



Air Quality Foundations

A Training for Belle Haven, North Fair Oaks,
and East Palo Alto communities

November 2022



Agenda

Topics

Welcome and Goals

Introduction to Bay Air Center

Air Quality Foundations

Understanding Data

Accessing and Interpreting Local Data

Actions

Discussion



Goal:
Provide training on
foundational air quality
concepts and data.

The Presenters: The Bay Air Center

- Provide technical assistance to communities interested in understanding air quality.
- Build technical capacity in organizations across the Bay Area.
- Provide accessible resources on best practices and methods.
- Support Bay Area Air Quality Management District initiatives and staff.



**BAY AIR
CENTER**

Working Together for Clean Air

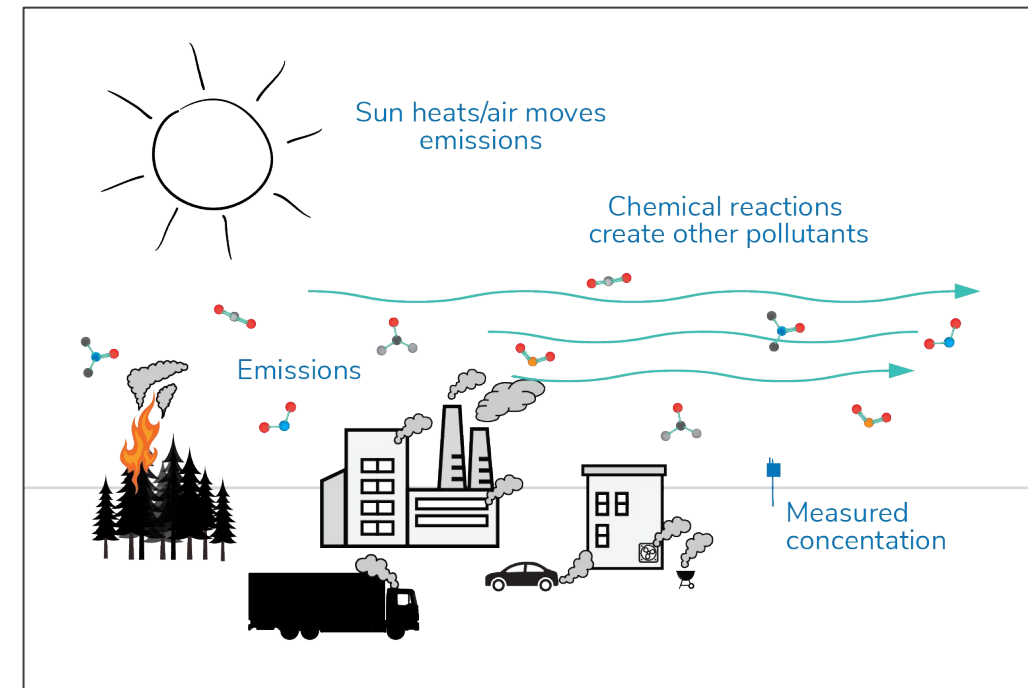


Working Together for Clean Air

Air Quality Foundations

About Air Quality: Pollutants

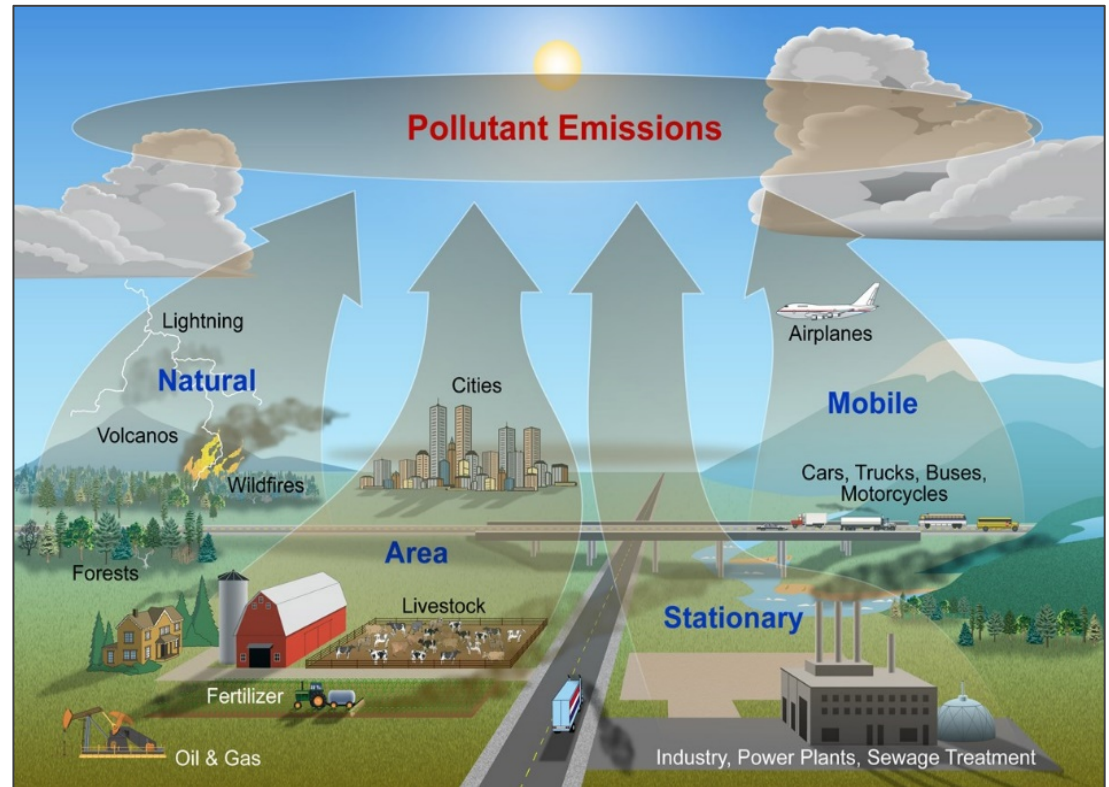
- Air quality is the level of specific pollutants or chemical compounds in the air that affect human and environmental health. Pollutants can be classified into the following categories:
 - Form (gas, particulate, liquid droplets);
 - Location (outdoor, indoor);
 - Origin (naturally-occurring or human-made pollutants — i.e., anthropogenic); and
 - Type (primary pollutants directly emitted from a source and secondary pollutants, which form in the atmosphere).
- Air quality is affected by a variety of factors, such as local emissions of pollutants, weather conditions, atmospheric chemistry, and geography.



Sources of Pollutants

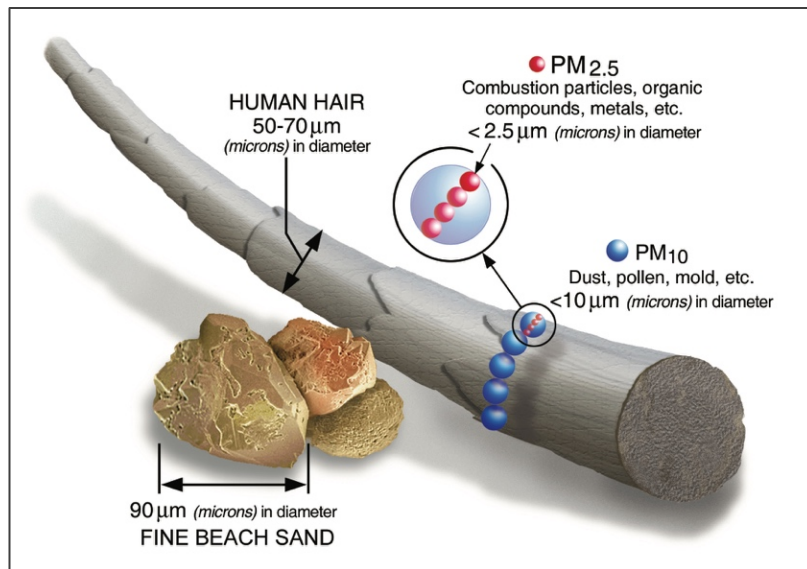
Different pollutants come from different sources.

- Transportation (cars, trains, planes, boats)
- Refineries & power plants
- Manufacturing and industry
- Wood stoves/fireplaces
- Wildfires
- Dust
- Many more



Sources of pollution. (Source: U.S. National Park Service)

The two most common pollutants in the Bay Area are fine particulate matter (**PM_{2.5}**) and ground level ozone (**O₃**), a secondary pollutant that forms from emissions of other pollutants.



Size comparison of PM_{2.5}, PM₁₀, human hair, and sand. (Source: U.S. EPA)

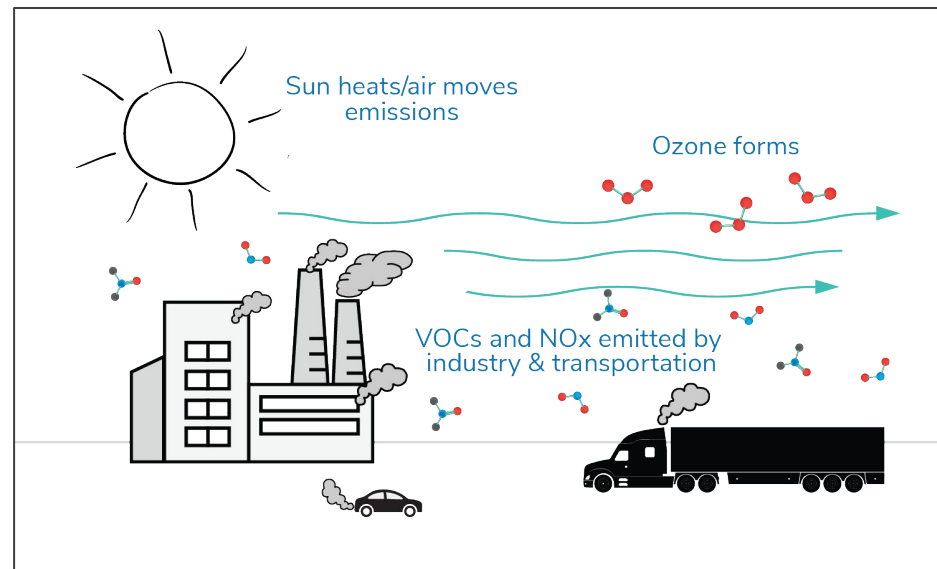


Figure 5: Ozone is a secondary pollutant, formed in the atmosphere by chemical reactions between VOCs and NOx in the presence of sunlight. (Source: Bay Air Center)

Pollutant Types

Criteria Air Pollutants

- The group of pollutants regulated by the Clean Air Act
- Standards for these are set based on human health and environmental criteria.
- Fine particulate matter (PM_{2.5}), Ozone (O₃), Sulphur dioxide (SO₂), Carbon monoxide (CO), Nitrogen dioxide (NO₂), Lead

Air Toxics

- Hazardous air pollutants that are known to cause cancer and/or other serious health issues or adverse environmental and ecological effects.
- California identifies more than 200 air toxics and has implemented 26 control measures.
- Ex: Benzene, Hexavalent chromium, Perchloroethylene

Greenhouse Gases (GHGs)

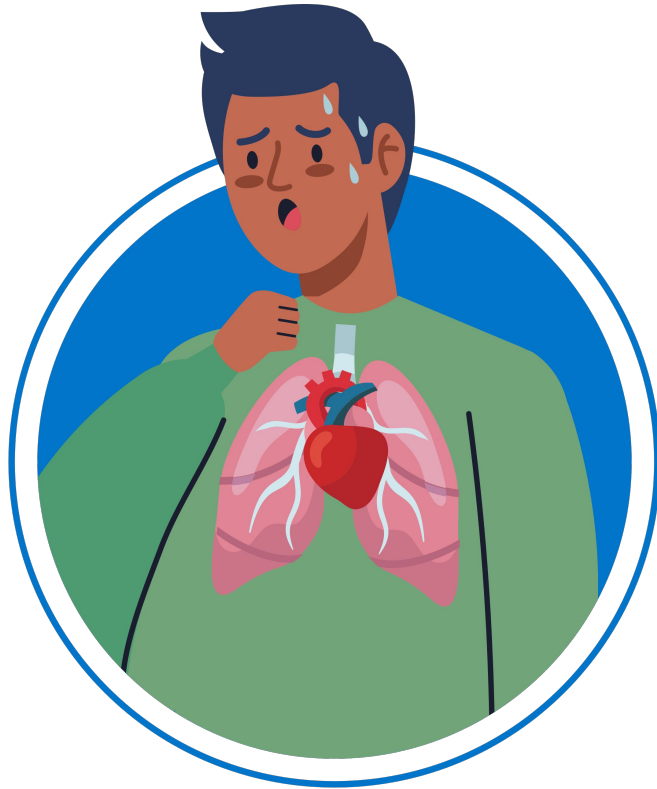
- Gases that trap heat in the atmosphere and contribute to climate change.
- Carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Fluorinated gases

Details: Common Important Pollutants

Pollutant	Description	Sources
Particulate matter (PM _{2.5} and PM ₁₀)	Microscopic particles of soot, dust, or other matter, including tiny liquid droplets (Criteria air pollutant)	<ul style="list-style-type: none"> • Diesel engines • Power plants • Industries • Windblown dust • Wood stoves/fireplaces • Wildfires
Ozone (O ₃)	Gaseous pollutant (Criteria air pollutant)	<ul style="list-style-type: none"> • Vehicle exhaust and fumes from other sources that react in the presence of sunlight to create ozone
Volatile Organic Compounds (Often benzene, toluene, ethylbenzene, xylene)	A variety of gaseous compounds (Air toxics)	<ul style="list-style-type: none"> • Combustion of fuel or burned organic waste • Paints and solvents • Consumer products
Nitrogen oxides (NO ₂)	A gaseous compound made up of nitrogen and oxygen (Criteria air pollutant)	<ul style="list-style-type: none"> • Vehicles • Power plants burning fossil fuels • Coal-burning stoves
Carbon monoxide (CO)	A colorless, odorless gas (Criteria air pollutant)	<ul style="list-style-type: none"> • Vehicles burning gasoline • Indoor sources, including kerosene, burning wood, natural gas, coal — or wood-burning stoves and heaters
Sulfur dioxide (SO ₂)	Gaseous pollutant made up of sulfur and oxygen (Criteria air pollutant)	<ul style="list-style-type: none"> • Coal-burning power plants and industries • Coal-burning stoves • Refineries
Lead (Pb)	Metallic pollutant (Criteria air pollutant)	<ul style="list-style-type: none"> • Vehicles burning leaded gasoline • Metal refineries

Health Effects

Air pollution harms human and animal health, damages agricultural crops, forests, ornamental and native plants, and creates haze that reduces visibility.



- Cause nausea, dizziness, headaches, chest pain
- Cause eye, nose, and throat irritation
- Make it more difficult to breathe
- Increase the likelihood of heart attacks
- Increase respiratory disease including asthma attacks
- Decrease lung function
- Decrease life expectancy

Regulation: Who Controls Pollution?

Government agencies are charged with regulating emissions to reduce pollutants entering the air.



Environmental Protection Agency (EPA)

- Carry out enforcement of the Clean Air Act: limits certain pollutants
- Work with state agencies to ensure compliance with federal laws
- Develop & update new *federal* pollutant standards



California Air Resources Board (CARB)

- Develops & updates mobile & area pollution regulations
- Enforce EPA & state adopted standards
- Work with air districts & communities to ensure regional compliance & monitor pollution



BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

Regional Air Districts

- Monitor & report pollution data
- Enforce local compliance with state & federal standards
- Work with communities on local air quality issues

Regulation: Who else has a say?

Land Use Decision-Makers

Cities and counties are responsible for land use and local development, which is guided by policies set by their general plan, zoning ordinances, and development agreements.

Transportation Agencies

Fund, plan, construct, operate, and maintain different transportation infrastructure, such as highways, streets and roads, bicycle and pedestrian systems, transit systems, and intercity rail.

City Council or County Board of Supervisors



Evaluates staff analyses, recommendations, and decisions by advisory bodies in making final decisions on land use.

Planning Commission and Other Advisory Bodies



Reviews applications, make findings, and acts as an advisory board to the governing body on planning and development issues. Not all cities or counties create planning commissions or advisory bodies.

Governor's Office of Planning and Research



Adopts the State General Plan Guidelines. The general plan is the long-term blueprint for the community's vision of future growth. Also, develops CEQA Guidelines with the California Natural Resources Agency.

State



California Department of Transportation: Responsible for the state highway system. Develops policy framework to guide transportation decisions statewide.

California Transportation Commission: Develops guidelines for transportation project identification and adopts transportation project lists.

Regional



Metropolitan Planning Organizations (urbanized) and Regional Transportation Planning Agencies (rural) prepare Regional Transportation Plans that project the area's long-term transportation needs and priorities, as well as identify specific transportation projects for funding.

Local



Cities and Counties: Own, maintain, and provide funding for the local streets and roads in their jurisdictions.

Transit Agencies: Deliver transit services, such as buses, subways, and light rail.

Source: CARB

Air Quality Standards

Federal and State ambient air quality standards for outdoor pollutants are set to protect public health and the climate.

Federal (EPA)

- $\text{PM}_{2.5}$:
 - $12.0 \mu\text{g}/\text{m}^3$, annual average
 - $35 \mu\text{g}/\text{m}^3$, 24-hour standard
- O_3 : 0.07 ppm, 8-hour average
- [National Ambient Air Quality Standards \(NAAQS\)](#): standards for the criteria air pollutants.

State (CARB)

- $\text{PM}_{2.5}$ and O_3 are the same as federal
- In most cases, CA's standards are more protective of health than the federal standards.
 - Ex: PM_{10} – no federal annual average, CA annual average $20 \mu\text{g}/\text{m}^3$

Measurement Methods



REGULATORY

- Highly accurate
- Very reliable
- Fixed location
- Sensitive
- Certified
- Long lifespan
- Expensive



SENSORS

- Accuracy varies
- Less reliable
- Mobile or fixed location
- Not as sensitive
- Not certified
- Shorter lifespan
- Low cost

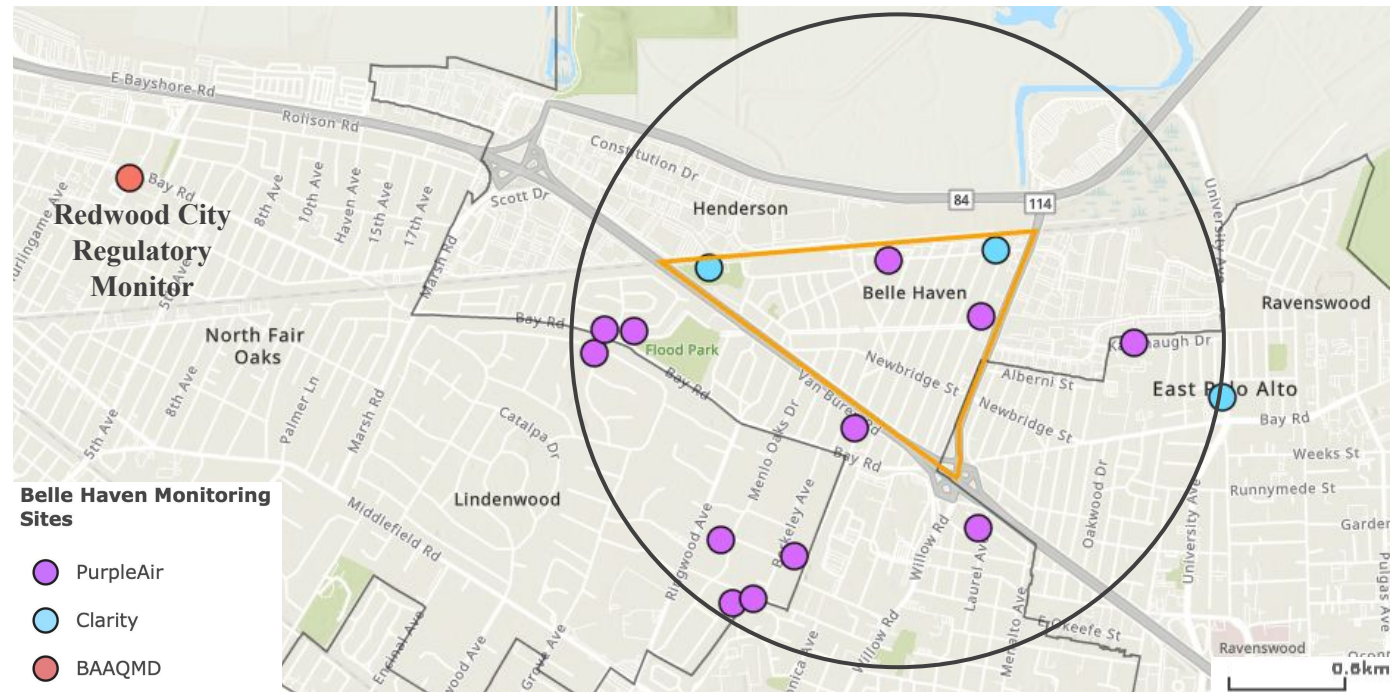
Also... Satellites!



Belle Haven Analysis

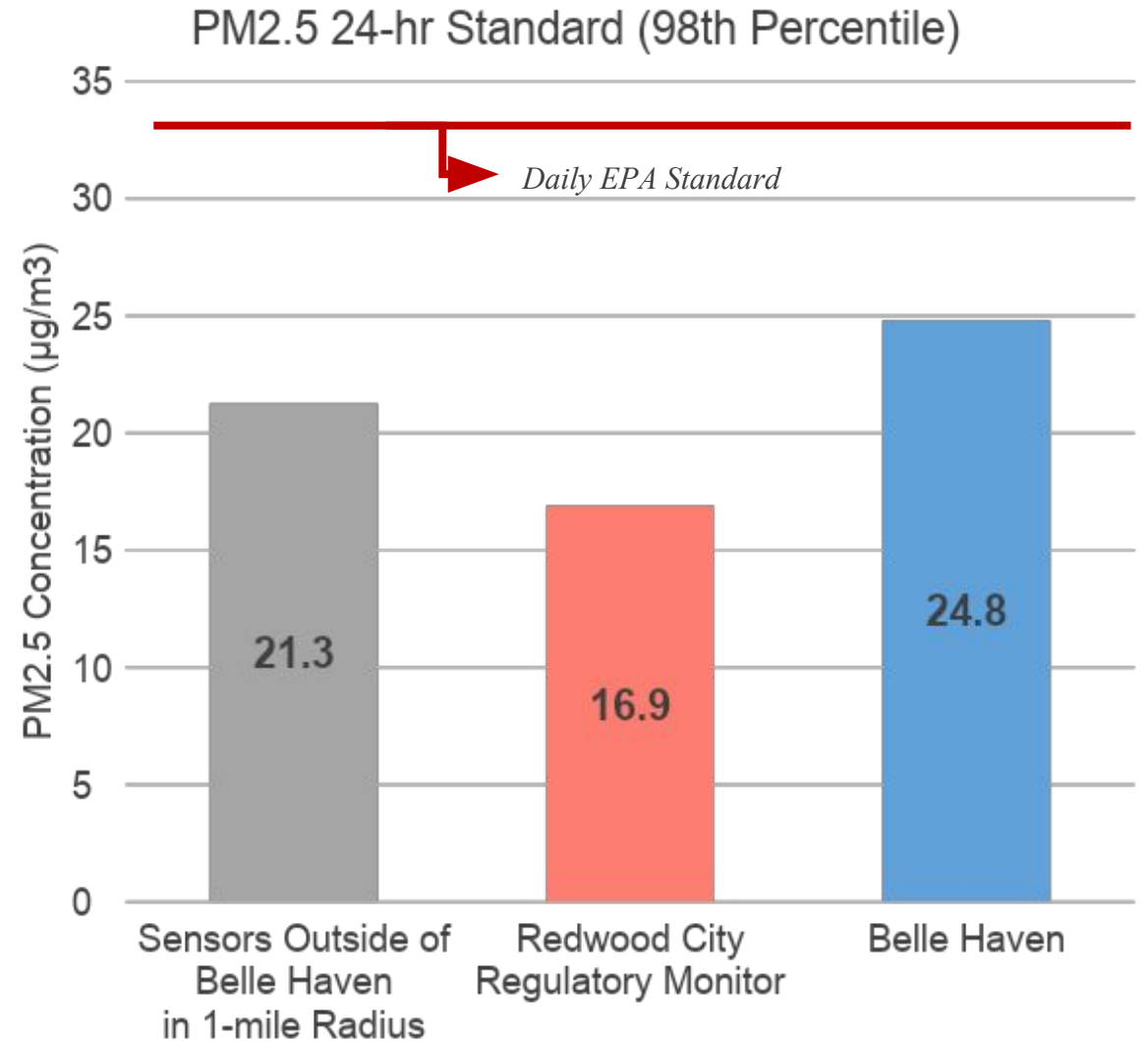
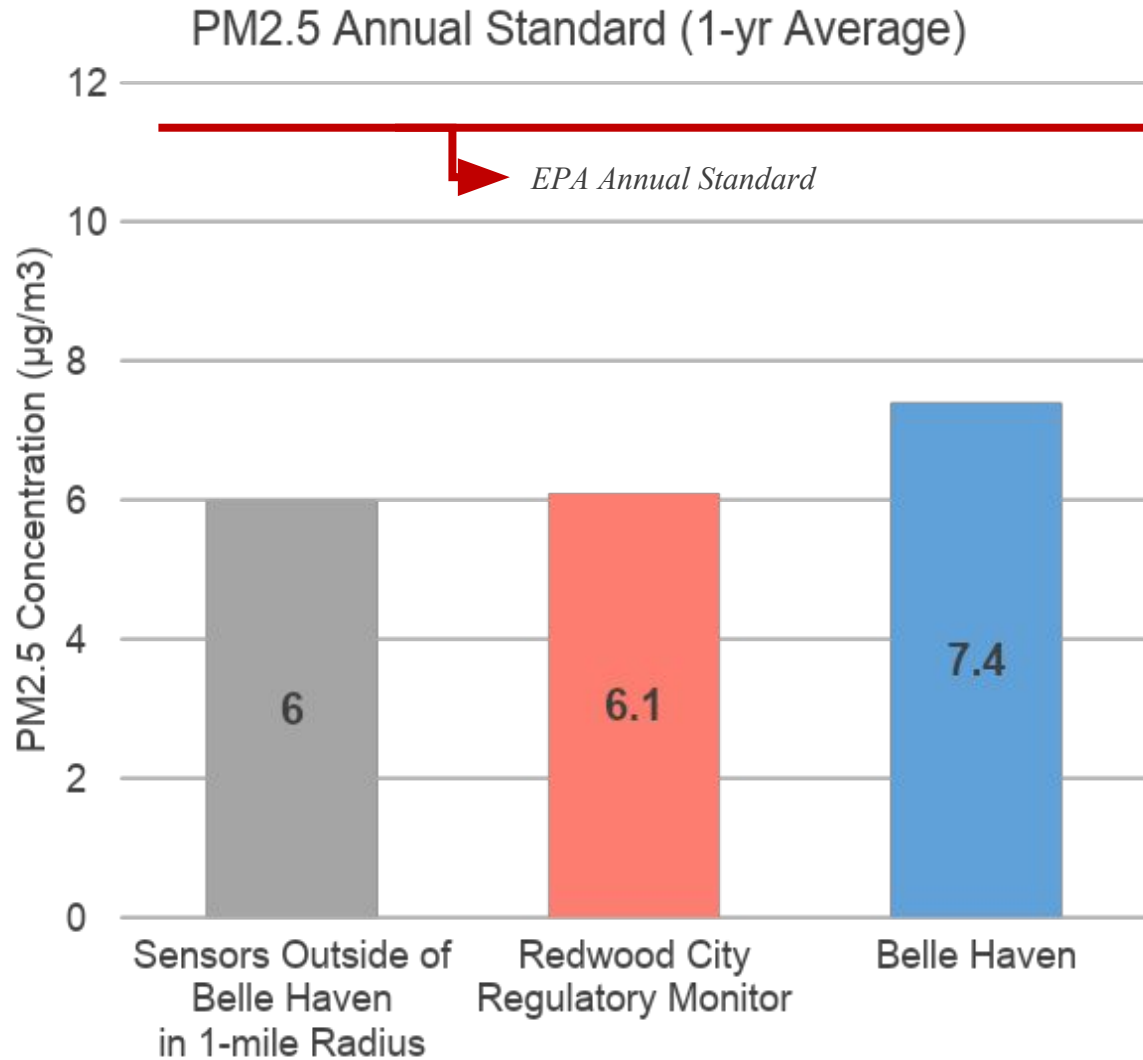
- Full-year 2021
- 14 PurpleAir, 4 Clarity
- BAAQMD Redwood City

18 sites measure PM_{2.5}
within a 1-mile radius



Belle Haven Results

All sites measured an annual average that was below the standards set by the United States Environmental Protection Agency (EPA)



Questions?



Working Together for Clean Air

Understanding Data

Types of Air Quality Data

Measured

Continuous

vs

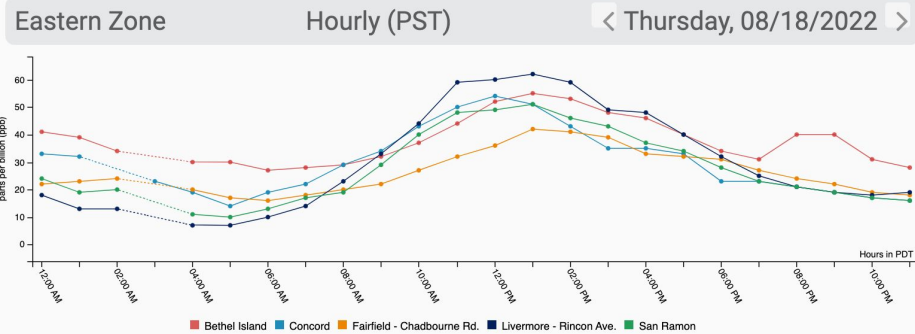
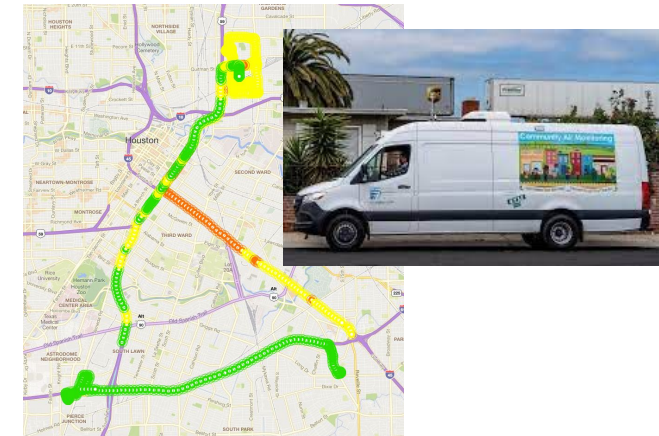
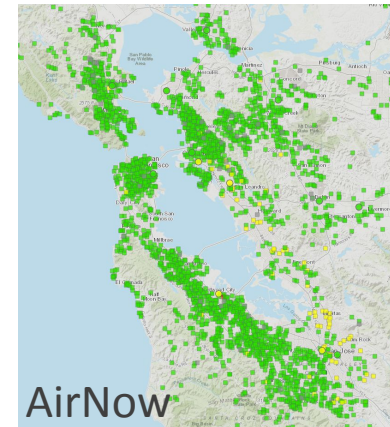
Integrated
(Sampler)



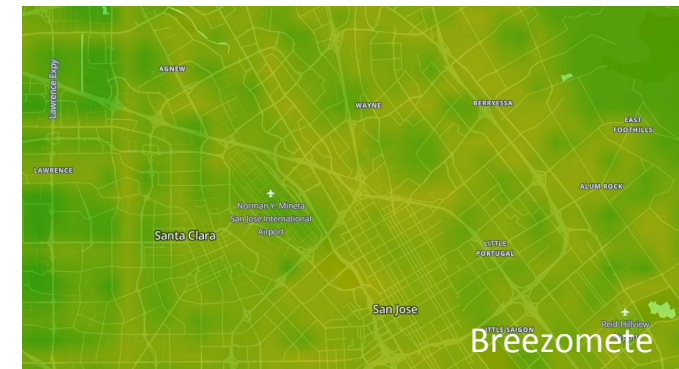
Fixed

vs

Mobile



Estimated Models



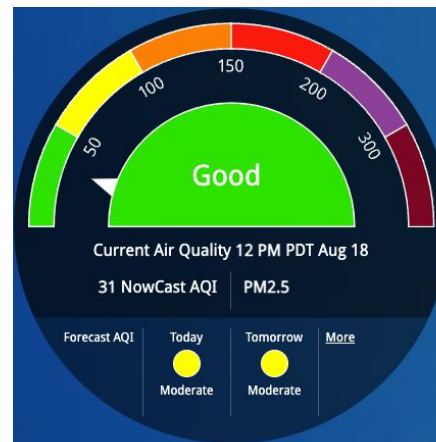
More Types of Data

Historical

- Data that has been taken in the past
- Usually, quality controlled
- Available to view/download from a number of sites

Real-Time

- Measured *continuously* & reported immediately
- Not always QA/QC'd



Forecasted

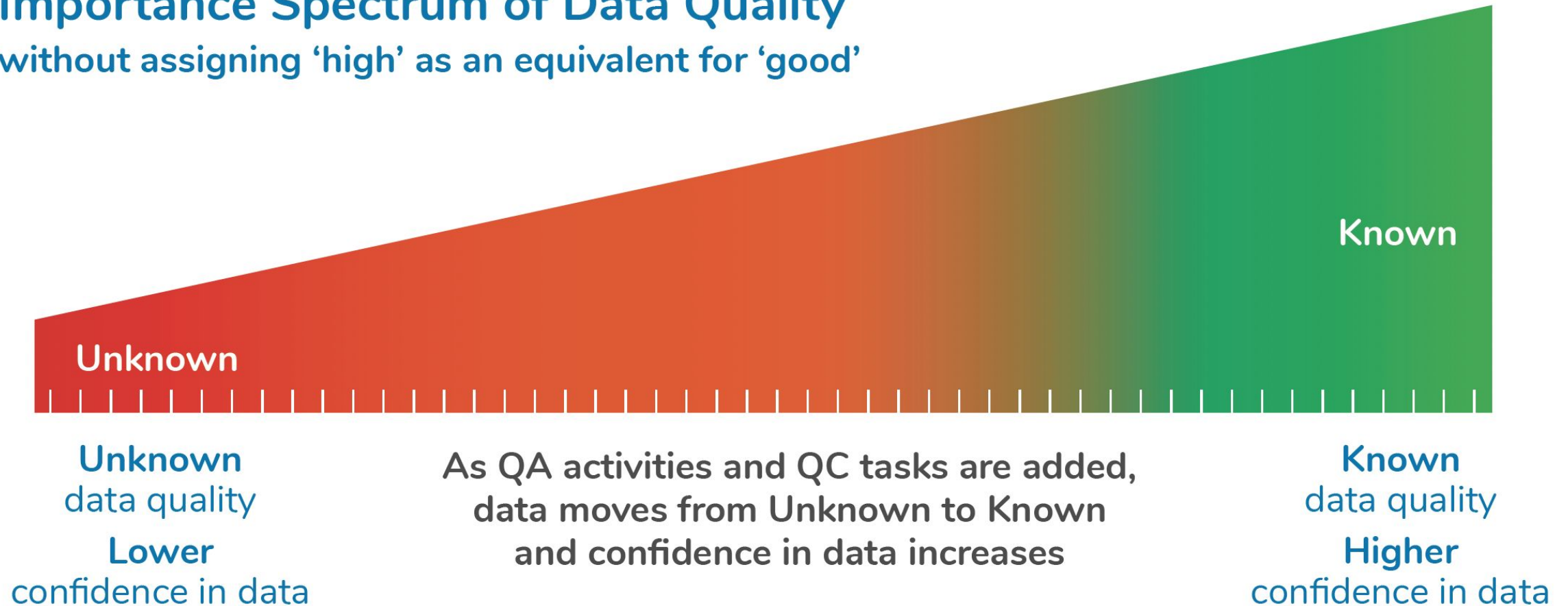
- Using data, including current conditions, wildfire information, and weather, models to predict future air quality concentrations

2 Day Forecast
Air Quality Forecast
Wednesday, November 25 at 12:38 PM

	Thu	Fri
North Counties	103	45
Coast and Central Bay	102	32
Eastern District	77	26
South Central Bay	77	29
Santa Clara Valley	87	36

Data Quality

Importance Spectrum of Data Quality without assigning 'high' as an equivalent for 'good'



Concentration

Concentration is the amount of pollutant in a standard volume of air.

- Parts-per-million (ppm)
- Parts-per-billion (ppb)
 - Ozone
 - NO₂
- Micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)
 - PM
 - Black Carbon (soot)



Figure 6: A single drop of ink in a 60-gallon bathtub would be about 70 ppb. (Source: Bay Air Center)

Air Quality Index

Air Quality Index (AQI):

The U.S. Environmental Protection Agency (EPA) created the AQI to report the status of air quality so that all pollutants appear on the same scale (or index).

Air Quality Index - Particulate Matter	
301 – 500	Hazardous
201 – 300	Very Unhealthy
151 – 200	Unhealthy
101 – 150	Unhealthy for Sensitive Groups
51 – 100	Moderate
0 – 50	Good

Exposure

- It is important to understand the effect of pollutant exposure over time.
- EPA and CARB set health-based standards for pollutants with different averaging times.
 - For example, for PM_{2.5} there is both an annual and 24-hour standard to protect against both long-term and short-term exposure to PM_{2.5}.
- While there are not shorter standards (e.g., 1-hour time periods), there is no safe level of PM and even short-term exposures may have health impacts.

AQI Category	Index Values	2015 Ozone Standard Breakpoints (ppb, 8-hour average)	2006 PM _{2.5} Standard Breakpoints (µg/m ³ , 24-hour average)
Good	0–50	0–54	0.0–12.0
Moderate	51–100	55–70	12.1–35.4
Unhealthy for Sensitive Groups	101–150	71–85	35.5–55.4
Unhealthy	151–200	86–105	55.5–150.4
Very Unhealthy	201–300	106–200	150.5–250.4
Hazardous	301–500	201–600	250.5–500

AQI vs. concentrations

Questions?



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Local Data Sources

BAAQMD Data

Air District Air Quality Data

- Local Bay Area data
- High quality, reliable regulatory data
- Lots of pollutants
- Over 30 locations
- Current & historical data
- Data downloaded through AQS



Air Quality Index
View health-based air quality information, as air quality measurements of pollutants at the Air District's air monitoring stations are translated into the U.S. EPA's color-coded Air Quality Index scale.



Air Pollution
View measurements of actual concentrations of pollutants at the Air District's air monitoring stations..



Meteorology
View various weather-related measurements - such as temperature, precipitation, and wind speed - collected from the Air District's meteorological stations.



www.baaqmd.gov/about-air-quality/current-air-quality/air-monitoring-data/#/

AirNow

[AirNow.gov](http://www.airnow.gov)

- EPA run site
- Regulatory data from states (BAAQMD data included)
- AQI: PM_{2.5} and O₃ (indicates primary pollutant)
- Forecasts
- Has suggested health actions
- Useful for daily health decisions



<http://www.airnow.gov/>

AirData

AirData

- EPA's data portal
- Regulatory data from states
- Lots of pollutants
- Current & historical data visualizations and raw data file downloads
- Useful graphs:
 - Concentration Plot
 - AQI Plot
 - Tile Plot - Multiyear



Search EPA.gov



Environmental Topics ▾

Laws & Regulations ▾

Report a Violation ▾

About EPA ▾

CONTACT US

Air Data: Air Quality Data Collected at Outdoor Monitors Across the US



Download Data

- [Pre-generated Data Files](#)
- [Download Daily Data](#)

Monitor Locations

- [Interactive Map of Air Quality Monitors](#)

About Air Data

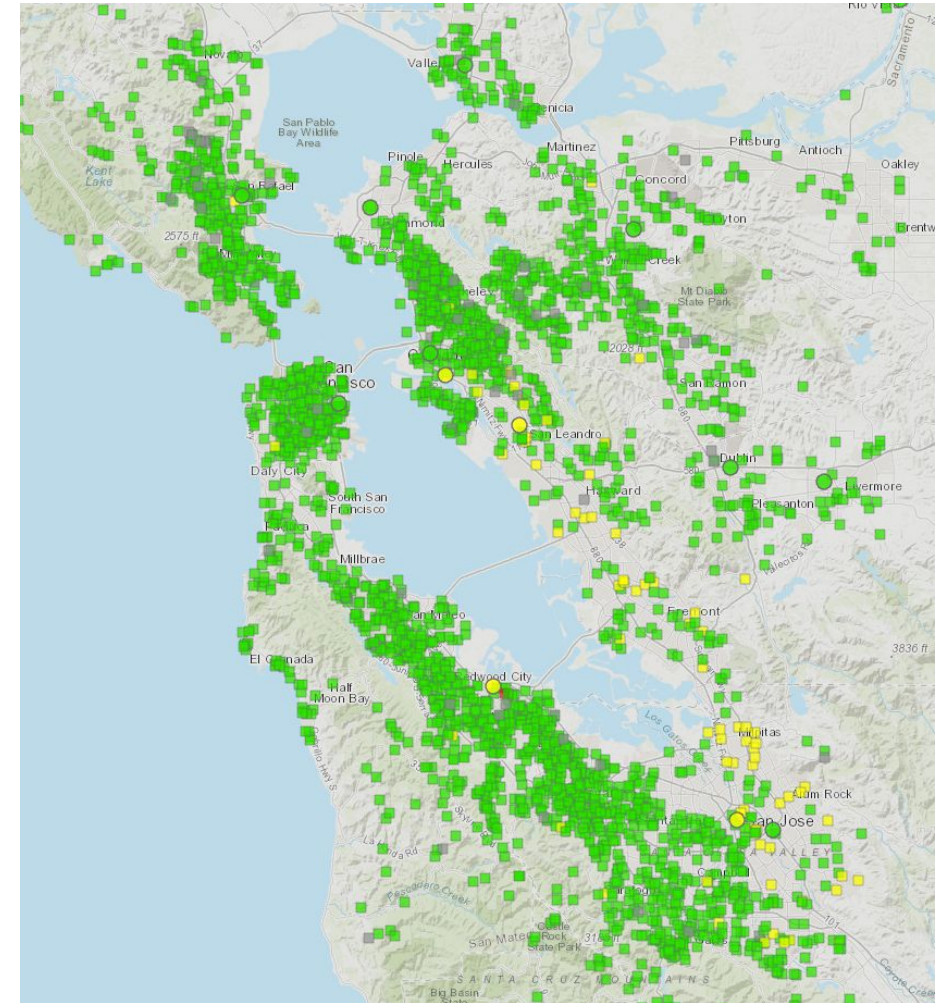
- [Basic Information](#)
- [Frequent Questions](#)

www.epa.gov/outdoor-air-quality-data

Fire & Smoke Map

Fire & Smoke Map

- EPA run site
- Mix of regulatory data from states & corrected PurpleAir sensor data
- PM_{2.5}/AQI
- Shows wildfire locations & smoke plumes
- Has suggested health actions

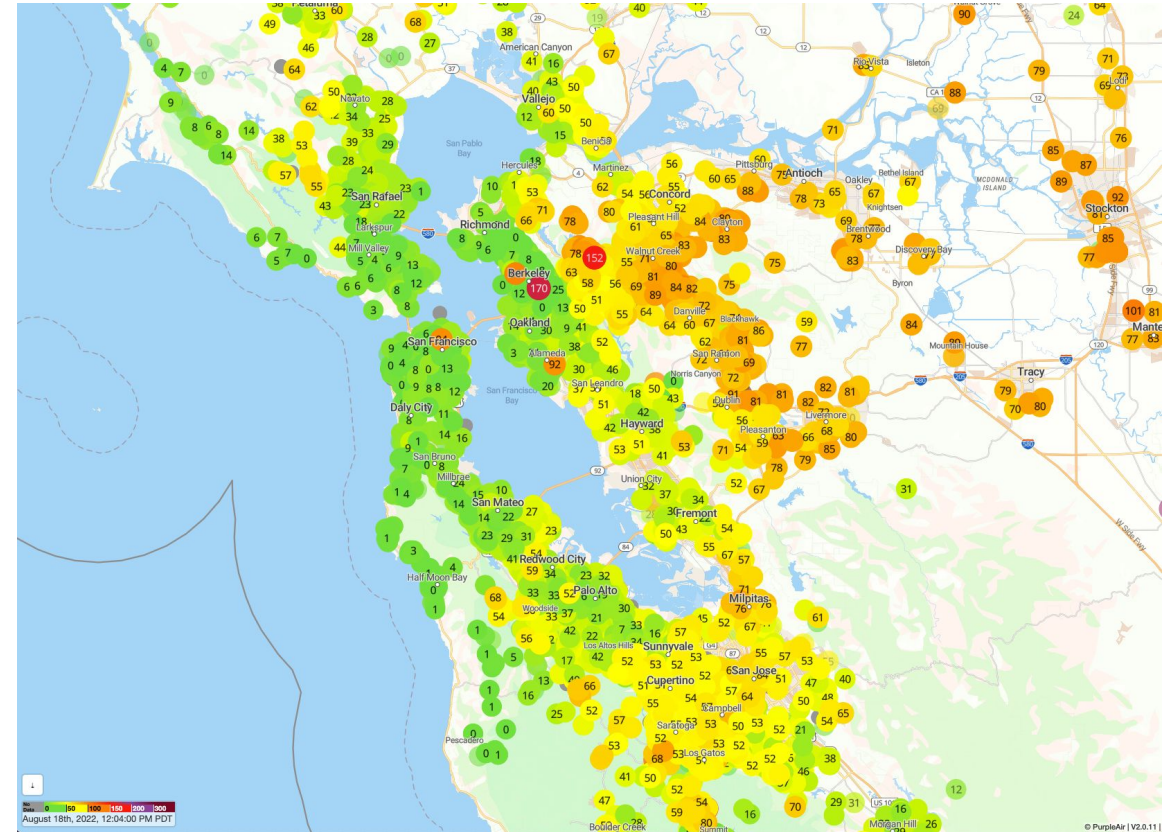


fire.airnow.gov

PurpleAir Data

PurpleAir

- Private air sensor company
- Lower quality sensor data
 - Used by the EPA's Fire & Smoke map
 - NOT CALIBRATED or quality controlled – Important!
- PM_{2.5}/AQI
- Global map
- Current & historical data
- Accessible data downloads



[EPA's PurpleAir Correction](#) - slide 48
(requires relative humidity)

Other Air Quality – Sensors & Estimates

Sensors

PurpleAir

- Not calibrated
- $PM_{2.5}$ /AQI

Clarity

- Calibrated using an internal calibration
- $PM_{2.5}$ /AQI

Estimates

Breezometer

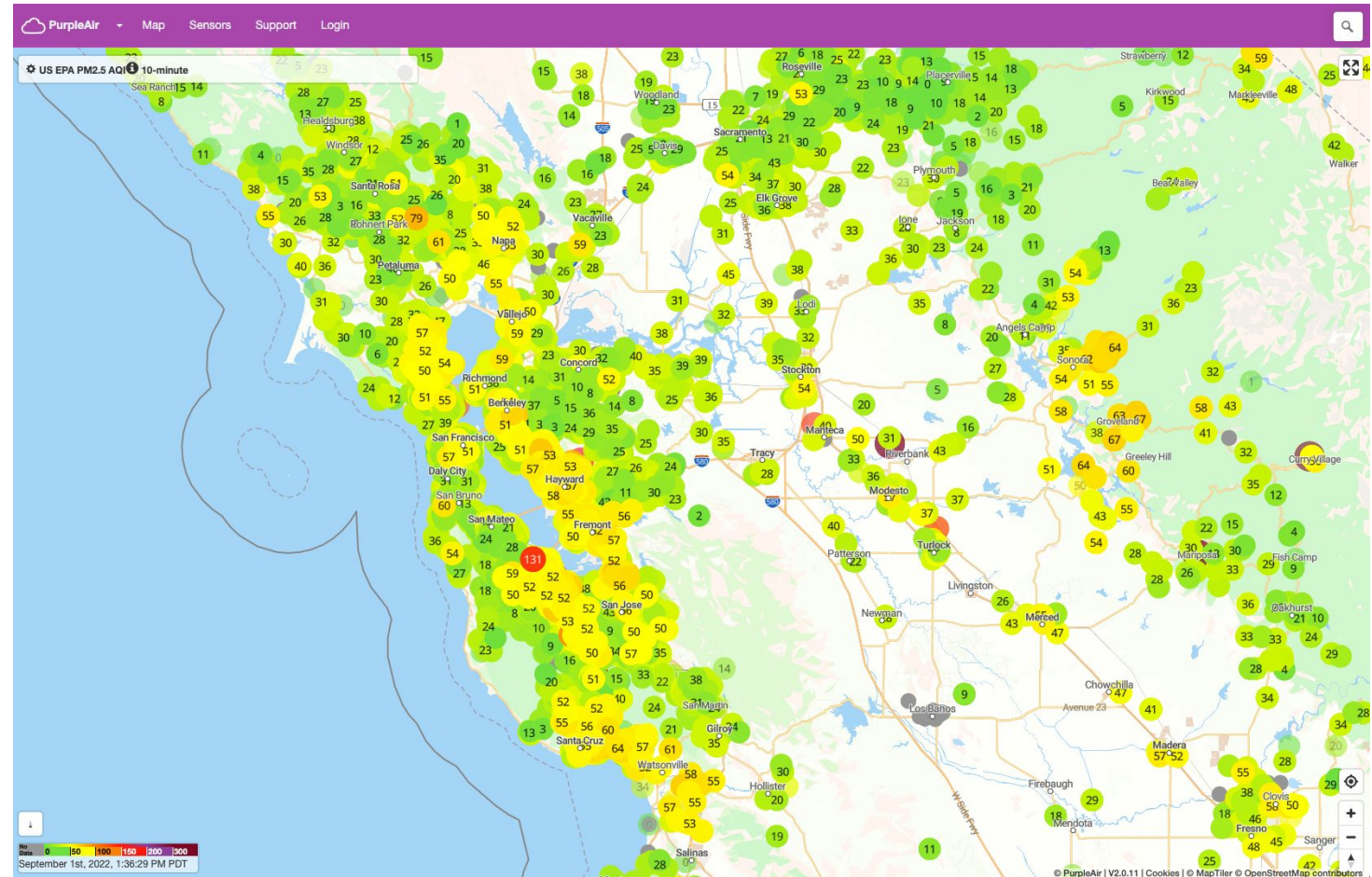
- Hyperlocal air quality model

Aclima

- Bay area mobile monitoring data

Plume Labs

- Global air pollution map



PurpleAir Map



Working Together for Clean Air

Actions

Actions: Overview

Educate yourself/others & raise awareness

Reduce exposure (Adapt)

Reduce emissions (Mitigate)

Actions: Overview

Educate

- Learn about pollution, educate others, raise awareness

Adapt

- Reduce your exposure to air pollution

Mitigate

- Actions to reduce emissions of air pollutants

Educate/Raise Awareness

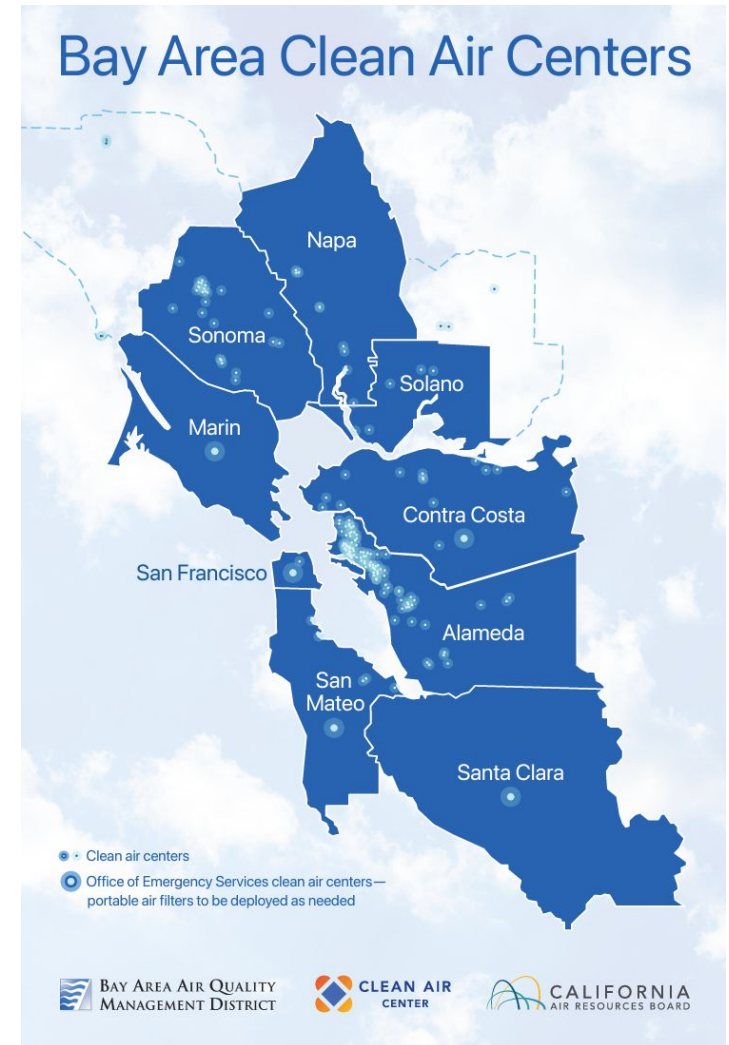
- Paying attention to air quality can help you understand what's happening in your community!
 - What do you see/smell?
 - How do you feel?
- Use public data sources to find information
- Sign up to receive Spare the Air alerts
- Share information and knowledge with others
 - Especially those more vulnerable: Children, elderly, those with heart & lung disease or diabetes, and people experiencing economic (or financial) hardship



sparetheair.org

Reduce Exposure to Air Pollution

- Change personal activity when air pollution levels are high
 - Limit time outdoors
 - If you must remain outdoors, limit strenuous activity
 - Wear a tight-fitting N95 mask
- Visit clean air centers for respite
 - Air District sponsors 300 clean air centers around the Bay Area
 - Map of locations:
rspcerp.mysocialpinpoint.com/clean-air-centers#/



Reduce Exposure: Indoor Air Quality

Improve the indoor air quality at your home:

- Seal leaky windows and doors
- Create clean air where you live or work
 - If you have an HVAC system:
 - Upgrade to HEPA or MERV 13 filters for HVAC system
 - Use HVAC in recirculation mode, if possible
 - If you don't have an existing HVAC system with filtration, purchase, or a build personal filtration device
- Avoid activities that create smoke or other particles indoors



Advocate for Emission Reductions: Air District

- Engage with the Air District on rulemaking, planning, and permitting decisions.
 - Using air quality data can provide support for advocating for local emissions reductions
 - Inform the District about the sources of air pollution you are concerned about
 - Compliant line:
<https://www.baaqmd.gov/online-services/air-pollution-complaints>

Your actions help ensure that the Air District is doing all it can to control the sources that exist in your community.

Advocate for Emission Reductions: Other

- Engage local government on general plans and land use decision making
 - Ensure new sources of air pollution or changes to existing land use does not increase or generate new emissions for nearby communities
 - City Council & Planning Commissions (City & County)
 - California Environmental Quality Act
- Engage with CARB and federal government agencies on air quality legislation

Emissions Reductions Incentives

- Take advantage of incentives and funding for local programs to help change to less-polluting options for homes and businesses
 - Clean Cars for All
 - Lawn mower exchanges & electric lawn equipment grants
 - Vehicle buy-back programs
 - Wood burning stove change outs
 - Home energy efficiency and weatherization programs

BAAQMD Funding and Incentives page: <https://www.baaqmd.gov/funding-and-incentives/residents>

CARB Incentives: <https://ww2.arb.ca.gov/our-work/topics/incentives>

California Home Energy Efficiency Information: <https://www.csd.ca.gov/Pages/Assistance-HomeEnergyEfficiency.aspx>

Reduce Personal Emissions

- Reduce vehicle idling.
- Walk or bike. If air quality is poor, consider taking public transit. If you drive, carpool!
- Find alternatives to wood burning, such as electric fireplaces or a heat pump.
- Avoid using gas-powered lawn and garden equipment.
- Use less energy – select more efficient appliances and heating systems.
- Choose a cleaner car with Clean Cars for All

Questions?

Air Quality Data Websites

	BAAQMD Data	AirNow	AirData	Fire & Smoke Map	PurpleAir	Clarity Movement
Data Quality	High	High	High	Medium/High	Low	Low/Medium
Coverage	Bay Area	USA	USA	USA	Global	Global
Applications	Exposure, trends, events	Exposure	Trends, events	Exposure, events	Exposure, trends, events	Exposure, trends, events
Real-time/historical	Both	Real-time	Historical	Real-time	Both	Real-time
Any limitations	Fewer monitors	Only PM/Ozone	Can be difficult to use	Only PM _{2.5}	Not corrected Only PM _{2.5}	Internal correction Only PM _{2.5}
Organization Type	Local government	Federal government	Federal government	Federal government	Private company	Private company
Concentration/AQI	Both	AQI	Concentrations	AQI	Both	Both
Site URL	www.baaqmd.gov/about-air-quality/current-air-quality/air-monitoring-data/#/	www.airnow.gov	www.epa.gov/outdoor-air-quality-data	fire.airnow.gov	map.purpleair.com	openmap.clarity.io

Resources: Actions

- Spare the Air alerts: www.sparetheair.org
- BAAQMD Clean Air Centers:
<https://www.baaqmd.gov/funding-and-incentives/public-agencies/clean-air-centers>
- Air purifier information
 - BAAQMD Air Purifier Information:
<https://www.baaqmd.gov/about-air-quality/wildfire-air-quality-response-program/wildfire-safety>
 - Video on building a DIY air filter:
<https://www.youtube.com/watch?v=XSNHdiEMGbA>
 - EPA Guide to air cleaners in the home:
<https://www.epa.gov/indoor-air-quality-iaq/guide-air-cleaners-home>
- EPA Indoor air quality information:
<https://www.epa.gov/indoor-air-quality-iaq>

Resources: Reduce Exposure

- Clean Air Centers list/map:
<https://rspcerp.mysocialpinpoint.com/clean-air-centers#/>
- Air Purifier Information:
 - BAAQMD:
<https://www.baaqmd.gov/about-air-quality/wildfire-air-quality-response-program/wildfire-safety>
 - EPA:
<https://www.epa.gov/indoor-air-quality-iaq/guide-air-cleaners-home>
- Building an Air Filter (Video):
<https://www.youtube.com/watch?v=XSNHdiEMGbA>
- EPA's Indoor Air Quality Homepage:
<https://www.epa.gov/indoor-air-quality-iaq>

Resources: Advocate

- BAAQMD Information Sign-up:
<https://www.baaqmd.gov/contact-us/sign-up-for-information>
- BAAQMD Compliant line:
<https://www.baaqmd.gov/online-services/air-pollution-complaints>
- CARB California air quality and climate legislation page:
<https://ww2.arb.ca.gov/california-air-quality-and-climate-legislation>
- Menlo Park Planning Commission:
<https://beta.menlopark.org/Government/Commissions-and-committees/Planning-Commission>
- San Mateo County Planning and Building site:
<https://www.smcgov.org/planning>

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<https://www.baaqmd.gov/funding-and-incentives/residents>
- CARB Incentives:
<https://ww2.arb.ca.gov/our-work/topics/incentives>
- California Home Energy Efficiency Information:
<https://www.csd.ca.gov/Pages/Assistance-HomeEnergyEfficiency.aspx>