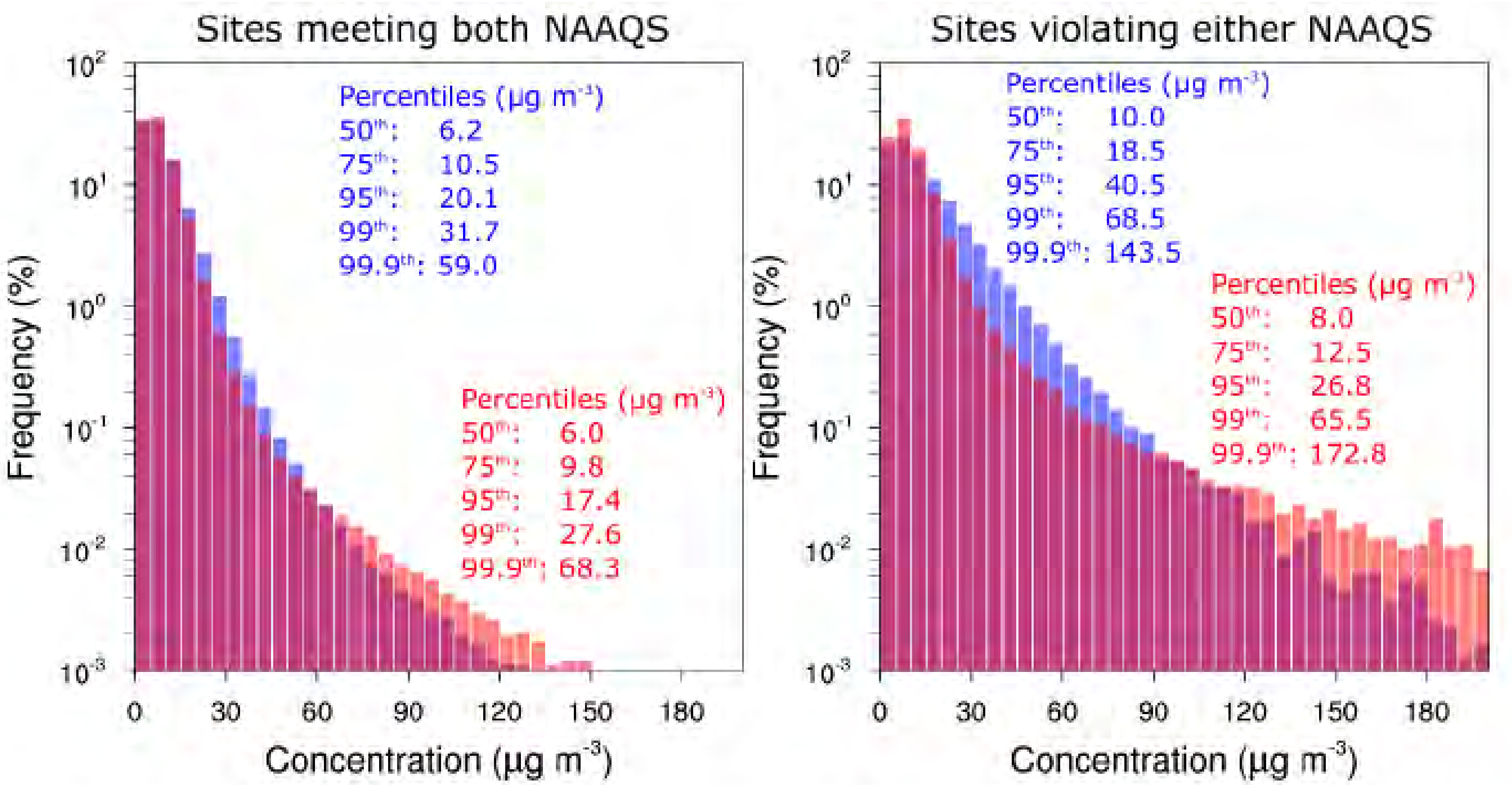
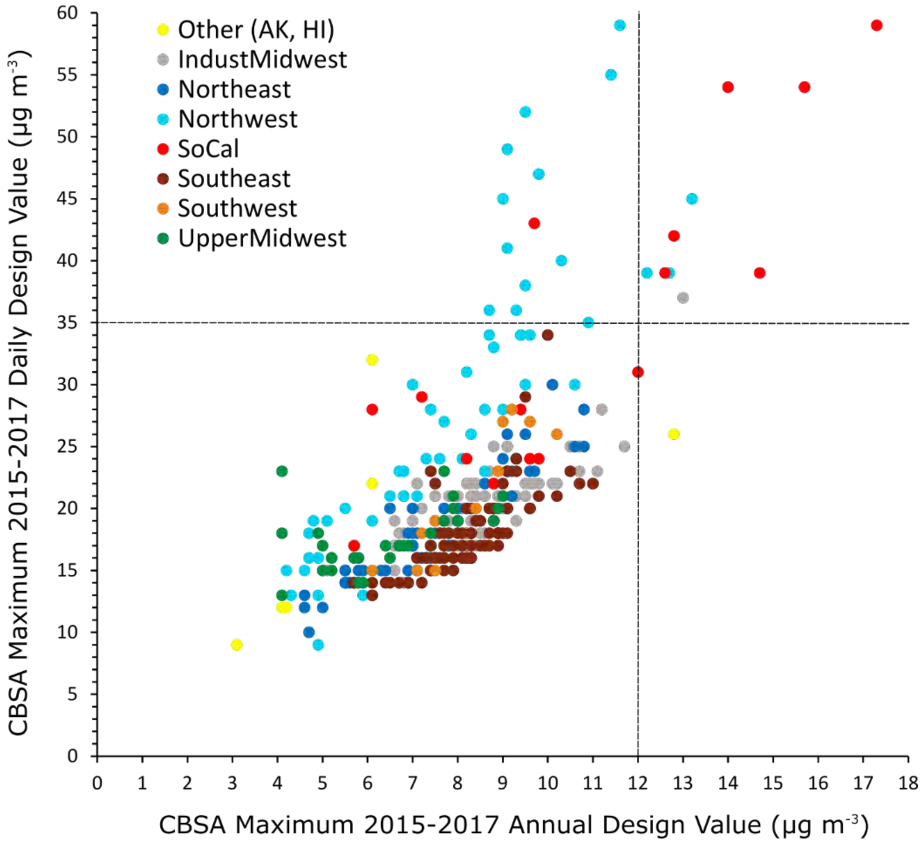


Figure 2-14.Frequency distribution of 2015-2017 2-hour averages for sites meeting or violating the annual $PM_{2.5}$ NAAQS for October to March (blue) and April to September (red).

C194

Annual and 24-Hour DVs

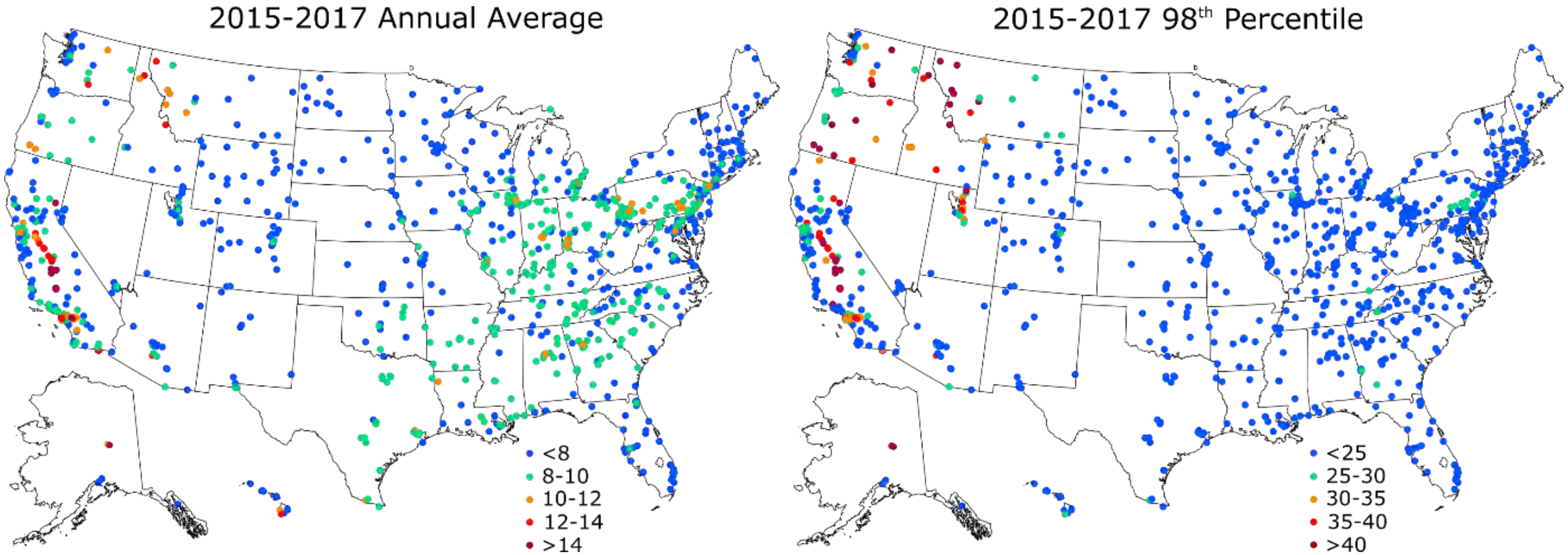


Draft PA Figure 2-11

It is likely that some of the annual and daily design values above are impacted by potential exceptional events associated with wildfire smoke that have yet to be removed from the calculations.

C195

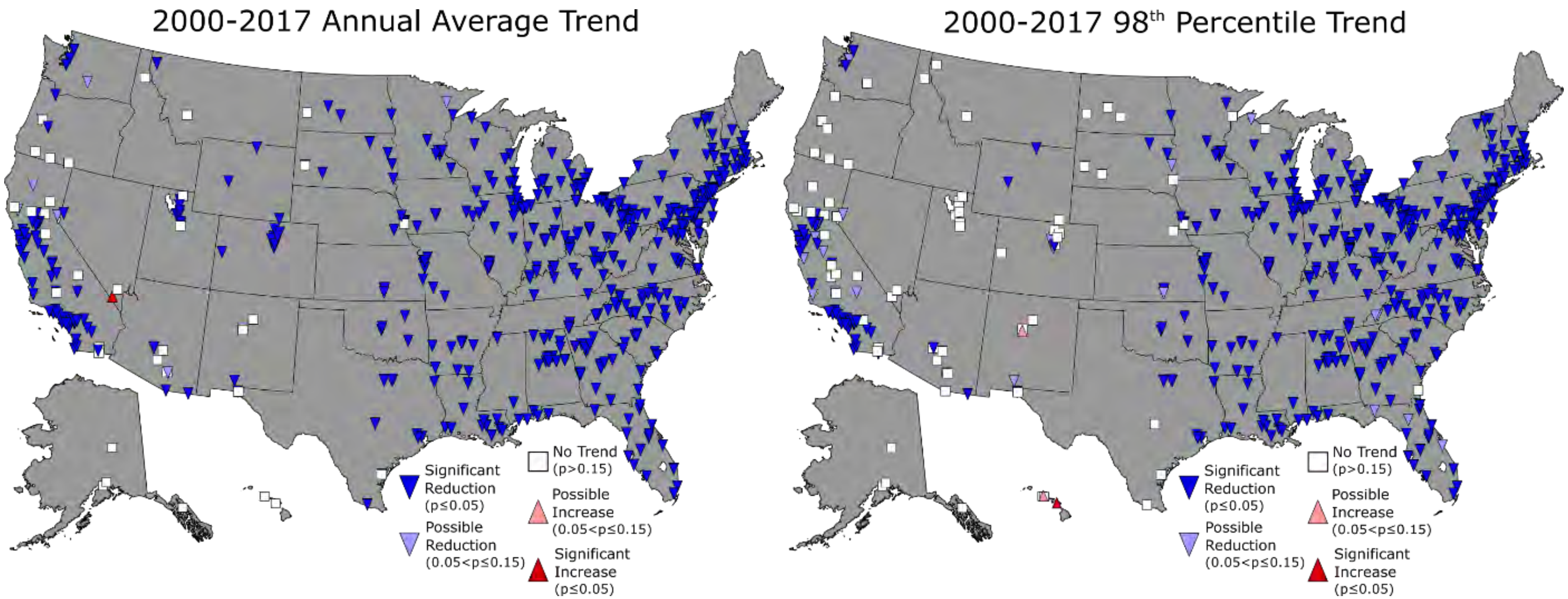
$PM_{2.5}$: Recent Concentrations



- Highest annual average and 98th percentile $PM_{2.5}$ concentrations are in California
- Fires in the Northwest were frequent during the 2015-2017 period
- Most Eastern sites had annual average and 98th percentile values below 10 and 25 μg m^{-3}, respectively

C196

$PM_{2.5}$ Trends



- The annual average and 98th percentile values have decreased over much of the Eastern US since 2000
- In the Western US, many sites have had no trend in the 98th percentile values in part because of the impact of meteorology and wildfires

C197

Key $PM_{2.5}$-Related Health Outcomes Considered in the Draft PA

Exposure Duration	Outcome	2009 ISA Conclusion	2018 Draft ISA Conclusion
Long-Term	Mortality	Causal	Causal
	Cardiovascular	Causal	Causal
	Respiratory	Likely to be causal	Likely to be causal
	Cancer	Suggestive	Likely to be causal
	Nervous System	None	Likely to be causal
Short-Term	Mortality	Causal	Causal
	Cardiovascular	Causal	Causal
	Respiratory	Likely to be causal	Likely to be causal

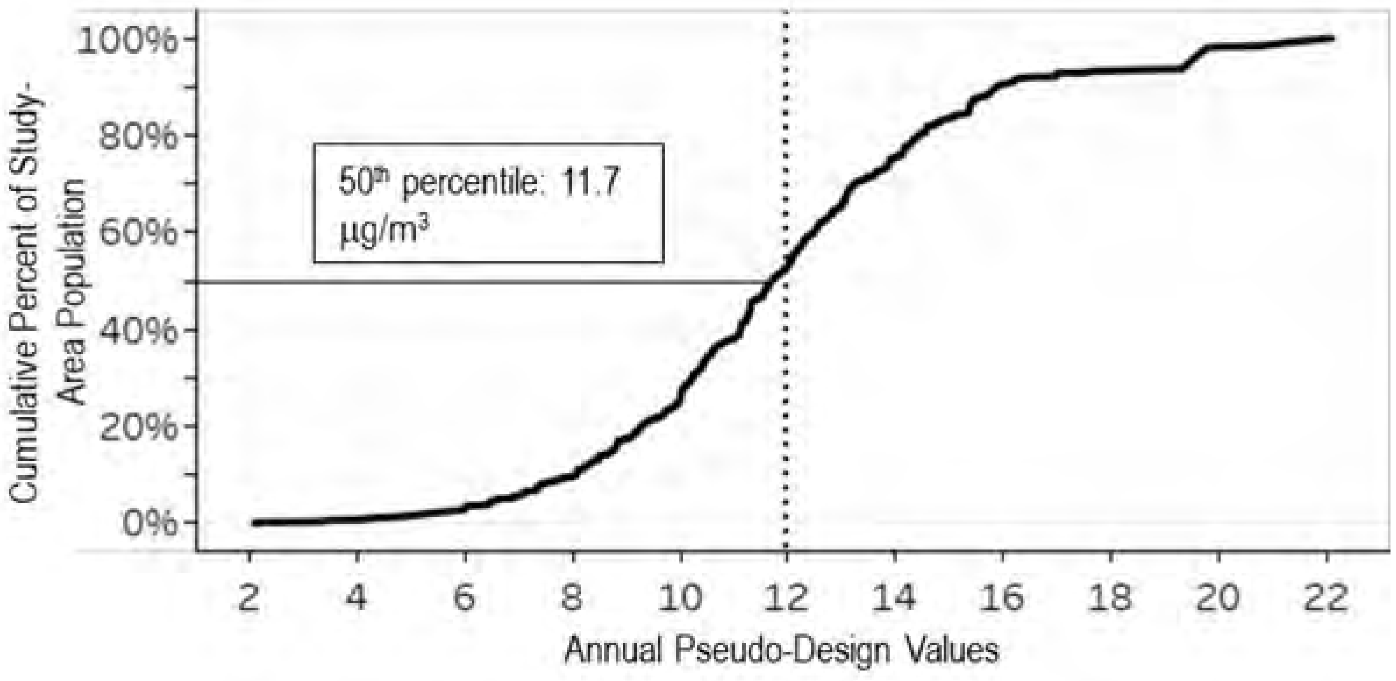
C198

Calculation of $PM_{2.5}$ Pseudo-Design Values

Approach

- Identify study areas (counties/cities) with sufficient monitoring data to calculate pseudo-design values
- For each monitored area and each 3-yr period of the study, identify the highest monitored $PM_{2.5}$ value
- For each monitored area, calculate the study-period average of these highest values
- Link study locations to study populations or health events
- Arrange study locations by ascending pseudo-design values
- Identify the cumulative percent of population or health events in study locations with various pseudo-design values

Example for Di et al. (2017)



C199

Particulate Matter:

Spotlight on Health Protection

Phil Martien, Ph.D.

- Director of the Assessment, Inventory, & Modeling Division at the Bay Area Air Quality Management District
- Leading role in the Technical Assessment of AB617's West Oakland Community Action Plan
- Leading role in the Technical Assessment of the Air District's 2017 Clean Air Plan: Spare the Air, Cool the Climate
- Leading role in the Air District's Community Air Risk Evaluation Program
- Ph.D. from UC Berkeley

Targeting Particulate Matter: West Oakland Community Emissions Reduction Program

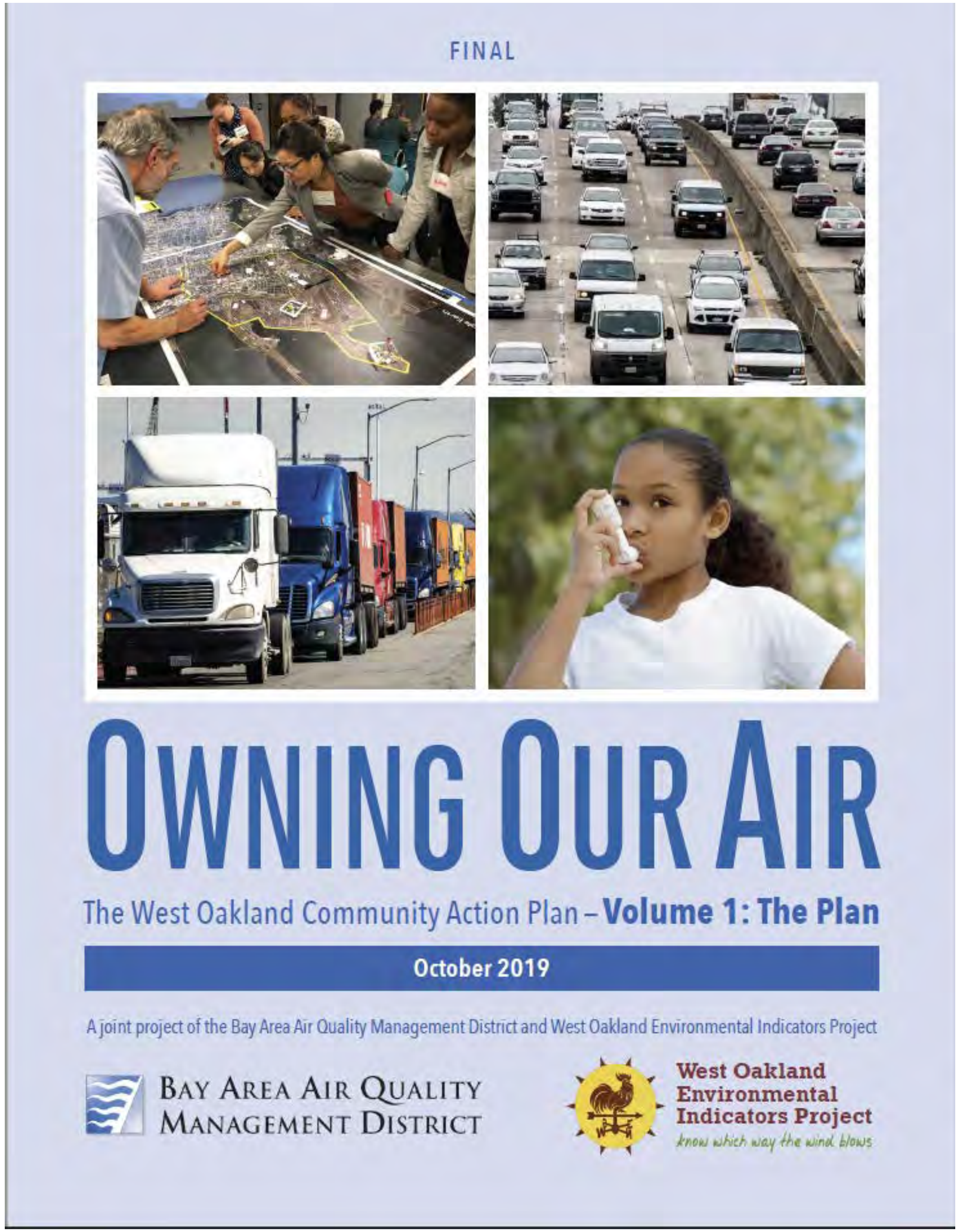
BAY AREA AIR QUALITY MANAGEMENT DISTRICT

West Oakland Environmental Indicators Project
know which way the wind blows

Phil Martien, PhD
Bay Area Air Quality Management District
Particulate Matter: Spotlight on Health Protection
October 28, 2019

Acknowledgements

- Bay Area Air Quality Management District
- West Oakland Environmental Indicators Project
- West Oakland Steering Committee
- California Air Resources Board



Assessment of Particulate Matter (PM) in West Oakland

- **Motivation**
  - Implementing Assembly Bill (AB) 617: West Oakland Community Emissions Reduction Program
- **Modeling-based assessment approach**
- **Findings**
  - Source contributions to impacts
  - Equity-based targets
  - Effective emission reduction measures

West Oakland

C204

Motivation

Implementing AB 617

- Address environmental justice concerns: higher air pollution in some communities
- Key mandates:
  - Local air districts to partner with community groups
  - Identify top sources of community impacts
  - Develop and implement plans to reduce emissions

C206

West Oakland: Year 1 Community Emissions Reduction Plan

West Oakland Environmental Indicators Project
know which way the wind blows

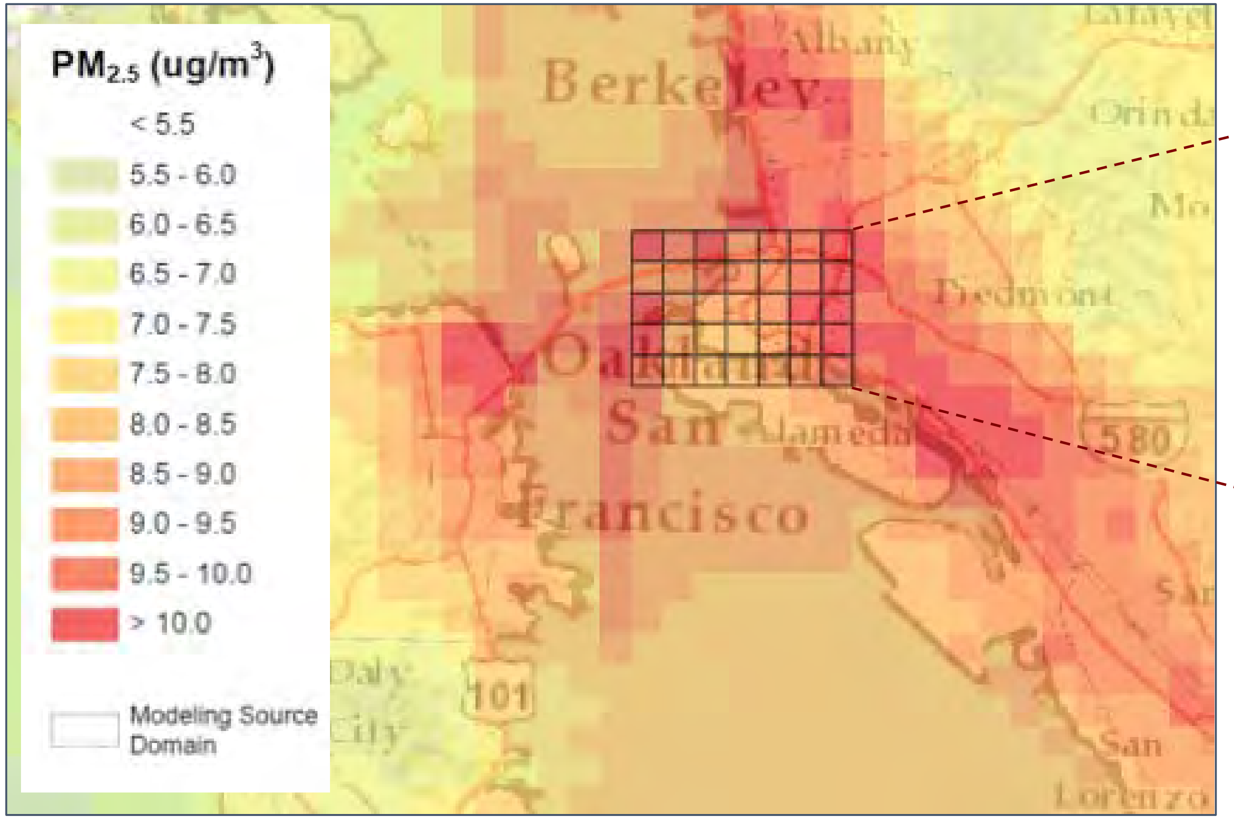
- Established partner: WOEIP has decades of experience

- High mobile-source emissions
  - Adjacent to the Port of Oakland
  - Surrounded by the I-880, I-80, I-580, and I-980 freeways
  - Industrial sources

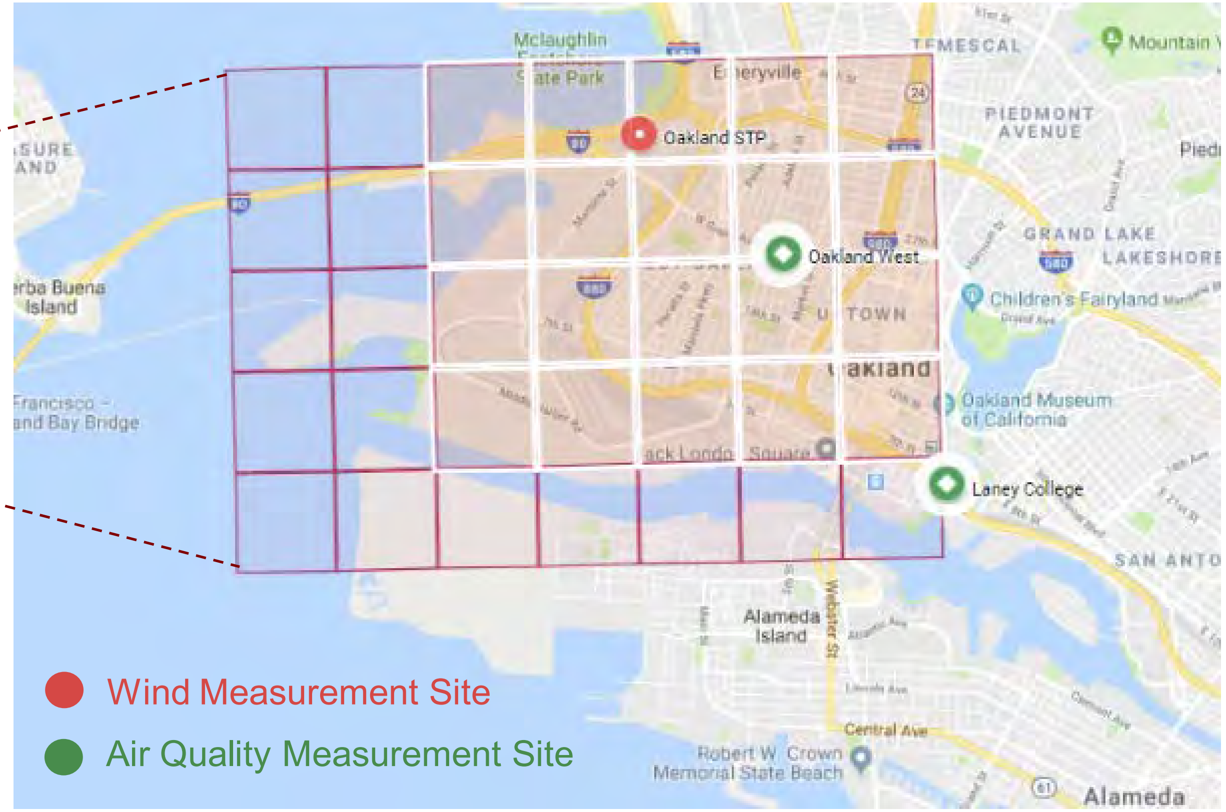
- High health burdens and socio-economic vulnerabilities

Assessment Approach

Regional-Scale and Community-Scale Modeling (2017)



Regional-scale modeling: covers the Bay Area



Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

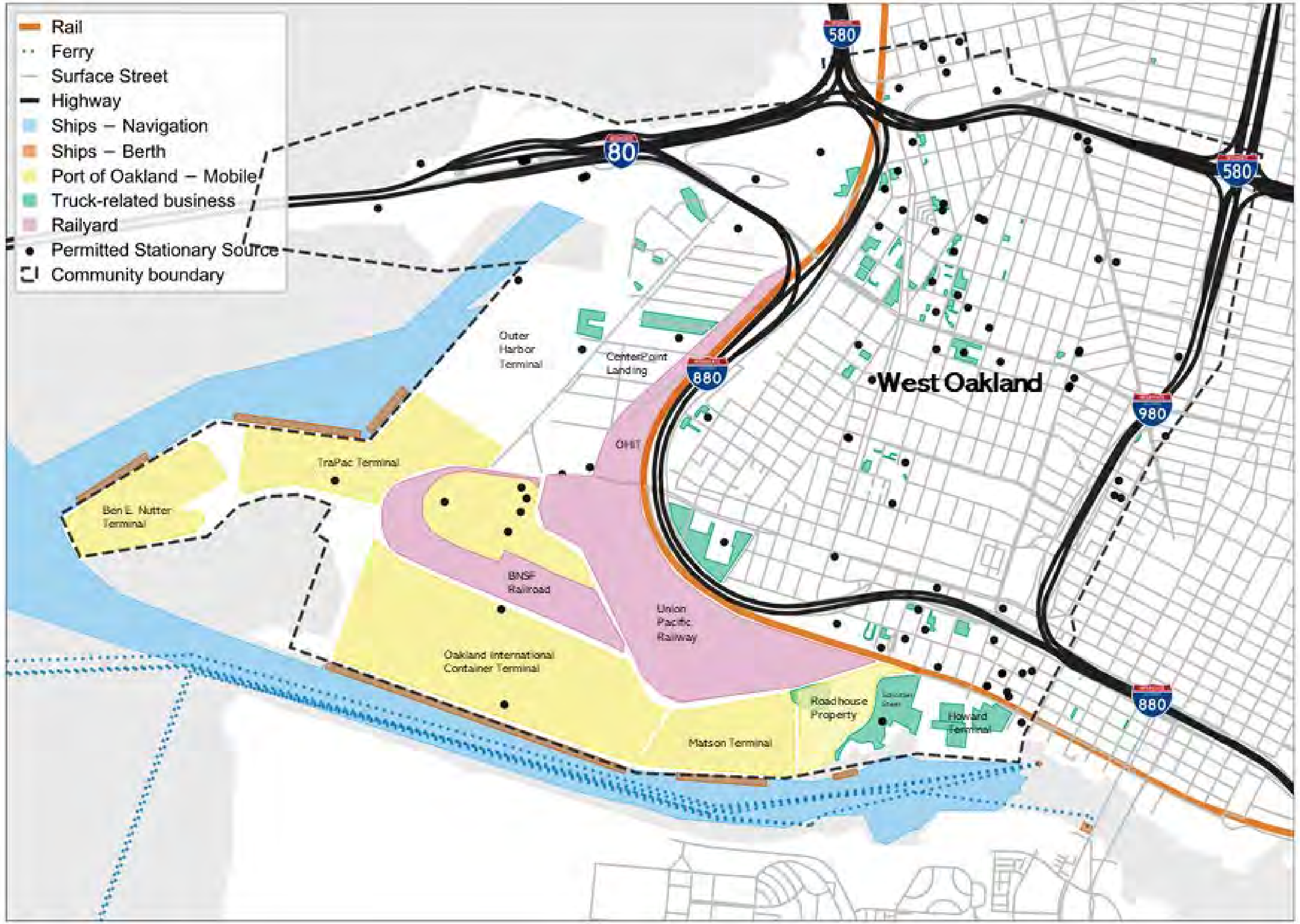
C209

Community-Scale Modeling

Pollutants
- $PM_{2.5}$
- Diesel PM
- Air toxics (cancer risk)

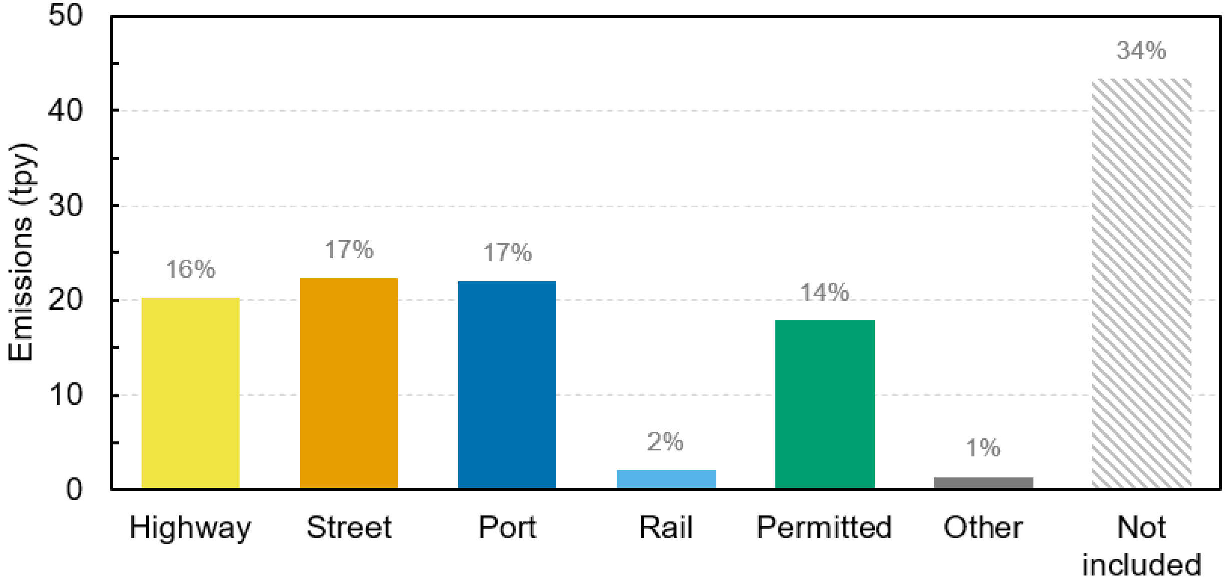
Sources modeled
- Port of Oakland and marine
- Railyards and trains
- Vehicles on freeways, streets
- Truck-related businesses
- Permitted stationary sources

Not modeled
- Construction, residential woodburning, and restaurants

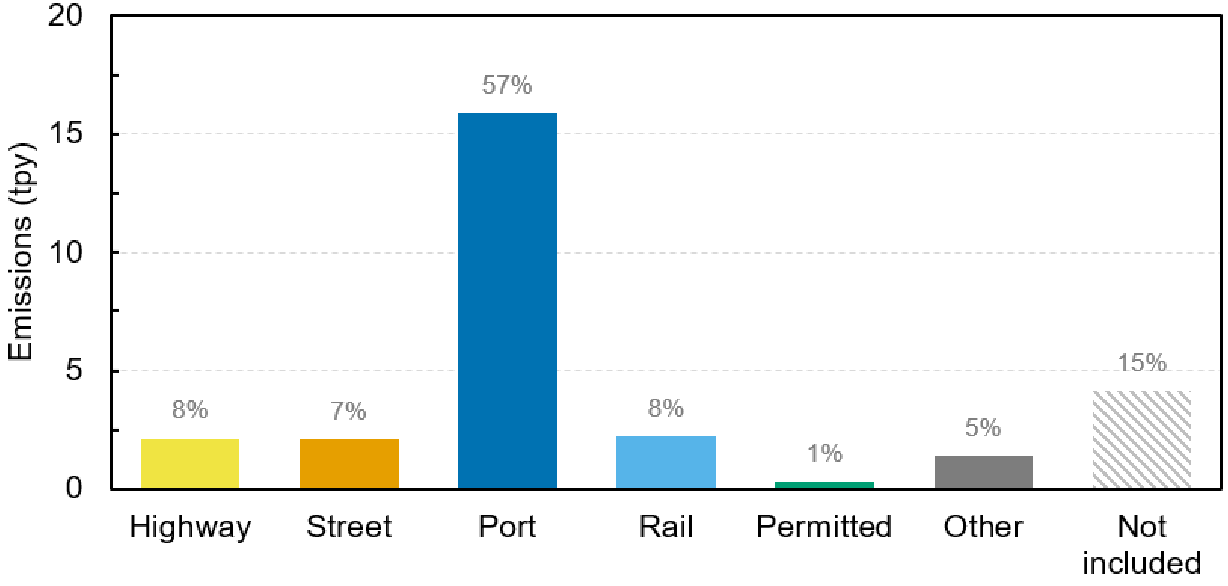


West Oakland Emissions by Source Category (2017)

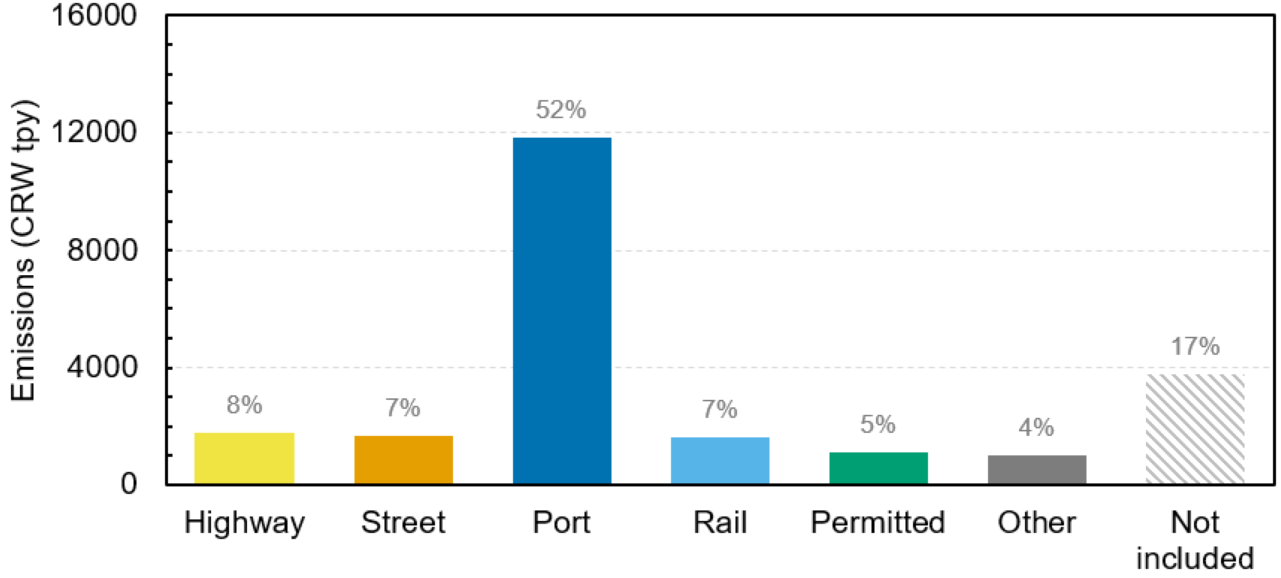
(a) $PM_{2.5}$



(b) Diesel PM



(c) Cancer risk-weighted toxics



Impact Varies by Location

Local Impact Zones

Local Impact Zones

1. Lower bottom/West Prescott
2. Third Street
3. Seventh Street
4. Acorn
5. Upper Adeline
6. Clawson
7. West Grand and San Pablo

Black Carbon above Median (Env. Def. Fund, 2019-01-13)

C213

Impact Zones

on Census Blocks

Leaflet | Map tiles by Stamen Design, under CC BY 3.0. Data by OpenStreetMap, under CC BY SA.

Source Apportionment

Block by Block

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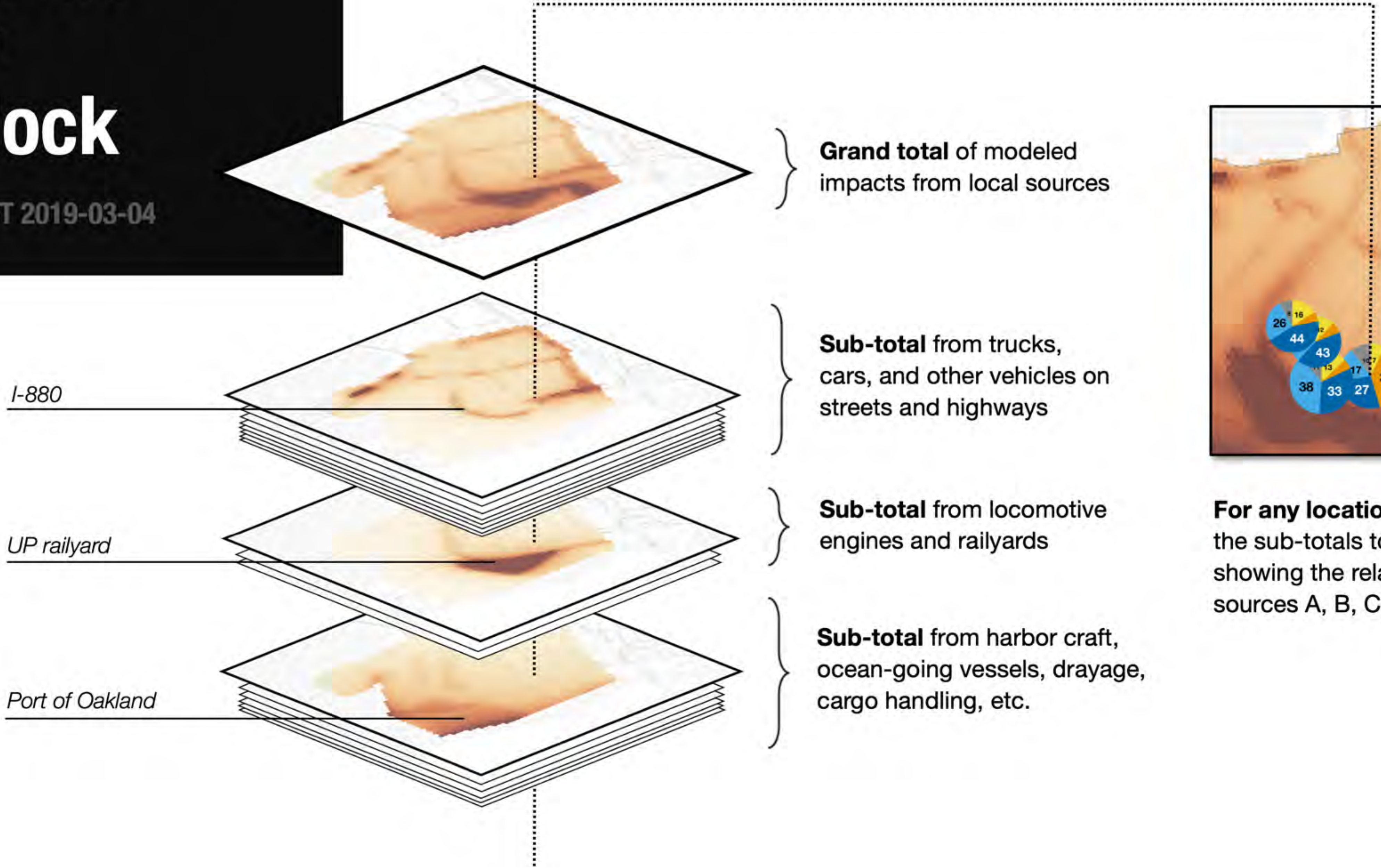
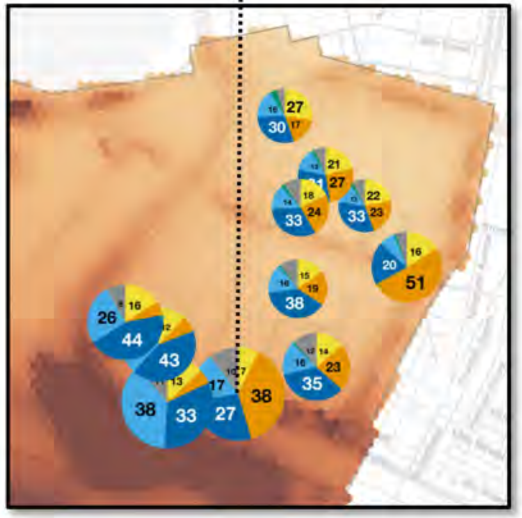


Grand total of modeled impacts from local sources

Sub-total from trucks, cars, and other vehicles on streets and highways

Sub-total from locomotive engines and railyards

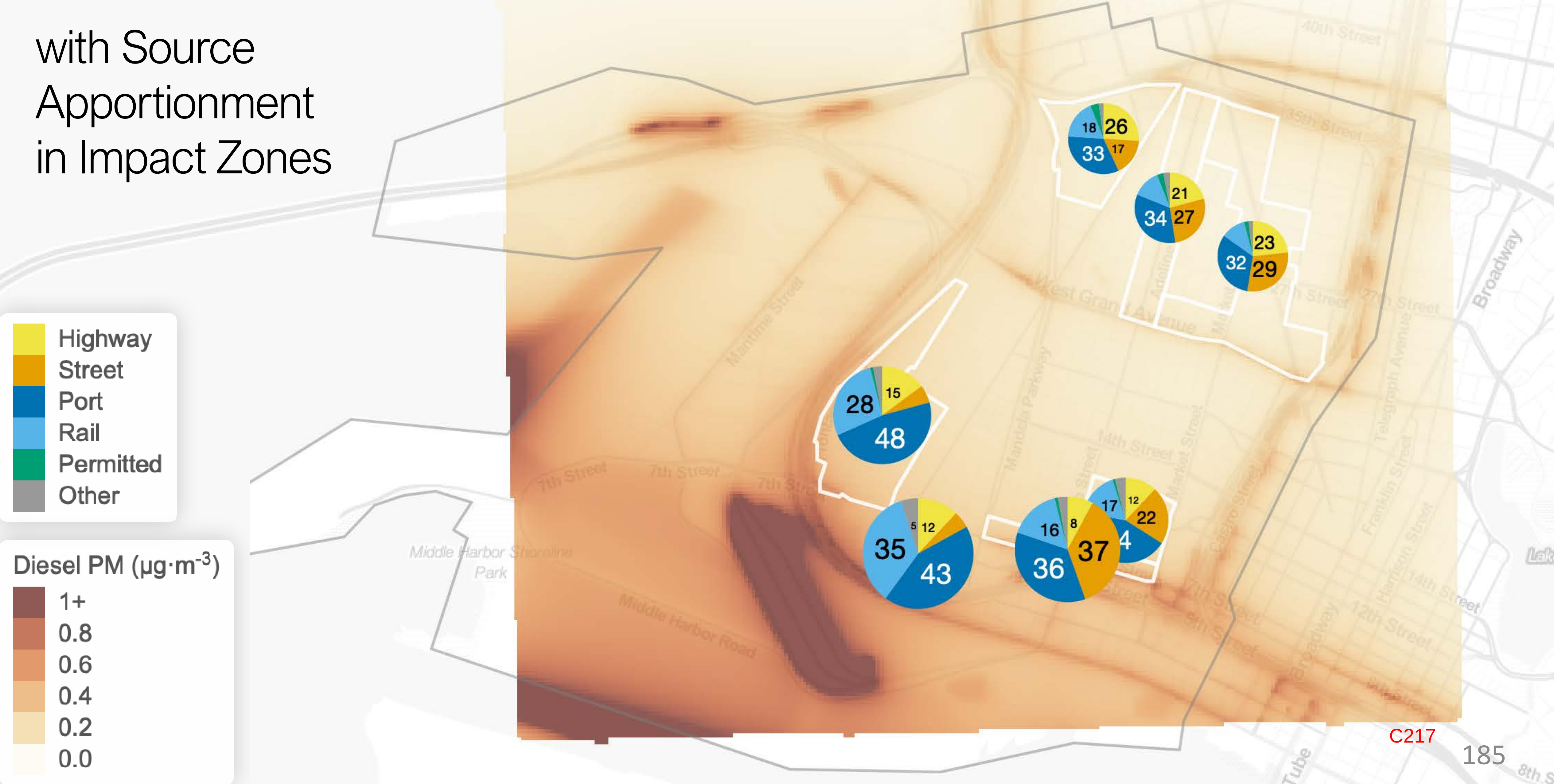
Sub-total from harbor craft, ocean-going vessels, drayage, cargo handling, etc.



For any location, we can use the sub-totals to draw piecharts showing the relative impacts of sources A, B, C, etc.

Modeled Diesel PM (from Local Sources)

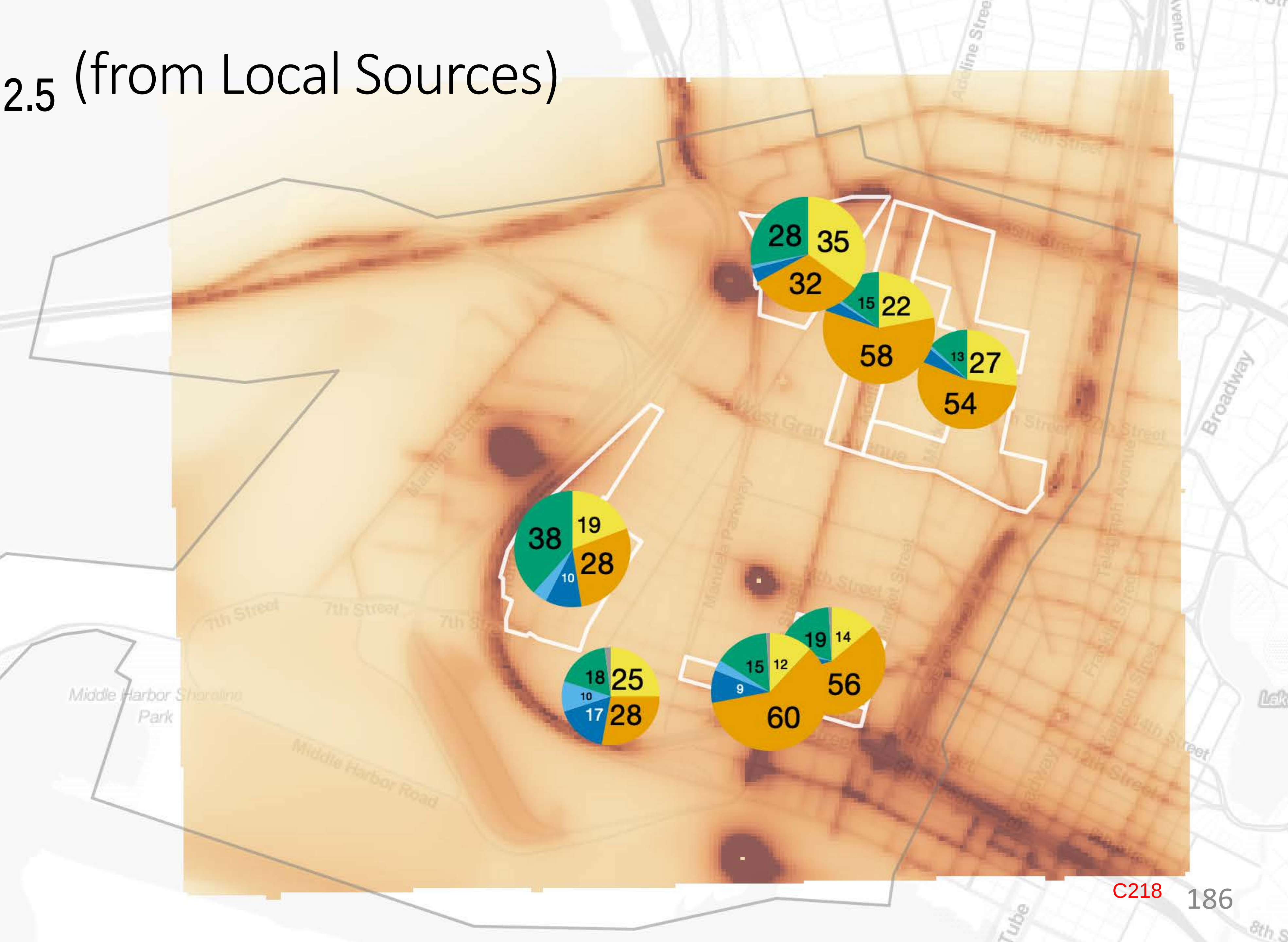
with Source Apportionment in Impact Zones

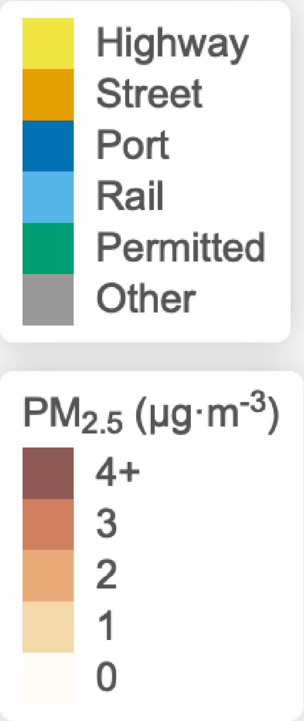


C217

Modeled $PM_{2.5}$ (from Local Sources)

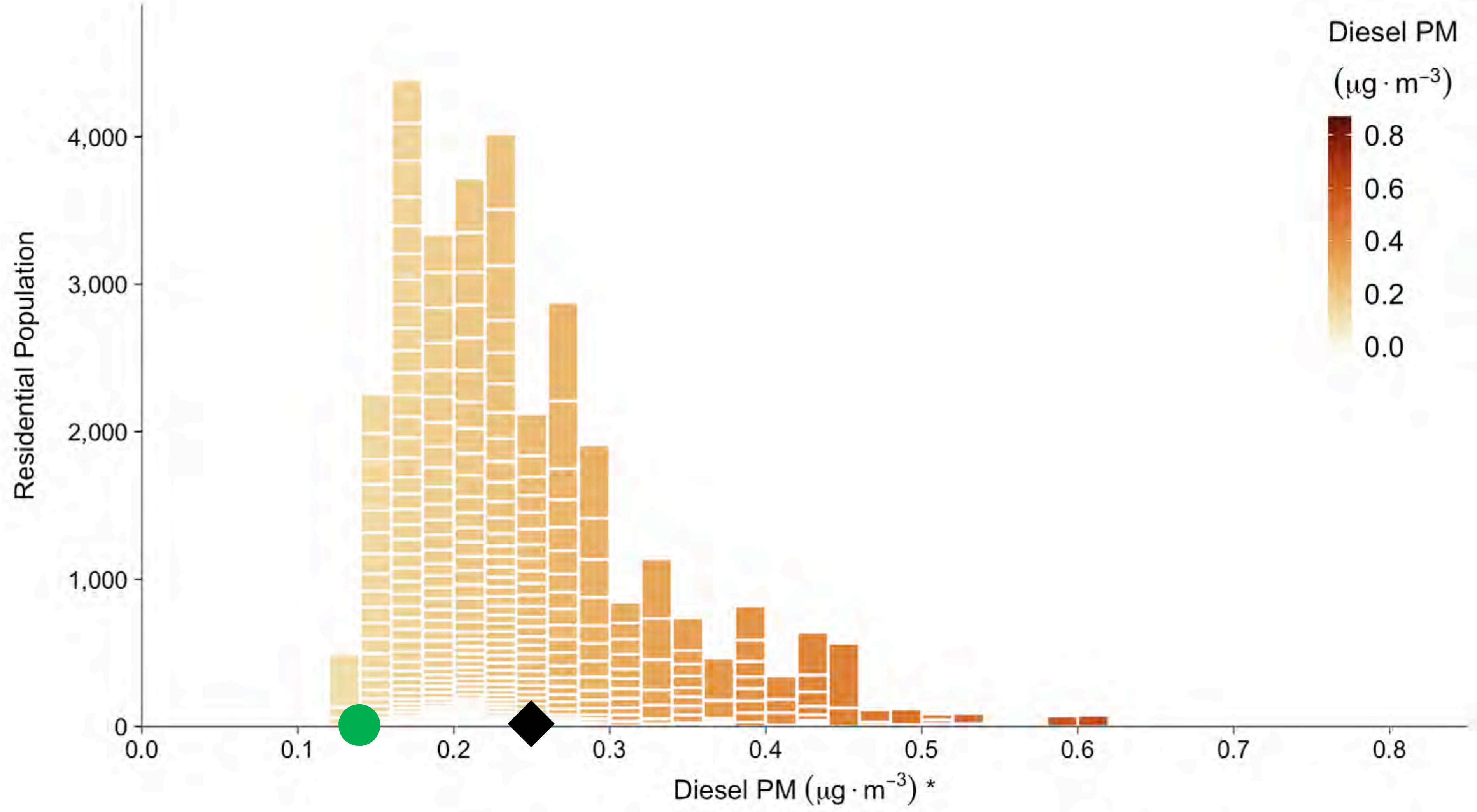
with Source Apportionment in Impact Zones





Equity-Based Targets

Unequal Impacts: Diesel PM Across West Oakland



* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

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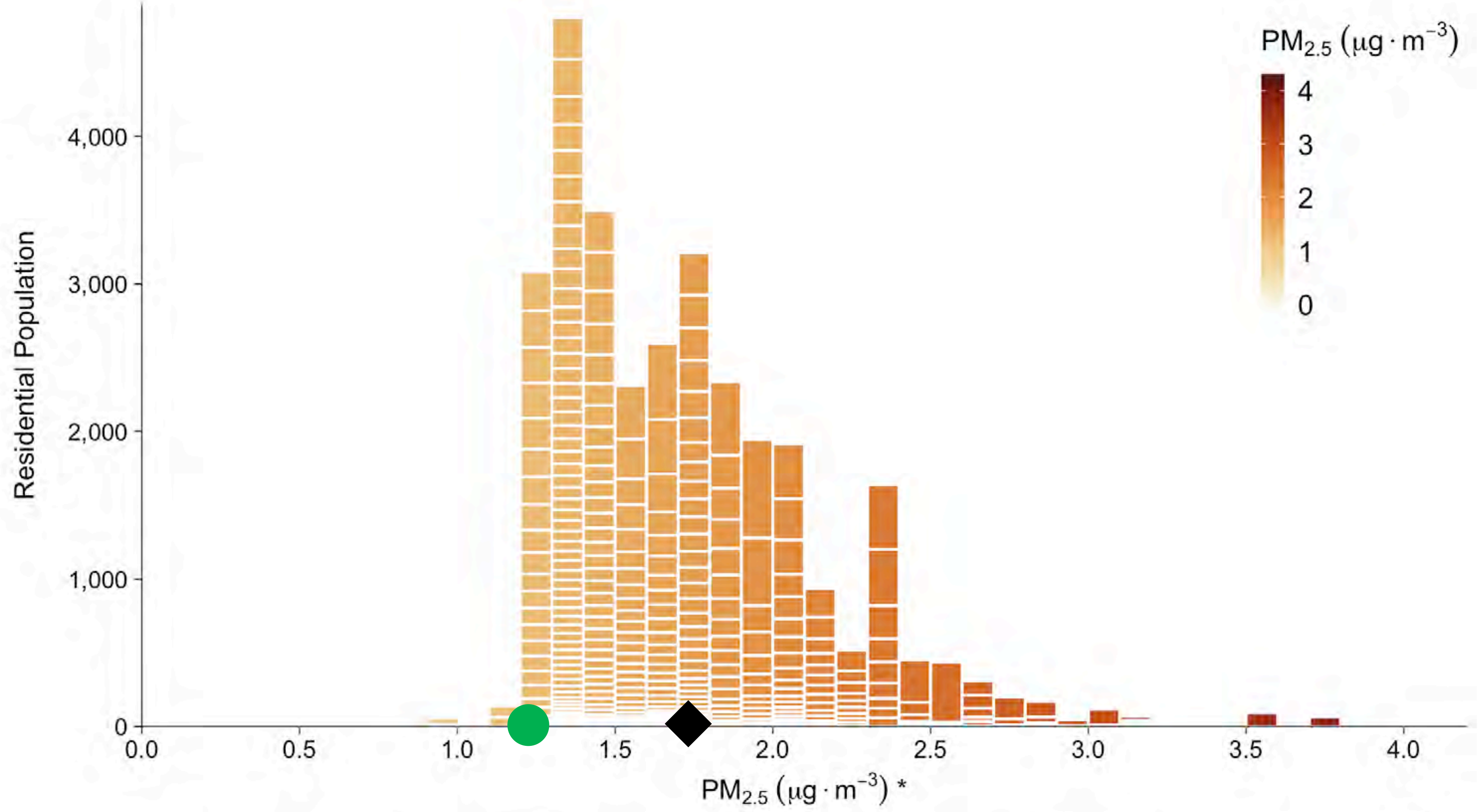
C220

Unequal Impacts: $PM_{2.5}$ Across West Oakland



* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

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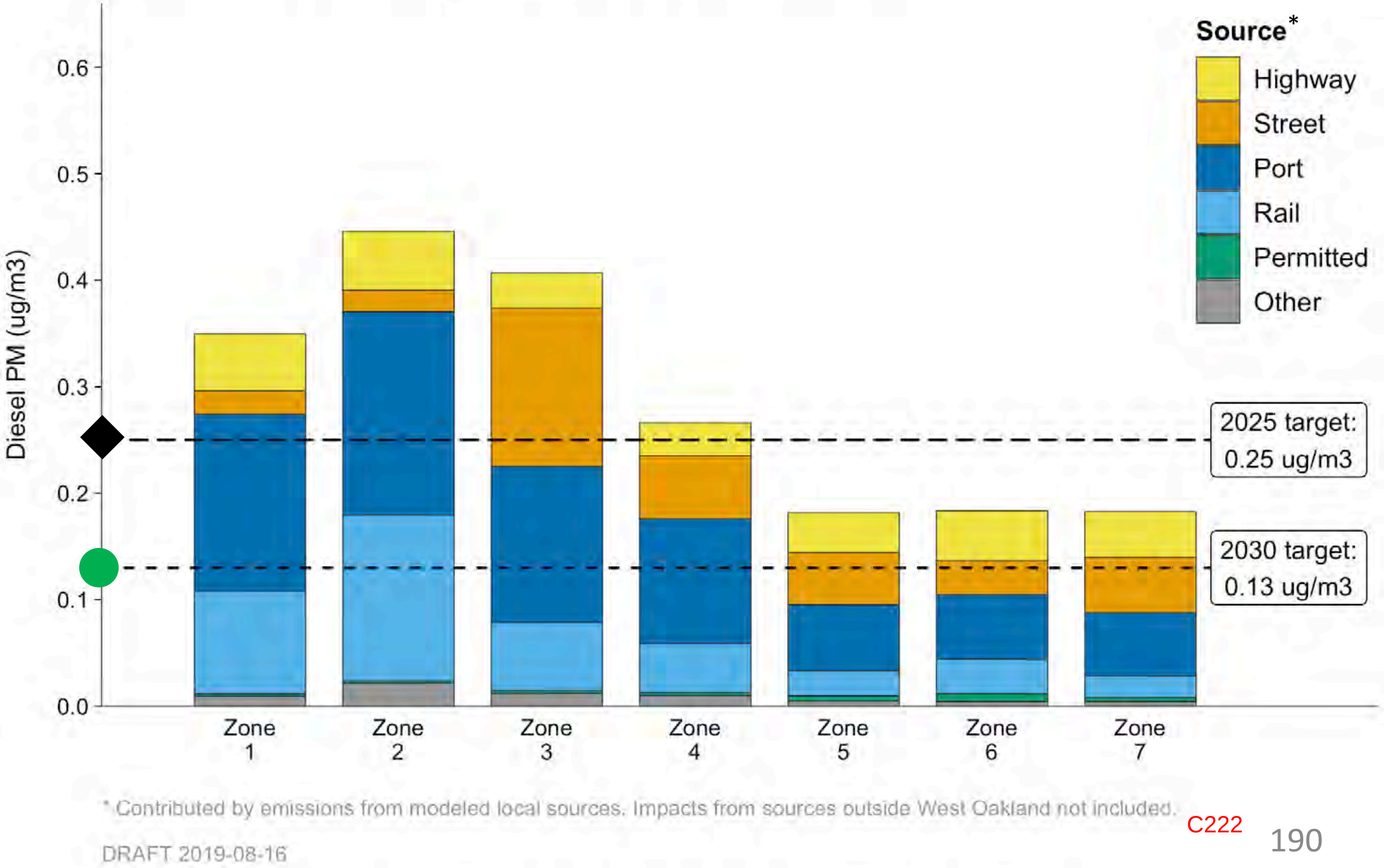
C221

Targets and Source Contributions for Diesel PM

Targets:

2025 – Today's *average* residential neighborhood

2030 – Today's *cleanest* residential neighborhood



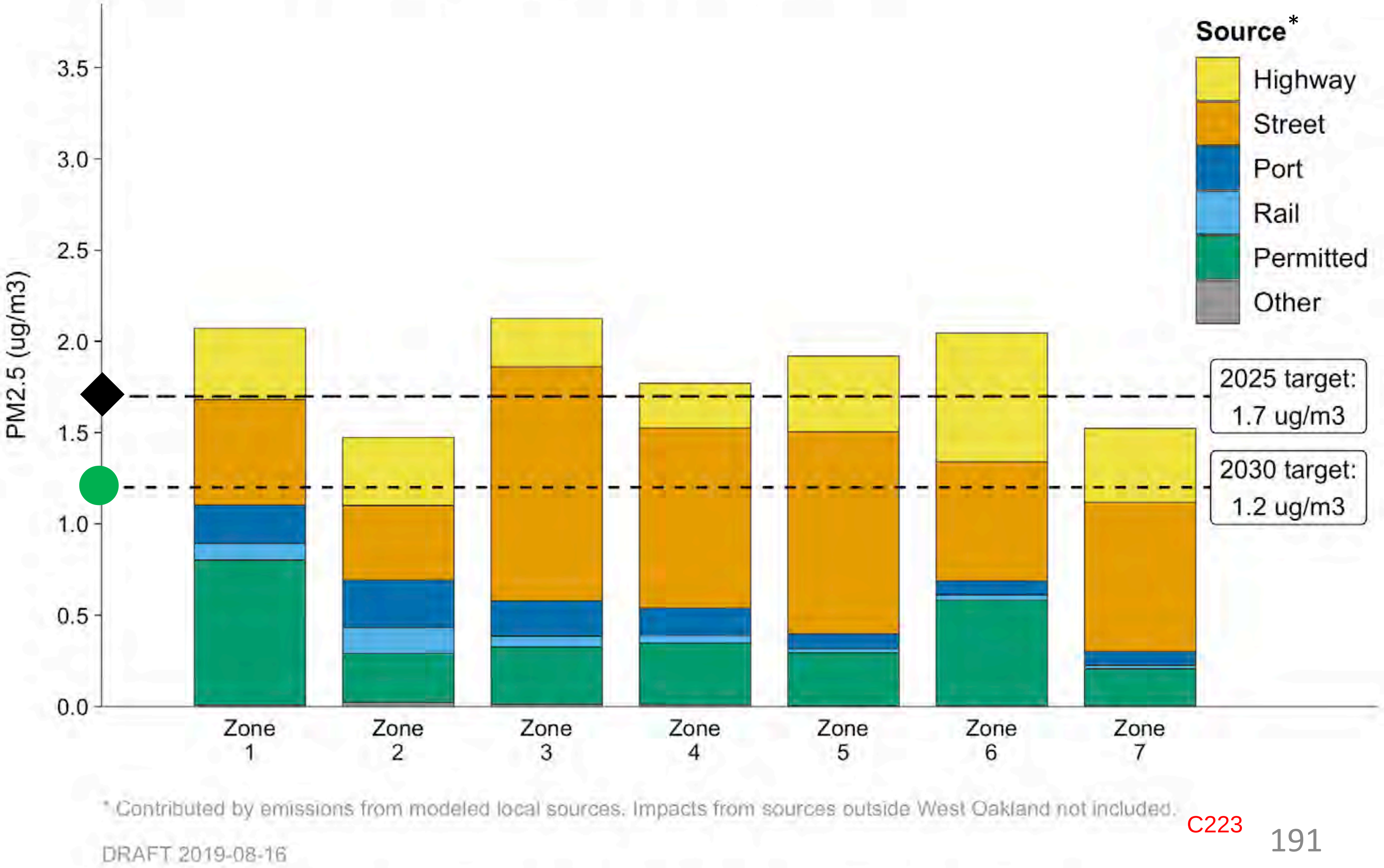
C222

Targets and Source Contributions for $PM_{2.5}$

Targets:

2025 – Today's *average* residential neighborhood

2030 – Today's *cleanest* residential neighborhood

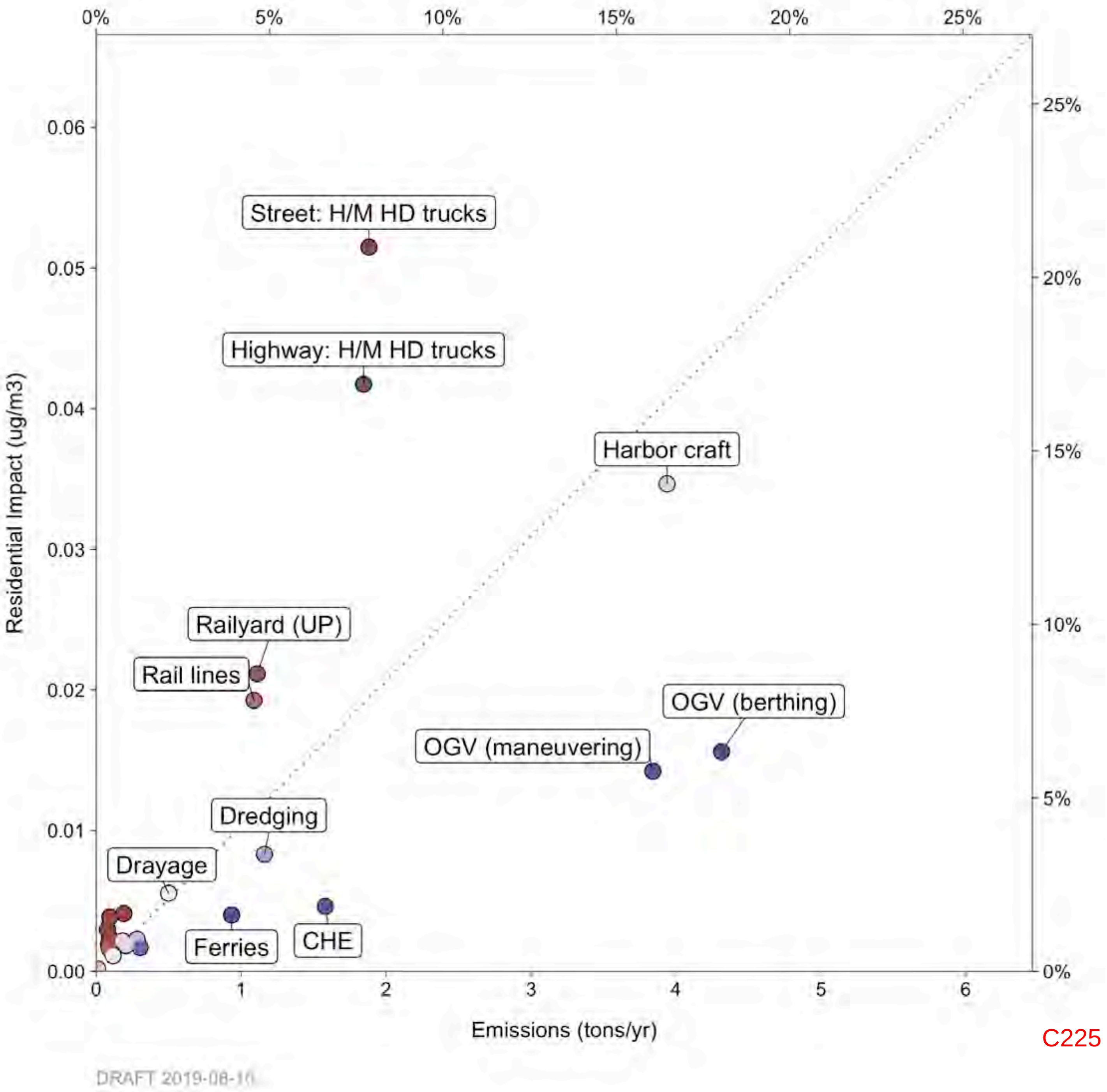


Impact Per Ton Varies by Source

What Moves the Needle?

Impact Per Ton: Diesel PM in West Oakland

Circles are modeled local sources.
Red is more impact.
Blue is less impact.
Percentages are shares of modeled impact.



Impact Per Ton: $PM_{2.5}$ in West Oakland

Circles are modeled local sources.
Red is more impact.
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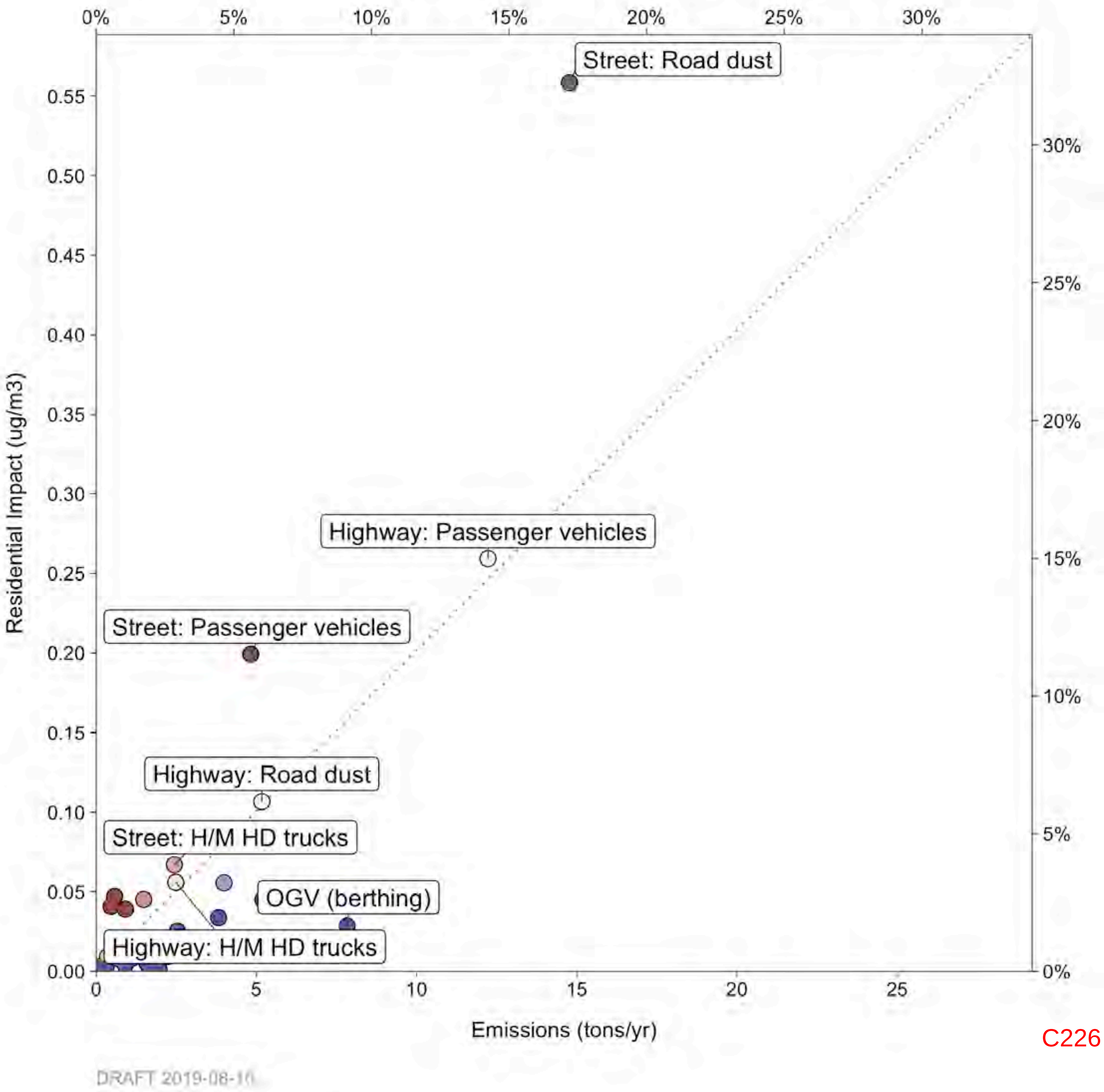
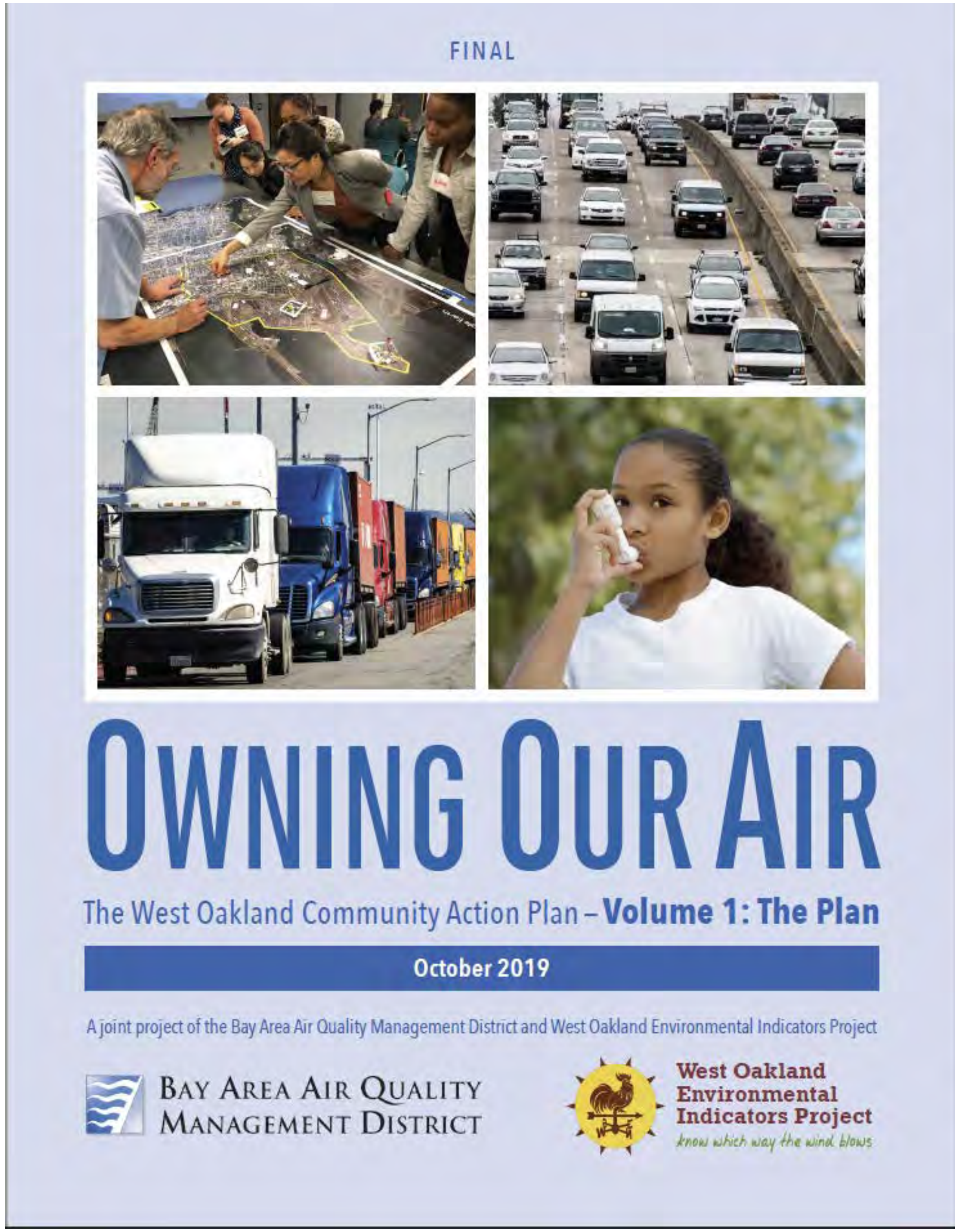


C226

More Information

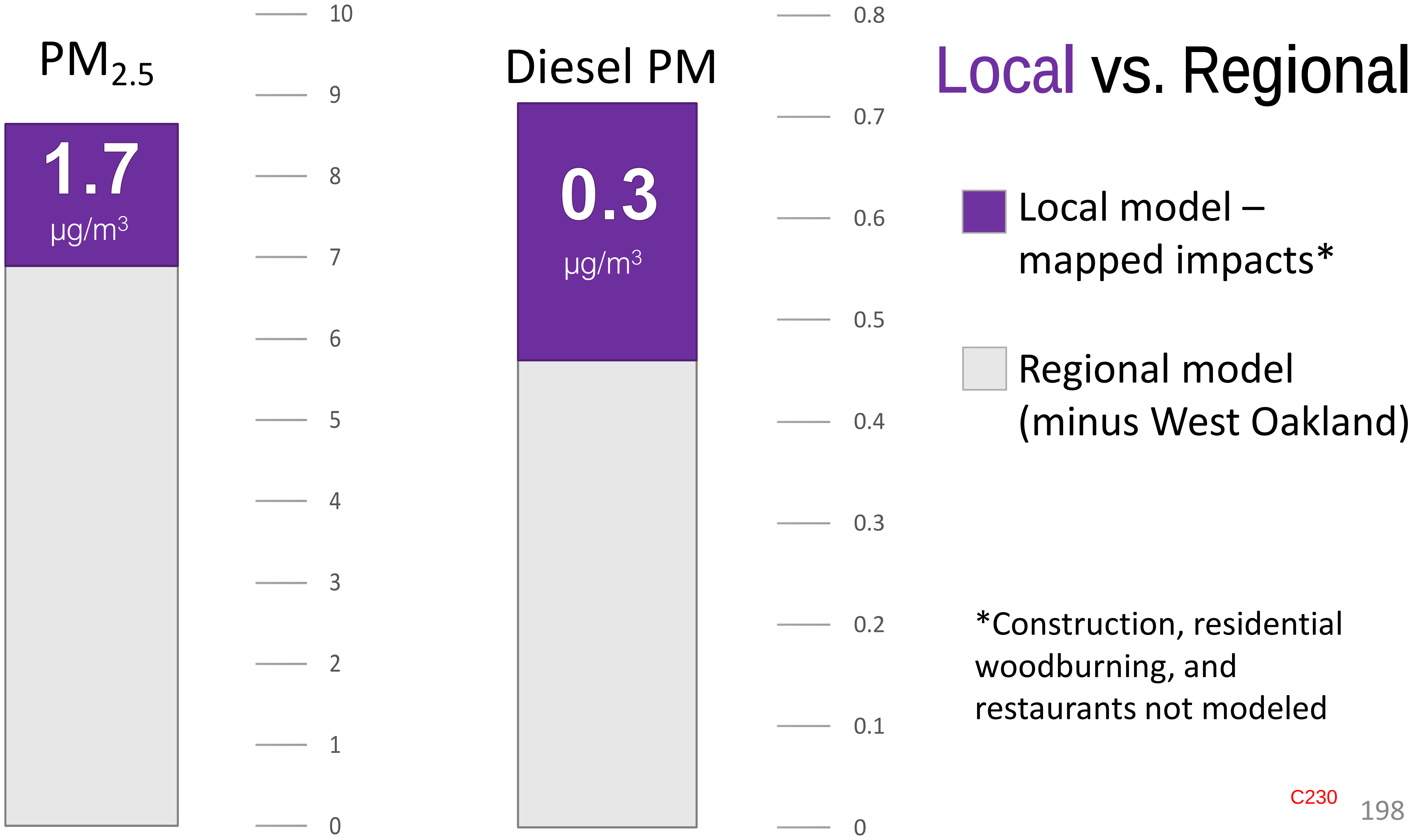
- baaqmd.gov/communityhealth/community-health-protection-program/
- woeip.org/
- arb.ca.gov/ourwork/programs/community-air-protection-program
- pmartien@baaqmd.gov



Extra Slides

How Much is Local?

Local vs. Regional



*Construction, residential woodburning, and restaurants not modeled

Thank you

Particulate Matter:
Spotlight on Health Protection

Break




Advisory Council Discussion with Exposure and Risk Panel

Discussion Questions

What are major sources of PM in the Bay Area?

What PM levels exist in Bay Area? What health risks do they pose?

How much additional health benefit can be achieved?

How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?

How should we determine which measures would most move public health needle?

Advisory Council Deliberation

Particulate Matter:
Spotlight on Health Protection

Adjournment

Particulate Matter:
Spotlight on Health Protection

Particulate Matter:
Spotlight on Health Protection

Particulate Matter:
Spotlight on Health Protection

Advisory Council Meeting Summary: BAAQMD Update on Current and Emerging Efforts on Particulate Matter

December 9, 2019

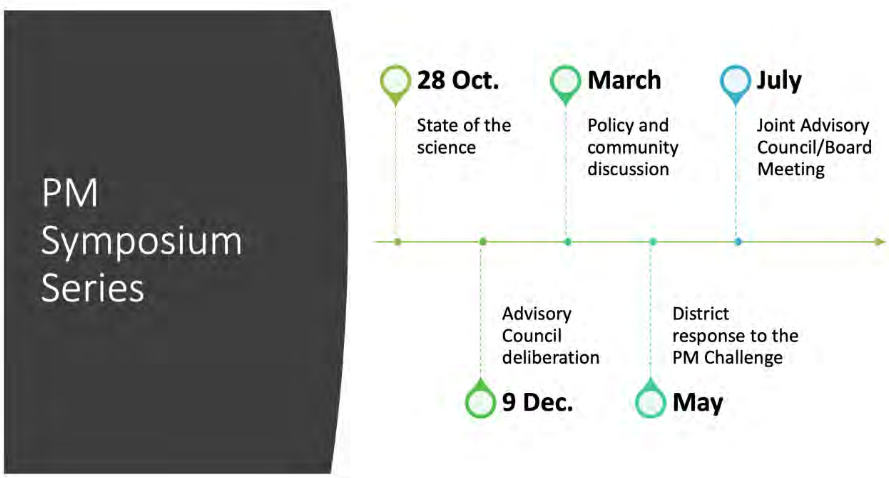
Bay Area Air Quality Management District

Table of Contents

Executive Summary

The December 9, 2019 meeting of the Advisory Council (Council) of the Bay Area Air Quality Management District (Air District) focused on the Air District's current and emerging work to understand, monitor, reduce, and control regional and localized particulate matter (PM) concentrations.

As the timeline below illustrates, this Advisory Council meeting followed the October PM Symposium, which focused on the state of the science, and preceded the upcoming March PM Symposium. The March PM Symposium will focus on local community work, needs, and priorities. The PM Symposium Series as a whole will inform recommendations from the Advisory Council to the Air District's Board concerning further action the Air District can take to protect the health of Bay Area residents, particularly those who are disproportionately impacted by PM exposure.



[Note: At the time of the presentation, the PM Symposium Series was anticipated to continue through July; however, due to the COVID-19 pandemic and the Bay Area shelter-in-place order, this timeline has changed. Air District staff, together with the Advisory Council and community members, are continuing to discuss particulate matter reduction strategies.]

The December meeting featured presentations regarding local, regional, and state PM reduction initiatives from Air District staff members and a representative from the California Air Resources Board (CARB). Additional agenda items included Advisory Council discussion of a written report on the October PM Symposium; development of a new document by the Advisory Council, which will provide responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists; and public comment.

Presentations

Source Apportionment. Phil Martien, Director of Assessment, Inventory, and Modeling, presented the Air District's current knowledge and information gaps regarding the sources of fine particulate matter (PM) in the Bay Area (excluding wildfires). New priorities require the Air District and its partners (CARB, Caltrans) to evaluate and update source apportionment procedures and corresponding regulatory frameworks. As PM emissions from previously dominant sources (such as vehicle emissions) are reduced, additional sources emerge as priorities for controlling PM, yet less information is available about these newly emergent top sources. In particular, models for brake and tire wear and road dust have not been updated since the 1980s. Equally, the Air District's new focus on local-scale exposures requires new approaches to data collection, analysis, and rulemaking regarding stationary-source emissions. Point sources that are not significant at the regional level have not historically been prioritized for monitoring and control. These sources may be significant contributors of $PM_{2.5}$ at the local level.

Monitoring. Ranyee Chiang, Director of Meteorology and Measurements, along with assistant managers Ila Perkins and Katherine Hoag, presented regarding the Air District's monitoring network. They discussed both region-wide monitoring — largely designed to track progress against national ambient air quality standards — and more recently deployed monitoring approaches that are designed to address the Air District's emerging focus on community-scale concentrations or impacts from specific sources of emissions. In response to the Advisory Council's requests, additional information was shared regarding ultrafine particles and wildfires. Ultrafine particle monitoring has been in place for several years but is limited in scope by costs and scientific limitations of the instrument. Wildfires have caused dramatic increases to $PM_{2.5}$ concentration levels in the Bay Area, reversing a decade-long downward trend. The Air District is currently conducting an Integrated PM Network Assessment to evaluate its PM measurement network and recommend improvements.

Grants and Incentives. Karen Schkolnick, Director of Strategic Incentives, presented a summary of the Air District's grant revenue sources, current grants and incentive programs, and recent program results. Because these grant programs generally require emission reductions that go beyond regulatory requirements, the majority of the Air District's grant funding is targeted at reducing $PM_{2.5,}$ other criteria pollutants, air toxics, and greenhouse gases from mobile sources and complementing the Air District's regulatory PM reduction strategies targeting stationary sources. She highlighted several key initiatives focused on reducing mobile-source emissions through adoption of the cleanest commercially available technology (such as Diesel Free by '33 and Port of Oakland partnerships) and discussed how these programs connect to other Air District priorities including health risk reduction in communities disproportionately impacted by air pollution. Since 1991, more than $1.2 billion has been invested through the Air District's grants and incentives programs, resulting in significant emissions reductions and accelerated adoption of cleaner and zero-emission technology. However, each program is constrained by the requirements of its funding source — for example, only one of the Air District's sources of funding can be used to target vehicle miles traveled (VMT) reduction.

CARB PM Research and Rules. Alvaro Alvarado, Manager of Health & Ecosystems Assessment for CARB, described the PM research currently being conducted at CARB and the emerging regulations designed to further decrease PM emissions. In line with the Advisory Council's requests, he focused on research concerning wildfires, brake and tire wear, and ultrafine particles. Wildfire research includes study of a monkey colony at UC Davis, mobile platforms to monitor in-home exposures, and collaboration with NASA to track wildfires using aircraft. Brake and tire wear research includes laboratory studies to quantify emissions as well as exposure studies with UC Riverside and health effects studies with UCLA. Studies of ultrafine particles include modeling annual average concentrations and speciation throughout the state and associating mortality with long-term exposures using the California Teachers Study cohort. With respect to rulemaking, several regulations are underway or forthcoming to reduce emissions from trucks, cars, and trains.

Air District PM Rules and Regulatory Development. Victor Douglas, Manager of Rule Development, presented a brief overview of the history, current efforts, and emerging directions for rule development in the Air District, which continues to update its rules and regulations to further limit PM exposures. As its focus shifts from an exclusively regional perspective to reducing risks for disproportionately impacted local communities, the Air District is exploring further regulation regarding restaurants, wood smoke, and indirect or magnet sources (e.g. warehouses), as well as the possibility of treating PM as a toxic air contaminant. Although the State of California does not presently recognize undifferentiated PM as an air toxic, it may be possible for the Air District to do so independently.

<u>Discussion of Draft October PM Symposium Report</u>

The Advisory Council discussed the draft report on the October PM Symposium prepared by consulting technical writer Elisabeth Andrews on behalf of the Air District, available online at https://www.baaqmd.gov/news-and-events/conferences/pm-conference. Three clarifying edits were made to the section on "Advisory Council Deliberation," and consensus was reached on releasing the draft report for public comment.

<u>Advisory Council Q&A Document</u>

Advisory Council Chair Stan Hayes introduced a document he initiated that provides responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists concerning PM health effects, exposures, and risks. His aim was to distill the information shared by the panelists into concise answers to each of the questions. Council Member Gina Solomon volunteered to assist Chair Hayes in further developing the question-and-answer document.

Public Comment

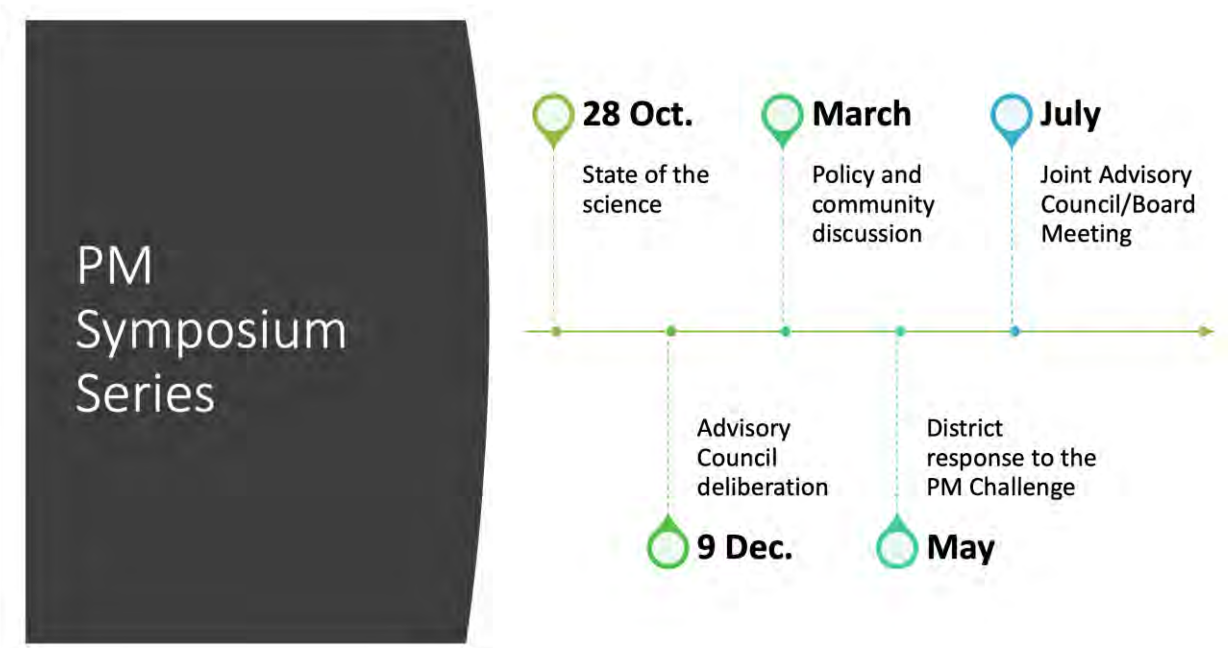
Commenters focused on the urgency of decreasing PM exposures and articulated a need to phase out fossil fuels and transition to a zero-carbon economy. Specific suggestions for the Air District included setting PM threshold levels based on sensitive subgroups rather than population averages, utilizing data from low-cost sensors and the California Household Exposure Study, and developing messaging campaigns focused on demonstrating the connection between specific sources of air pollution and health outcomes.

Next Steps

The next PM symposium will take place on March 24, 2020 in Oakland and is focused on presentations from community organizations and leaders. The May event is expected to focus on formulating potential Air District plans to further reduce Bay Area health risks from PM. The final event in the series brings together the Advisory Council and the Air District's Board of Directors to discuss the information and suggestions shared throughout the PM Symposium Series. During the July meeting, the Advisory Council is expected to present its findings to the Air District's Board of Directors regarding particulate matter and health in the Bay Area.

Background and Timeline

The December 9, 2019 meeting of the Advisory Council (Council) of the Bay Area Air Quality Management District (Air District) followed the October PM Symposium with updates on the Air District's current work on particulate matter (PM). Recognizing that PM is the overwhelming driver of health risks from Bay Area air quality, the Advisory Council requested that the Air District convene the PM Symposium Series in order to clarify the state of the science (October 28, 2019), describe current and forthcoming Air District work (December 9, 2019); learn about local community efforts, needs, and priorities (March 24, 2020); and present potential policy strategies (May 2020). As the timeline below illustrates, the series will culminate in recommendations from the Advisory Council to the Air District's Board of Directors concerning further action the Air District can take to protect the health of Bay Area residents, particularly those who are disproportionately impacted by PM exposure. An additional goal of the Air District and Advisory Council is to provide national leadership on improving air quality at a time when the federal government is retreating from this mission.



[Note: At the time of the presentation, the PM Symposium Series was anticipated to continue through July; however, due to the COVID-19 pandemic and the Bay Area shelter-in-place order, this timeline has changed. Air District staff, together with the Advisory Council and community members, are continuing to discuss particulate matter reduction strategies.]

The first symposium took place on October 28, 2019, convening national, state, and local experts to discuss the state of the science on PM health effects, exposures, and impacts. Details on the presenters and the information they shared can be found in the Draft October PM Symposium Report available at https://www.baaqmd.gov/news-and-events/conferences/pm-conference. Following that event, Chair Hayes presented to the Air District Executive

Committee of the Board of Directors on November 6, 2019 and to its full Board of Directors on November 20, 2019 concerning the Advisory Council's takeaways from the October PM Symposium.

Chair Hayes summarized those presentations at the December meeting. He highlighted several key topics discussed at the October PM Symposium: new evidence of causal relationships between PM and adverse health outcomes including premature death, evidence that the health of children and non-white people are disproportionately harmed by PM, strategies for understanding the sources and distribution of PM, and associations between wildfires and both respiratory and cardiovascular illness. He shared the Sense of the Advisory Council statement that emerged from deliberation at the close of the October PM Symposium:

> The current standards are not adequately health protective.
> Further reductions in PM will realize significant additional health benefits.
> We need more science, *and* we should act now.

Chair Hayes also listed the topics the Advisory Council sought to explore further: approaching PM as an air toxic, expanding monitoring of ultrafine particles, examining health effects of acute PM exposures (e.g. wildfire smoke), identifying PM species that are particularly dangerous, assisting the Air District in identifying strategies with the "highest bang for the buck" in terms of health protection, and pursuing strategies that have climate and other co-benefits.

These priorities set the agenda for the December meeting, which focused on the Air District's current and emerging work to understand, monitor, reduce, and control regional and localized PM concentrations. A representative from the California Air Resources Board (CARB) also presented on state-level PM research and regulations. Additional agenda items included Advisory Council discussion of a written report on the October PM Symposium as well as public comment.

The meeting was shared live via webcast, the video archive of which can be viewed at http://baha.granicus.com/MediaPlayer.php?clip_id=6369.

Update on Particulate Matter (PM) Air District Work: Regional- and Local-Scale $PM_{2.5}$ Source Apportionment

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

Main takeaway	**New priorities require the Air District and its partners (CARB, Caltrans) to evaluate and update source apportionment procedures and corresponding regulatory frameworks. As PM emissions from previously dominant sources are reduced, additional sources emerge as priorities for controlling PM, yet less information is available about these newly emergent top sources. This is particularly true for brake and tire wear and re-entrained road dust. Equally, the Air District's new focus on local-scale exposures requires new approaches to data collection, analysis, and rulemaking regarding stationary-source emissions.**

Dr. Martien presented the Air District's current knowledge and information gaps regarding the sources of fine particulate matter in the Bay Area (excluding wildfires). He first described how sources contribute to $PM_{2.5}$ concentration levels at the regional level and then turned to the Air District's community-scale analysis of local sources of $PM_{2.5}$ for West Oakland. The report provided here reflects both the presentation from Dr. Martien and the additional comments and clarifications from other Air District staff members during the presentation.

Current Air District Work

Proportion of regional vs local contributions. Regional sources are the main driver of Bay Area $PM_{2.5}$ concentrations: in West Oakland, local sources appear to contribute about 20% of the overall $PM_{2.5}$ burden in the community. However, time constraints on the West Oakland analysis precluded modeling approximately 30% of local $PM_{2.5}$ sources including construction, residential wood burning, and commercial cooking; these sources may constitute an additional proportion of local contribution to $PM_{2.5}$ concentration levels. Moreover, local sources may have highly significant impacts for people living or working in the immediate vicinity of those sources.

Regional Scale Apportionment

Based on newly updated modeling, peak levels of annual-average $PM_{2.5}$ in the Bay Area are on the order of 10 micrograms per cubic meter ($\mu g/m^3$). In Air District modeling the highest values are seen in the Central Valley. It now appears that **secondary PM formation contributes almost half of $PM_{2.5}$**, which is higher than earlier estimates.

Sources of PRIMARY $PM_{2.5}$ in the Bay Area:

- **Permitted sources (23%)** - Within this category, refineries produce more than 40% of emissions from permitted sources. The top five emitters contribute approximately half of all $PM_{2.5}$ from permitted facilities.
- **On-road mobile sources (27%)** - Within this category, vehicle exhaust now contributes less than 20% of on-road mobile emissions. Brake and tire wear and road dust are far more significant contributors.
- **Non-road mobile sources (16%)** - Within this category, construction activity and commercial marine vessels each account for approximately one third of emissions from non-road mobile sources.
- **Area sources (34%) -** These sources tend to be individually small emitters that collectively make up a large portion of $PM_{2.5}$ emissions, including residential wood combustion and commercial cooking (largely char-broilers).

Sources of SECONDARY $PM_{2.5}$ in the Bay Area:

- **Diesel** trucks and off-road equipment contribute **NO_x**
- **Stationary sources** (including refineries and manufacturing plants) contribute **SO_2**
- **Agricultural activity** contributes **NH_3**

Community Scale Apportionment

Hyperlocal analysis of local-source primary $PM_{2.5}$ emissions was conducted for West Oakland, as described in the report on the October PM Symposium (https://www.baaqmd.gov/news-and-events/conferences/pm-conference) and the West Oakland Community Action Plan. Annual averages of $PM_{2.5}$ concentrations exclusively from local sources were calculated for each census block. $PM_{2.5}$ concentration levels were observed to vary seasonally, across the week, and even hour-by-hour with local activity.

Roadways and permitted facilities. Roadways and permitted facilities emerged as predominant local sources of primary $PM_{2.5}$ in West Oakland (acknowledging again that time constraints precluded modeling construction, residential wood burning, and commercial cooking).

Hyperlocal variation in source apportionment. Predominant sources of local-source $PM_{2.5}$ vary within West Oakland: in its southwest corner, the contributions of port and rail to local-source $PM_{2.5}$ are as high as 25%; roadway contributions in some locations are more than 75%; in other locations stationary sources contribute on the order of 40% of local-source $PM_{2.5}$.

Unequal impacts. Certain census blocks in West Oakland are exposed to much higher levels of local-source $PM_{2.5}$ than others.

Forthcoming Air District Work

The Air District faces challenges in overcoming information gaps concerning newly dominant sources of $PM_{2.5}$. As PM emissions from top sources are reduced, additional sources emerge as priorities, yet less information is available about these other sources. As a result of this lag between re-prioritization and updated scientific literature, there is considerable uncertainty in the estimates of source apportionment, and this uncertainty cannot yet be quantified.

Road dust. As emissions from vehicle exhaust are reduced, the proportion of $PM_{2.5}$ attributed to re-entrained road dust increases. However, calculations for re-entrained road dust were last updated in the late 1980s. These methods are being currently evaluated and updated by CARB and Caltrans.

More analysis of permitted sources. Point sources that are likely significant contributors of $PM_{2.5}$ at the local level may not be significant at the regional level. Because the Air District's focus has historically been at the regional level, direct measurements have not been collected for most of these sources. For example, because West Oakland permitted facilities account for only about 0.5% of emissions in the Bay Area, they have not historically been prioritized for monitoring and control. The Air District's new focus on localized impacts demands greater attention to these sources. For other Bay Area locations, particularly those in which the top five stationary-source emitters are located, the Air District is also in the process of determining local-scale impacts for residents. It is not yet clear how much exposure people experience from these emissions, particularly where emissions are distributed through tall stacks.

Post-Presentation Discussion

<u>Brake and Tire Wear and Road Dust</u>

- Council Member Linda Rudolph inquired about the **climate impacts** of newly emerging $PM_{2.5}$ priorities such as brake and tire wear and road dust. Dr. Martien responded that different $PM_{2.5}$ species can have different climate effects: soot tends to be warming, whereas secondary aerosol can be cooling. Air District Deputy Air Pollution Control Officer Greg Nudd added that road dust tends to be a localized issue as concentrations drop off quickly in spatial terms. However, brake and tire wear have emerged as water quality issues: microplastics in the San Francisco Bay have been shown to originate from tire wear.
- Council Member Severin Borenstein inquired about **technologies to reduce these effects**; Mr. Nudd and Air District Deputy Air Pollution Control Officer Damien Breen responded that reduction in vehicle miles traveled (VMT) is the primary control strategy as few technologies have emerged apart from vacuuming highways and some new European experiments in under-vehicle misting technologies. He later remarked that successful strategies for reducing road dust involve reducing the load on the road; while sweeping can have some positive effect, reducing track-out from construction and limiting roadside contributions through landscaping or paving tend to be more successful.

- Chair Hayes confirmed with Dr. Martien that brake and tire wear and road dust contribute significantly to both local and regional $PM_{2.5}$ exposures and remarked that addressing this issue will be an **important issue for the Air District**.
- Council Member Borenstein inquired about the **relationship between speed, congestion, and $PM_{2.5}$**. Mr. Breen explained that less speed generally means higher exhaust emissions; Dr. Martien stated that dynamometer testing is currently investigating the relationship between speed and brake wear for light- and heavy-duty vehicles.

Air toxics approach. Council Member Michael Kleinman suggested that the greatest benefit to public health may be gained through focusing on the most toxic components of $PM_{2.5}$. He provided the example of lead-contaminated particles from the cement plant in Cupertino posing more of a public health threat than ammonium sulfate aerosols (from secondary $PM_{2.5}$ formation) and stated that many of the secondary aerosols in $PM_{2.5}$ are less toxic than the primary aerosols.

Challenges with commercial cooking and residential wood burning. Council Member Solomon inquired about the Air District's authority with respect to commercial cooking, noting that the categories of regionally significant sources of $PM_{2.5}$ that are within the Air District's jurisdiction appear to make up 43% of the total regional apportionment. Mr. Nudd, with confirmation from Air District Legal Counsel Brian Bunger, explained that the Air District's regulatory authority for commercial cooking is clear. The Air District has an existing rule for large charbroilers. However, available post-combustion controls for restaurant cooking are too large to fit on a restaurant roof and too expensive to preserve profit margins. With respect to reducing residential wood burning, the challenge lies in overcoming cultural barriers.

Update on Particulate Matter (PM) Air District Work: Monitoring

Ranyee Chiang
Director, Meteorology & Measurements, Bay Area Air Quality Management District

Ila Perkins
Assistant Manager, Meteorology & Measurements, Bay Area Air Quality Management District

Katherine Hoag
Assistant Manager, Meteorology & Measurements, Bay Area Air Quality Management District

Main takeaway	**The Air District's new focus on community-scale monitoring complements its ongoing region-wide monitoring efforts. UFP monitoring has been in place for several years but remains limited in scope by costs and scientific limitations of the instruments. Wildfires have caused dramatic increases to $PM_{2.5}$ concentration levels in the Bay Area, reversing a decade-long downward trend.**

Dr. Chiang presented along with two assistant managers in Meteorology & Measurements, Ms. Perkins and Dr. Hoag, on the Air District's current monitoring network. They discussed both region-wide monitoring — largely designed to track progress against national ambient air quality standards — and more recently deployed monitoring approaches that are designed to address the Air District's emerging focus on community-scale concentrations or impacts from specific sources of emissions. In response to the Advisory Council's requests, additional information was shared regarding ultrafine particles and wildfires.

Current Air District Work

Regional/Regulatory Network

The Air District currently has 35 fixed air monitoring stations (as well as 20 meteorology stations) that provide timely air quality data to the public, compare PM concentration levels with national and state standards, inform air quality forecasts for the Spare the Air program, and support research studies. Most sites are selected based on the distribution of the population (2010 Census) and the concentration of pollutants, with some additional sites placed downwind of major pollution sources, to describe regional transport of pollutants, or in areas representing general background PM levels.

The measurement instrumentation used for Air District PM monitoring is described in Table 1. Mass measurements support compliance with California and national PM_{10} and $PM_{2.5}$ health-based standards and designate which areas are in attainment or nonattainment; chemically resolved or speciated data measurements support emission reduction strategies; and particle counts of smaller particle sizes support science on emissions, air quality impacts, and health effects of types of PM for which there is currently no health-based standard.

Table 1 - Air District PM Instrumentation

Measurement Type	Mass		Chemically resolved or speciated		Particle count
Measurement application	Compliance with standards; Designate areas as attainment or nonattainment		Support emission reduction strategies		Assess air quality impacts and exposures
Analytical Target	PM_{10} mass	$PM_{2.5}$ mass	Black carbon	$PM_{2.5}$ speciation	Ultrafine particles ($PM_{0.1}$)
Analytical Methods	Gravimetric	Gravimetric or Filter-based beta attenuation	Filter-based light attenuation	Chemical extraction	Laser-based
Number of Active Monitors	7	20	7	4	6

Ultrafine Particle Monitoring

Strengths. The Air District has conducted ultrafine particle monitoring for more than seven years in a range of sites, producing data that can be used to understand diurnal and seasonal patterns and trends as well as differences between background, near-road, and typical urban settings.

Limitations. Ultrafine particle instrumentation is costly ($60,000-$100,000 per unit), requires frequent maintenance in PM-burdened areas, and cannot presently support identification of sources and sinks or robust links to specific health impacts.

Results. Air District ultrafine particle monitors installed in a variety of locations reveal that UFP concentrations reflect fresh, primary particulate emissions from both combustion and secondary formation. Higher levels of ultrafine particles are seen in near-road environments, with peaks at high-commute hours and the middle of the day, indicating a photochemical signature.

Wildfires

Prior to 2017, occasional impacts from wildfires did not have a significant influence on year-to-year trends, yet recent wildfires have dramatically affected Bay Area $PM_{2.5}$ concentration levels. Figure 1 shows the overwhelming effect of wildfires in 2017 and 2018. With wildfire days removed, there has been a downward trend in $PM_{2.5}$ concentration levels for the past decade, yet wildfires have caused a sharp reversal of that trend, resulting in the Bay Area substantially exceeding the 24-hour federal standard for 2016 – 2018.

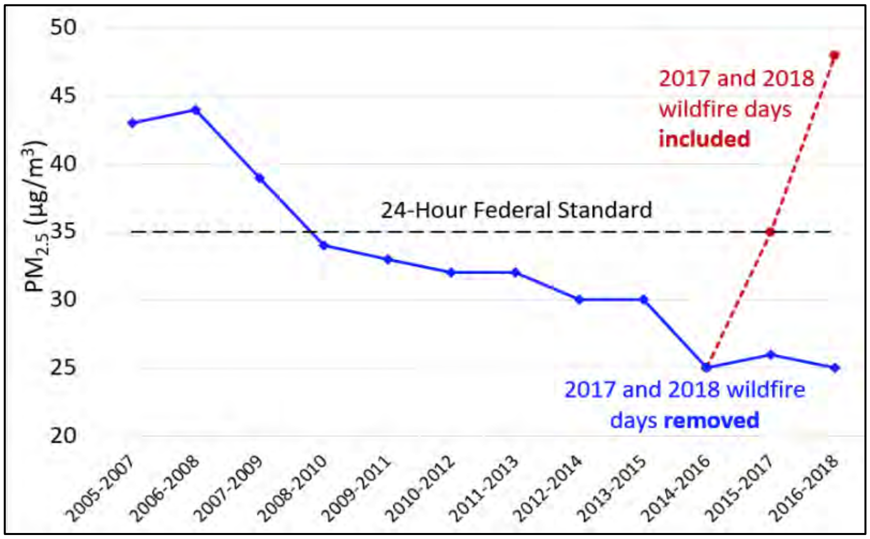


Figure 1 - Wildfire impact on 24-hour $PM_{2.5}$ concentration levels

Air District initiatives to minimize exposure to wildfire PM include:

- Communicating with the public about reducing personal exposure
- Collaborating with public health officers and other agencies to ensure consistent messaging
- Funding Clean Air Centers in which vulnerable people can seek refuge
- Offering grants and incentives for recovery assistance
- Providing guidance for local organizations, particularly schools

Forthcoming Air District Work

Community-Scale Monitoring

Several new developments support the Air District's new focus on community-scale monitoring:

Hyperlocal monitoring

In partnership with Aclima, the Air District is conducting street-by-street monitoring using vehicle-mounted sensor-based instrumentation measuring NO_x, CO, O_3, and $PM_{2.5}$, similar to previous studies Aclima performed in West Oakland and other areas. Measurements for a short-term study in the AB 617 Richmond-San Pablo study area will soon be available, and the Air District aims to use this technology to map average baseline hyperlocal air quality for the entire Bay Area within two years.

Mobile Laboratories

The Air District is also developing a van with mobile monitoring capabilities that can perform high-accuracy, detailed mobile or short-term measurements of PM and many specific gaseous air toxics, including the amount of PM of different sizes. Potential uses of this new monitoring van include supporting localized source apportionment and prioritization, confirming and improving the understanding of air quality issues identified by the AB 617 Steering Committees, and identifying locations for further fixed-site or portable monitoring.

Portable platforms

Highly portable, suitcase-sized monitoring systems will also be developed for battery-powered, continuous, real-time PM measurements. Although these technologies are expensive, they could enable measurements during power outages, which is important for supplying real-time air quality data during wildfires and periods of heightened wildfire hazard. These instruments can also be used to verify data from lower-cost sensor networks (such as PurpleAir).

Combining Monitoring Strategies

Whereas the regional fixed site network is primarily focused on large-scale assessments and long-term trends, the special projects and sensor networks described in Table 2 enable more community-specific assessment. The Air District's engagement in sensor networks involves working closely with community organizations and companies to provide technical capacity building and advice regarding the advantages, limitations, and uncertainties of different technologies.

Table 2 – Air District PM Monitoring Strategies and Objectives

Network	Measurements	Objectives	Limitations
Regional Network	$PM_{2.5}$ and PM_{10} mass	-Comparison with standards -Public information -Track long-term trends -Assess out-of-area transport	-High cost -Information gaps at community scale
Special projects: -fixed site -mobile laboratory -portable platforms	-PM size distribution -PM speciation -Ultrafine particles -Black carbon	-Source identification -Assessment of specific emission sources -Characterization of near-road environments	-High cost
Sensor networks: -fixed site -mobile/portable	-PM mass -Particle count	-Public education -Personal exposure monitoring -Identification of hot spots -Comparative assessment of local air quality -Tracking high-PM episodes	-Higher level of uncertainty

To strengthen these approaches, the Air District will complete an **Integrated PM Network Assessment by July 2020** to evaluate its PM measurement network and recommend improvements. The assessment aims to determine how available resources and multiple monitoring approaches can best be deployed not only to continue addressing federal and state requirements but also to support and expand community-scale air monitoring activities and other Air District programs.

Post-Presentation Discussion

Ultrafine Particles

- **Monitoring costs.** Council Member Solomon inquired whether ultrafine particles monitoring equipment costs are expected to drop in the foreseeable future. Ms. Perkins replied that the Air District relies on one primary manufacturer and does not anticipate near-term cost reductions. Council Member Solomon introduced the idea of a challenge to technology developers to accelerate innovation in the direction of affordability. Dr. Chiang responded that she would contact representatives from the Environmental Protection Agency and CARB to investigate the possibility of pooling resources to propose such an initiative.
- **Data application.** Council Member Rudolph asked how the Air District's ultrafine particle data is being used to improve public health. Dr. Hoag responded that the data adds to the imperative to reduce roadway emissions. Mr. Nudd added that the Air District is implementing project grants to install filtration in near-roadway schools and is advising the Plan Bay Area initiative on limiting near-roadway exposures.
- **"We need more science, and we should act."** Chair Hayes reiterated the message from the first PM Symposium that while it is clear that more science is needed on UFP — including a federal reference method standardizing ultrafine particle measurement and epidemiological studies linking exposures to health effects — the Air District should also take immediate action.
- **Near-road health effects.** Following clarifications from Air District staff that the high levels of monitored UFP were due to roadway proximity, Council Member Kleinman pointed out that the documented health effects of near-road environments include low birth weight and cardiovascular problems. While there are many challenges for ultrafine particle research, including the difficulty of assessing dosage due to the extraordinarily low mass of UFP, studying the health effects of near-road environments may be an effective approach to understanding UFP exposures. He added that ultrafine particle concentrations drop precipitously as the distance from the roadway increases, with particle counts dropping by 80% at a 100-meter distance from the center of the road (and an additional 80% at a further 100 meters). Therefore, zoning regulations, berms, and buffers can make a significant difference in limiting exposures.
- **Combustion as source of UFP.** Dr. Hoag clarified in response to Council Member Borenstein's question about brake and tire wear and road dust that the source of UFP is combustion, not vehicle wear or road dust. She further clarified in response to Council Member Tim Lipman's question about ultrafine particle precursors that the sources of UFP appear to be anthropogenic.

- **Stationary sources and UFP.** Council Member Solomon asked whether the Air District has investigated UFP emissions from stationary sources. Dr. Hoag responded that such analysis has not been conducted, in part because UFP concentrations are unlikely to remain high outside the perimeter of the facilities due to the distance-based decreases in particle counts described above. However, she stated that this type of measurement could be a possible application for the new mobile and portable monitoring technologies.
- **UFP gradient studies in the Bay Area.** Council Member Solomon asked whether the Air District is conducting studies to assess the persistence of UFP concentrations at increasing distances from Bay Area roadways. Dr. Hoag replied that this analysis had not been undertaken as part of UFP monitoring in the Bay Area but that many previous studies had established the patterns of near-roadway UFP distribution, including the influence of meteorology, topography, and roadway design.

Data sharing. Council Member Rudolph also asked for clarification on how data is being shared with the public. Mr. Breen stated that regional network monitoring data is available on the Air District website (http://www.baaqmd.gov/about-air-quality/current-air-quality). Dr. Hoag added that the community-scale data being collected by Aclima will also be publicly available once it has undergone quality assurance.