AGENDA: 4

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

PM Health Protection Symposium
(Advisory Council Meeting of October 28, 2019)

Chair Stan Hayes
Advisory Council
December 9, 2019

PM Focus:
Context

- Following three years of intense wildfire smoke, focus on reducing diesel PM emissions, and conclusion that PM is overwhelming health risk driver in Bay Area air
- Air District asked Advisory Council to focus on PM
- Provide Advisory Council's take on latest and best science, in science-affirming way
- Assist Air District to identify those further PM measures that would most move public health needle, especially in most impacted communities

PM Symposia:
Overview

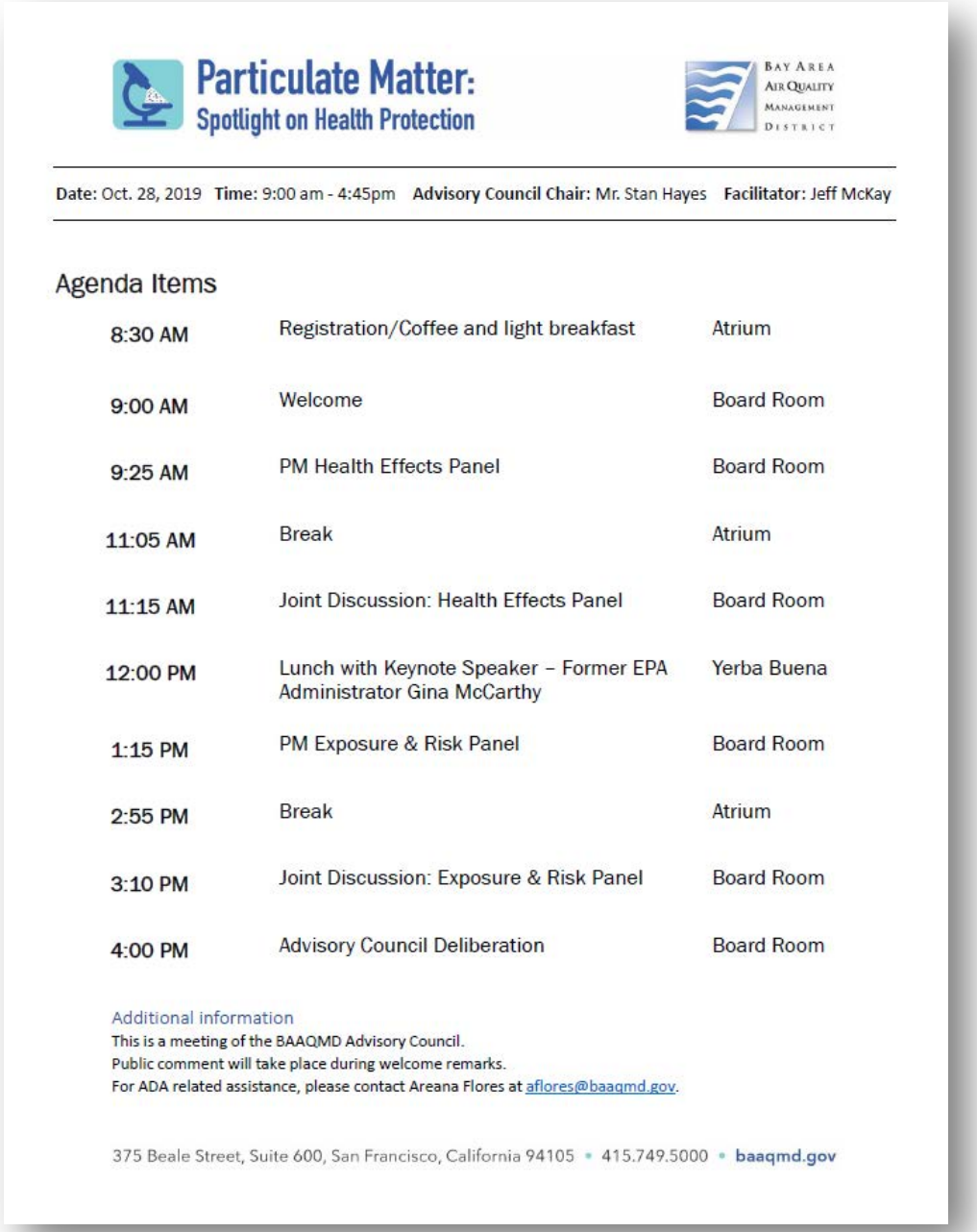
- Convened by Advisory Council as series of meetings
- Engage nationally-recognized experts, including leading experts previously engaged at the Federal level
- Support Air District in identifying health-focused “target” guidelines based on latest science, beyond standards already in effect
- Facilitate Advisory Council feedback on Air District planning
- Include local stakeholders
- Provide national leadership

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

Particulate Matter:
Spotlight on Health Protection

Bay Area Air Quality Management District



Particulate Matter:
Spotlight on Health Protection

Bay Area Air Quality Management District

Date: Oct. 28, 2019 **Time:** 9:00 am - 4:45pm **Advisory Council Chair:** Mr. Stan Hayes **Facilitator:** Jeff McKay

Agenda Items

8:30 AM	Registration/Coffee and light breakfast	Atrium
9:00 AM	Welcome	Board Room
9:25 AM	PM Health Effects Panel	Board Room
11:05 AM	Break	Atrium
11:15 AM	Joint Discussion: Health Effects Panel	Board Room
12:00 PM	Lunch with Keynote Speaker – Former EPA Administrator Gina McCarthy	Yerba Buena
1:15 PM	PM Exposure & Risk Panel	Board Room
2:55 PM	Break	Atrium
3:10 PM	Joint Discussion: Exposure & Risk Panel	Board Room
4:00 PM	Advisory Council Deliberation	Board Room

Additional information
This is a meeting of the BAAQMD Advisory Council.
Public comment will take place during welcome remarks.
For ADA related assistance, please contact Areana Flores at aflores@baaqmd.gov.

375 Beale Street, Suite 600, San Francisco, California 94105 • 415.749.5000 • baaqmd.gov

Particulate Matter:
Spotlight on Health Protection

- ~160 registrants
- 2 panels
  - PM Health Effects
  - PM Exposure & Risk
- 9 leading experts

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

Jason Sacks, M.P.H.

- Senior Epidemiologist in the Center for Public Health & Environmental Assessment within U.S. EPA's Office of Research and Development
- **Assessment lead for the Particulate Matter Integrated Science Assessment (Draft PM ISA)**
- Key leadership roles in synthesizing the health effects evidence of air pollution for various National Ambient Air Quality Standards reviews
- International training on U.S. EPA's Environmental Benefits Mapping and Analysis Program – Community Edition
- M.P.H. from Johns Hopkins University in 2003

Michael Kleinman, Ph.D.

- UC Irvine Professor of Environmental Toxicology
- Co-Director of the Air Pollution Health Effects Laboratory in the Department of Community and Environmental Medicine
- Adjunct Professor in College of Medicine
- **Serves on the Air District Advisory Council**
- Ph.D. in Environmental Health Sciences from New York University
- **CA Scientific Review Panel on Toxic Air Contaminants; CA Air Quality Advisory Committee**

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**

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
- **Former Chair/Member, EPA Clean Air Scientific Advisory Committee (CASAC)**
- **Former Chair/Member, 10 different CASAC NAAQS Review Panels**
- **Chair, Independent PM Review Panel**

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

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

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 Ambient 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

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

PM Health Effects Panel

PM Exposure & Risk Panel

Advisory Council Discussion with Experts

BAAQMD's Questions

Example Response

- 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.**

Discussion Questions (EXAMPLE, DO NOT CITE)

Are current PM standards sufficiently health protective?

NOT PROTECTIVE, STANDARDS SHOULD BE LOWERED

Are some species of PM more dangerous than others?

QUITE POSSIBLY BUT NOT ENOUGH INFORMATION, NO PM COMPONENTS "EXONERATED"

What is role of ultrafine particles (UFPs)?

NOT YET CLEAR, TOX STUDIES OF CONCERN, NEED UFP FEDERAL REFERENCE METHOD, MORE MONITORING, EPI STUDIES

Should PM "target" expand to account for more than just mass?

IN RESEARCH ABSOLUTELY, IN REGULATION TOO SOON, UNLESS HIGHLY RISK-AVERSE

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)?

NEW HEALTH EFFECTS AND GROWING RECOGNITION OF "AT RISK" GROUPS IMPORTANT (SUCH AS CHILDREN AND LOW SES), NEED TO CONSIDER

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

NOT WELL-KNOWN SCIENTIFICALLY BUT OF CONCERN, DATA ON SUB-DAILY EXPOSURES TOO LIMITED AS YET, POTENTIALLY SERIOUS EFFECTS IN EARLY STUDIES, OTHER STUDIES ONGOING, MORE RESEARCH NEEDED

Advisory Council:
Initial Deliberation

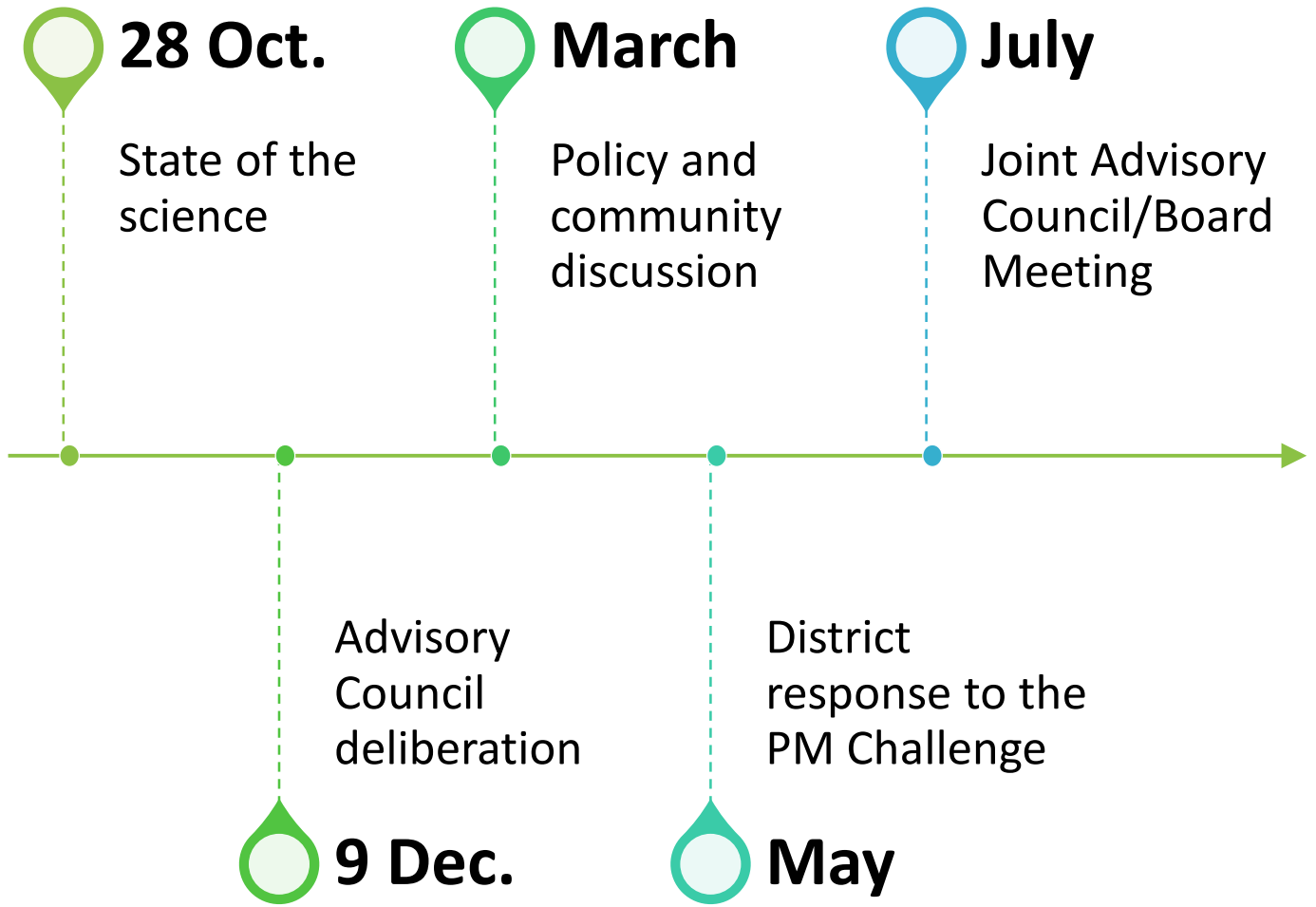
Sense of the Council

- 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.

Further Exploration

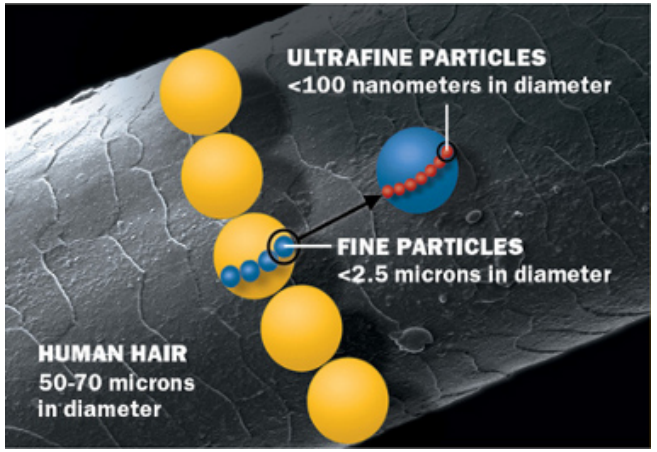
- Treating PM as an air toxic
- Expanded monitoring of UFP
- Health effects of acute PM exposures, e.g., wildfire smoke
- Identifying PM species that are particularly dangerous
- Assisting District in identifying strategies having "highest bang for buck" for health protection
- Pursuing strategies that have climate and other co-benefits

PM Symposium Series



Ambient Particulate Matter (PM)

- PM is a mixture, including particles of differing origin (combustion, crustal, biological) and varying size.
- Multiple sources



Mortality – Long-term $PM_{2.5}$ Exposure

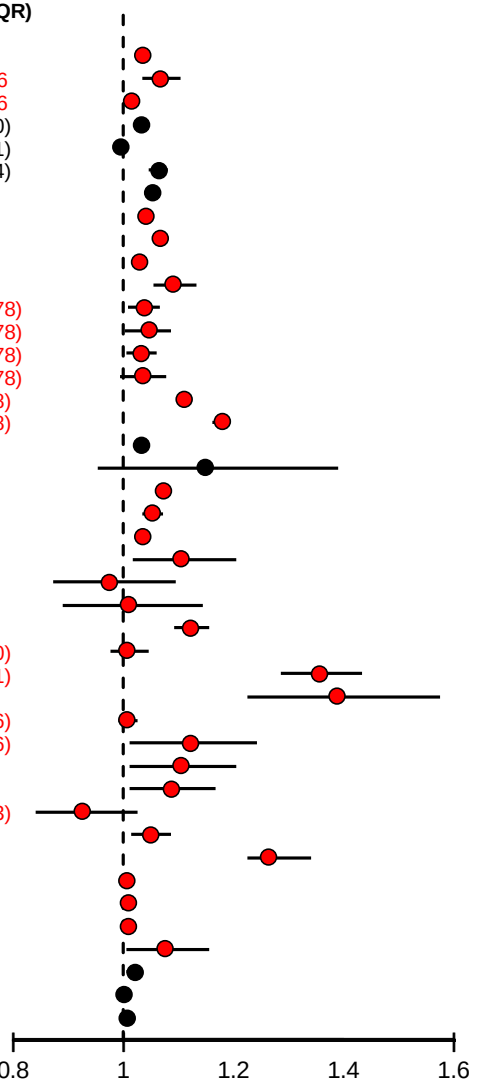
Recent evidence supports and extends the conclusions of the 2009 PM ISA that there is a causal relationship between long-term $PM_{2.5}$ exposure and mortality

Figure 11-18. Associations between long-term $PM_{2.5}$ and total (nonaccidental) mortality in recent North American cohorts.

Note: Associations are presented per 5 µg/m³ increase in pollutant concentration.

Red = recent studies;
Black = studies evaluated in the 2009 PM ISA

Reference	Cohort	Notes	Years	Mean (IQR)
†Pope et al. 2014	ACS		1982-2004	12.6
†Lepeule et al. 2012	Harvard Six Cities		1974-2009	11.4-23.6
†Thurston et al. 2015	NIH-AARP		2000-2009	10.2-13.6
Zeger et al. 2008	MCAPS	Eastern	2000-2005	14.0 (3.0)
Zeger et al. 2008	MCAPS	Western	2000-2005	13.1 (8.1)
Zeger et al. 2008	MCAPS	Central	2000-2005	10.7 (2.4)
Eftim et al. 2008	ACS-Medicare		2000-2002	13.6
†Di et al. 2017	Medicare		2000-2012	11.5
†Di et al. 2017	Medicare	exp<12	2000-2012	11.5
†Di et al. 2017	Medicare	nearest monitor	2000-2012	11.5
†Kioumourtzoglou et al. 2016	Medicare		2000-2010	12
†Shi et al. 2015	Medicare	mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	exp <10, mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	no mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	exp <10, no mutual adj	2003-2008	8.12 (3.78)
†Wang et al. 2017	Medicare		2000-2013	10.7 (3.8)
†Wang et al. 2017	Medicare	exp<12	2000-2013	10.7 (3.8)
Lipfert et al. 2006	Veterans Cohort		1997-2001	14.34
Goss et al. 2004	U.S. Cystic Fibrosis		1999-2000	13.7
†Crouse et al. 2012	CanCHEC	Satellite data	1991-2001	8.9
†Crouse et al. 2012	CanCHEC	Monitor data	1991-2001	11.2
†Crouse et al. 2015	CanCHEC		1991-2006	8.9
†Chen et al. 2016	EFFECT		1999-2011	10.7
†Weichenthal et al. 2014	Ag Health		1993-2009	8.84
†Weichenthal et al. 2014	Ag Health	more precise exp	1993-2009	8.84
†Pinault et al. 2016	CCHS		1998-2011	6.3
†Lipsett et al. 2011	CA Teachers		2000-2005	15.6 (8.0)
†Ostro et al. 2010	CA Teachers	within 30 km	2002-2007	17.5 (6.1)
†Ostro et al. 2010	CA Teachers	within 8 km	2002-2007	17 (6.1)
†Ostro et al. 2015	CA Teachers		2001-2007	17.9 (9.6)
†Puett et al. 2009	Nurses Health		1992-2002	13.9 (3.6)
†Hart et al. 2015	Nurses Health	nearest monitor	2000-2006	12.7
†Hart et al. 2015	Nurses Health	spatio-temp. model	2000-2006	12
†Puett et al. 2011	Health Prof	full model	1989-2003	17.8 (4.3)
†Hart et al. 2011	TrIPS		1985-2000	14.1 (4)
†Kloog et al. 2013	MA cohort	CVD+Resp	2000-2008	9.9 (1.6)
†Garcia et al. 2015	CA cohort	Kriging	2006	13.06
†Garcia et al. 2015	CA cohort	IDW	2006	12.94
†Garcia et al. 2015	CA cohort	closest monitor	2006	12.68
†Wang et al. 2016	NJ Cohort		2004-2009	11.3
Enstrom 2005	CA Cancer Prev		1973-1982	23.4
Enstrom 2005	CA Cancer Prev		1983-2002	23.4
Enstrom 2005	CA Cancer Prev		1973-2002	23.4



Draft PM ISA Health Effects: Causality Determinations

Table 1-5. Summary of causality determinations for health effect categories for the draft PM ISA.

Draft PM ISA:

- **1,879 pages**
- **2,647 references**

HUMAN HEALTH EFFECTS				
ISA		Current PM Draft ISA		
Indicator		$PM_{2.5}$	$PM_{10-2.5}$	UFP
Health Outcome: Respiratory	Short-term exposure			
	Long-term exposure			
Cardiovascular	Short-term exposure			
	Long-term exposure		*	
Metabolic	Short-term exposure	*	*	*
	Long-term exposure	*	*	*
Nervous System	Short-term exposure	*		*
	Long-term exposure	*	*	*
Reproductive: Male/Female Reproduction and Fertility	Long-term exposure			
Reproductive: Pregnancy and Birth Outcomes	Long-term exposure			
Cancer	Long-term exposure	*	*	
Mortality	Short-term exposure			
	Long-term exposure		*	

Causal | Likely causal | Suggestive | Inadequate

* = new determination or change in causality determination from 2009 PM ISA

Respiratory (LIKELY CAUSAL)

Cardiovascular (CAUSAL)

Nervous System (LIKELY CAUSAL)

Cancer (LIKELY CAUSAL)

Mortality (CAUSAL)

Populations Potentially at Increased Risk of a PM-related Health Effect

- The NAAQS are intended to protect both the population as a whole and those potentially at increased risk for health effects in response to exposure to criteria air pollutants
  - *Are there specific populations and lifestages at increased risk of a PM-related health effect, compared to a reference population?*
- The ISA identified and evaluated evidence for factors that may increase the risk of $PM_{2.5}$-related health effects in a population or lifestage, classifying the evidence into four categories:
  - Adequate evidence; suggestive evidence; inadequate evidence; evidence of no effect
- Conclusions:
  - **Adequate: children and nonwhite populations**
  - Suggestive: pre-existing cardiovascular and respiratory disease, overweight/obese, genetic variants glutathione transferase pathways, low SES
  - Inadequate: pre-existing diabetes, older adults, residential location, sex, diet, and physical activity

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 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.

Current annual standard of 12 ug/m3 = ~ 47 thousand deaths per year

Lower annual standard from 12 to 10 ug/m3 = ~ 6-7 thousand fewer deaths per year (13-15%)

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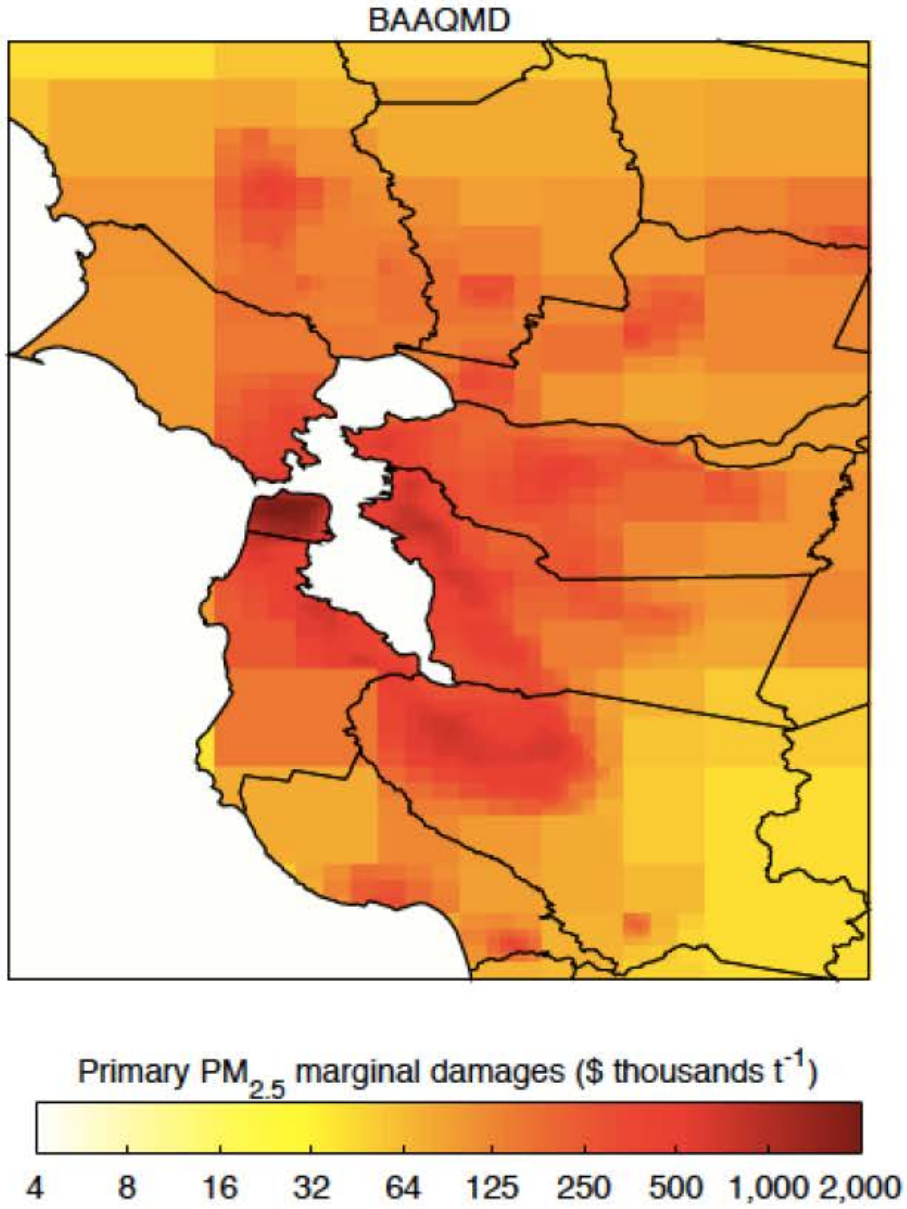
Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards

- 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

Draft EPA PM Policy Assessment (PA)

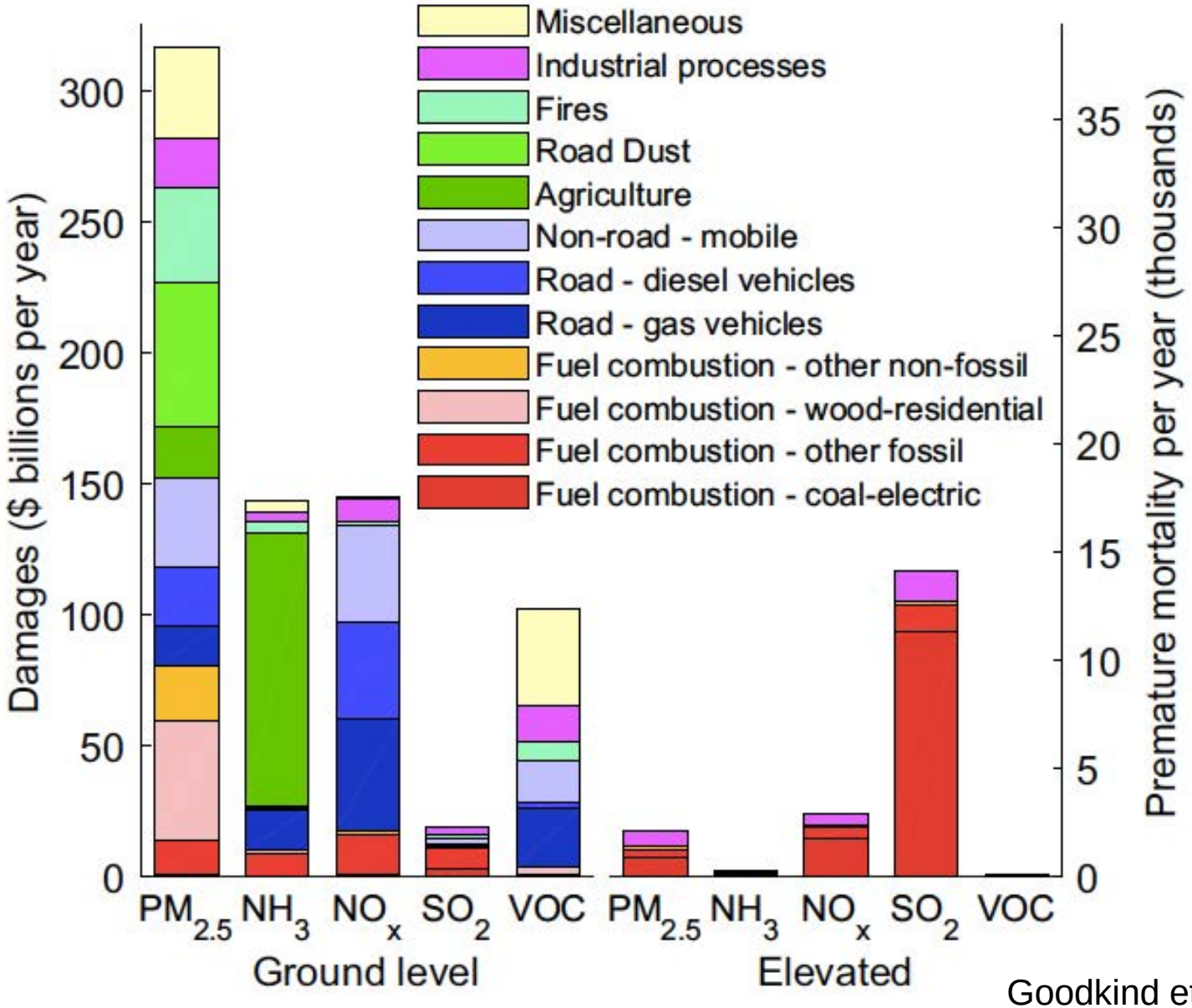
- Basis for this preliminary conclusion:
  - Long-standing body of health evidence, strengthened in this review, supporting relationships between $PM_{2.5}$ exposures and various outcomes, including mortality and serious morbidity effects
  - Recent U.S. and Canadian epidemiologic studies reporting positive 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)

Primary $PM_{2.5}$ Marginal Damages



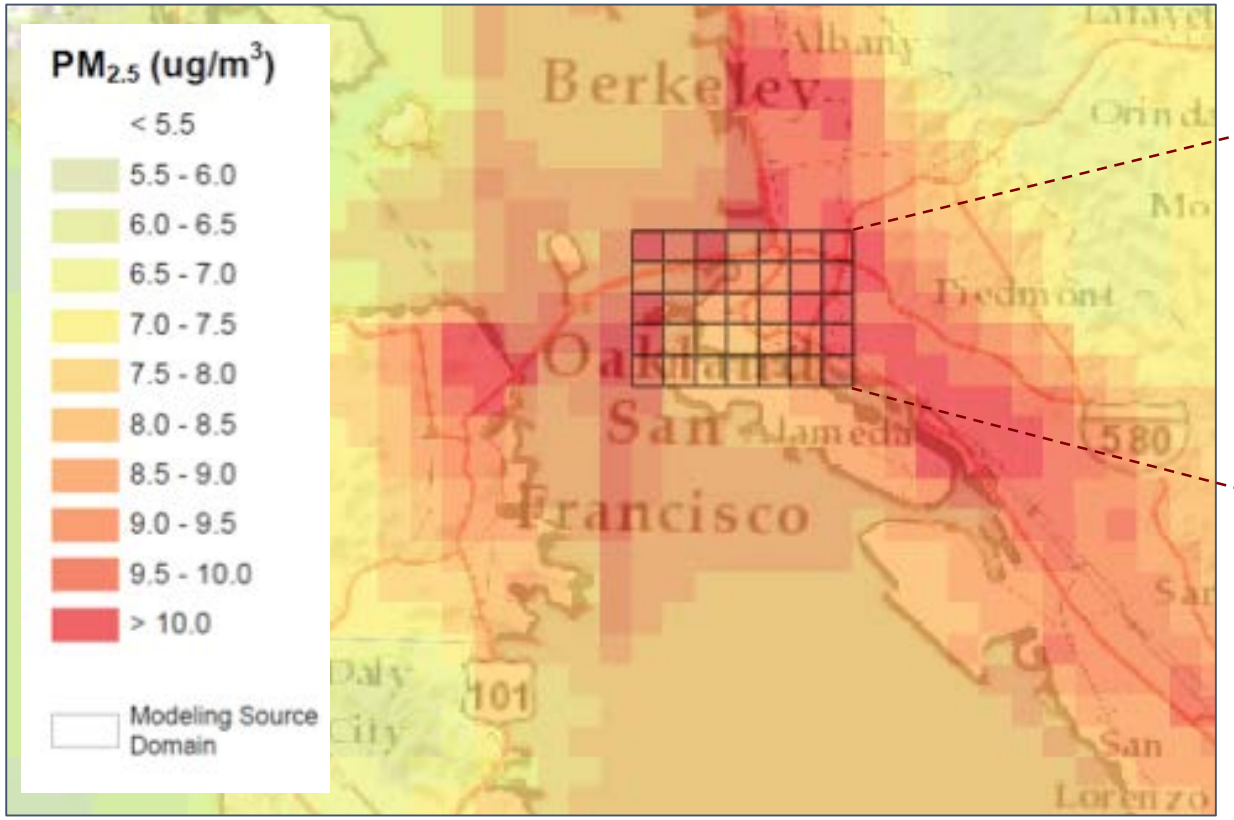
Goodkind et al., *PNAS*, 2019

Damages and Premature Mortality

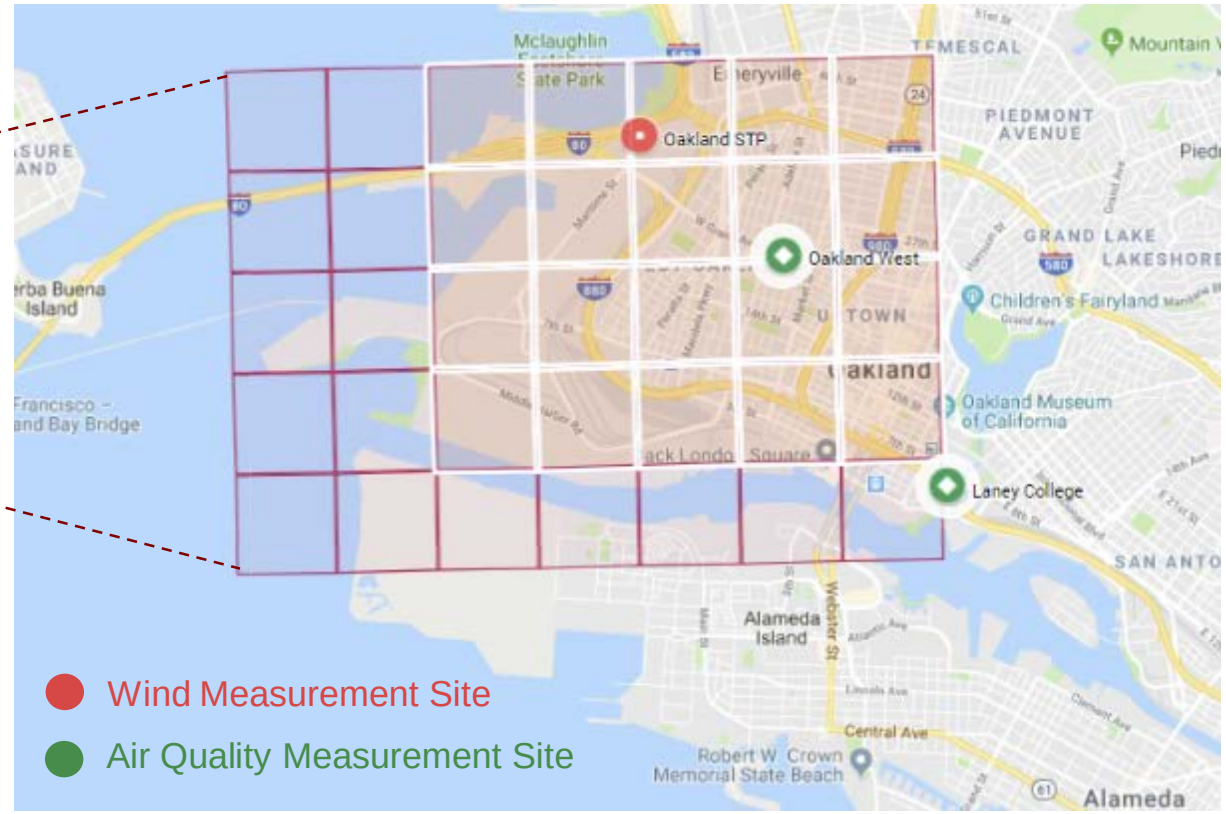


Goodkind et al., *PNAS*, 2019

Regional-Scale and Community-Scale Modeling (2017)



Regional-scale modeling: covers the Bay Area



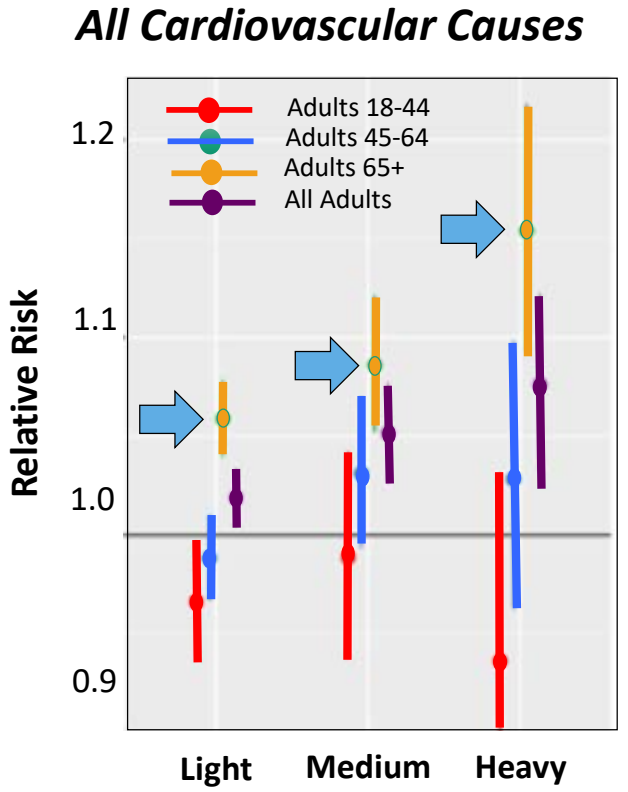
Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

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)



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

Slide credit: Wayne Cascio

AGENDA: 5A

Update on Particulate Matter (PM) Air District Work:

Regional-and Local-Scale $PM_{2.5}$ Source Apportionment

Phil Martien, PhD
Director of Assessment, Inventory, and Modeling

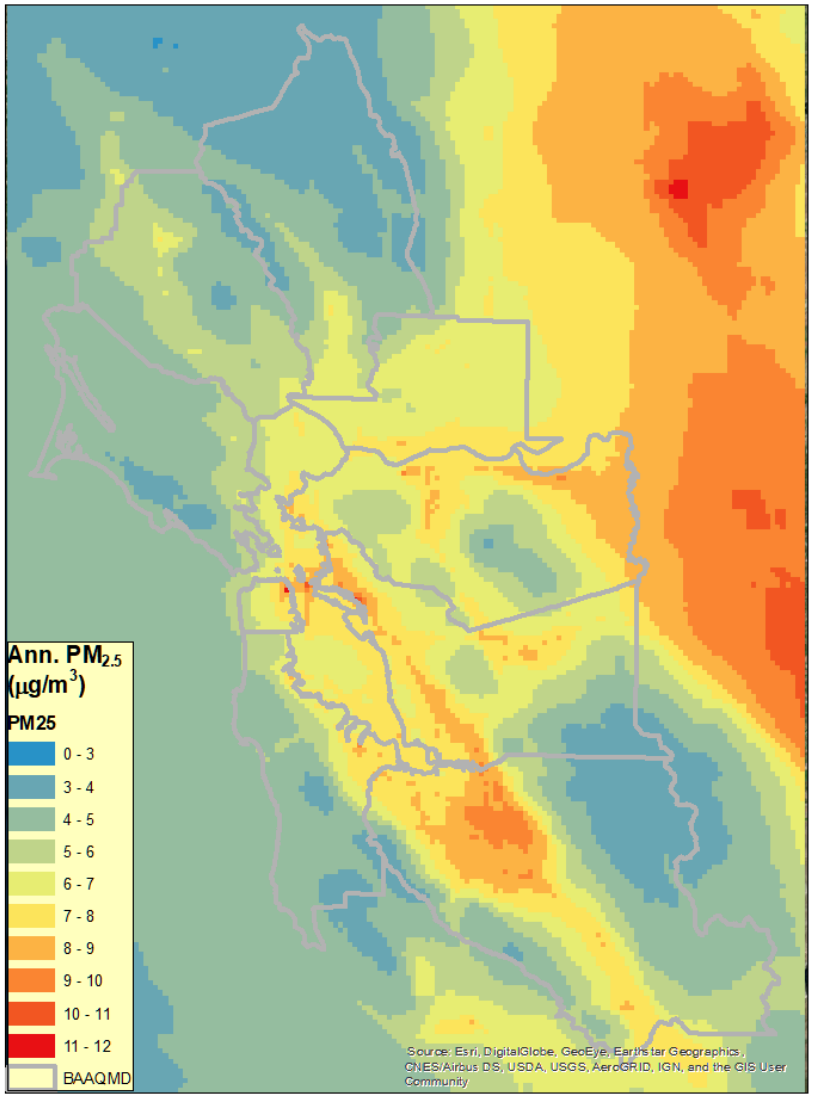
Advisory Council Meeting
December 9, 2019

Overview

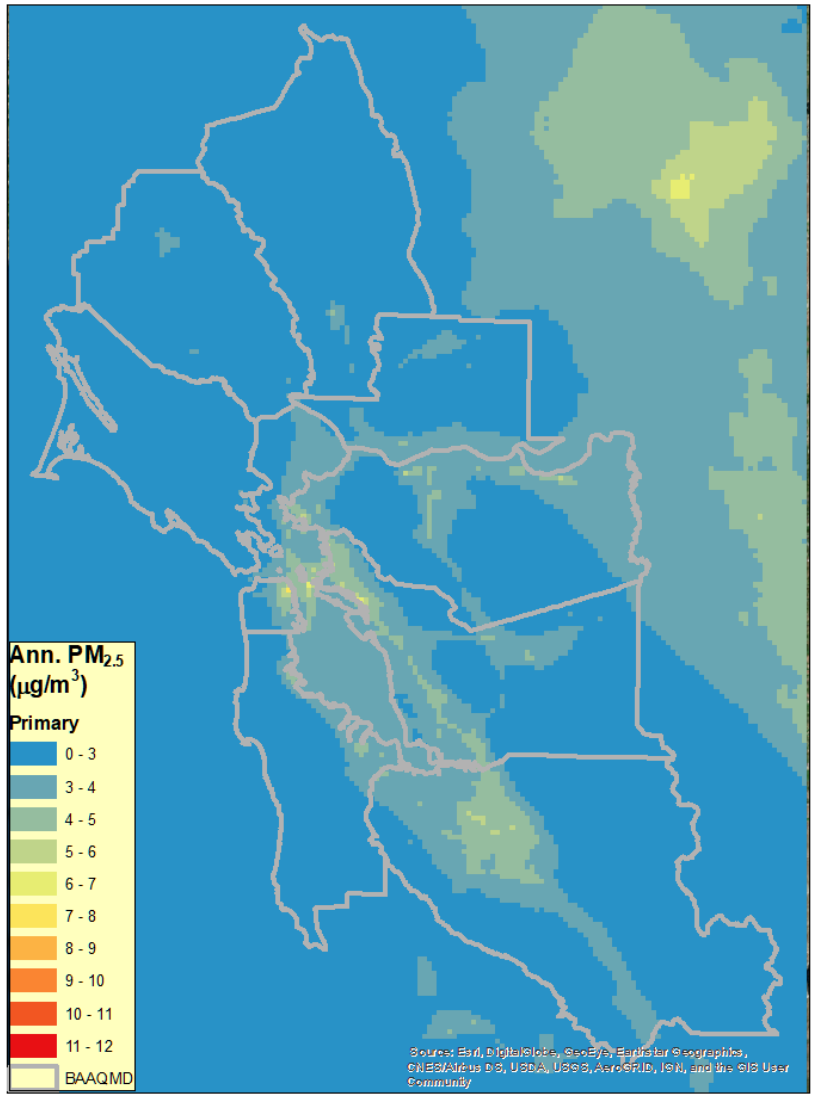
- **Regional-scale $PM_{2.5}$ source apportionment:**
  - Informs actions to maintain attainment of PM standards
  - Reveals information gaps, as top sources are controlled
- **Local-scale $PM_{2.5}$ source apportionment:**
  - Indicates near-source exposures add to total pollution burden
  - Reveals additional information gaps
  - Suggests a regulatory gap: actions to reduce near-source exposures?

Regional Modeling: Primary and Secondary Contributions

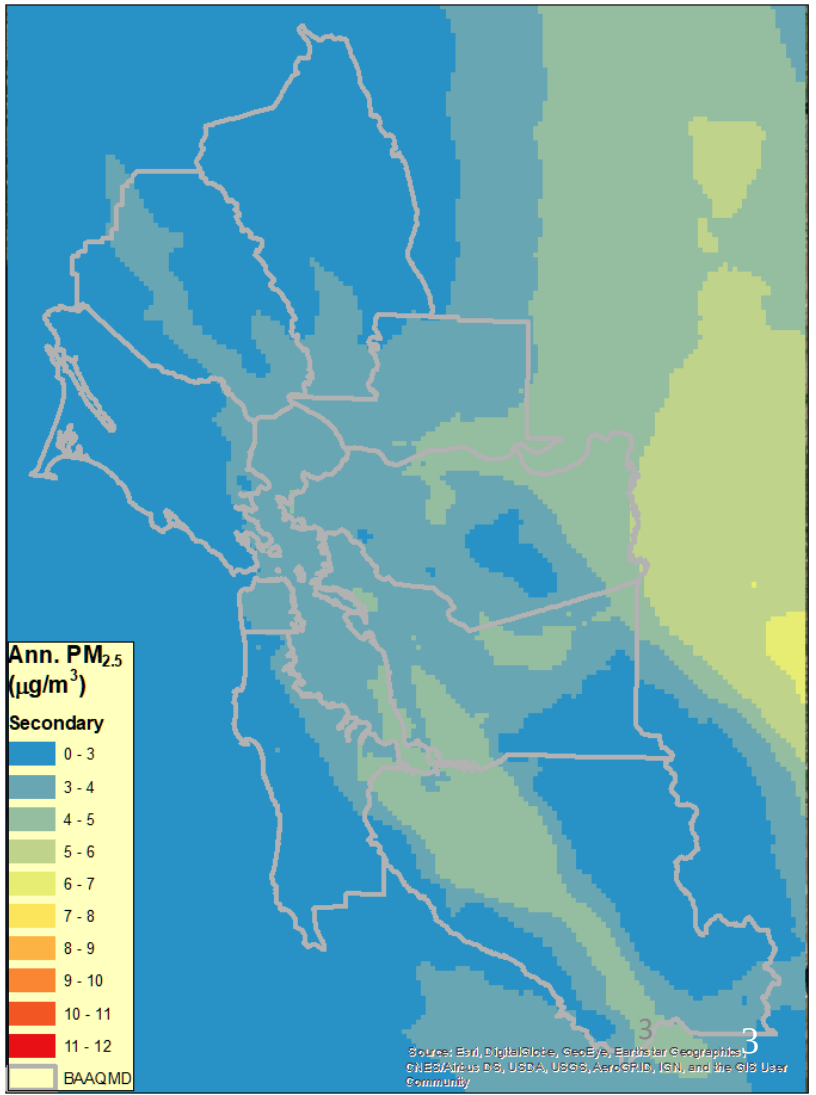
Total $PM_{2.5}$



Primary $PM_{2.5}$ (about 53%)

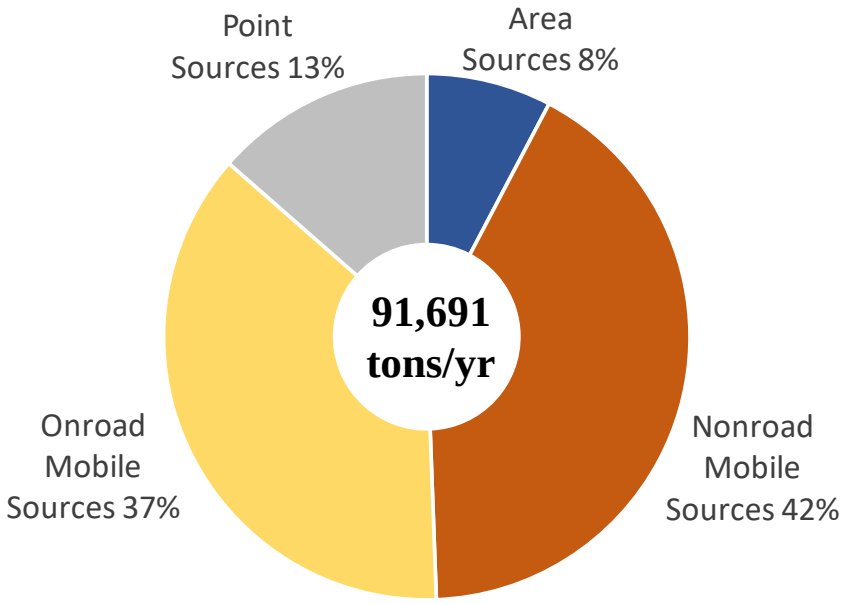


Secondary $PM_{2.5}$ (about 47%)



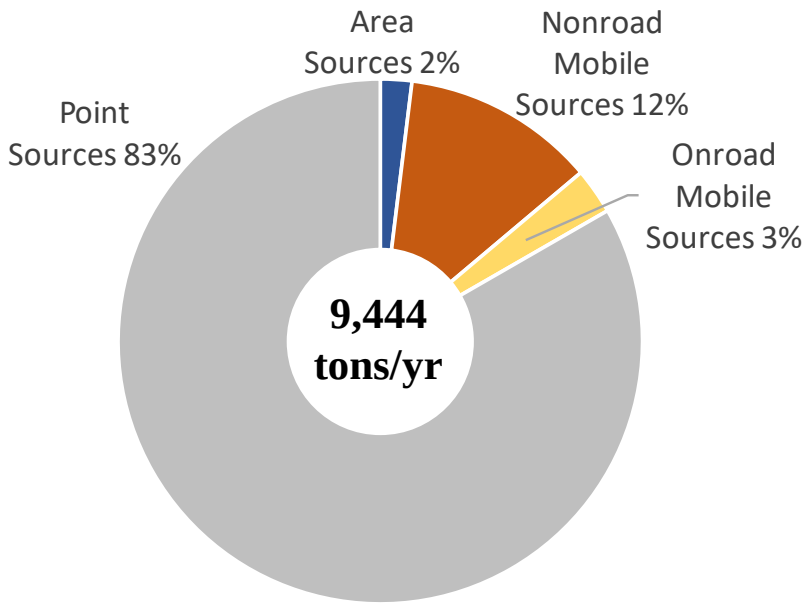
2016 Bay Area Emissions Summary for Key Secondary $PM_{2.5}$ Precursors

NO_x



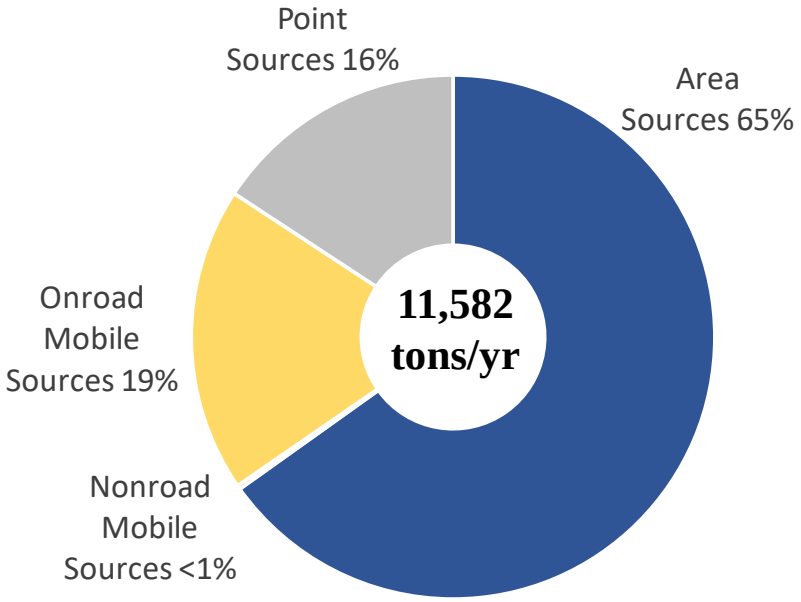
Key NO_x Sources: Diesel trucks and diesel-powered off-road equipment

SO_2



Key SO_2 Sources: Petroleum refineries, manufacturing plants (cement, chemicals)

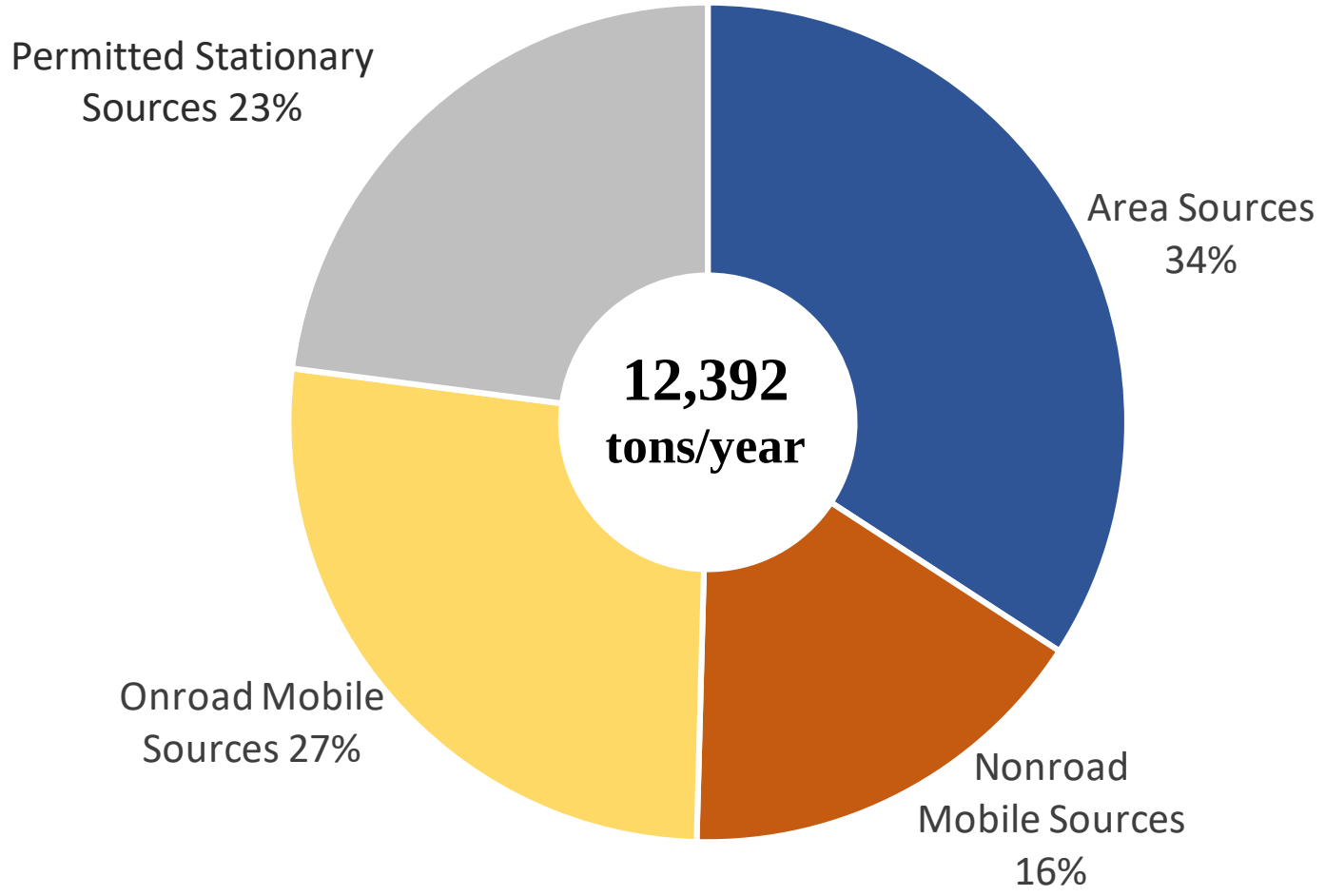
NH_3



Key NH_3 Sources: Agricultural activity (livestock husbandry, fertilizer application)

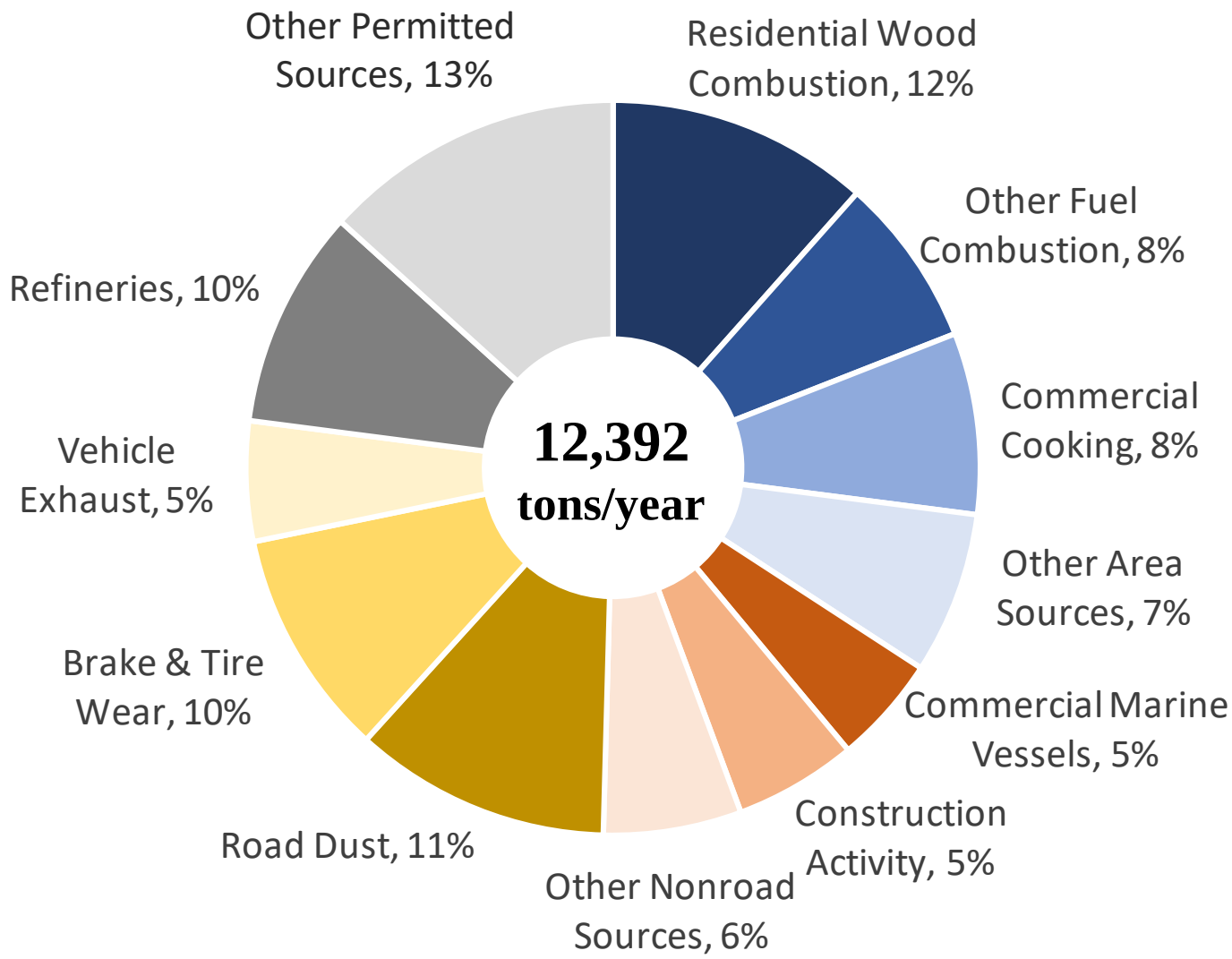
$PM_{2.5}$ Bay Area Emissions Summary for Primary $PM_{2.5}$

2016 annual average $PM_{2.5}$ emissions



$PM_{2.5}$ Bay Area Emissions Summary for Primary $PM_{2.5}$

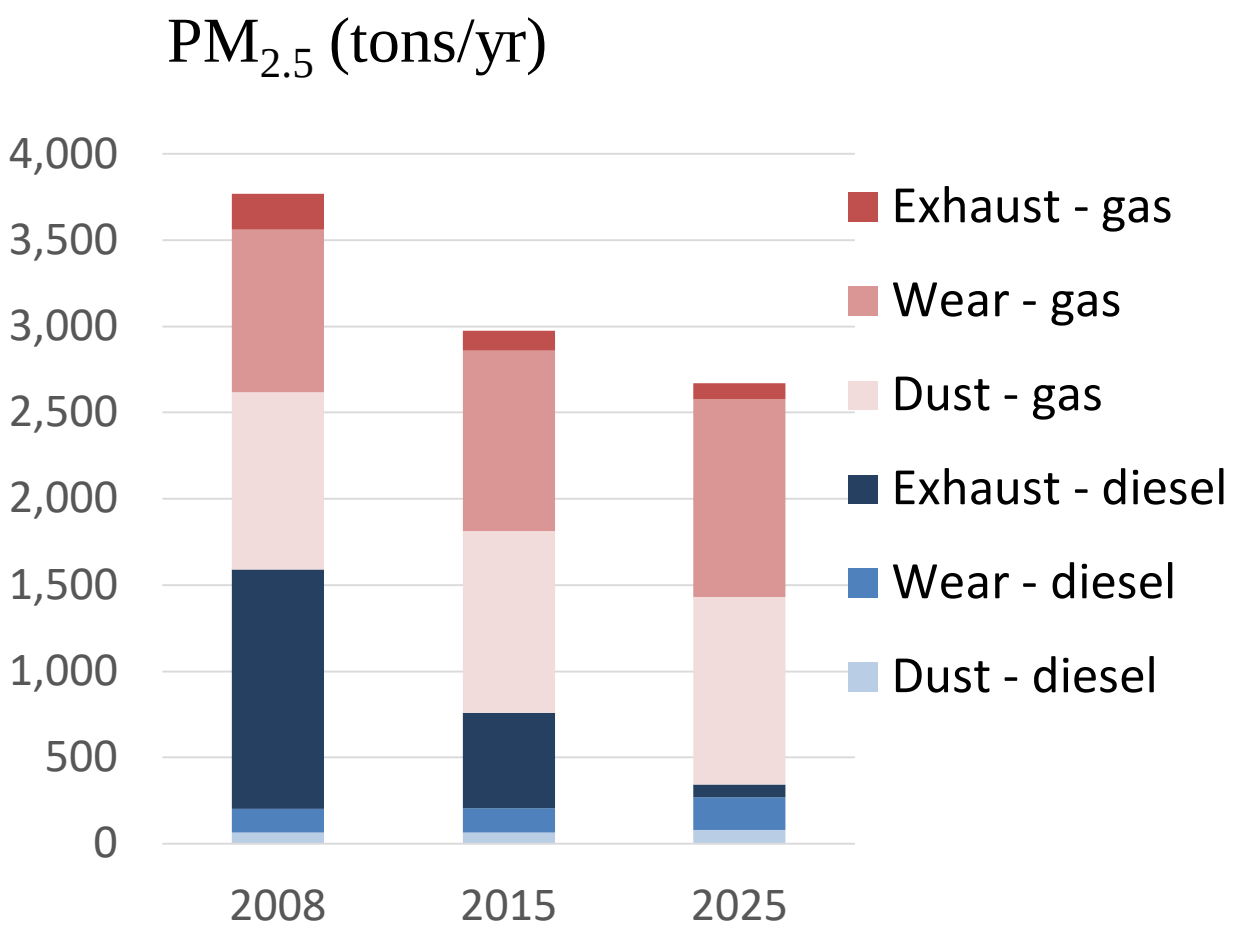
2016 annual average $PM_{2.5}$ emissions

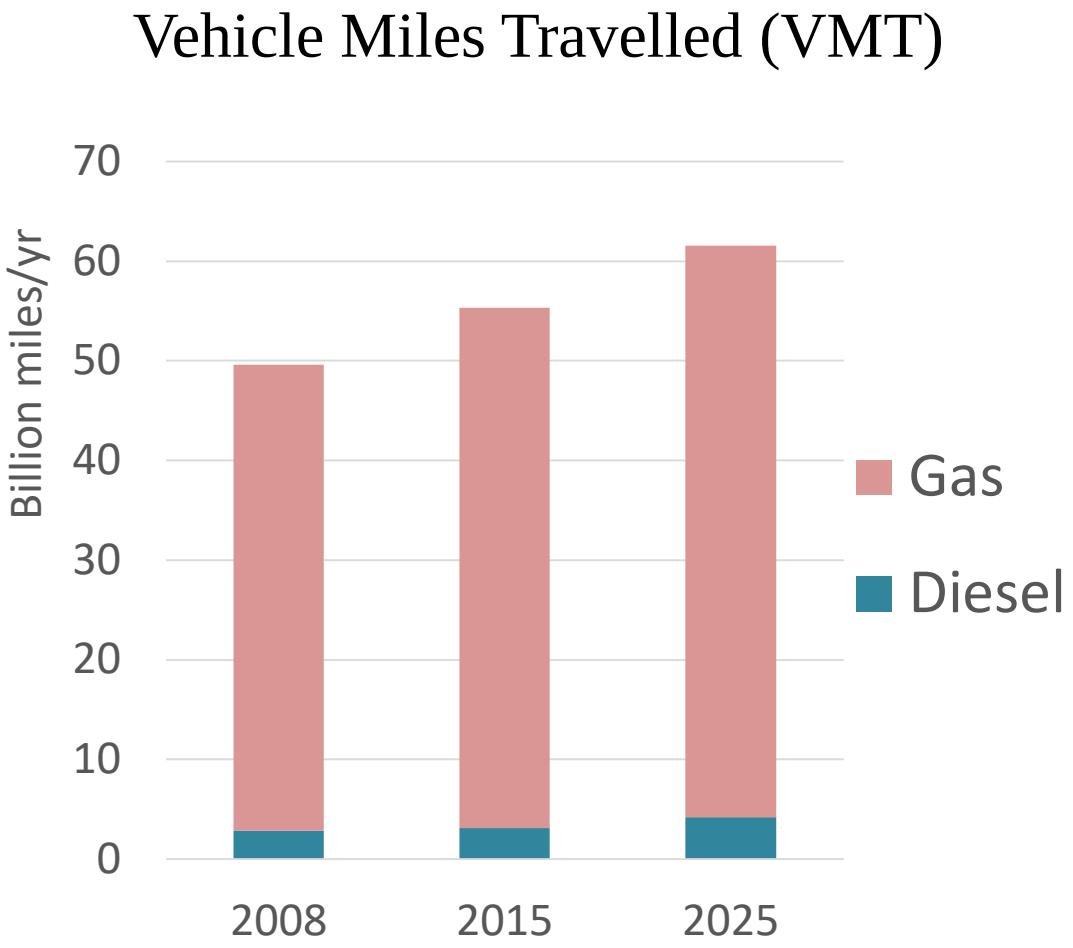


Emissions Inventory Information Gaps

- **On-road wear emissions and road dust**
- **Some area source categories**
  - Residential wood combustion
  - Commercial cooking

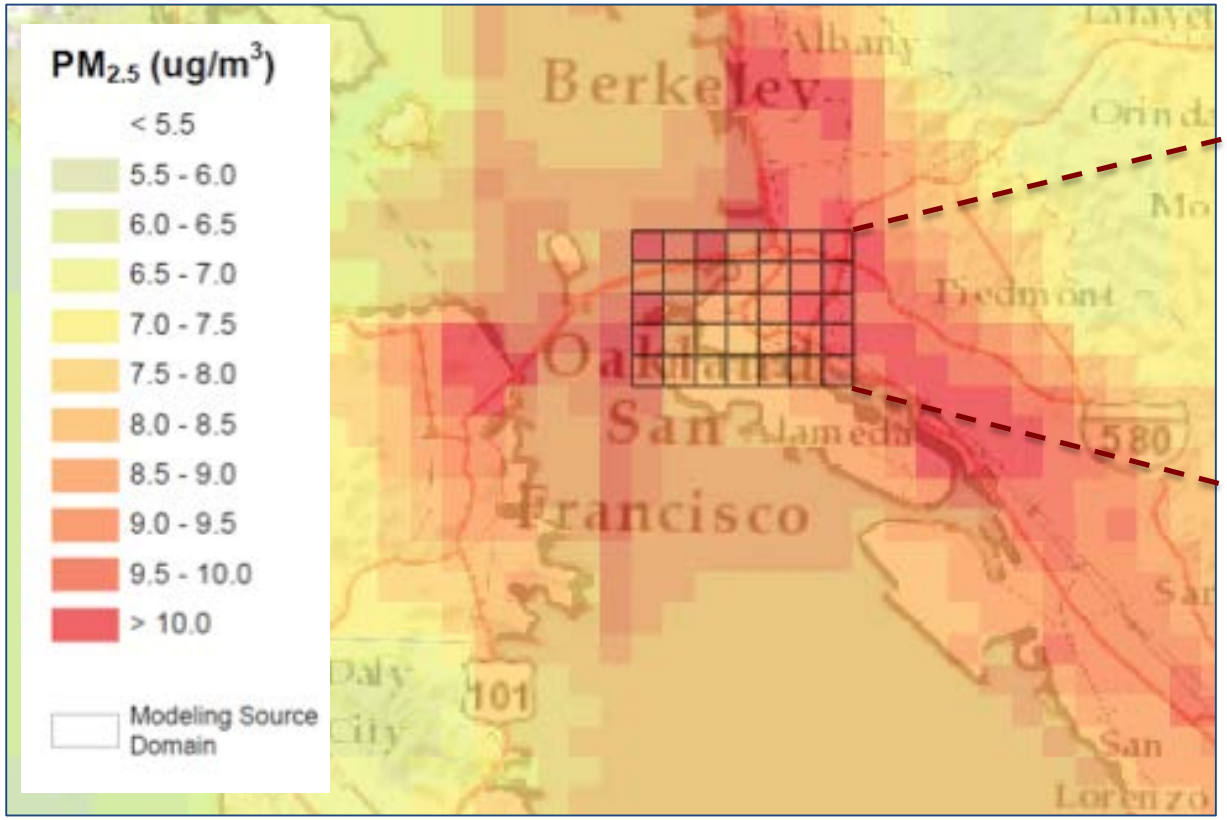
$PM_{2.5}$ Bay Area Emissions Apportionment: On-road Vehicles



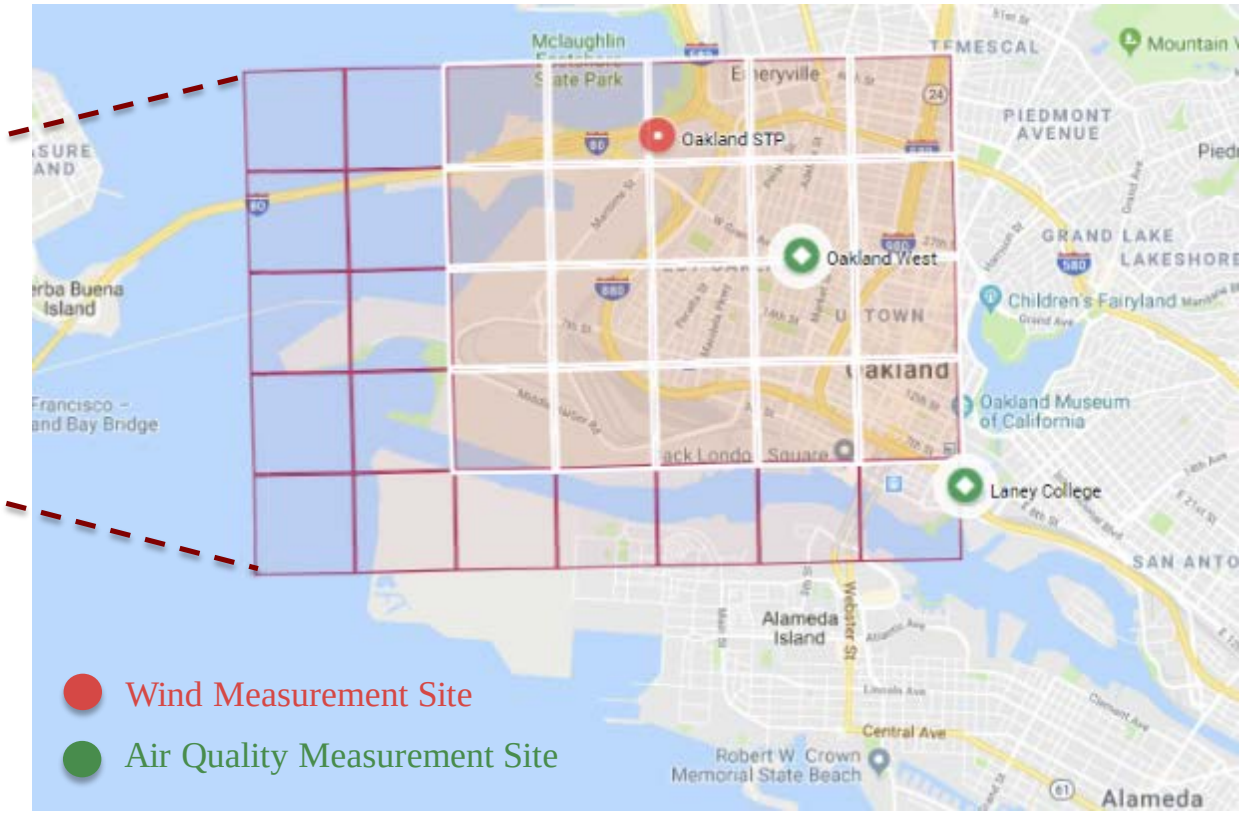


Data sources: EMFAC2017, California Air Resources Board 2016 State Implementation Plan Inventory

Regional-Scale and Community-Scale Modeling (2017)



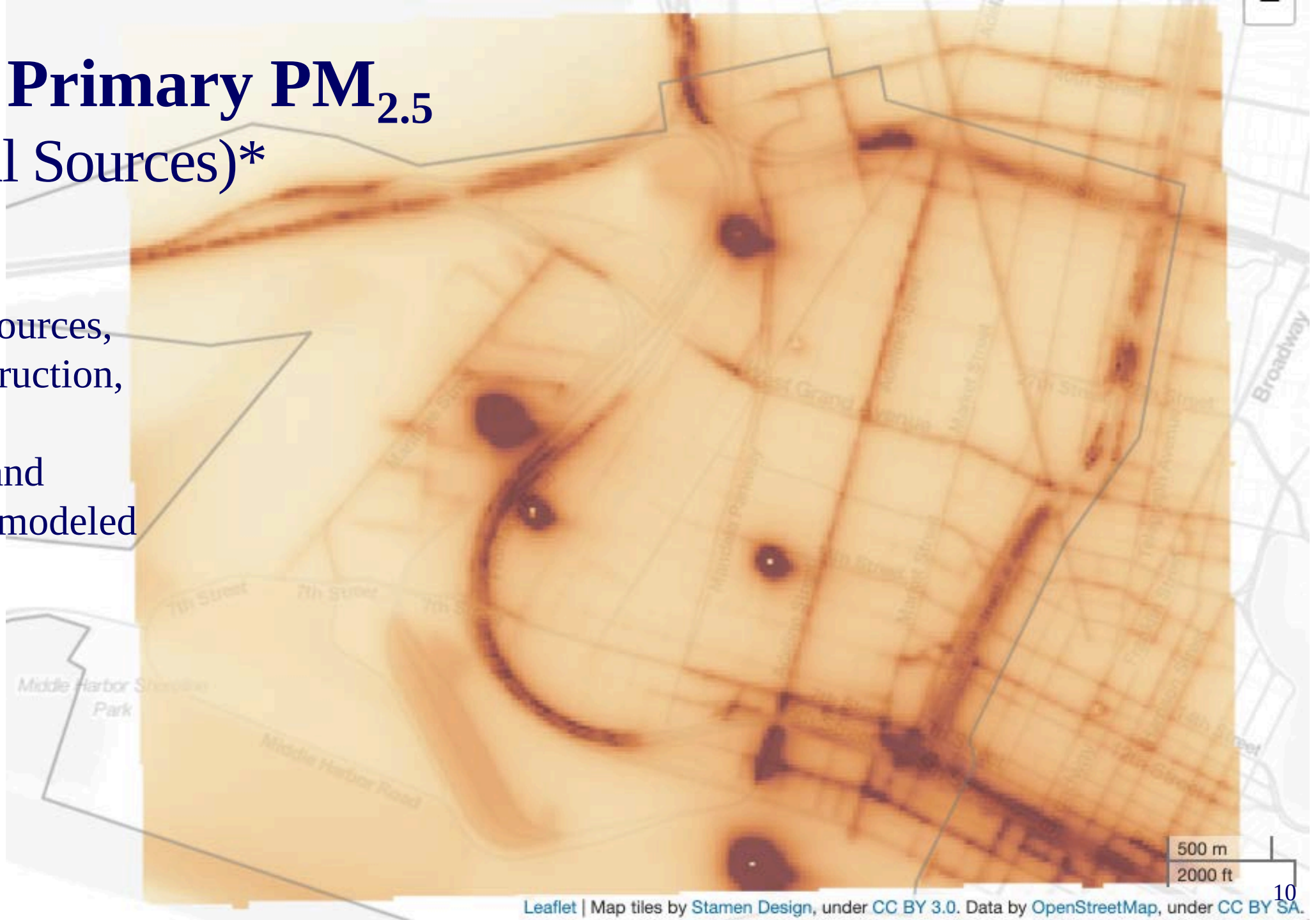
Regional-scale modeling: covers the Bay Area



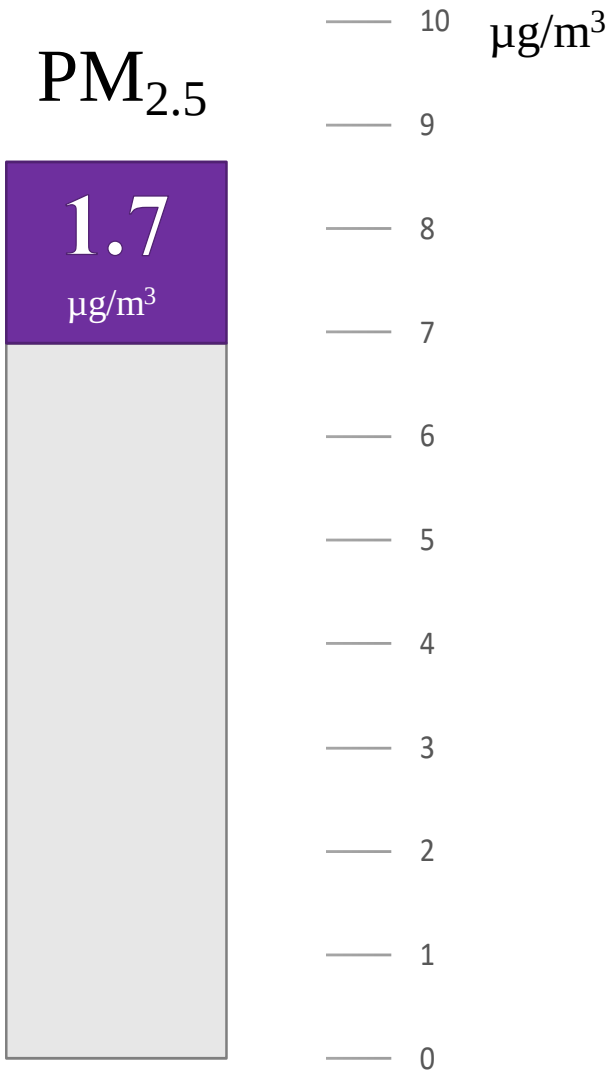
Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

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

* 30% of $PM_{2.5}$ sources, including construction, residential woodburning, and restaurants not modeled



Local vs. Regional: West Oakland Example

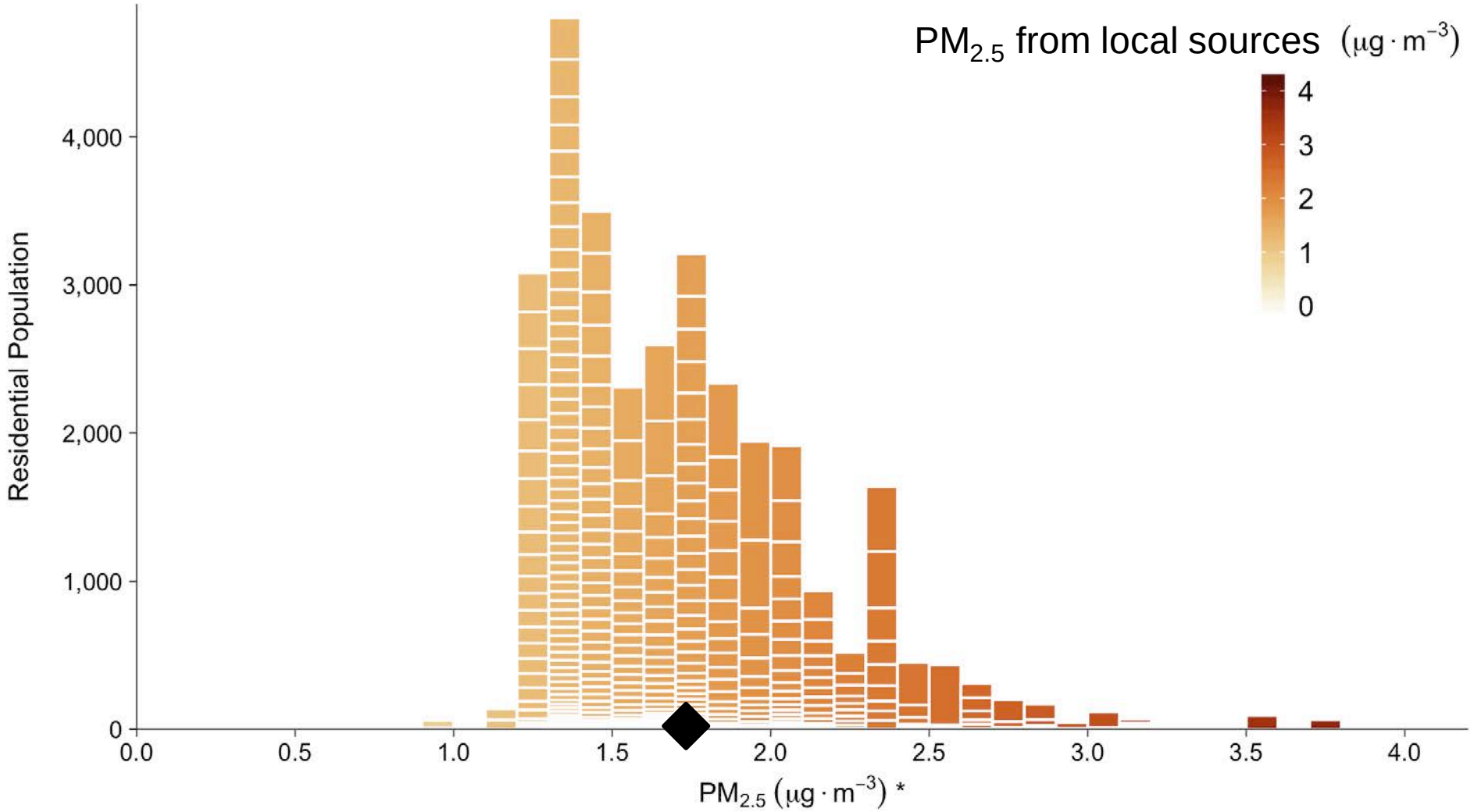


Community-scale model – mapped impacts*

Regional-scale model (minus West Oakland)

*30% of $PM_{2.5}$ sources, including construction, residential woodburning, and restaurants not modeled

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

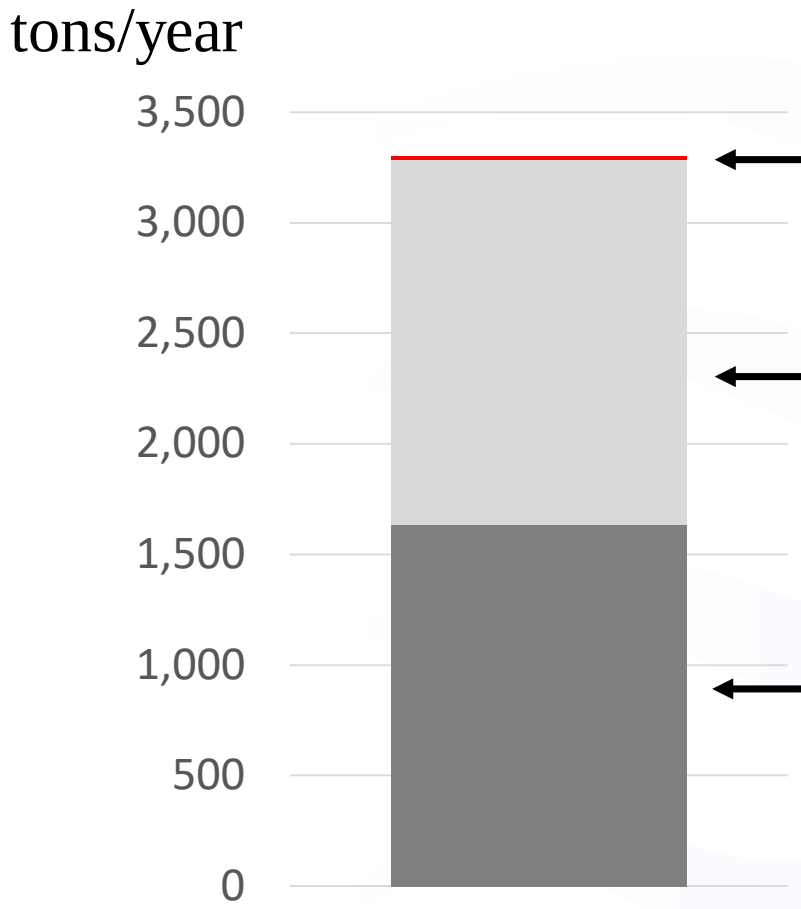


* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

Additional Emissions Inventory Information Gaps Identified

- Local-scale exposures: a different lens for evaluating priorities
- Same concerns about on-road wear and road dust emissions estimates
- We require more information about permitted sources that are not top priorities from a regional perspective

$PM_{2.5}$ Emissions (tons/yr) from Permitted Facilities



West Oakland facilities ≈ **0.5%** (15 tons/yr, within community boundary)

Top 5 facilities (Air District-wide) ≈ **50%**

(All others)

Summary

- Continuing regulatory programs to reduce $PM_{2.5}$ with the current regional focus will improve health throughout the Bay Area
- As top sources are controlled, new sources become priorities and we identify new information gaps
- Local-scale assessments bring to focus the importance of some permitted sources that are a low priority from a regional perspective
- A regulatory gap: a framework that promotes $PM_{2.5}$ reductions from near-source exposures will improve health in Assembly Bill 617 communities

AGENDA: 5B

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Update on Particulate Matter (PM) Air District Work:

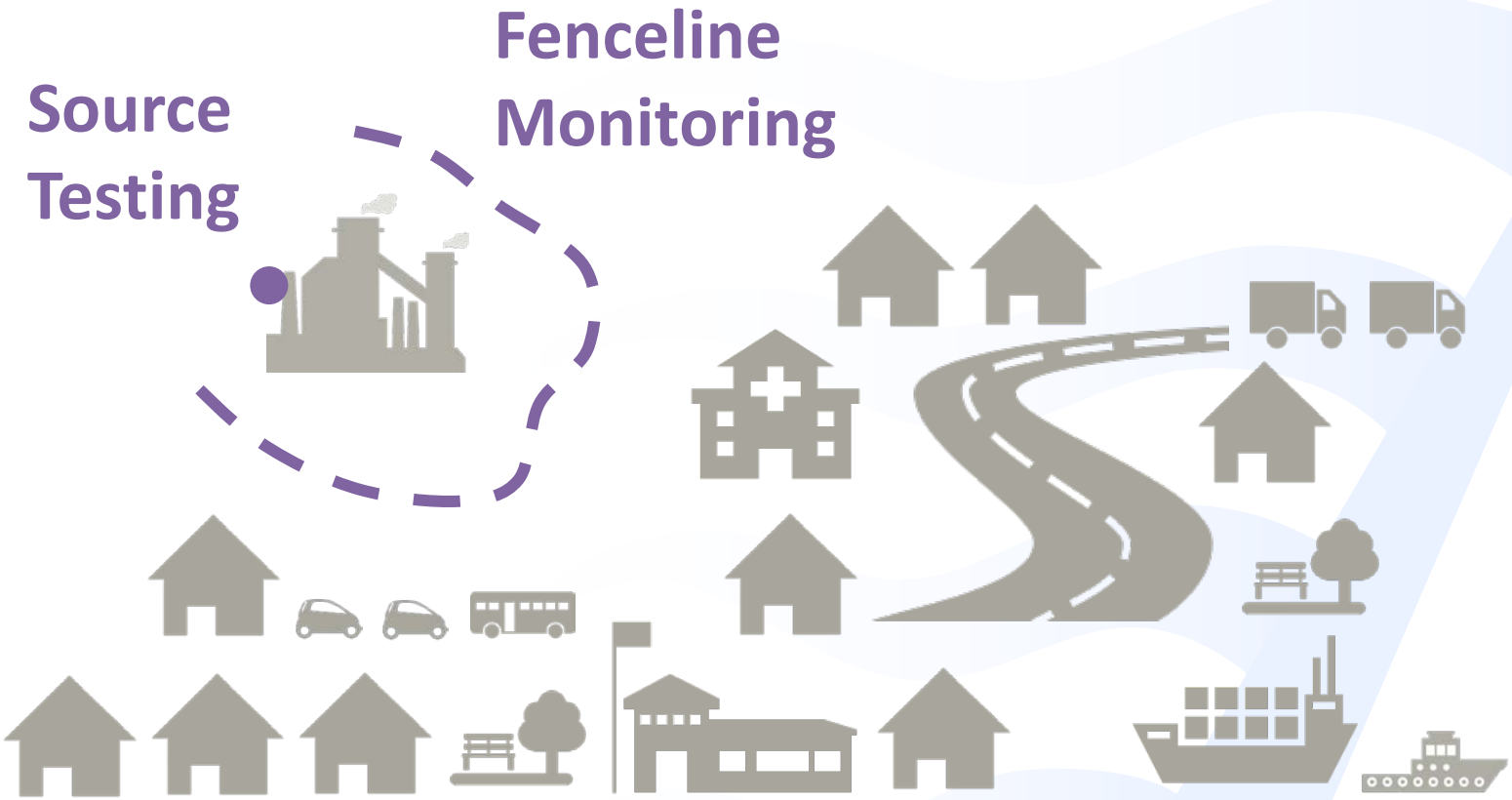
Monitoring

Ranyee Chiang
Director of Meteorology & Measurements

Advisory Council Meeting
December 9, 2019

Measurements in the Bay Area

Measurements in the Bay Area (cont.)



Measurements in the Bay Area (cont.)

Measurements in the Bay Area (cont.)

Sensor Networks

Outline: PM Monitoring

- Regional Network and Community Monitoring
  - Current capabilities
  - New developments
- What does the data show?
  - Ultrafine particles
  - Wildfire incidents
- Looking ahead
  - How could data be used
  - Options to strengthen air quality monitoring

Regional/Regulatory Network: Objectives

- Provide timely ambient air quality data to the general public
- Air quality forecasting for Spare the Air Program
- Support compliance with California and national ambient air quality standards
- Support air pollution research studies

Monitoring Network Design Criteria

- Site Types
  - Population-oriented
  - Highest concentration of pollutants
  - Source-oriented (downwind of major pollution sources)
  - General background sites
  - Regional transport (near borders of the Air District)

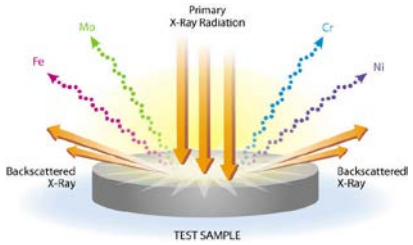
40 Code of Federal Regulations 58 Appendix D

- Based on population (2010 Census or estimates)
  - Number of monitoring sites in the Bay Area exceeds the required number

Particulate Matter (PM) Measurements

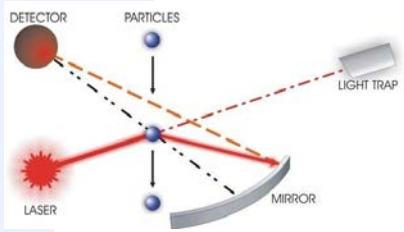
Mass Measurements

- Compliance with California and National PM_{10} and $PM_{2.5}$ standards
- Designate areas as attainment or nonattainment



Chemically Resolved or Speciated Data

- Support emission reduction strategies



Particle Counts

- Explore science on emissions, air quality impacts, and health effects associated with exposures

Air District PM Instrumentation

	PM_{10} Mass	$PM_{2.5}$ Mass	$PM_{2.5}$ Speciation	Ultrafine Particles ($PM_{0.1}$)	Black Carbon Mass
Analytical methods	Gravimetric	Gravimetric or Filter-based beta attenuation	Chemical extraction	Laser-based particle counter	Filter-based light attenuation
Active monitors	7	20	4	6	7
Example photo					

Ultrafine PM Monitoring

Strengths:

- 7+ years of experience with deployment in diverse siting applications
- Current data can be used to understand diurnal and seasonal patterns, trends, or differences between background, near-road, and typical urban settings

Limitations:

- Cost ($60k - $100K / unit)
- Instruments in PM-burdened areas require frequent maintenance
- Difficult to assess sources and sinks
- Data may not be robust enough to link to specific health impacts

New Developments: Hyperlocal, Street-by-Street Monitoring

- Partnership with Aclima to determine differences in air quality on a highly localized scale
- Sensor-based instrumentation (NOx, CO, O3, BC, PM2.5)
- Data reported through a public portal
- Began in Richmond-San Pablo in summer 2019; entire Bay Area within two years

Use cases:

- Empower communities with information about air quality typical of where they live and work
- Identify areas having elevated background concentrations for further investigation

New Developments: Mobile Laboratory

- High accuracy, real-time instrumentation to screen for PM and air toxics at a local scale
  - PM concentration
  - Inferred particle age
  - Size-binned measurements (ultrafine through PM_{10})
  - Black carbon
  - Potential to test for chemical components of PM in the future

Use cases:

- Identify and prioritize local sources of air toxics or PM
- Air quality between fixed-site monitors
- Identify locations for portable or fixed-site monitoring stations

New Developments: Portable Platforms

- High quality, battery powered, filter-based PM samplers that are relocatable
- Self-contained “suitcase” for continuous, real-time measurements using high quality, low power instruments

Use cases:

- Concentration variations throughout the day or week near an identified PM hotspot
- Measure air quality when the power is out due to high winds and fire hazard
- Verify low-cost sensor nodes

Outline: PM Monitoring

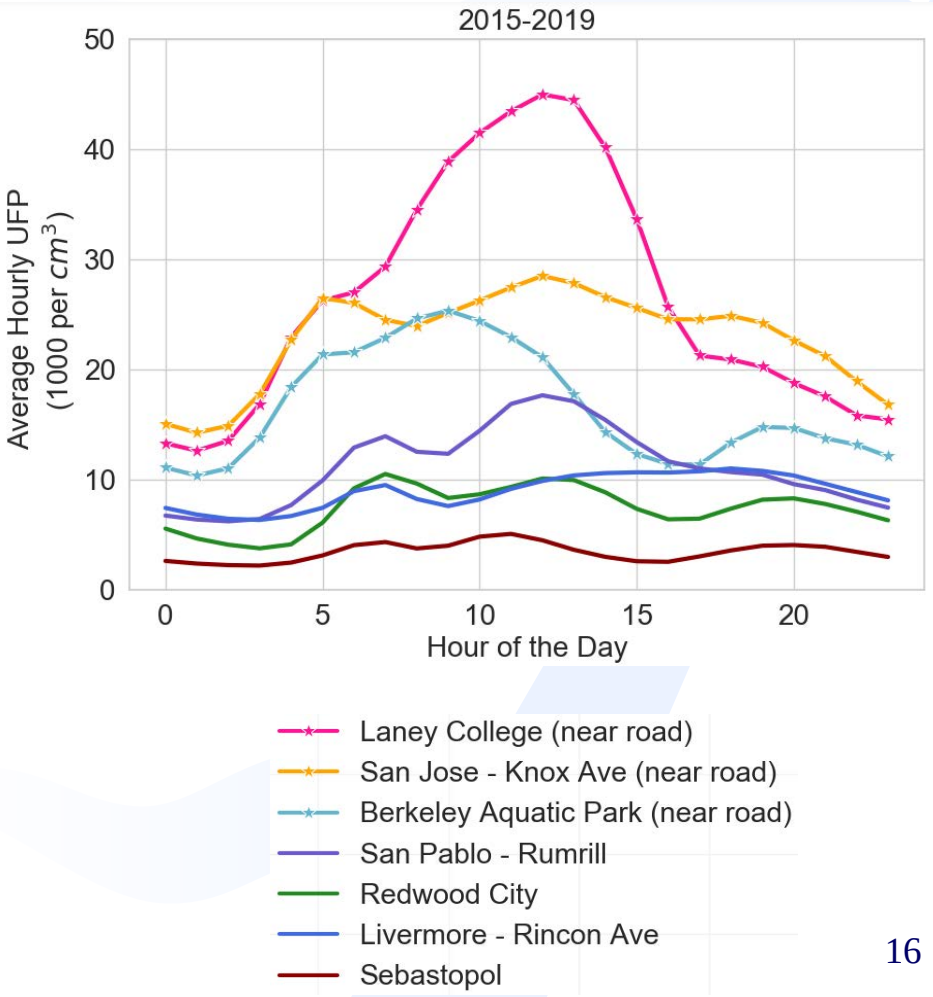
- Regional Network and Community Monitoring
  - Current capabilities
  - New developments
- What does the data show?
  - Ultrafine particles
  - Wildfire incidents
- Looking ahead
  - How could data be used
  - Options to strengthen air quality monitoring

What Do the Ultrafine Particulate (UFP) Data Show?

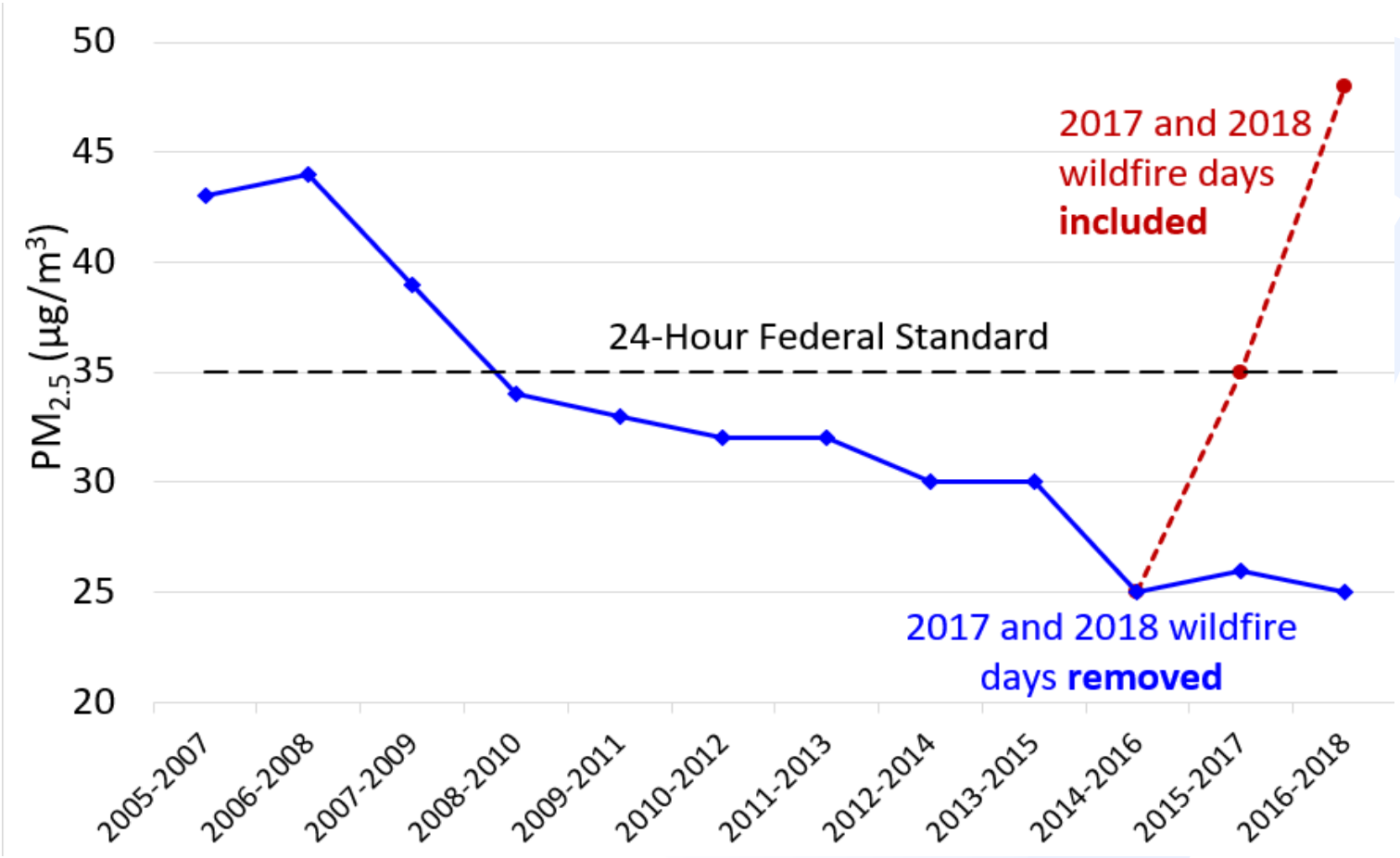
Levels influenced by traffic and/or photochemical reactions

- UFP highest at near-road sites
- Some sites consistently low, while others vary

Patterns of UFP throughout region differ from $PM_{2.5}$



Wildfire Smoke Dramatically Affects Bay Area $PM_{2.5}$ Levels



Air District's Strategy to Reduce Impacts from Wildfire Smoke

Communication with the public

- Issue smoke advisories and Spare the Air alerts based on air quality forecasts
- Understanding air quality measurements and data
- How to reduce exposure during smoke impacts

Grants and incentives for recovery assistance

Work with other Air Districts and Public Health Officers

- Consistent wildfire health information
- Provide guidance for schools

Outline: PM Monitoring

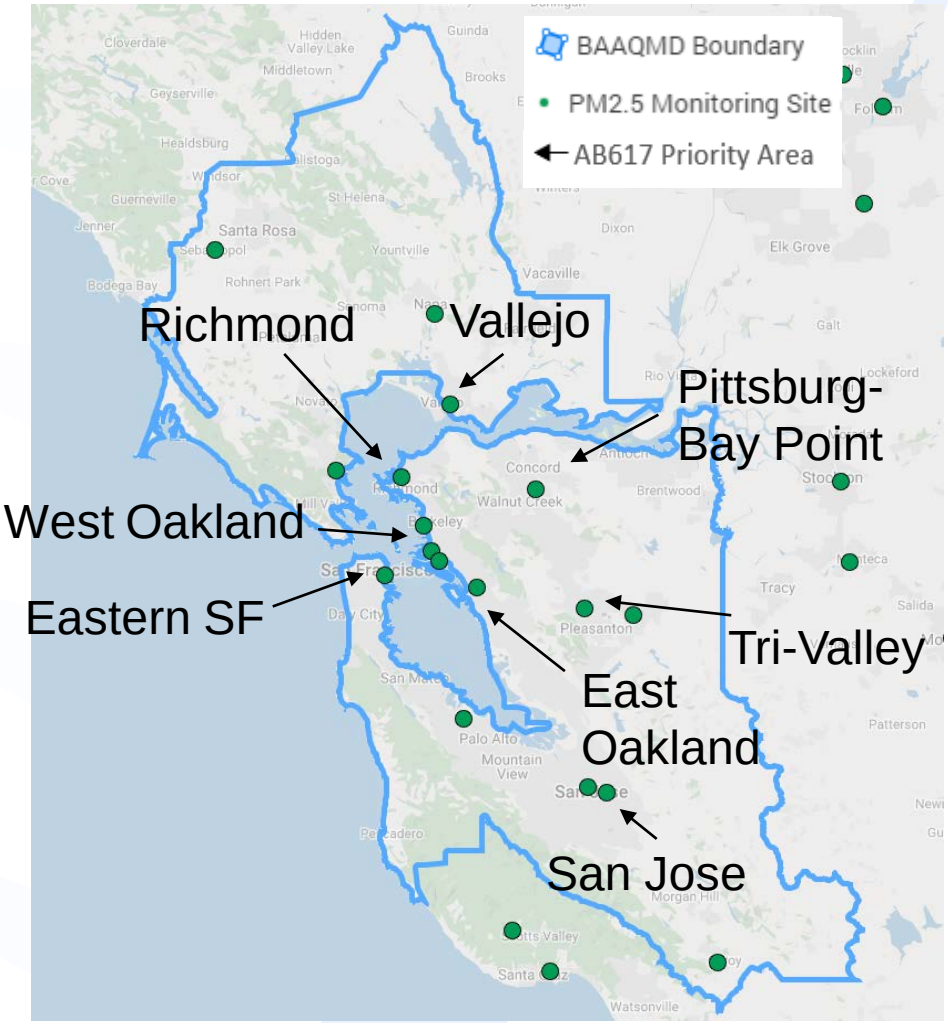
- Regional Network and Community Monitoring
  - Current capabilities
  - New developments
- What does the data show?
  - Ultrafine particles
  - Wildfire incidents
- Looking ahead
  - How could data be used
  - Options to strengthen air quality monitoring

Combining Monitoring Strategies for Multiple Objectives

Network	Measurements	Network Objectives
Regional Network	- $PM_{2.5}$ and PM_{10} Mass	- Comparison with health-based standards - Public information - Track long-term trends - Assess out of area transport
Special Projects (fixed site, portable, or mobile)	- PM size distribution - PM speciation - UFP - Black Carbon	- Source identification - Assessment of specific emission sources - Characterization of near-road environments
Sensor Networks (mobile or fixed)	- PM Mass - Particle Count	- More challenging to interpret due to higher levels of uncertainty - Public education - Personal exposure - Identification of hot-spots - Comparative assessment of local air quality - Tracking high PM episodes

Integrated PM Network Assessment (to be completed by July 2020)

- Evaluate PM measurement network to recommend improvements with available resources
- Address existing requirements and goals
  - Federal and state requirements
  - Understand criteria pollutant levels
- Strengthen network to address gaps
  - Incorporate multiple monitoring approaches
  - Support community air monitoring activities
  - Provide data to support other Air District activities



AGENDA: 5C

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Update on Particulate Matter (PM) Air District Work:

Air District Grant Programs Overview

Karen Schkolnick
Strategic Incentives Division Director

Advisory Council Meeting
December 9, 2019

Overview

- Background
- Grants Overview and Priorities
  - Project Evaluation
  - Eligible Projects
- Supporting Air District Initiatives
- Results and Highlights
- Next Steps

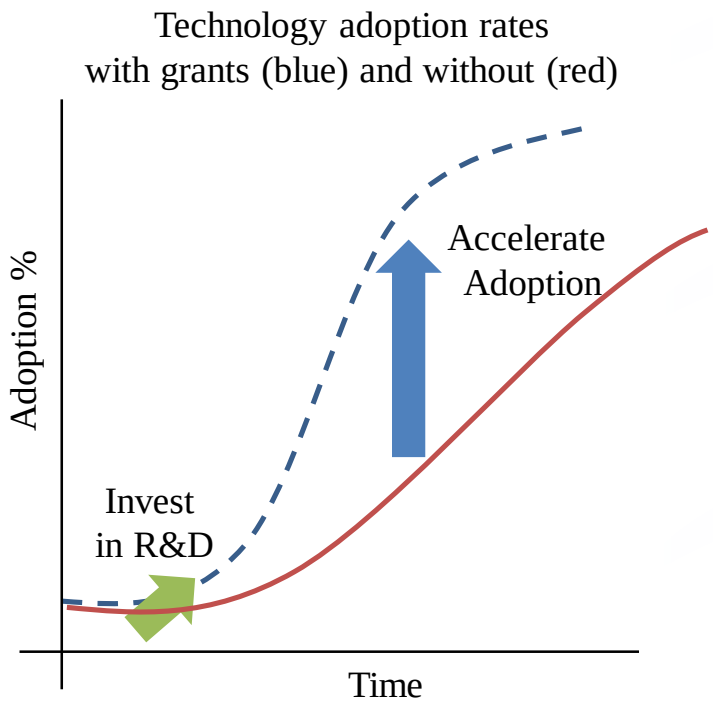
Background

Monitoring
Planning
Regulations &
Enforcement

Education
&
Outreach

Grants
&
Loans

Grants Overview and Priorities



- Cost-effective air quality and climate protection benefits
- Accelerated adoption of cleanest commercially available technologies and investments in R&D
- Expedited emissions reductions in disproportionately impacted communities

Project Evaluation

Cost-Effectiveness (CE)

$$CE = \frac{Funds\ Awarded}{Tons\ of\ NOx + ROG + (\boldsymbol{PM_{10}\ x\ 20})\ reduced}$$

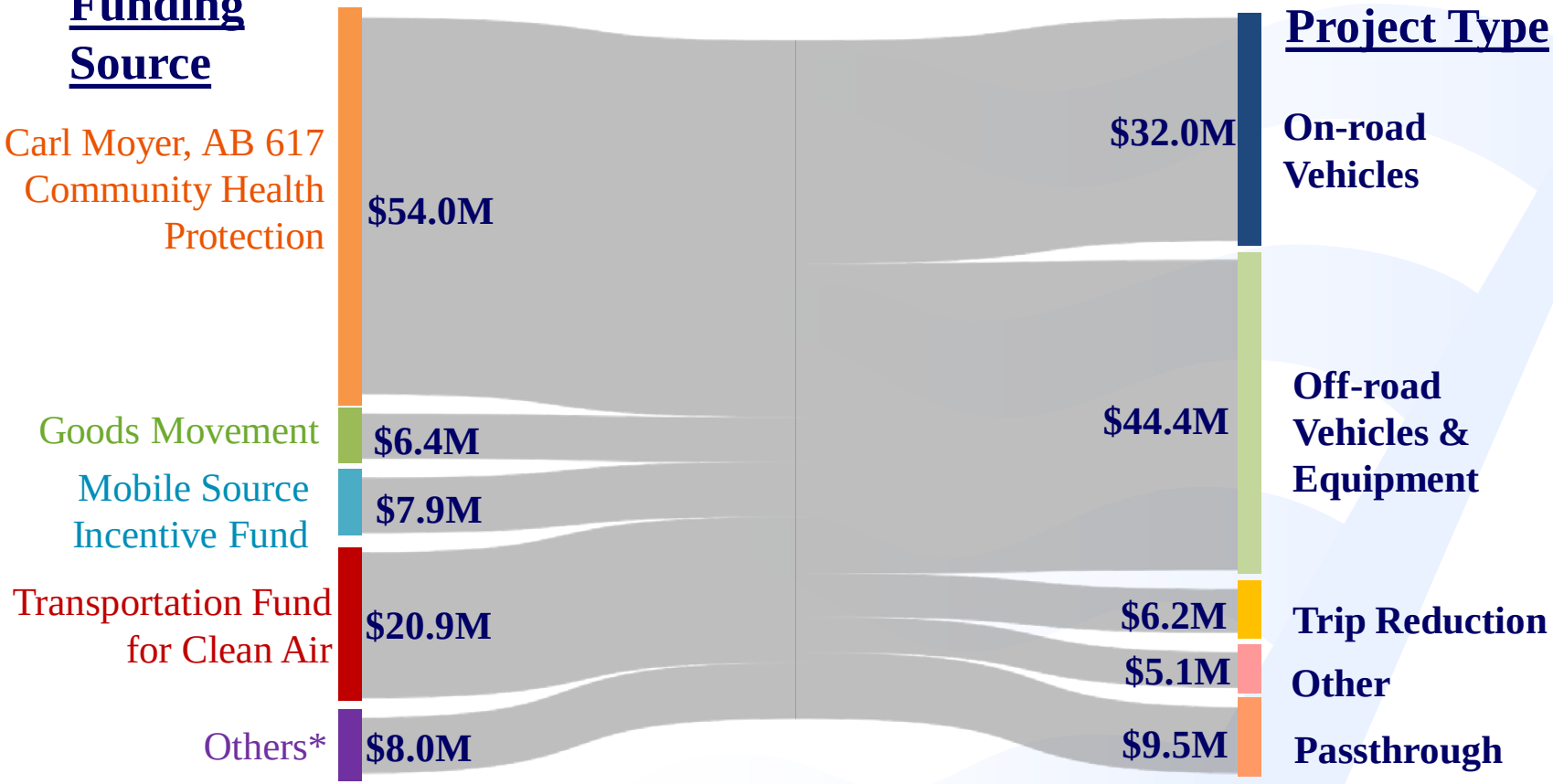
CE* estimates ***quantifiable,***

verifiable,

and surplus lifetime emission reductions

**CE formula is provided by CARB Carl Moyer Program Guidelines*

>$97M Awarded in 2018 to Eligible Projects



* Other funding sources include U.S. EPA's DERA, California Climate Investments, & Air District's general fund

Eligible Projects
On-road Vehicles

$32.0M

On-road Vehicles

Cars & Charging Stations	Trucks	Buses
		
		

Eligible Projects

Off-road Vehicles & Equipment

$44.4M

Off-road Vehicles And Equipment

Cargo Equipment	Ag Equipment	Marine & Locomotive	Other Off-road
			
			

Eligible Projects
Trip Reduction

$6.2M **Trip Reduction**

Shuttles & Ridesharing	Pilot Services	Bicycle Projects

Eligible Projects
Other & Passthrough

Lawn & Garden	Wood Smoke	Climate Protection	County Programs





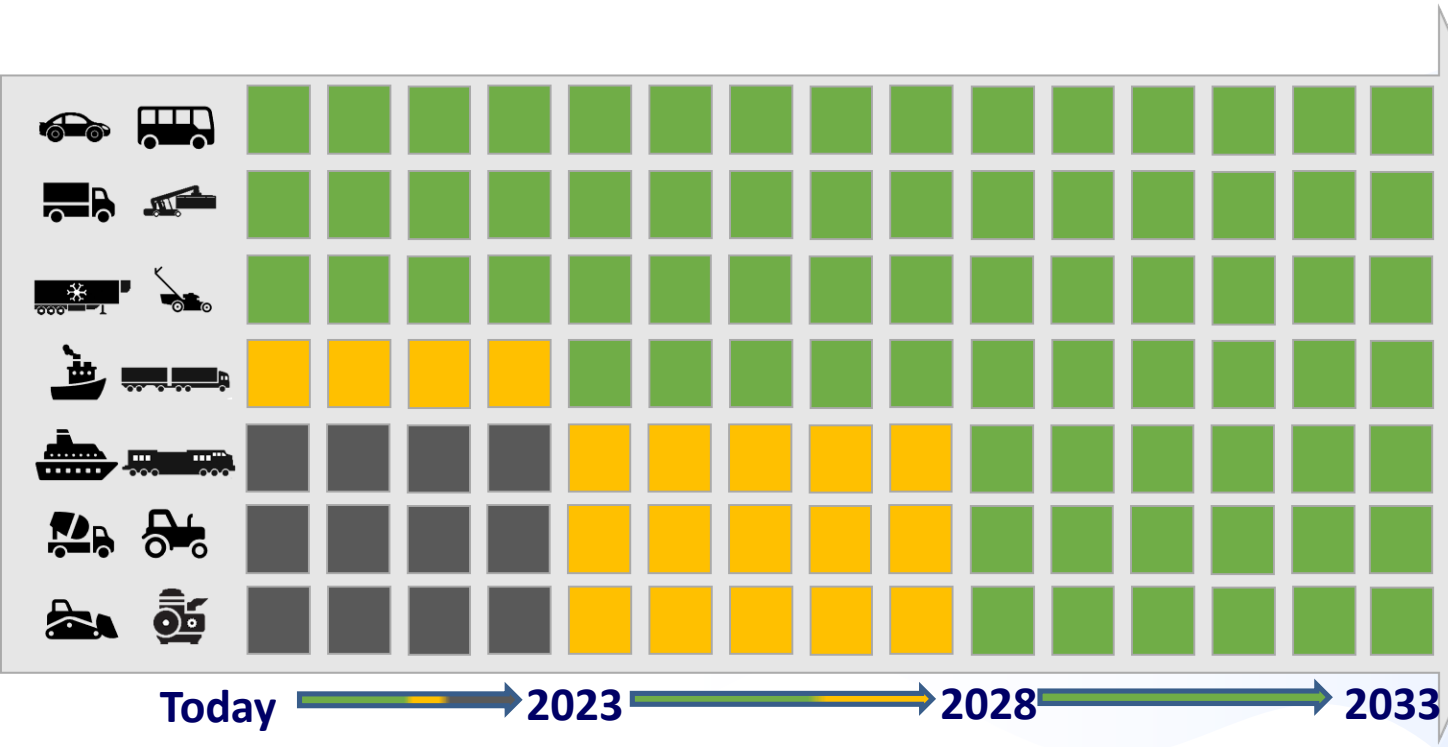


$5.1M Other

$9.5M Passthrough

Supporting Air District Initiatives

Path to Diesel Free by '33



DIESEL FREE BY '33

- Commercially Available
- Pre-Commercial
- R&D

Supporting Air District Initiatives

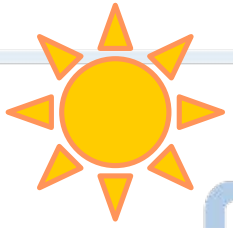
Bay Area Electric Vehicle Trends & Goals

7,750 public charging ports

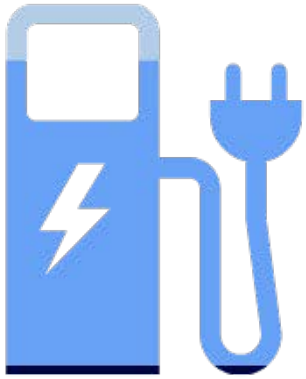
Over $15M invested to date

3% of the cars are EVs

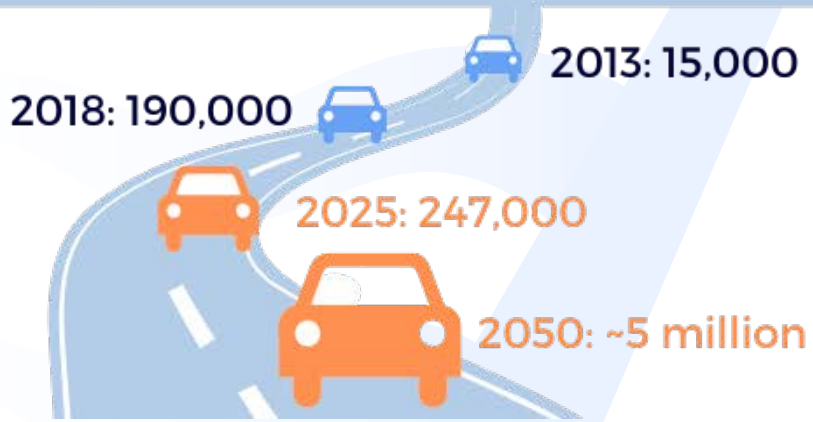
10+ EV Incentive Programs



~25% of funded stations included renewables



Progress towards our EV Adoption Goals

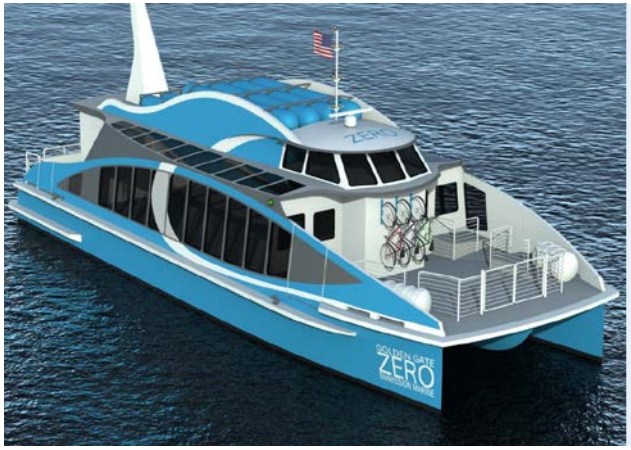


Supporting Air District Initiatives

Advanced Technology Demonstrations

$2.9M to deploy 11 electric trucks & haulers for commercial delivery service

$3M to deploy hydrogen-powered ferry for passenger service



Supporting Air District Initiatives

Early Emissions Reductions at Port of Oakland

Equipment Type	*DPM Inventory (tons)	
	2005	2017
Oceangoing Vessels	208.5	42.2
Harbor Craft	13.4	6.1
Cargo Handling Equipment	21.2	1.6
Trucks	15.9	0.3
Locomotives	2.0	0.3
Other	--	0.3
Total	**261**	**51**

>$100M in grants invested at Port of Oakland including:

- Retrofitted/replaced <1,900 drayage trucks
- Installed shorepower at 14 berths
- Replaced >1,090 on-road trucks

*Diesel Particulate Matter

Results and Highlights

Regionwide Cumulative Emissions Reduced (tons) Since 2015

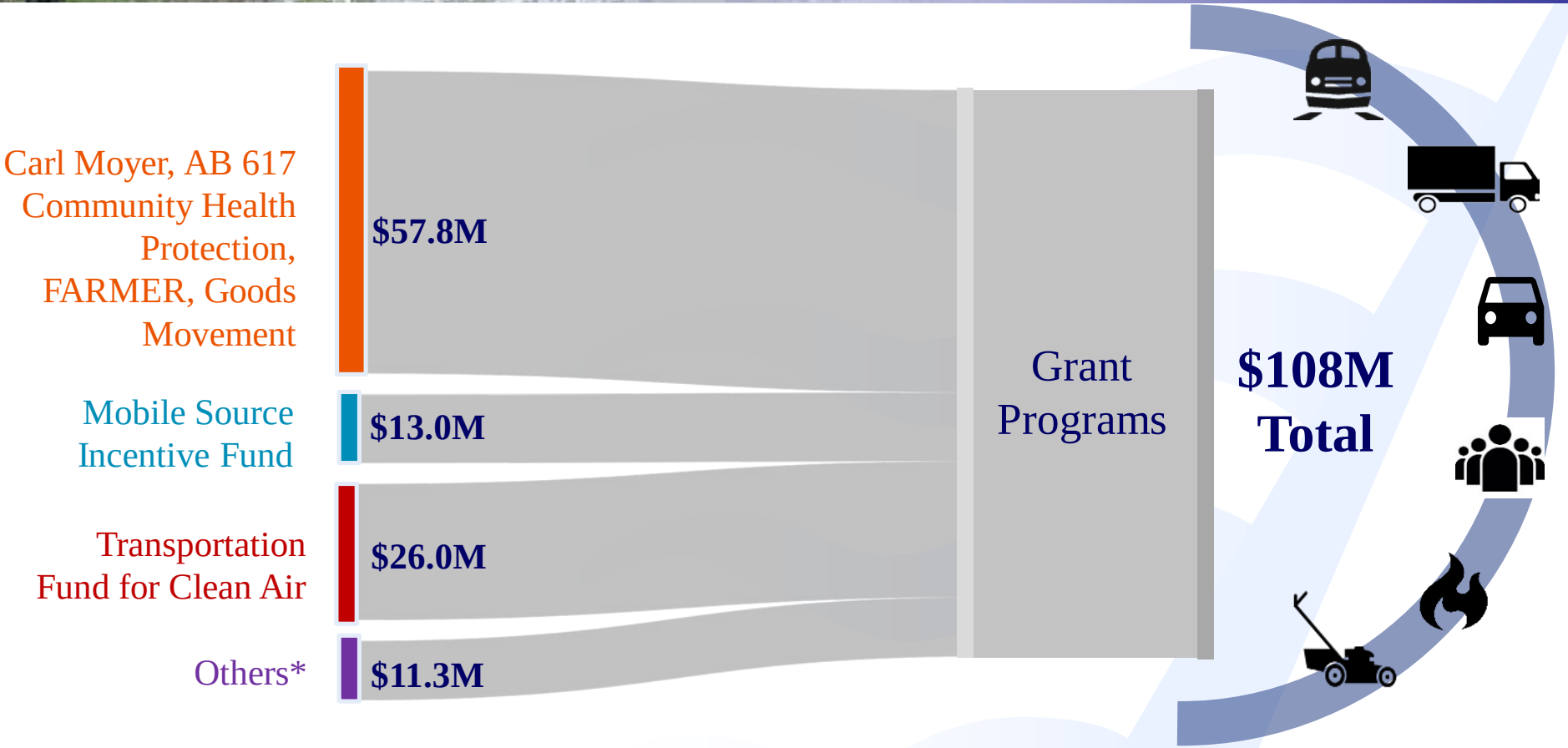
Highlights 2015 - 2019

- **1,000+** EV charging stations
- **~40 miles** of bikeways
- **1,200+** woodstoves and fireplaces
- **>100** ZE transit and school buses

53% of funds in CARE areas

Next Steps

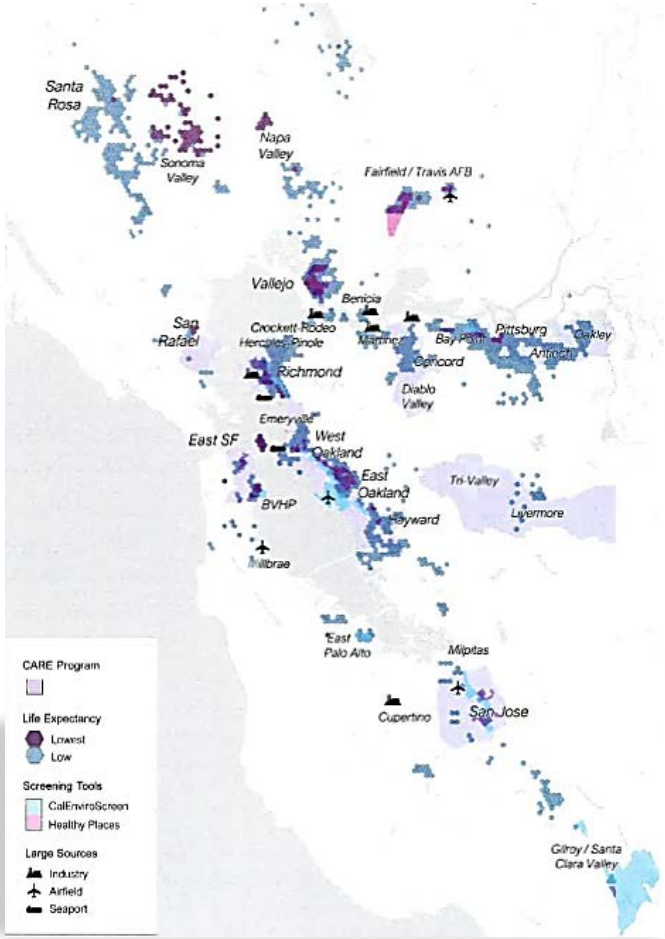
Incentive Revenues for 2020 (in millions)



* Others include Clean Cars for All and Climate Tech Finance (loan guarantee)

Next Steps

New & Expanded Grant Programs



- Secure new sources of funding
- Expand eligibility and initiate new programs
  - Expediting public health benefits in disproportionately impacted areas
  - Prioritizing programs that provide co-benefits

AGENDA: 5D

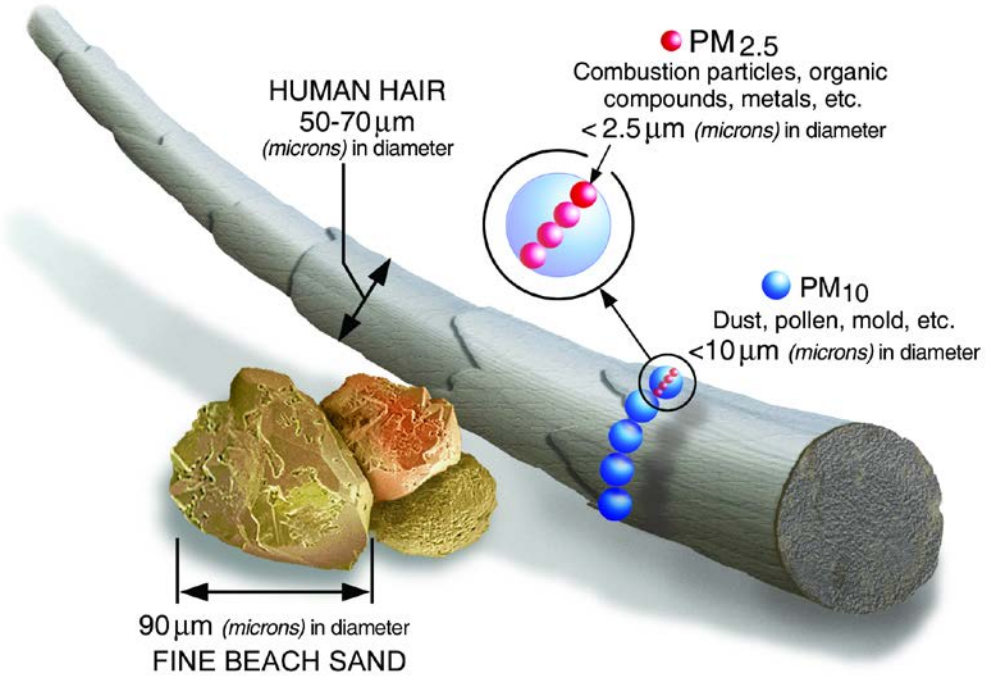
Particulate Matter Exposure
CARB Health Research and Rule

Álvaro Alvarado
California Air Resources Board
December 9, 2019

PM Exposure is an Important Public Health Concern

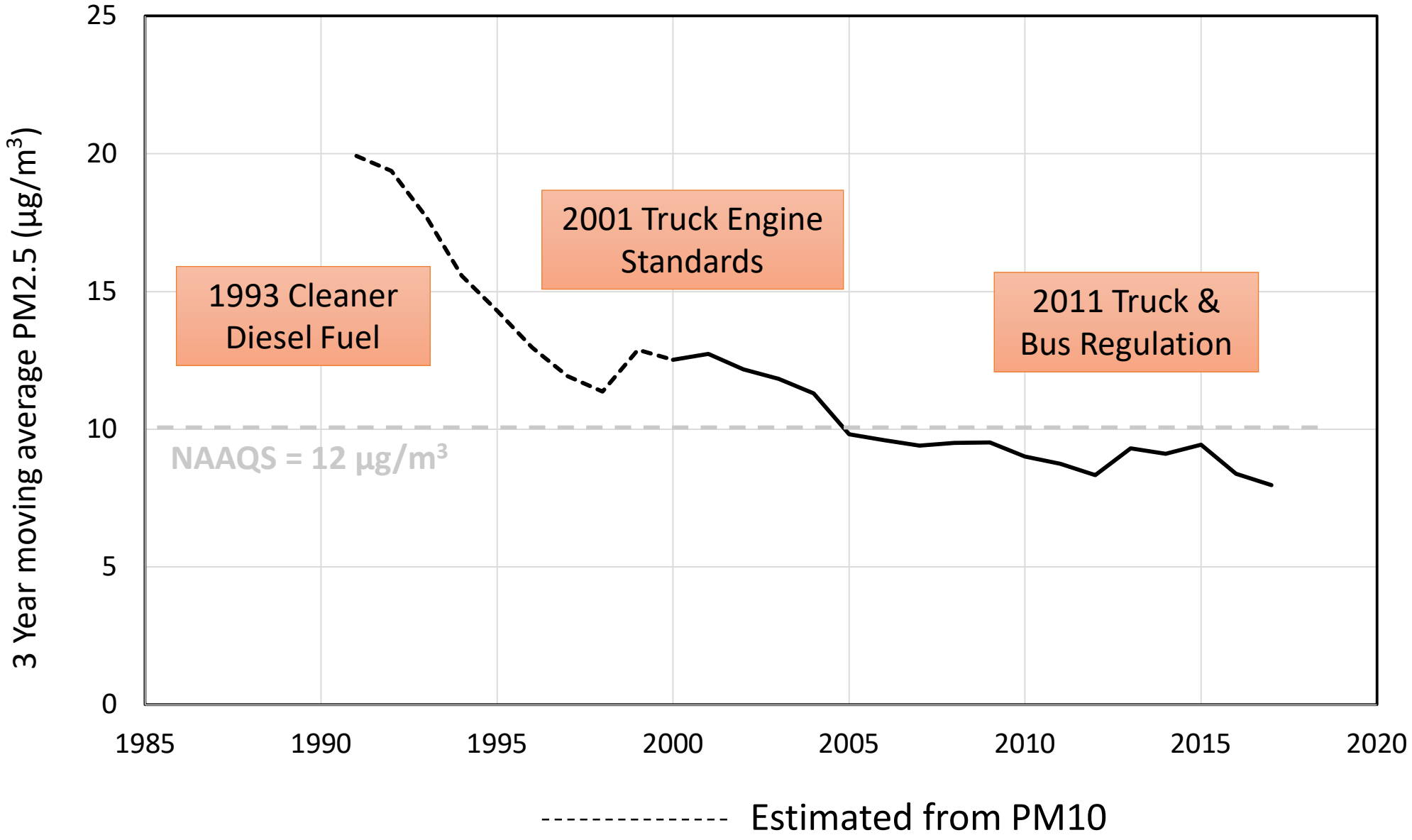
- Why are we concerned about PM?
  - Lots of evidence for health impacts
- If PM2.5 ↓ to background levels, could prevent (annually) about:
  - 7,200 premature deaths
  - 1,900 hospitalizations
  - 5,200 emergency room visits

But That's Not All – Additional Evidence of PM's Negative Health Impacts



- Strong evidence for increased:
  - Asthma attacks
  - Respiratory symptoms
- Probable association with:
  - Work loss days
  - Restricted activity days
  - Adverse brain effects

PM2.5 Trend in the San Francisco Bay Area Air Basin

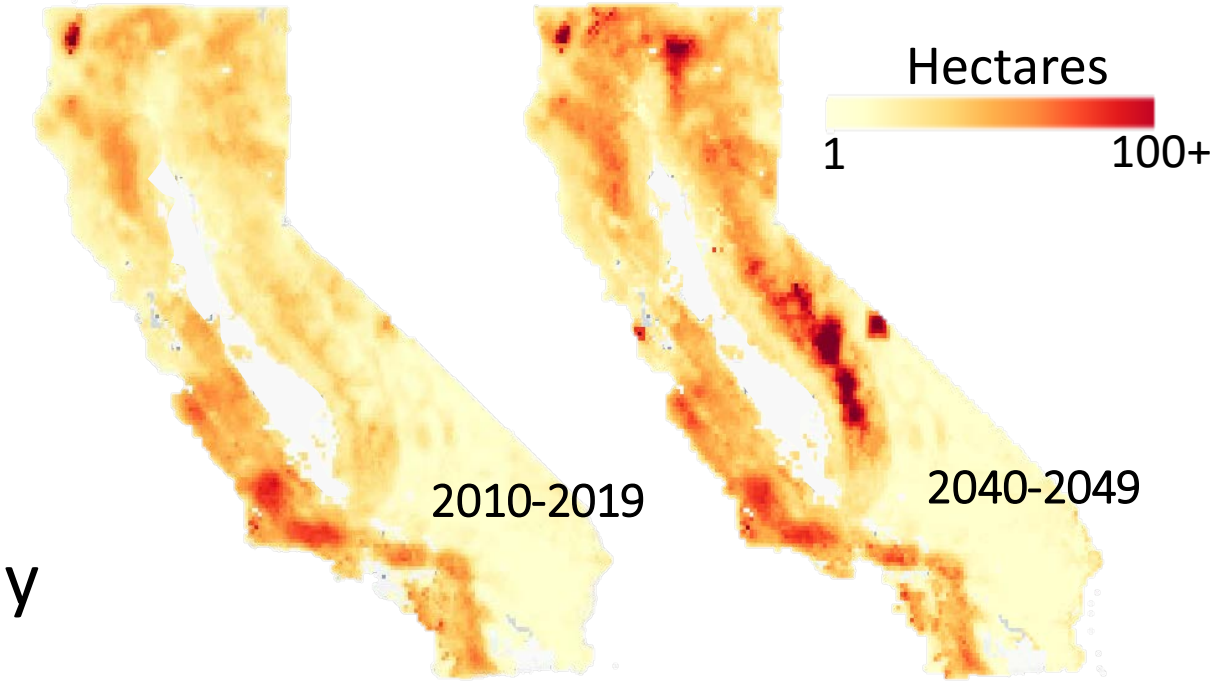


CARB's Current Efforts and New Challenges

Wildfire-related PM Exposures

- Millions of Californians exposed to wildfires in 2018
- Wildfires: more frequent & intense with climate change
- Little known about health impacts
  - PM emitted during fire; post-fire ash
  - More structure/vehicle fires
- Particular concern: children & elderly

Forecast Average Annual Area Burned



Source: CalAdapt.org

CARB Research: Wildfire Health Impacts in Rhesus Macaques

- Infant monkeys in outside enclosures unintentionally exposed to wildfire smoke (Miller, UC Davis)
- As adolescents & young adults:
  - Impaired immune function
  - Changes in lung structure
  - Reduced lung function
  - Changes passed to next generation

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CARB Research, in progress: Wildfire Emissions

- Understanding and mitigating wildfire risks (Goldstein, UC Berkeley)
  - Mobile measurements (in-house research with UC Berkeley & UC Riverside)
- NASA aircraft: investigating wildfire emissions & downwind air quality (Blake, UC Irvine)

PM from Brake & Tire Wear

BRAKE WEAR

- Successful reduction of regional PM from vehicle exhaust
- Vehicle tailpipe emissions most important regionally
- Non-tailpipe emissions may have localized importance
- Uncertainties in emissions & health impacts

TIRE/ROAD WEAR

CARB Research, in progress: Brake & Tire Wear

- Quantifying brake & tire wear emissions (Kishan, Eastern Research Group)
- Examining real-world brake & tire emissions and exposure to downwind communities (Jung, UC Riverside)
- In-house laboratory research projects
- Understanding potential health impacts (Jerrett, UCLA)

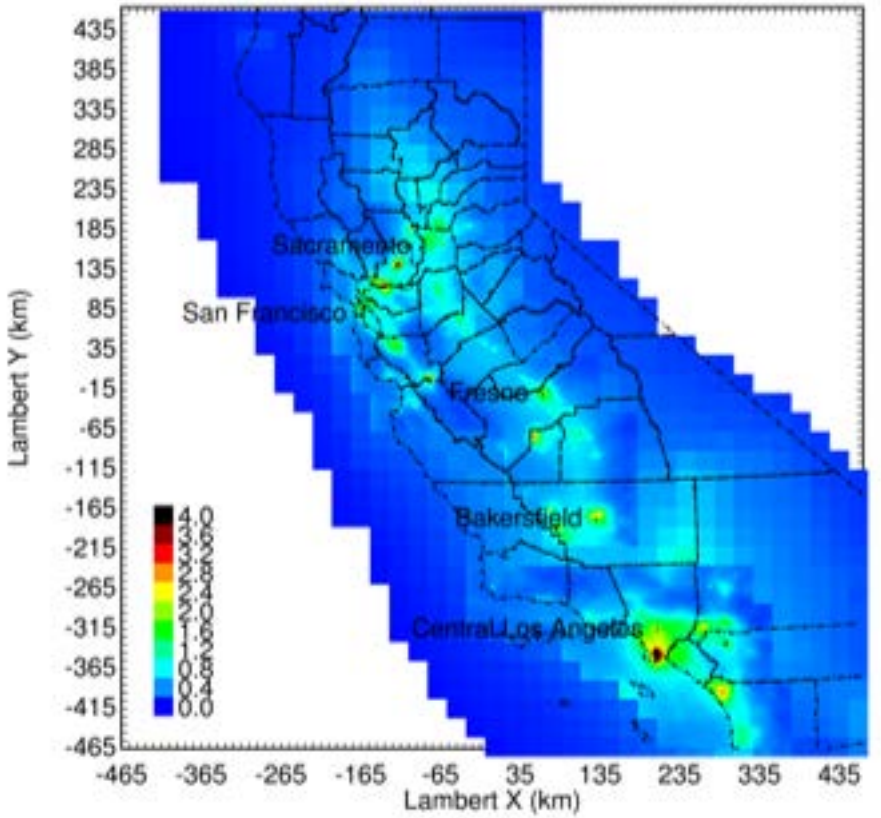
Health Risk from Ultrafine PM (UFPM)

- Potential exposure risks:
  - High numbers & chemicals attach to surface
  - Once inhaled, can go deep into lung
  - Can enter bloodstream, travel to organs
  - UFPM highly variable (space & time)
  - Sparse historical data

CARB Research: Health Effects of UFPM

- Monitoring, modeling, and health impacts of UFPM (Kleeman, UC Davis)
- Preliminary results suggest increased risk of premature death with higher exposure

Ultrafine Mass Concentration



CARB Research, in progress: Short-term PM Exposure

- White paper: reviewing short-term PM exposure impacts (Kleinman, UC Irvine; in progress)
- Air monitoring in AB 617 communities
  - Localized pollutant exposures
- Determine if need to address short-term exposures

Statewide Mobile Source Strategies Overview

Heavy Duty Trucks

Warehouses

Passenger Cars

Trains

Heavy Duty Trucks

- Advanced Clean Trucks regulation
- Heavy-duty vehicle inspection and maintenance
- Innovative Clean Transport
- Airport Shuttles
- Low NOx Omnibus Rule

Warehouses

- Freight Handbook
- Transport refrigeration unit regulations
- Drayage truck regulation amendments
- Cargo handling equipment amendment

Passenger Cars

- Advanced Clean Cars 2
- Catalytic converter theft reduction

Trains

- Reduce idling for all rail yard sources
- Potential development of regulation to reduce emissions for locomotives

Thank you

AGENDA: 5E

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Update on Particulate Matter (PM) Air District Work:

PM Rules and Regulatory Development

Victor Douglas
Rule Development Manager

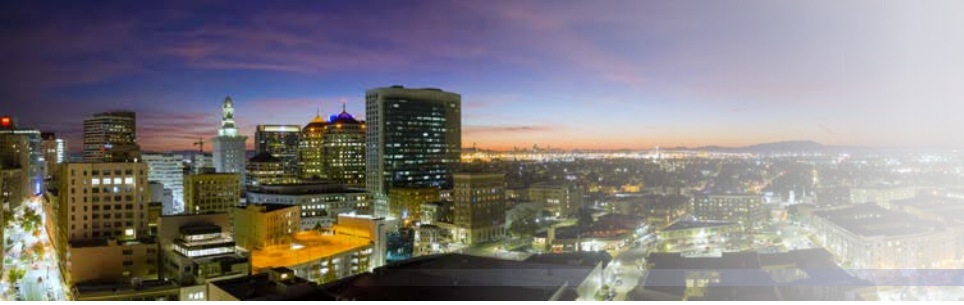
Advisory Council Meeting
December 9, 2019

Overview

- Approaches to Regulate PM
- PM Rules and Regulations
- Current and Future Efforts
  - Regional attainment
  - Localized impacts
  - Gap analysis

Regulation of PM

- Three Ways to Regulate PM:
  1. Originally regulated as a Nuisance
     - Open burning (original Reg 1)
     - Dust and aerosol (original Reg 2)
  2. Criteria (i.e., regional)
  3. Toxic (i.e., local/community level)
     - Diesel PM



Regional Approach

- Attainment of ambient air quality standards
- Control of Primary PM
  - Filterable
  - Condensable
- Control of Secondary PM
  - Oxides of Nitrogen (NOx)
  - Sulfur Dioxide (SO_2)

PM Rules & Regulations

- Regulation 2: Permits
- Regulation 5: Open Burning
- Regulation 6: Particulate Matter
- Regulation 9: Inorganic Gaseous Pollutants
- Regulation 11: Hazardous Pollutants
- Regulation 12: Miscellaneous Standards of Performance

PM Rulemaking Efforts

- 2012 – **Rule 2-2 amendments** to add New Source Review permitting requirements for $PM_{2.5}$
- 2012 – **New Rule 9-13** to reduce PM emissions from Portland cement kilns
- 2013 – **New Rule 6-4** and **new Rule 12-13** to reduce PM emissions from metal foundries and shredding facilities

PM Rulemaking Efforts

- 2015 – **Rule 6-3 amendments** to further reduce wood smoke from wood-burning devices
- 2016 – **New Rule 9-14** to reduce precursors of secondary PM from petroleum coke calcining operations
- 2018 – **New Regulation 6**, **new Rule 6-6**, and **Rule 6-1 amendments** to reduce PM emissions from fugitive dust sources
- 2019 – **Rule 6-3** to extend No Burn Days for the Wildfire Response Program

2018 PM Rules

- New Regulation 6 for common definitions and test methods
- New Rule 6-6 for prohibition of trackout
- Rule 6-1 amendments for general requirements and bulk material handling
- Reduce PM emissions from fugitive dust sources
- Expected emission reductions of 1.6 tpd PM_{10}, 0.2 tpd $PM_{2.5}$

Current and Future Efforts

- Continued **regional** efforts on further PM reductions (e.g., Rule 6-5: PM from FCCUs)
- Source categories and rule efforts identified in planning efforts
- Additional areas from gap analysis
  - Restaurants
  - Wood smoke
  - Indirect and magnet sources
  - PM as a toxic pollutant

Current and Future Efforts (cont.)

- To address **localized** PM issues
- Regulatory framework for site-specific localized PM impacts
- Existing localized approaches for toxics
  - Air District Rule 11-18 for Air Toxic Emissions from Existing Facilities
  - AB 2588 Air Toxic Hot Spots Program

Discussion

Questions?

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)?
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?

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?

Deliberation Questions

What is bullseye in clean air target? How clean is clean enough?

How will we know when we get to target? What metrics should we use to track progress?

How do we combine criteria pollutants and toxics? Cancer and non-cancer health endpoints? Short- and long-term effects?

How can we make sure everyone is treated fairly?

How can we ensure that everyone breathes clean air?

What are most important actions that can be taken now? And, in future?

Discussion Questions (DRAFT)

Are current PM standards sufficiently health protective?

NOT SUFFICIENTLY PROTECTIVE; MORE STRINGENT STANDARDS NEEDED

Are some species of PM more dangerous than others?

QUITE POSSIBLY BUT NOT ENOUGH INFORMATION; NO PM COMPONENTS "EXONERATED" THOUGH

What is role of ultrafine particles (UFPs)?

NOT YET CLEAR, BUT TOX STUDIES OF CONCERN; NEED UFP FEDERAL REFERENCE METHOD; MORE MONITORING; EPI STUDIES NEEDED

Should PM "target" expand to account for more than just mass?

IN RESEARCH, ABSOLUTELY; IN REGULATION, TOO SOON, UNLESS HIGHLY RISK-AVERSE

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)?

STRONGER EVIDENCE, NEW HEALTH EFFECTS; GROWING RECOGNITION OF "AT RISK" GROUPS (E.G., CHILDREN AND LOW SES); NEED TO CONSIDER

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

NOT WELL-KNOWN SCIENTIFICALLY, BUT OF CONCERN; DATA ON SUB-DAILY EXPOSURES TOO LIMITED AS YET; POTENTIALLY SERIOUS EFFECTS REPORTED IN EARLY STUDIES; NEW STUDIES ONGOING; MORE RESEARCH NEEDED

Discussion Questions (DRAFT)

What are major sources of PM in the Bay Area?

WEST OAKLAND: PM2.5, TOP 3 – PORT (17%), STREET (17%), HIGHWAY (16%);
DIESEL PM, TOP 3 – PORT (57%), STREET (7%), HIGHWAY (8%)

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

WEST OAKLAND: PM2.5 = 8.7 ug/m3 (ALL SOURCES, AVERAGE), LOCAL SOURCES = 1.5 to 2.2 ug/m3 (BY NEIGHBORHOOD);
DIESEL PM = 0.7 ug/m3 (AVERAGE);
HYPER-LOCAL HOT SPOTS COULD BE HIGHER

How much additional health benefit can be achieved?

REDUCING ANNUAL PM2.5 FROM 12 ug/m3 TO 10 ug/m3 COULD REDUCE RISK BY 10-15%; THOUSANDS FEWER DEATHS IN U.S. EACH YEAR

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

SPATIAL SCALE IMPORTANT; REGIONAL- VS. LOCAL- VS. HYPER-LOCAL-SCALE IMPACTS
WEST OAKLAND: PM2.5 CONCENTRATION – OVERALL, 80% FROM REGIONAL SOURCES, 20% FROM LOCAL SOURCES;
DIESEL PM CONCENTATION – OVERALL, 40% FROM REGIONAL SOURCES, 60% FROM LOCAL SOURCES; HYPER-LOCALIZED HOT SPOTS COULD BE HIGHER

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

NEED MORE SCIENCE, AND NEED TO ACT NOW; OPTIONS TO BE DETERMINED; DISTRICT STAFF TO IDENTIFY

Deliberation Questions (DRAFT)

What is bullseye in clean air target? How clean is clean enough?

XXX

How will we know when we get to target? What metrics should we use to track progress?

XXX

How do we combine criteria pollutants and toxics? Cancer and non-cancer health endpoints? Short- and long-term effects?

XXX

How can we make sure everyone is treated fairly?

XXX

How can we ensure that everyone breathes clean air?

XXX

What are most important actions that can be taken now? And, in future?

XXX