AGENDA: 3

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

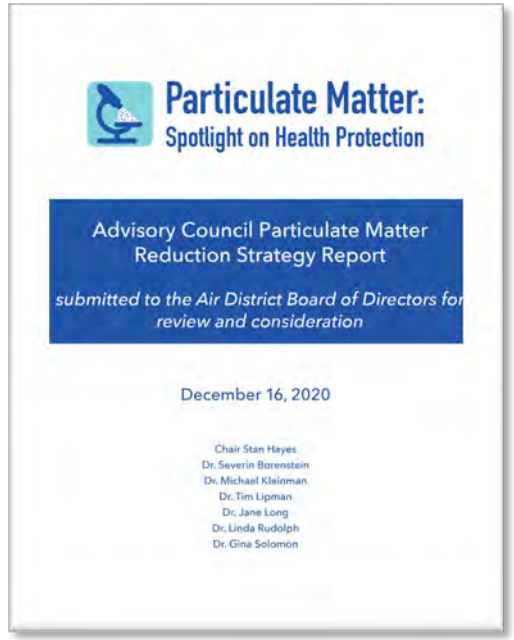
# Overview of Particulate Matter

## Advisory Council Meeting
## December 13, 2021

**Greg Nudd**
**Deputy Air Pollution Control Officer**
gnudd@baaqmd.gov

# Highlights from Advisory Council Recommendations (December 2020)

- The current particulate matter national ambient air quality standards (NAAQS) are **not health protective**. (PMRS3)
- There is **no known threshold for harmful PM2.5 health effects**; thus, it follows that additional reductions of $PM_{2.5}$ concentrations will achieve additional public health benefits. (PMRS5)
- An Air **District guideline "target" below the current $PM_{2.5}$ NAAQS is warranted** to protect public health; …as low as 8 µg/m3… scientific evidence that annual average targets in that range would save additional lives. (PMRS6)
- Although a large fraction of $PM_{2.5}$ is regionally contributed, substantially elevated $PM_{2.5}$ exposures can occur in locations adjacent to local PM sources. Therefore, **controlling emissions in these local impacted areas** is of primary importance. (PMRS7)

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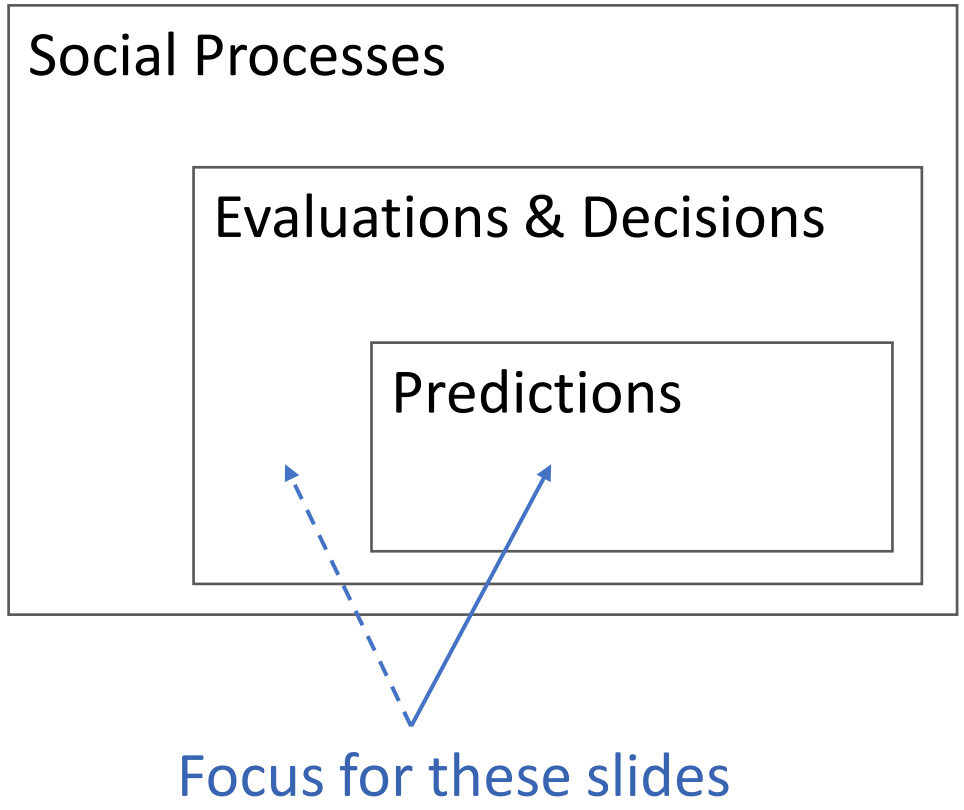
# Permitting Regulatory Needs

- How do we make our permitting rules more health protective?
  - Permitting rules set requirements for new and modified stationary sources
  - Currently proposing amendments to reduce exposure to Toxic Air Contaminants in overburdened communities
  - Current rules and proposed amendments do not address localized PM impacts – need to take action
- How do we reduce localized PM through our permitting rules?
  - What is the appropriate health-based permitting action level for PM?
    - How low is “low enough”?
  - Do we translate PM emissions into risk? How?

# Modeling Local-Scale $PM_{2.5}$ Impacts for Risk Management

David Holstius, PhD
Senior Advanced Projects Advisor
dholstius@baaqmd.gov

# Overview / Framing




Larger context, evolving over time

**g**(impacts, …) = decisions

**f**(emissions, …) = predicted impacts

# Update: State of the Science

The draft Oct 2021 Policy Assessment (PA) finds that new evidence appraised by the Draft Integrated Science Assessment (ISA) Supplement:

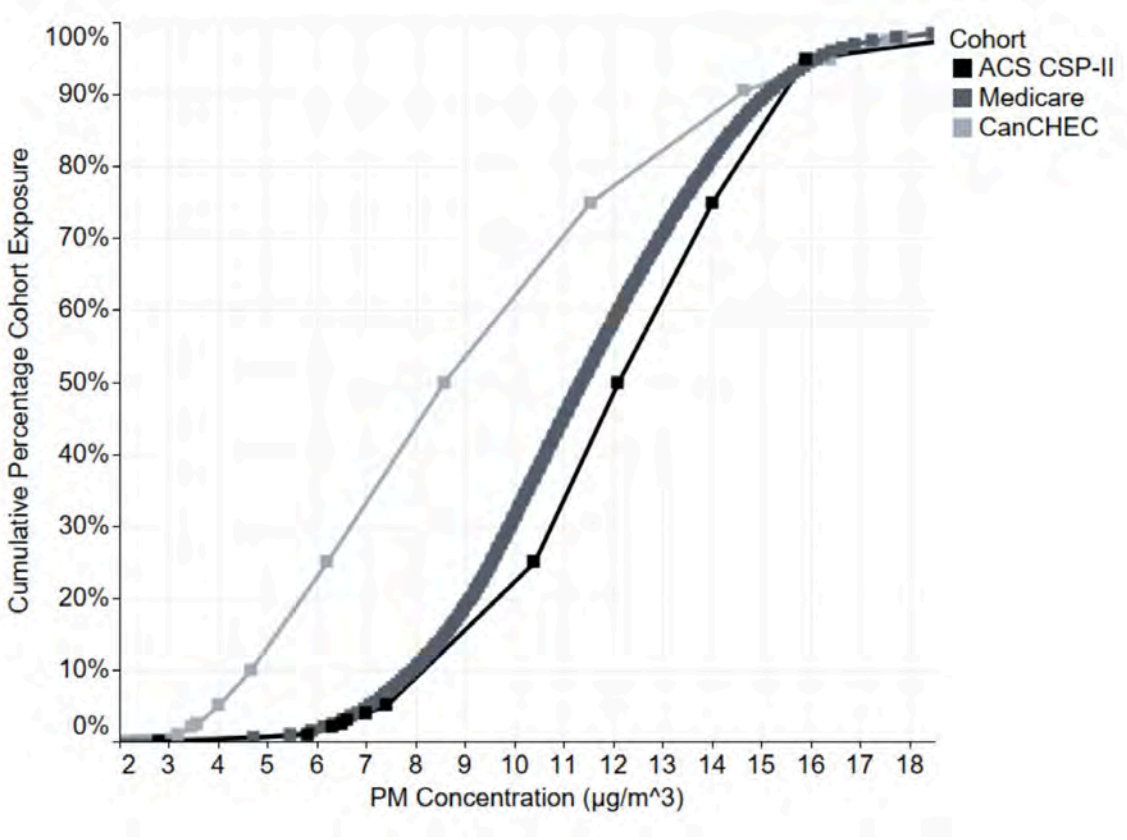
- Reaffirms and in some cases strengthens the 2019 ISA findings regarding mortality and cardiovascular endpoints
- Offers additional support—based on accountability studies, new statistical methods, and experimental studies—for causal interpretations
- Improves our understanding of $PM_{2.5}$ impacts at low levels

*US EPA (2021). Policy Assessment for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft. EPA-452/P-21-001.*

# Policy-Relevant Range

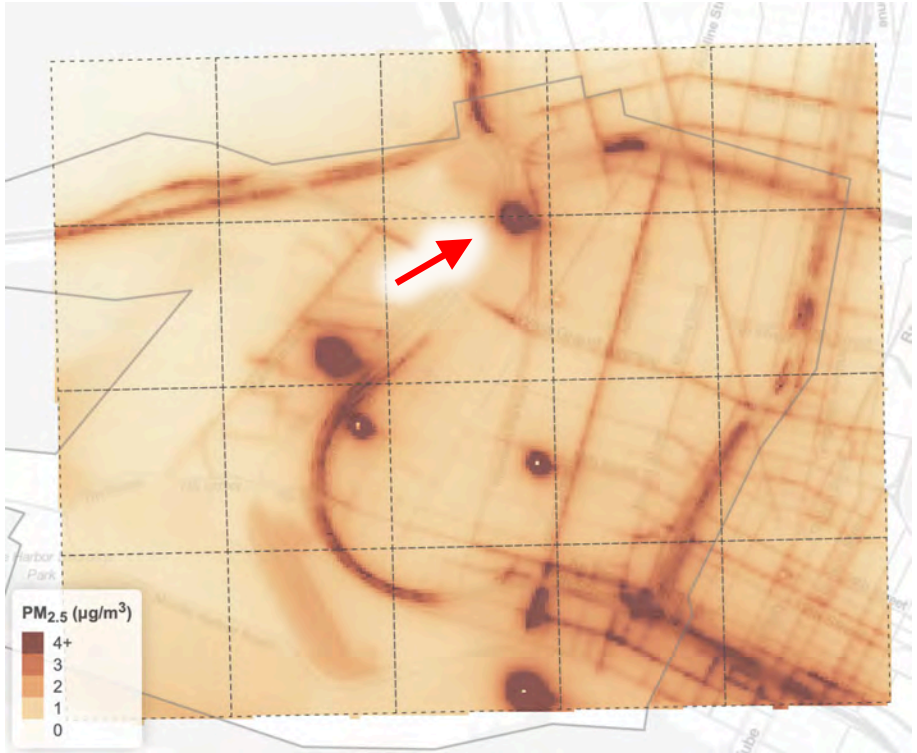
For our purpose today:

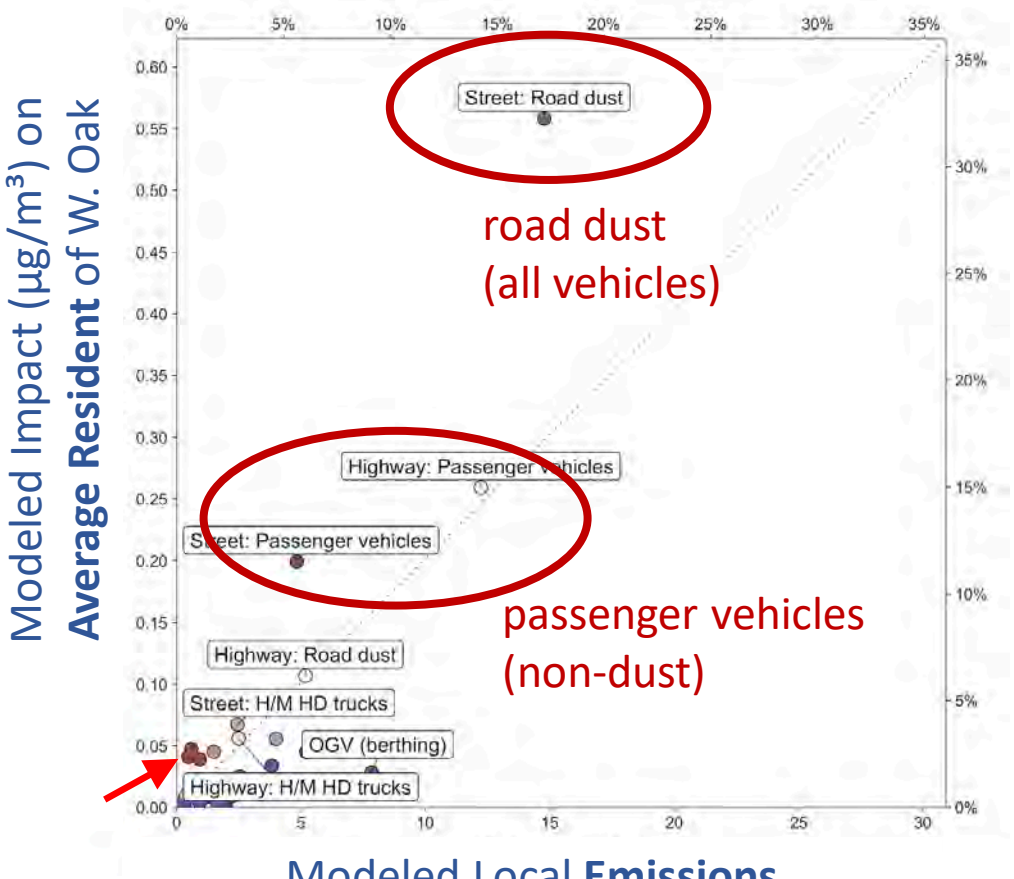
- What matters are changes within a policy-relevant range for the SF Bay Area
- What happens at or near background can be set aside
- Small changes within policy-relevant range are near-linear, in our example to follow



# Emissions, Concentrations, Exposures

Modeled Impacts (µg/m³) of Local Sources on
**Average Concentrations**



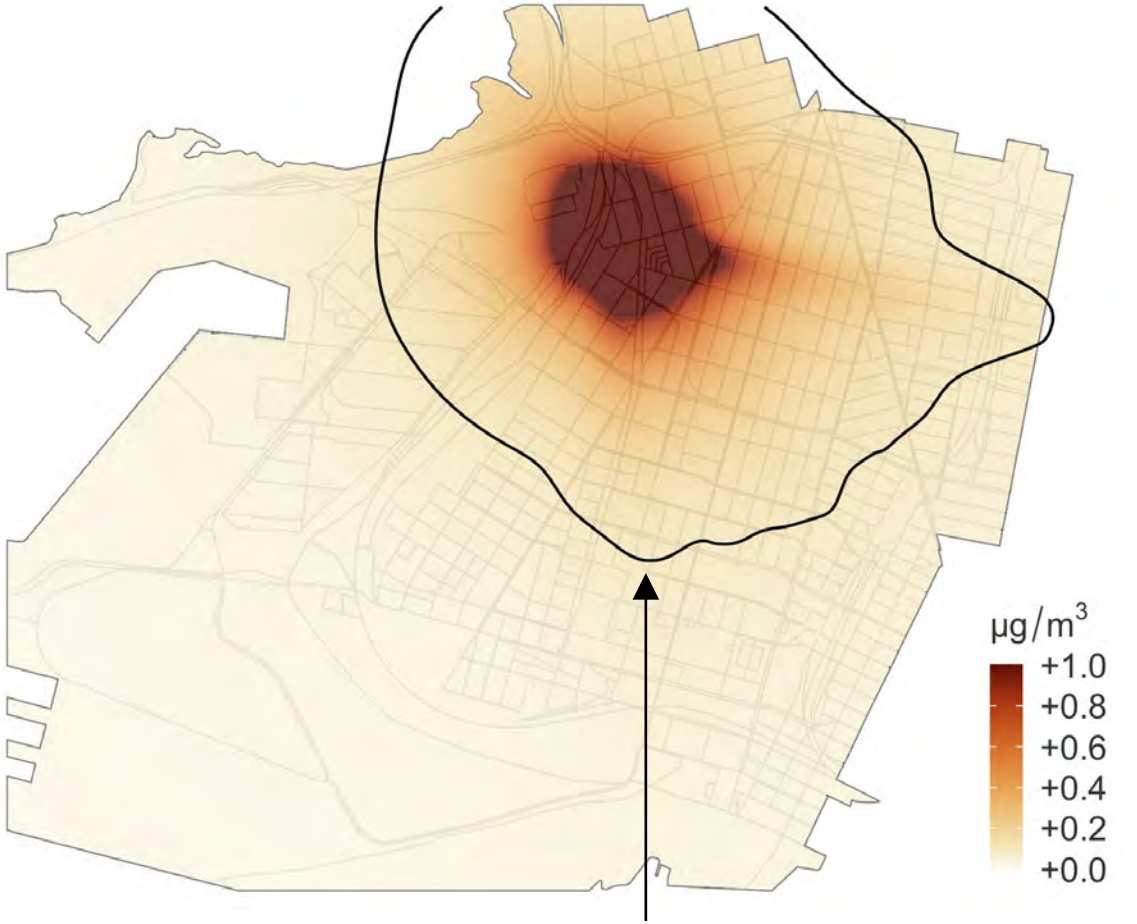



# Risk: $PM_{2.5}$ and Mortality

| Publication | Basis | | RR per +10 µg/m³ |
|---|---|---|---|
| | Cohort | Exposure Estimate | |
| Turner et al (2016) | ACS CSP-II | Hybrid[1,2] | *1.06 (1.04, 1.08)* |
| Pope et al (2015) | ACS CSP-II | LURBME[3] | 1.07 (1.06, 1.09) |
| Di et al (2017) | Medicare | Hybrid[1] | *1.073 (1.071, 1.075)* |
| Di et al (2017) | Medicare | Monitors only | 1.061 (1.059, 1.063) |

[1] Ground-level monitoring measurements combined w/photochemical model predictions
[2] Hierarchical Bayesian space-time model (HBM)
[3] Land use regression (LUR) with Bayesian Max Entropy (BME) kriging of residuals

# Risk: $PM_{2.5}$ and Mortality (cont'd)




| | | |
|---|---|---|
| I | Exposure increment | 0.1 µg/m³ $PM_{2.5}$ |
| | Effect size | ln(1.07) |
| | *Excess risk (multiplicative)* | **0.07%** |
| II | Relative risk | 1.0007 |
| | Baseline | $9\times10^{-3}$ death/yr |
| | *Excess risk (additive)* | $6\times10^{-6}$ death/yr |

**I. With assumptions, a long-term increment of +0.1 µg/m³ $PM_{2.5}$ ≈ excess risk (multiplicative) of 0.07%**

II. For a "statistically average" Bay Area adult, this would be an excess risk (additive) of $6\times10^{-6}$ death/yr

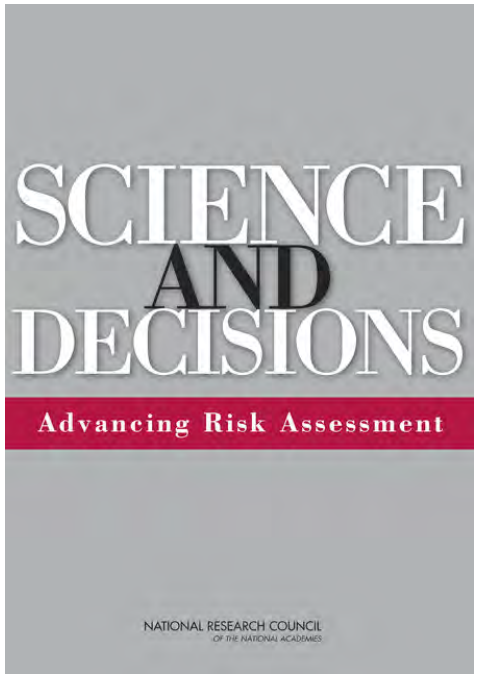
# From Modeling to Evaluation

Assuming for the moment that:

- ✓ Satisfactory health impact function(s) is/are identifiable
- ✓ We wish to evaluate individual sources using a model-based framework (e.g., in permitting decisions)

What should that evaluation framework be like?

- Transparent & interpretable
- Robust and accurate (low bias, low variance)
- Supportive of larger goals for a regulatory process



# Complexity: Multiple Metrics

**Typical approaches** to multiple endpoint(s) / metrics / statistics:

- Put on common scale
  - Example: willingness-to-pay + cost
- Normalize then combine
  - Examples: Hazard Index, disadvantage-screening tools
- Use logical composition: $Y_1 > A$ or ($Y_2 > B$ and $Y_3 > C$) …
  - Example: TAC framework overall, NAAQS

*Q: Who chooses relative weights & summary functions?*

# Complexity: Population Dependence

| | Emissions | Concentrations | Exposures | Relative Risks (RR) | Risk Differences (RD) |
|---|---|---|---|---|---|
| **Metric** | ton/yr | μg/m³ | person-μg/m³ | multiplier | increment |
| **Statistic** | – | max | sum | max | sum or max |
| **Required** | Emissions | Meteorology & land use | Boundary & pop. density | Effect size (β) | Baseline ($y_0$) |
| **Optional** | | | Time-activity | Groupwise variation in β | Spatial variation in $y_0$ |

*Q: What are the relative pros, cons, and/or tradeoffs?*

*Q: In the end, what would best support $PM_{2.5}$ risk management?*

# Selected References


- US EPA (2021). Supplement to the 2019 Integrated Science Assessment for Particulate Matter: External Review Draft. EPA/600/R-21/198.
- US EPA (2021). Estimating $PM_{2.5}$- and Ozone-Attributable Health Benefits: Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS. EPA-HQ-OAR-2020-0272.
- OEHHA and CARB (2015). Air Toxics Hot Spots Program: Guidance Manual for Preparation of Health Risk Assessments.
- Di Q, Wang Y, Zanobetti A, Wang Y, Koutrakis P, Choirat C, Dominici F, and Schwartz J (2017). Air Pollution and Mortality in the Medicare Population. N Engl J Med; 376:2513-2522.
- Turner M, Jerrett M, Pope CA, Krewski D, Gapstur S, Diver WR, Beckerman B, Marshall J, Su J, Crouse D, Burnett R (2016). Long-Term Ozone Exposure and Mortality in a Large Prospective Study. Am J Respir Crit Care Med 193(10):1134-42.

# Setting an Air Quality Target

Kate Hoag, PhD
Assistant Manager
khoag@baaqmd.gov

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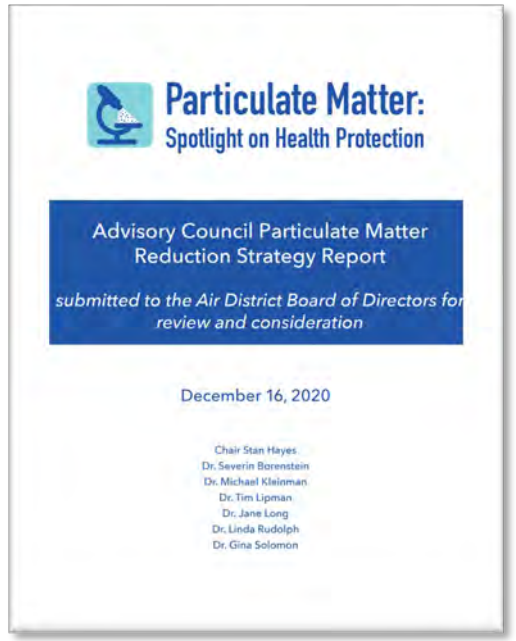


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# Objectives and Considerations

- Make sure we are aiming aggressively towards health-protective goals
- Demonstrate and track progress, in a robust and achievable way, as we implement reductions
- Repair, not perpetuate or worsen, cumulative impacts or disparities
- Drive reduction in combustion emissions

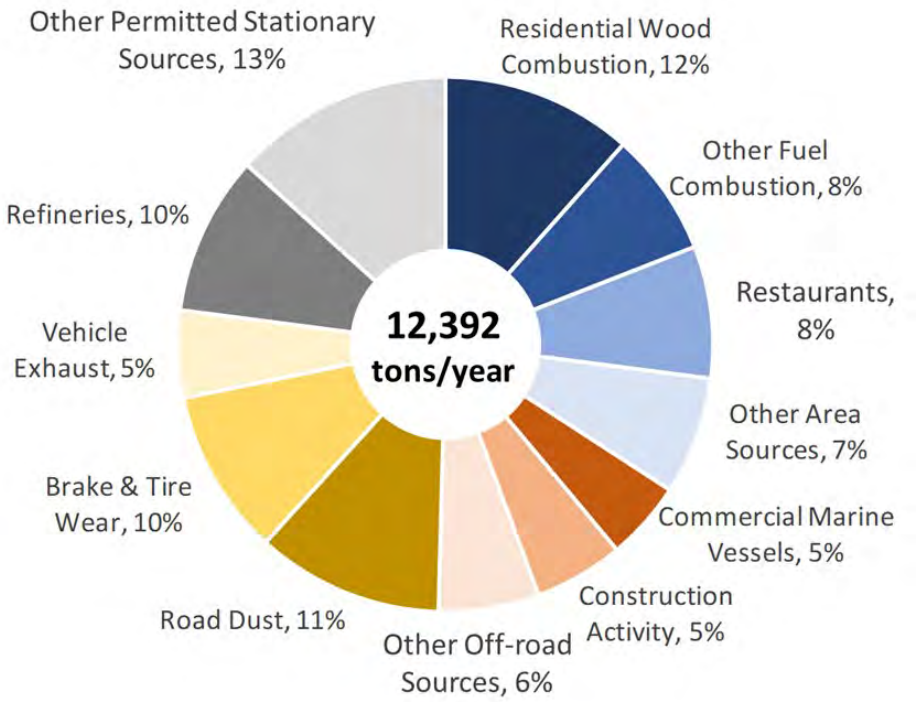
# Options for Implementing Recommendations

- Tools to identify issues
- Tools to demonstrate progress
- Regional or local disparities approaches

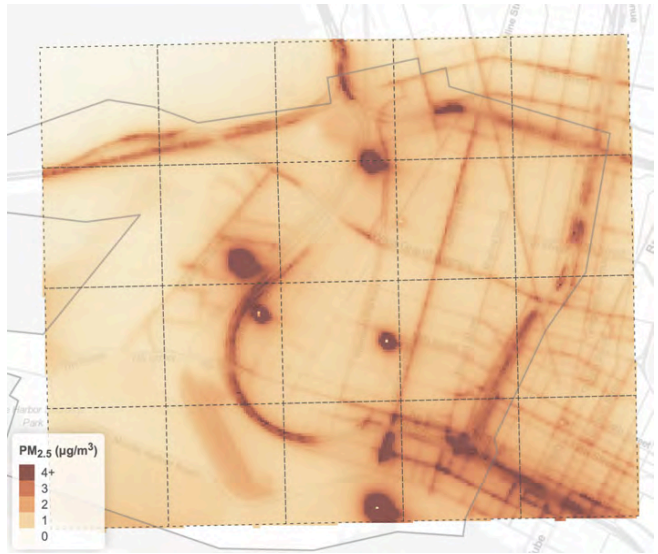
# Tools to identify issues

Annual $PM_{2.5}$ design values at each long-term monitoring station


Major Sources of Direct $PM_{2.5}$ Emission(2016 Annual Average)

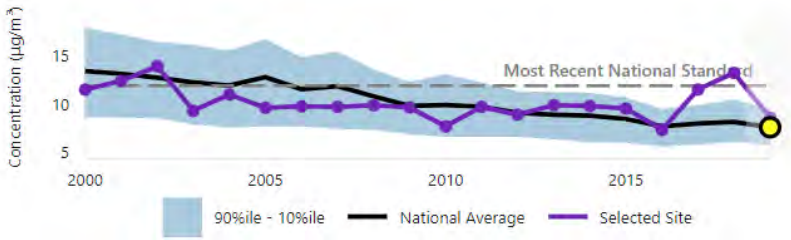



Modeled Impacts (µg/m³) of Local Sources on Average Concentrations



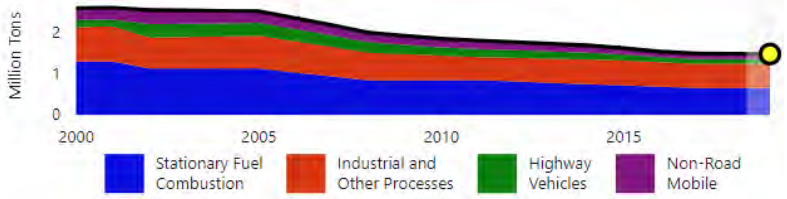
# Tools to demonstrate progress

## Annual Average $PM_{2.5}$ Concentrations



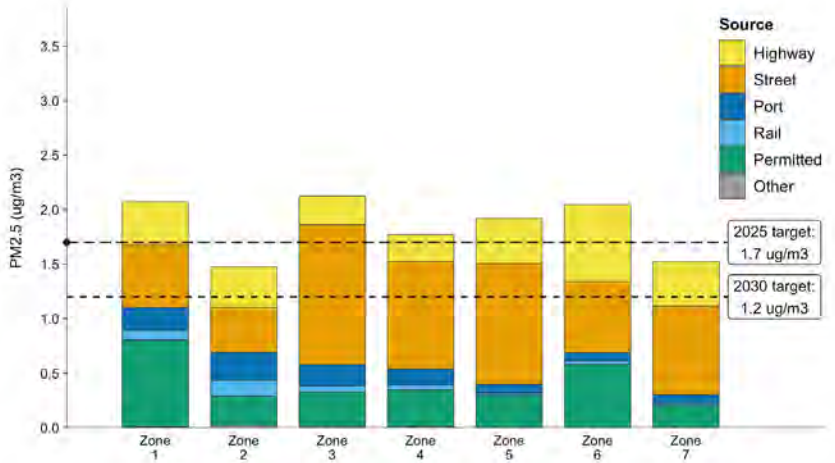

Source: U.S. EPA Air Quality System

## Direct $PM_{2.5}$ Emissions




Source: U.S. EPA National Emissions Inventory 2017

## Targets and Local, Modeling-Based Source-Attributed Impacts for $PM_{2.5}$




Source: West Oakland Action Plan (2019-08-16)

# Regional Approach

## Strengths

- Traditional methods and available datasets are already designed around this objective (also a challenge)
- Can get larger magnitude reductions compared to regional total and address area-wide common problems

## Challenges

- May not prioritize addressing sources of emissions on smaller spatial or temporal scales
- Improvements in emissions estimates could be perceived changes in emissions
- Measurements cannot reflect conditions in every area of interest
- Measured concentrations can reflect transport or uncontrolled emissions (e.g. wildfires) rather than implemented reductions

## Questions

*How does this approach strengthen what we already do?*

*How do we address the shortcomings of this approach?*

# Local Disparities Approach

## Strengths

- Leverage community knowledge and address sources not typically covered by traditional approaches
- Can consider equity, vulnerability to exposure, and cumulative impacts

## Challenges

- Need information about emissions or ambient concentrations not currently collected
- May draw resources away from sustaining current program requirements
- Lack of information about health impacts of short-duration and/or localized issues
- While measurements reflect local conditions, may not be sensitive enough to register changes in local emissions

## Questions

*How does this approach strengthen what we already do?*

*How do we address the shortcomings of this approach?*

# Other Open Questions on Metrics

- Should we use Annual Mean $PM_{2.5}$ or another PM metric?
- How do we account for cumulative impacts?
- How do we prioritize environmental justice and community input?
- Will upcoming changes to the NAAQS and subsequent requirements affect our decisions?

# Particulate Matter Key Issues

- What recommendations does the Advisory Council have for developing a method/framework to relate emissions to health risk?

- How can we assess the health risk of short-term, relatively high, exposures?

- What metric(s) should we use to measure and demonstrate progress?

# Questions?

AGENDA: 4

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

# Discussion of Advisory Council Meetings and 2022 Topics

**Advisory Council Meeting**
**December 13, 2021**

**Greg Nudd**
**Deputy Air Pollution Control Officer**
gnudd@baaqmd.gov

# Research and Discussion Questions

Air District seeks greater input and advice on the following items:

- **Climate Presentation:**
  - When prioritizing policy interventions, how should we account for climate benefits/dis-benefits?
  - What metrics should the Air District use to track progress and prioritize climate actions?

# Research and Discussion Questions (cont.)

Air District seeks greater input and advice on the following items:

- **Equity and Community Health Presentation:**
  - What metrics should the Air District use to track progress and prioritize actions?
  - Who should be at the table to decide those metrics?

# Research and Discussion Questions (cont.)

Air District seeks greater input and advice on the following items:

- **Particulate Matter:**
  - What recommendations does the Advisory Council have for developing a method/framework to relate emissions to health risk?
  - Who should develop a method/framework for relating emissions to health risk?
  - What metric(s) should we use to measure and demonstrate progress?