Appendix D: Air Monitoring

This appendix contains additional information on air monitoring data and insights to supplement Chapter 5: Air Quality Overview and Chapter 7: Key Issues and Strategies, including:

- Background on the air monitoring datasets from different projects and programs that were used to help characterize community air quality for the Plan technical assessment
- Additional findings from different analyses to support specific key issues or strategies
- Resources on air quality monitoring and links to available real-time air quality data

Background And Resources On Air Monitoring Programs And Projects

Air monitoring data used for analyses that were included in the Plan came from several different air monitoring programs and projects. Data from the Air District's long-term air monitoring network were retrieved largely from the U.S. Environmental Protection Agency's Air Quality System (AQS), which is EPA's official repository for ambient air quality data.[1] These data are also available for download via the EPA's Air Data website, which has tools for visualizing and summarizing air quality data.[2] Each year EPA also develops an interactive, national report on the status and trends in key air pollutions using data from air monitoring stations operated by state, local, and tribal air quality agencies nationwide.[3] Data for some pollutants measured at Air District monitoring sites, such as black carbon and ultrafine particles, were retrieved from Air District database systems. More information on the Air District's fixed-site air monitoring network, including the locations of air quality monitoring sites and the specific pollutants measured at different sites, is available in the latest version of the Annual Air Monitoring Network Plan.[4] The Air District's air monitoring network is designed for compliance with EPA network design and data quality requirements, including acceptable instrumentation, monitor siting and operation, and laboratory analysis methods. More information about the requirements of EPA's national air monitoring programs as implemented by the Air District is available through EPA's Ambient Monitoring Technology Information Center (AMTIC).[5]

Aggregated air monitoring data from different projects or programs were shown in several plots, such as daily or annual average concentrations of different pollutants. In general, to calculate average pollutant concentrations, valid data must be available for at least 75% of the averaging period. For example, to calculate a valid 24-hour average pollutant concentration from hourly data, at least 18 hours of valid data must be available. For criteria pollutants, there are specific data completeness and data handling requirements for calculating design values for comparisons with the National Ambient Air Quality Standards (NAAQS).[6]

Hourly $PM_{2.5}$ data from the network of Clarity air sensors in the PTCA area operated by Groundwork Richmond and Ramboll were provided to the Air District by Groundwork Richmond, Clarity, and Ramboll.[7] Accuracy of data from lower-cost air sensors can vary greatly across

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[1] EPA's Air Quality System (AQS), the official repository for ambient air quality data: https://www.epa.gov/aqs
[2] EPA's Air Data webpage: https://www.epa.gov/outdoor-air-quality-data
[3] EPA's Air Quality Trends Report webpage: https://www.epa.gov/air-trends
[4] Air District webpage for the Annual Air Monitoring Network Plan: https://www.baaqmd.gov/about-air-quality/air-quality-measurement/ambient-air-monitoring-network
[5] EPA's Ambient Monitoring Technology Information Center (AMTIC) website: https://www.epa.gov/amtic
[6] EPA's Air Quality Design Values website: https://www.epa.gov/air-trends/air-quality-design-values
[7] Groundwork Richmond Air Rangers webpage: http://www.groundworkrichmond.org/air-rangers.html

manufacturers and from unit to unit, and can change over time. Where the air sensor is mounted relative to its surrounding and air flow can also cause differences between units that are not due to differences in concentrations. These air sensors, their siting/placement, and the data they provide do not undergo the same rigorous quality control and assurance protocols that are used for the Air District's fixed-site air monitoring network. However, the data from these networks can still show relatively large differences between locations or times that are helpful in identifying potential sources of fine particulate matter.

The Air District's PTCA Community Air Monitoring Plan (CAMP) website[8] contains additional information and resources on air monitoring projects and programs that are referenced in this Appendix and in Chapter 5 of the Plan, including:

- The CAMP document[9] and materials and resources from CAMP development
- Quarterly updates during implementation of the CAMP with information on air monitoring projects in the PTCA area and data analyses with insights
- The Air Monitoring Reference Guide for the PTCA area[10], containing brief descriptions of several ongoing or completed air monitoring projects and programs, as well as links to available data and additional resources
- Materials related to the CAMP air toxics monitoring study, including an interactive StoryMap with insights[11]; a Technical Support Document with more detail on the study development, approach, data collection, and findings; and a downloadable dataset

The CAMP air toxics monitoring study was conducted using the Air District's air monitoring van, to screen areas for certain Volatile Organic Compounds (VOC)s and identify locations with higher levels of those VOCs. This study found numerous occurrences of higher than typical levels of different VOCs, some of which were located in the vicinity of specific facilities and operations in the study area. Compared to measurements from nearby areas, these occurrences of relatively higher levels of VOCs can point to air quality issues, including unknown or potentially under-controlled sources of air pollution that may be opportunities for reducing pollution emissions and exposure. Several examples of these occurrences of higher levels of different VOCs are described in this Appendix. While some types of air monitoring data are comparable with health-based thresholds or standards, the 1-second data collected in this study are not directly comparable to health metrics (which are typically based on much longer averaging periods) and do not provide enough information to estimate health risk.

Information to Support Key Issues, Strategies, and Actions

Information on air monitoring data and analyses is organized below by community concern thematic areas and key issues. Much of the data and analyses provided are intended to inform generally at the Community Concern thematic area/key Issue level. References are provided for instances where certain data or analyses relate to specific Strategies.

[8] The Air District's PTCA CAMP website: https://www.baaqmd.gov/community-health/community-health-protection-program/richmond-area-community-health-protection-program/community-air-monitoring
[9] The PTCA CAMP document: https://www.baaqmd.gov/~/media/files/ab617-community-health/richmond/richmondsanpabloairmonitoringplanjuly2020-pdf.pdf?la=en
[10] Air Monitoring Reference Guide for the PTCA area: https://www.baaqmd.gov/~/media/files/ab617-community-health/richmond/quarterly-report-documents/ptca-monitoring-data-inventory-pdf.pdf?la=en
[11] Interactive, public-facing StoryMap for the CAMP air toxics monitoring study: https://storymaps.arcgis.com/stories/21c9cd2252fe4a7d8ab26ae2fa81ec47

Fuel Refining

The Chevron Refinery operates certain air monitoring systems for compliance with different EPA regulations and Air District rules, described briefly in the PTCA Air Monitoring Reference Guide.[12] Air District Regulation 9, Rule 1 (Rule 9-1)[13] and Regulation 9, Rule 2 (Rule 9-2)[14] require Chevron to conduct ground-level monitoring of sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) to demonstrate compliance with concentration limits. These monitoring stations are also audited by the Air District. SO_2 and H_2S are common byproducts of refinery operations and can contribute to odors. These pollutants also have other sources that are found in the PTCA area, including landfills, composting facilities, and water treatment facilities, and have natural sources as well. Exposure to SO_2 can harm the respiratory system and is particularly impactful on people with existing respiratory conditions like asthma. SO_2 also contributes to the formation of particulate matter.[15]

SO_2 data from the refinery ground-level monitoring sites are shown in comparison with data from nearby Air District monitoring sites in Figure 1. Each smaller dot represents an hourly SO_2 concentration, and the larger black dot represents the five-year average concentration. There were many more occurrences of higher SO_2 levels at the Chevron-Castro ground-level monitor compared to other monitors. Data from the refinery ground-level monitors are not subject to the NAAQS since they are inside a facility fenceline, but they do show numerous occurrences of SO_2 concentrations approaching and exceeding the NAAQS (75 ppb) at the Chevron-Castro monitor.[16] There were fewer occurrences of higher SO_2 concentrations at the other monitoring sites. SO_2 concentrations at Air District monitoring sites, which are located outside the refinery fenceline, were comparatively lower and were well below the NAAQS. Data from the Oakland West monitoring site (near the Port of Oakland) and the San Jose-Jackson (urban area without refinery or port related SO_2 sources) are also shown for context. When comparing only Air District monitoring sites, there were more occurrences of relatively higher SO_2 concentrations (but below the NAAQS) at the Richmond-7th St., San Pablo-Rumrill, and Oakland West monitoring sites compared to the San Jose-Jackson monitoring site.

At the Chevron-Castro location, where measured SO_2 concentrations were generally highest compared to other monitoring sites, the higher concentrations occurred much more frequently from spring to early autumn (Figure 2). Factors such as seasonal operations at specific nearby refinery sources and meteorology (wind patterns and temperatures) may contribute to this seasonal variability.

The higher SO_2 concentrations measured at the Chevron Castro ground-level monitor tended to occur when winds were from the southwest, indicating a source or sources located to the southwest of the monitor. Figure 3 shows measured hourly SO_2 concentrations at Chevron Castro paired with wind speed and direction data from the nearby Chevron Gertrude ground-level monitor. The warmer colors (yellow, orange, red) indicate higher average SO_2 concentrations

12 Air Monitoring Data Reference Guide for the Path to Clean Air area: https://www.baaqmd.gov/~/media/files/ab617-community-health/richmond/quarterly-report-documents/ptca-monitoring-data-inventory-pdf.pdf?la=en
13 Air District Regulation 9, Rule 1: Sulfur Dioxide. https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-1-sulfur-dioxide
14 Air District Regulation 9, Rule 2: Hydrogen Sulfide. https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-2-hydrogen-sulfide
15 EPA Sulfur Dioxide Basics: https://www.epa.gov/so2-pollution/sulfur-dioxide-basics
16 NAAQS for Sulfur Dioxide: https://www.epa.gov/so2-pollution/primary-national-ambient-air-quality-standard-naaqs-sulfur-dioxide

occurring predominantly when winds are from the southwest. There are multiple possible SO_2 sources nearby to the southwest of the Chevron Castro monitor, including the Chemtrade facility and the Chevron bioreactor. The above information on SO_2 measurements at and near the refinery can help inform *Fuel Refining Strategy 5: Reduce Exposure and Public Health Impacts from Particulate Matter and Other Criteria Air Pollutants Emitted by the Fuel Refining Sector*. This data could be evaluated further for possible attribution to specific flaring events to inform *Fuel Refining 2: Reduce Persistent Flaring and Improve Incident Response*.

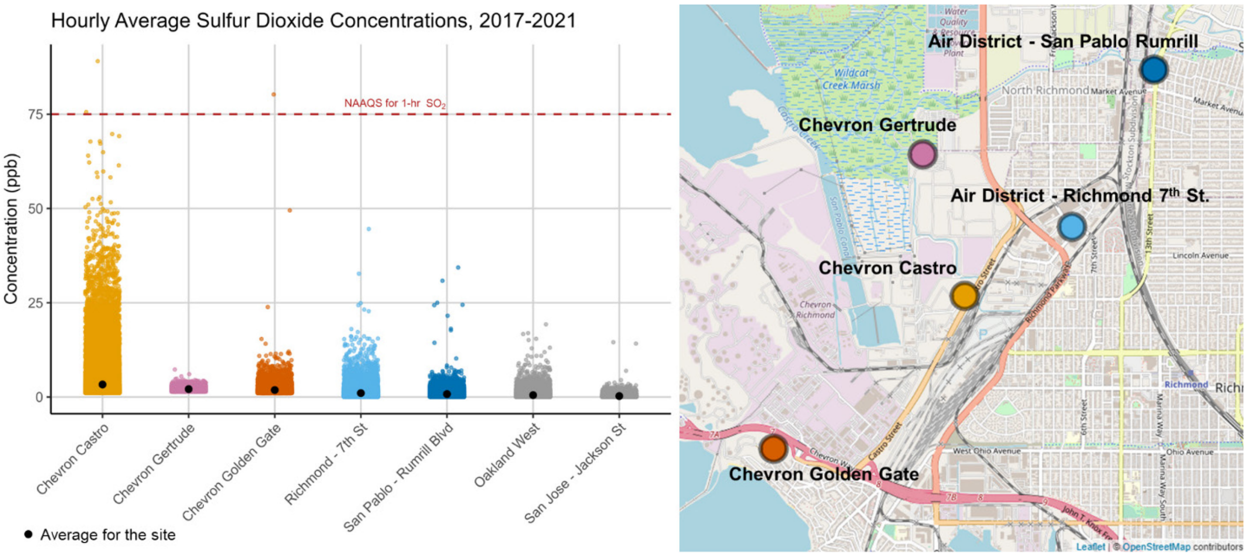

Figure 1. Hourly average SO_2 concentrations at Chevron ground-level monitors and selected Air District monitoring sites for the period 2017-2021 (left) and map of monitoring site locations (right).

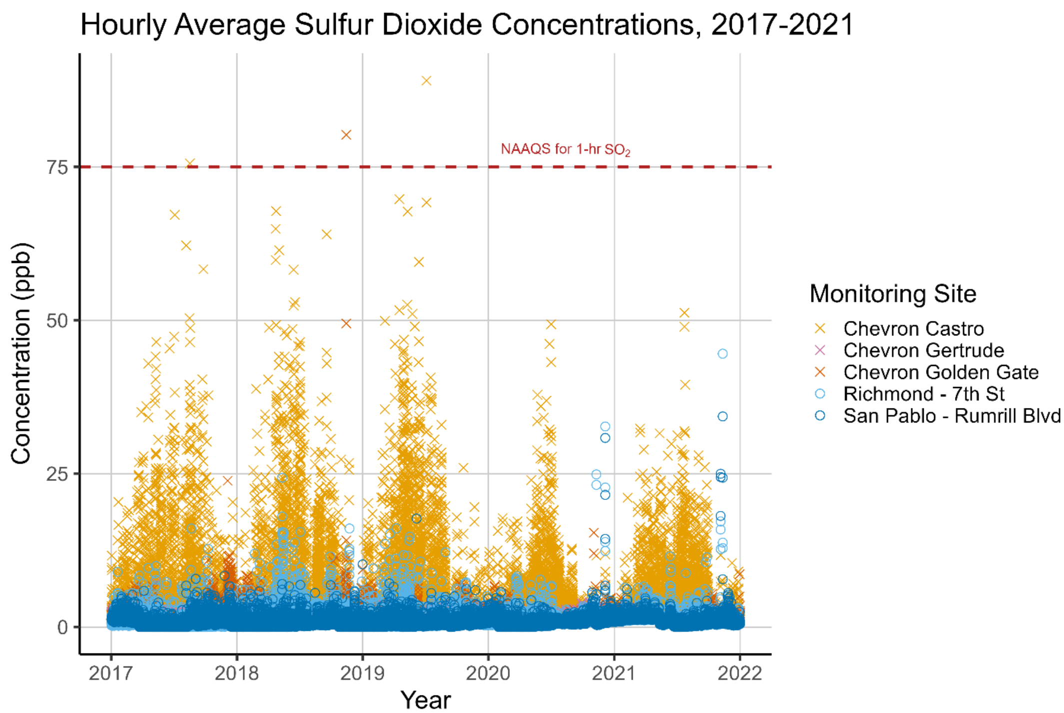

Figure 2. Time-series plot of hourly average SO_2 concentrations at Chevron ground-level monitors and nearby Air District monitors for the period 2017-2021.

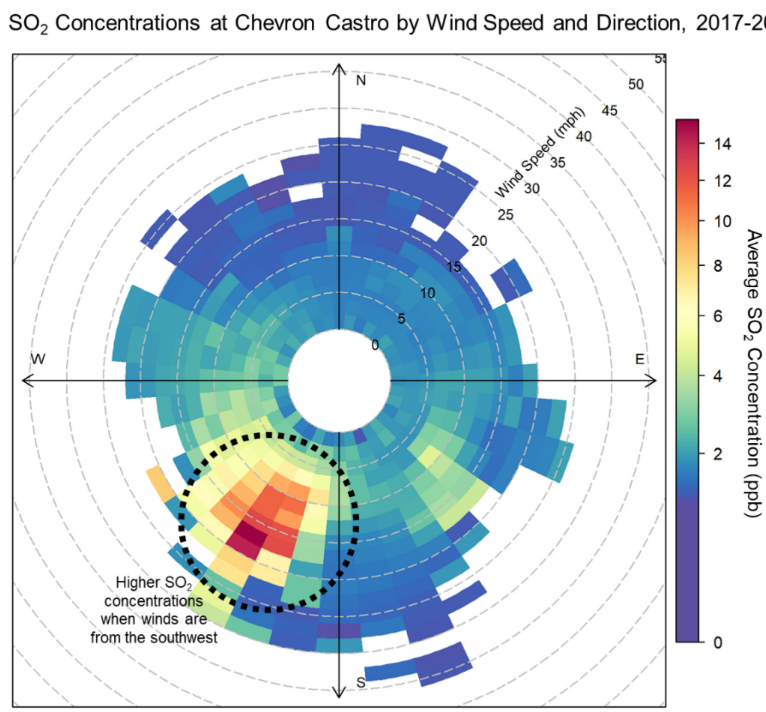

Figure 3. Polar frequency plot of hourly SO_2 concentrations from the Chevron Castro ground-level monitor and wind measurements from the Chevron Gertrude ground-level monitor. Warmer colors (yellow, orange, red) indicate higher levels of SO_2. In this case, SO_2 concentrations are higher on average when winds are from the southwest, indicating a source or sources of SO_2 in that direction.

H_2S data from the refinery ground-level monitoring sites and Air District monitoring sites are shown in Figure 4. While H_2S is not a criteria pollutant regulated under the Clean Air Act, CARB has established a California Ambient Air Quality Standard (CAAQS) for 1-hr hydrogen sulfide of 30 ppb for the purpose of odor control, though some people may detect odors at lower concentrations.[17] H_2S data from the refinery ground-level monitors and Air District monitoring sites were mostly below 30 ppb, though there have been isolated occurrences of higher concentrations near or exceeding 30 ppb.

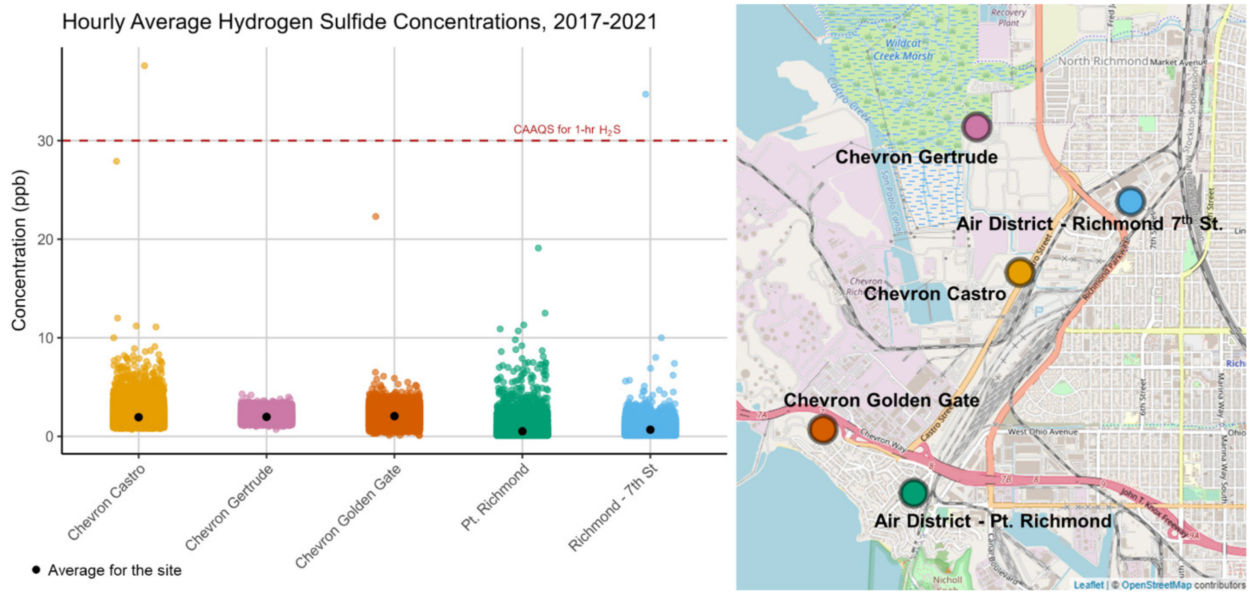

Figure 4. Hourly average H_2S concentrations at Chevron ground-level monitors and selected Air District monitoring sites for the period 2017-2021 (left) and map of monitoring site locations (right).

Chevron operates fenceline air monitoring systems for compliance with Air District Regulation 12, Rule 15 (Rule 12-15)[18] as well as the U.S. EPA's Refinery Maximum Achievable Control Technology (MACT) Rules.[19,20] These air monitoring systems are intended to provide information about refinery emissions that cross the refinery fenceline into neighboring communities. Under an agreement with the City of Richmond, Chevron also operates three community air monitoring sites that provide measurements for several pollutants, including $PM_{2.5}$ and selected VOCs. Real-time data from Chevron's SO_2 and H_2S ground-level monitors, fenceline monitors, and community monitors are available on Chevron's Richmond Air Monitoring website.[21] SO_2, H_2S, and meteorological data from Chevron's GLMs that were used in analyses for the Plan were retrieved from Air District database systems. Chevron transmits this data to the Air District at

[17] CARB Hydrogen Sulfide & Health webpage. https://ww2.arb.ca.gov/resources/hydrogen-sulfide-and-health
[18] Air District Regulation 12 Rule 15. http://www.baaqmd.gov/rules-and-compliance/rules/regulation-12-rule-15--petroleum-refining-emissions-tracking
[19] U.S. EPA Petroleum Refinery Sector Rule. https://www.epa.gov/stationary-sources-air-pollution/petroleum-refinery-sector-rule-risk-and-technology-review-and-new
[20] U.S. EPA Petroleum Refinery Fenceline Monitoring Data. https://www.epa.gov/stationary-sources-air-pollution/slides-petroleum-refinery-fenceline-monitoring-data
[21] Chevron's Richmond Air Monitoring Website. https://richmondairmonitoring.org/

regular intervals as required by Air District Rules 9-1[22] and 9-2[23] and can be made available by submitting a public records request to the Air District.[24] *Fuel Refining Strategy 3: Hold Chevron and Other Emitters Accountable for Reducing Pollution and Negative Public Health Impacts from their Operations* includes actions to improve refinery air monitoring programs, in part through improving reporting and accessibility of refinery-related monitoring data.

Petroleum refineries and supporting facilities have many individual sources and operations that produce VOCs, including refining and processing of crude oil as well as storage and transport of products like fuels and chemicals. The air toxics monitoring study under the PTCA CAMP also found occurrences of relatively higher concentrations of different VOCs near and downwind of the Chevron refinery (Figure 5), tank terminals that support refinery operations (Figure 6 and Figure 7), and a gas station (Figure 8). In these example, concentrations of combustion indicators like carbon monoxide were comparatively low, likely indicating non-combustion sources of these VOCs. These examples of findings from the CAMP air toxics monitoring study can help inform *Fuel Refining Strategy 4*: *Reduce Exposure and Public Health Impacts from Toxic Air Contaminants Emitted by the Fuel Refining Sector.*

Figure 5. Map view of measured a) 1,3-butadiene concentrations along Ohio Ave. on 1/31/2022 and b) toluene concentrations near the Chevron Refinery on 2/02/2022.

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[22] Air District Regulation 9, Rule 1: Sulfur Dioxide. https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-1-sulfur-dioxide
[23] Air District Regulation 9, Rule 2: Hydrogen Sulfide. https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-2-hydrogen-sulfide
[24] Air District Public Records Request website: https://www.baaqmd.gov/contact-us/request-public-records

Figure 6. Relatively higher levels of styrene were measured along Wright Ave. near and downwind of the Transmontaigne tank terminal, 3/29/2022.

Figure 7. Relatively higher levels of trimethylbenzene were measured along Cutting Blvd. near and downwind of tank terminals and marine-related operations and facilities, 1/31/2022.

Figure 8. Relatively higher levels of benzene were measured outside the Top Gas station at Rumrill Blvd. and Pine Ave., 2/8/2022. Relatively higher levels of other VOCs were also measured at this location.

Commercial and Industrial

Data from community-operated air sensor networks, such as from the project led by Groundwork Richmond and Ramboll described in Chapter 5, can be useful in detecting localized, short-term variability in fine particulate matter that is not readily apparent in longer-term averages. Figure 9 shows examples when certain locations measured frequent occurrences of much higher $PM_{2.5}$ concentrations compared to nearby locations, possibly indicating contributions from localized, intermittent pollution sources. In both examples shown, there are several possible sources of $PM_{2.5}$ in the immediate vicinity. Both examples are also in the immediate vicinity of residences. The occurrences of higher concentrations of $PM_{2.5}$ in San Pablo near Rumrill Boulevard and Market Avenue are likely due to nearby food cooking operations or restaurants given the proximity of those operations to the $PM_{2.5}$ sensor and air quality complaints for food operations in that location (see *C&I Strategy 3*: *Reduce Exposure from Food Preparation*).

In the Carlson Boulevard example, there are several small industrial and commercial facilities in the immediate vicinity, as well as a partially unpaved roadway (see *C&I Strategy 1*: *Control Fugitive Dust*), and a rail line with piles of dirt in the right of way. In this example, the occurrences of higher $PM_{2.5}$ concentrations were no longer prevalent after summer 2020, possibly indicating a temporary source of $PM_{2.5}$.

The PTCA CAMP air toxics monitoring study also found several examples of occurrences of relatively higher concentrations of VOCs near specific commercial and industrial facilities and operations, including a plastics manufacturing facility (Figure 10), auto body shops (Figure 11), and baking operations (Figure 12). VOCs can enter the air through evaporation of certain products like gasoline and other fuels, chemicals, paints, solvents, and cleaners. VOCs may also be released as byproducts of industrial processes. These findings can inform *C&I Strategy 3*: *Reduce Exposure from Food Preparation* (e.g., bakeries), *C&I Strategy 4*: *Large Industrial Sources,* and *C&I Strategy 5*: *Commercial and Smaller Industrial Facilities (e.g., autobody shops and other small businesses*).

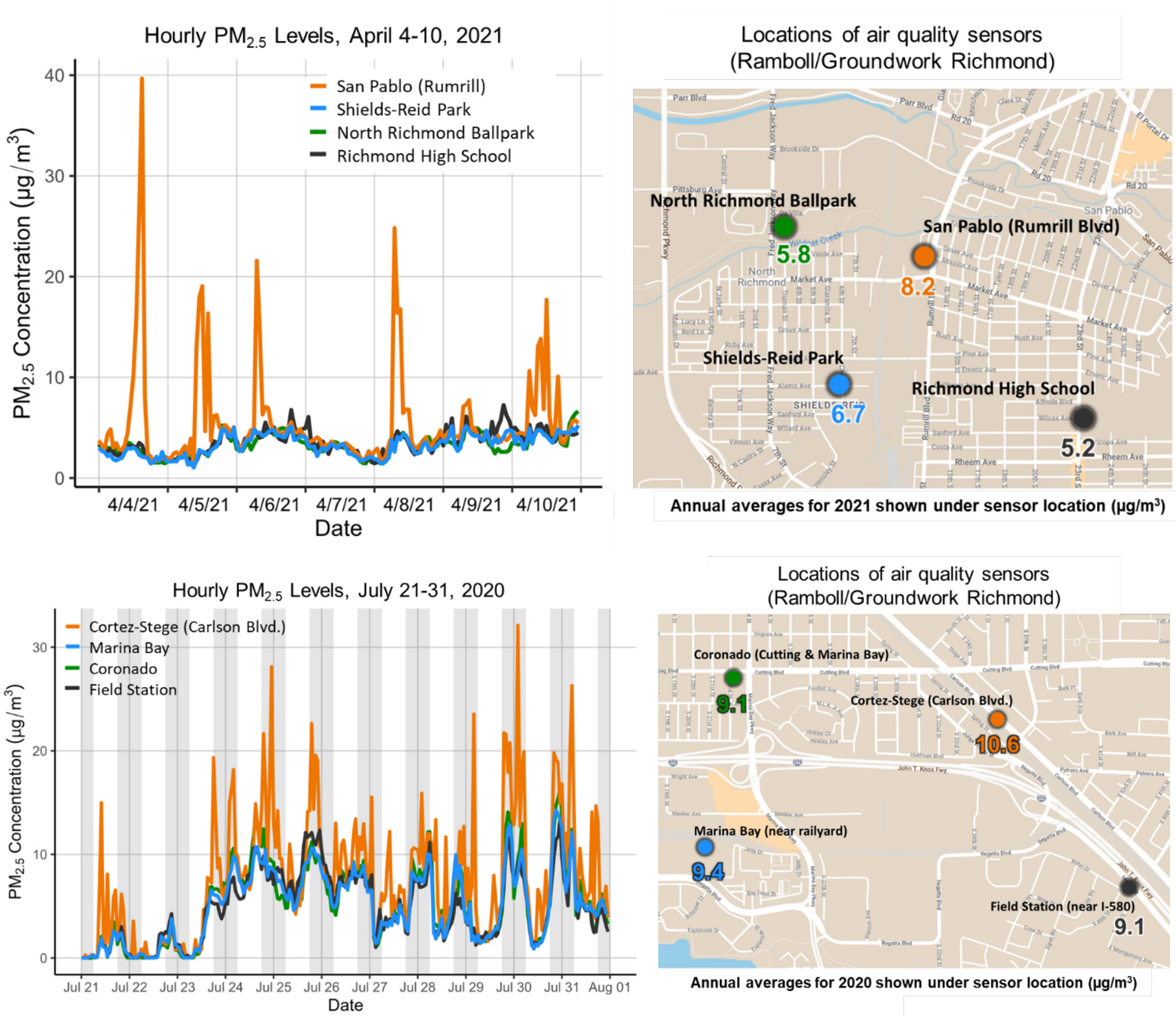

Figure 9. Examples of occurrences of short-term higher $PM_{2.5}$ concentrations measured at lower-cost sensors, San Pablo and North Richmond (top) and the vicinity of Carlson Blvd. (bottom).

Figure *10*. Relatively higher levels of styrene were measured near and downwind of ATS Products, a plastics manufacturing facility, on a) 2/10/2022, b) 3/17/2022, and c) 4/1/2022.

Figure 11. Relatively higher levels of toluene were measured near and downwind of autobody shops along a) Giant Hwy. on 3/17/2022, b) Giant Hwy. on 4/1/2022, and c) Market Ave. on 4/1/2022.

Figure 12. Relatively higher levels of acetaldehyde were measured near and downwind of the Safeway Bread Plant, as shown in a) 1/31/2022, b) 2/18/2022, and c) 3/29/2022.

Some commercial and industrial operations and activities can be sources of odors. Generally, outdoor odors have many sources, including natural sources and human activities. Examples of natural sources of odors include wetlands and shorelines where organic matter may be decaying. Examples of odors associated with human activities include refinery operations, including chemical transport and storage; waste management facilities such as landfills, recyclers, and compost sites; sewers and wastewater and sewage treatment plants; smaller commercial and industrial operations like printers, dry cleaners, restaurants, gas stations, and auto body shops; and remediation efforts for contaminated soils. One example of an ongoing soil remediation effort is at the Zeneca Site in Richmond.[25]

Different people have different sensitivities to odors, can detect odors at different thresholds, and have different responses to odors. Even if an odor is not associated with high levels of a pollutant, odors can still affect health and well-being. Odors may indicate the presence of one or more pollutants. Odors can also indicate the presence of pollutants that don't have odors but are being emitted at the same time.

Odors typically occur in short-term, intermittent episodes. Measuring pollutants associated with odors can be difficult and typically requires specialized studies with specific equipment. H_2S,

[25] California Department of Toxic Substances Control website for the Zeneca Richmond Ag Products site cleanup and remediation: https://dtsc.ca.gov/smrp-projects/zeneca-richmond-ag-products/

commonly referred to as sewer gas, is one pollutant that the Air District and Chevron conduct continuous air monitoring for at locations in the PTCA area. These monitors are described in more detail in the Fuel Refining key issue since H_2S emissions are also associated with refinery operations. In addition, the City of Richmond operates an H_2S monitoring program at the Point Richmond Wastewater Treatment Plant, with data available to the public in real-time.[26]

Mobile Sources and Logistics

Measurement data from Air District air monitoring sites and numerous studies of air monitoring data show that levels of several traffic-related air pollutants, such as nitrogen oxides (NO_x), carbon monoxide (CO), black carbon (soot), ultrafine particles, fine particulate matter ($PM_{2.5}$), and volatile organic compounds (VOCs), are often higher near busy roadways. Pollutant levels along roadways are typically higher when traffic is worse, such as during daily commute periods.

The Air District operates four near-road air monitoring sites in the Bay Area, part of a national network of near-road monitors required by U.S. EPA.[27] Figure 13 shows the locations of the Air District's near-road air monitoring sites and a photo of the general siting of the San Jose-Knox Ave. near-road monitoring site, to illustrate the proximity of these monitoring sites to the freeway. These sites are located alongside freeways with high traffic counts where maximum impacts from on-road pollution sources are expected and monitor for pollutants that are commonly associated with traffic, such as nitrogen dioxide (NO_2), CO, and $PM_{2.5}$. While the Air District's near-road air monitoring sites are located outside the PTCA area, they are sited in locations that are expected to be representative of impacts near freeways in the PTCA area. Table 1 describes several pollutants that are associated with mobile sources of air pollution that are measured at different Air District air monitoring sites but note that these pollutants also have other sources.

Figure 13. Locations of the Air District's near-road air monitoring sites (left) and photo of the San Jose-Knox St. near-road air monitoring site along the US-101/I-680 interchange (right).

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[26] City of Richmond H_2S Monitoring at the Wastewater Treatment Plant: https://richmondwpcp-h2s.org/

[27] U.S. EPA Near Road Monitoring website: https://www.epa.gov/amtic/near-road-monitoring

Table 1. Summary of pollutants associated with mobile sources of air pollution and are measured at different Air District air monitoring sites. Note that these pollutants also have other sources.

Pollutant	Description / Examples	Main Sources on Roadways	Notable / Example Health Impacts
Fine particulate matter ($PM_{2.5}$)	Smaller than 2.5 µm (1/20th the thickness of a human hair). Smaller size makes it easier to inhale & be deposited in lungs.	Exhaust from gasoline, diesel fuel, etc., being burned in engines Brakes & tires wearing down Road dust being kicked back up	Asthma development, asthma attacks, difficulty breathing, bronchitis, heart disease, heart attacks, strokes, neurological (brain) disease, lung cancer, low birth weight, lost days of work and/or school. Increased emergency room visits, medicine usage, hospital admissions, and premature deaths / years of life lost.
Black carbon	Soot; a component of $PM_{2.5}$; correlated with **diesel particulate matter (DPM)**	Exhaust from gasoline, diesel fuel, etc., being burned in engines Road dust being kicked back up	Asthma development, asthma attacks, difficulty breathing, bronchitis, heart disease, heart attacks, strokes, neurological (brain) disease, lung cancer, low birth weight, lost days of work and/or school. Increased emergency room visits, medicine usage, hospital admissions, and premature deaths / years of life lost.
Ultrafine particles	Diameter smaller than 0.1 µm.	Exhaust from gasoline, diesel fuel, etc., being burned in engines Brakes & tires wearing down Road dust being kicked back up	Asthma development, asthma attacks, difficulty breathing, bronchitis, heart disease, heart attacks, strokes, neurological (brain) disease, lung cancer, low birth weight, lost days of work and/or school. Increased emergency room visits, medicine usage, hospital admissions, and premature deaths / years of life lost.
Volatile organic compounds (VOCs)	Gases such as benzene, toluene, ethylbenzene, xylene, formaldehyde. Some are odorless, some not.	Exhaust Fuel evaporation	Some VOCs cause cancer. Many can cause irritation of the eyes, nose, and throat; headaches, rashes, nausea, or disorientation, depending on how much is inhaled.

Pollutant	Description / Examples	Main Sources on Roadways	Notable / Example Health Impacts
Nitrogen oxides (NO_x)	Family of reactive gases; contributes to formation of $PM_{2.5}$ in outdoor air	Exhaust	Coughing, wheezing, difficulty breathing, increased asthma & allergy attacks.
Carbon monoxide (CO)	Colorless, odorless gas	Exhaust	Harder for blood to carry oxygen; at high levels (about 100,000 ppb), poisoning

Figure 14 shows average concentrations of several pollutants by time of day over the period 2016-2020 at Air District monitoring sites, categorized by general siting location (near-road, urban/suburban, and rural). Concentrations of NO_2, CO, black carbon, and ultrafine particles were generally higher at the near-road monitoring sites (red lines) compared to other monitoring sites (blue and green lines). For $PM_{2.5}$, average concentrations at the near-road monitoring sites (red lines) were higher than many of the other sites, though concentrations at some of the non-near road urban/suburban sites (blue lines) were very similar to concentrations at near-road sites. Average peak concentrations of black carbon and ultrafine particles at the near-road monitoring sites were about twice as high as compared to other monitoring sites. The higher black carbon concentrations observed at the near-road monitoring sites may indicate a greater contribution from diesel truck exhaust.

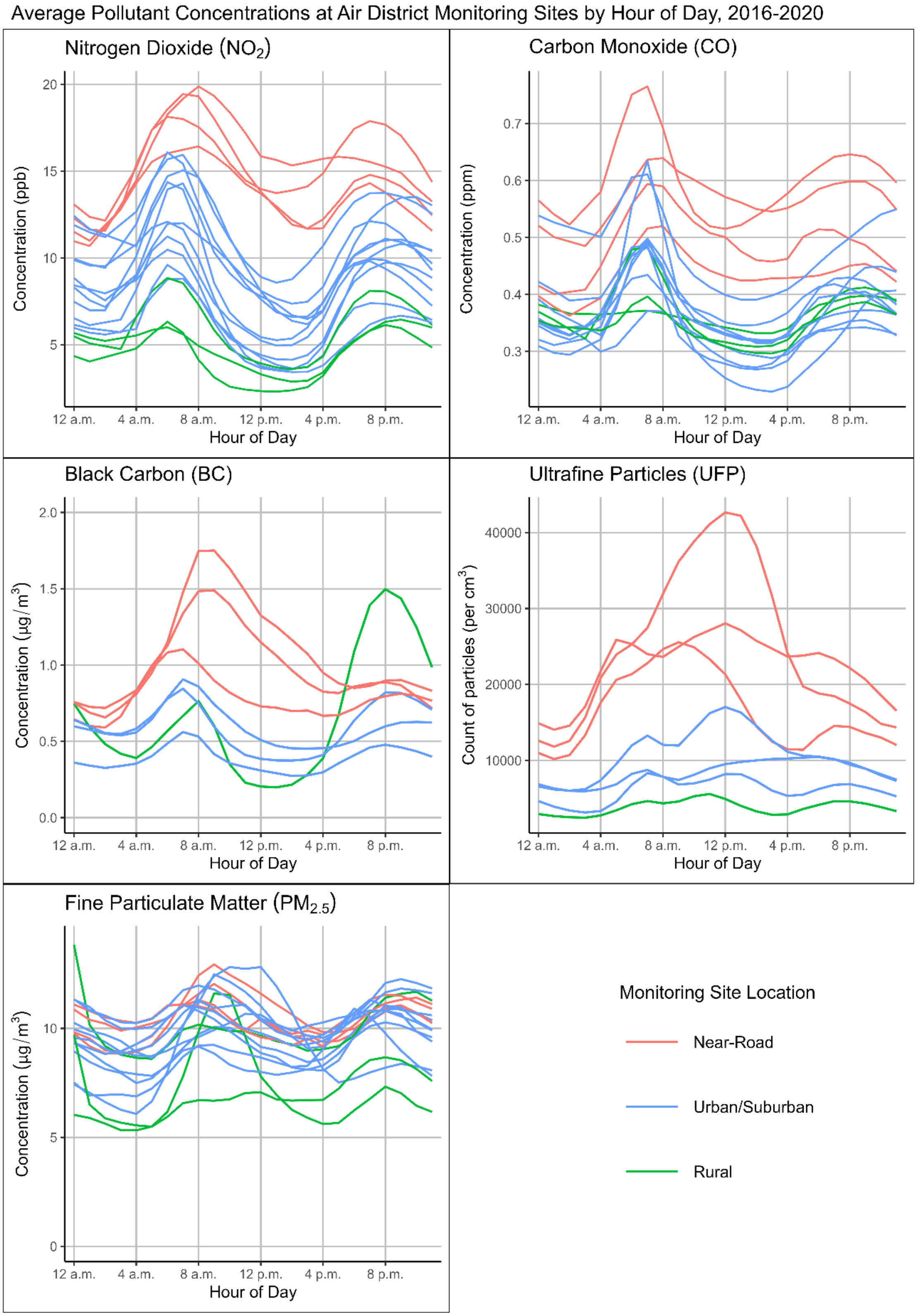

Figure *14*. Average concentrations of nitrogen dioxide (NO_2), carbon monoxide (CO), black carbon (BC), ultrafine particles (UFP), and fine particulate matter ($PM_{2.5}$) by hour of day at Air District monitoring sites, 2016-2020. Each line represents data from one monitoring site.

Concentrations of these pollutants fluctuate throughout the day due to changes in emissions, meteorology, and chemical reactions in the atmosphere. Pollutant concentrations generally increase during the morning commute period, due in part to increased emissions from traffic at that time. The rural monitoring site that shows higher concentrations of black carbon in the evening hours is in a valley where residential wood burning is a dominant source of air pollution. On any given day, the fluctuations and patterns in pollutant concentrations may be substantially different than the average concentrations shown in Figure 14.

Numerous studies on characterizing near-road air quality have found higher measured concentrations of traffic-related air pollutants near roadways.[28,29,30] While these specific studies took place outside the PTCA area, their findings can be applicable to near-road environments more broadly. Within the Bay Area, a mobile monitoring project conducted by Aclima found higher levels of traffic-related pollutants along several freeway corridors, including I-80 and I-580 through the PTCA area.[31]

Physicians, Scientists, and Engineers for Healthy Energy (PSE), in partnership with the Asian Pacific Environmental Network (APEN), operated a sensor network in the PTCA area with measurements of $PM_{2.5}$, NO_2, and ozone, in addition to periodic measurements of black carbon. Their analyses found that traffic was an important source of $PM_{2.5}$, NO_2, and black carbon in the study area, highlighted spatial variability in $PM_{2.5}$ levels across neighborhoods, and found higher levels of NO_2 near major roadways, among other insights.[32]

The PTCA air toxics monitoring study, a project in the PTCA CAMP, found relatively high correlations of several VOCs (notably, the BTEX compounds) with CO and NO_x, which are signatures of fuel combustion. Some VOCs are air toxics that are associated with significant health effects. Combustion-related sources of VOCs, such as traffic, are prevalent throughout the PTCA area.

Marine and Rail

Air monitoring to attribute air pollution to marine and rail operations typically requires specialized studies since there are often many contributing sources of the same air pollutants in the immediate vicinity of a port or railyard. An example of an air monitoring study that focuses on rail operations is the Roseville Railyard Aerosol Monitoring Project (RRAMP)[33]. In RRAMP, levels of several pollutants were notably higher near the railyard, including aerosols associated with diesel emissions, NO and NO_2, very fine sulfur, and black carbon, among others. In 2019, CARB awarded a Community Air Grant to a project to assess air pollution impacts from coal and

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[28] Baldauf, R., Thoma, E., Hays, M. et al., *Traffic and Meteorological Impacts on Near-Road Air Quality: Summary of Methods and Trends from the Raleigh Near-Road Study*, Journal of the Air & Waste Management Association, 58:7, 865-878 (2008). https://doi.org/10.3155/1047-3289.58.7.865

[29] Baldauf, R., Watkins, N., Heist, D. et al. *Near-road air quality monitoring: Factors affecting network design and interpretation of data*. Air Qual Atmos Health 2, 1–9 (2009). https://doi.org/10.1007/s11869-009-0028-0

[30] Polidori A., Fine P. M. *Ambient Concentrations of Criteria and Air Toxic Pollutants in Close Proximity to a Freeway with Heavy-Duty Diesel Traffic*. Final report prepared by the South Coast Air Quality Management District (2012). http://www.aqmd.gov/docs/default-source/air-quality/air-quality-monitoring-studies/near-roadway-study.pdf

[31] Aclima's Air.Health website: https://air.health/

[32] Final report on PSE's Richmond Air Monitoring Network, 2022: https://www.psehealthyenergy.org/our-work/publications/archive/understanding-air-quality-trends-in-richmond-san-pablo/

[33] Placer County APCD Final Report on the Roseville Railyard Aerosol Monitoring Project: https://ca-placercounty.civicplus.com/AgendaCenter/ViewFile/Item/188?fileID=504

petroleum coke operations in Richmond. An update on this project, called the Assessment of Coal Air Pollution Project (ACAPP), was included in a quarterly update on implementation of the PTCA CAMP.[34]

During the PTCA CAMP air toxics monitoring study, the Air District's air monitoring van collected data on roadways near railyards and along the harbor and found several occurrences of higher levels of different TACs. Higher levels of 1,3-butadiene, a TAC and known carcinogen, were detected along Ohio Avenue immediately downwind of the Burlington Northern-Santa Fe railyard, but also downwind of Chevron refinery operations (see Figure 5). Occurrences of higher levels of several TACs were also detected in the vicinity of several facilities along the harbor area in the vicinity of tank terminals and marine repair facilities (see Figure 7).

Health

Smoke from wildfires caused periods of unhealthy air quality in the PTCA area and throughout the Bay Area in recent years. Figure 15 shows 24-hour average (midnight to midnight) $PM_{2.5}$ concentrations at the Air District's San Pablo monitoring site from 2018 to 2022. The bold blue line indicates data from 2022 to highlight the variability in $PM_{2.5}$ concentrations over a year, and the gray shaded area represents the range of daily $PM_{2.5}$ concentrations that were measured during the 2018-2022 period. The fluctuations in $PM_{2.5}$ concentrations from day to day are driven largely by changes in meteorology (wind patterns, mixing and ventilation) and in emissions. The highest $PM_{2.5}$ concentrations occurred during wildfire periods, during which the NAAQS for daily average $PM_{2.5}$ of 35 $\mu g/m^3$ was exceeded on numerous occasions. Wildfire smoke also contains numerous other pollutants, including CO, NO_x, and various TACs. The highest levels of benzene, a carcinogen, measured in recent years at the Air District's air monitoring sites in Richmond and San Pablo occurred during periods of wildfire smoke (see Figure 5-10 in Chapter 5). The U.S. EPA's AirNow program[35], CARB[36], and the Air District[37] have websites with information and resources on wildfire smoke and steps to take to reduce exposure to wildfire smoke (see *Health Strategy 2: Reduce Air Pollution at Home*). The AirNow Fire and Smoke Map website displays real-time $PM_{2.5}$ data from air quality agencies (such as the Air District) as well as data from PurpleAir lower-cost sensors (whose data are adjusted by an EPA-developed algorithm that compensates for some of the inaccuracies of the sensors).[38]

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[34] Update on Implementation of the PTCA CAMP, Q3 2021: https://www.baaqmd.gov/~/media/files/ab617-community-health/richmond/quarterly-report-documents/2021_10_05-update-on-monitoring-projects-q3-2021-pdf.pdf?la=en&rev=fe34f8920c5241cb8734c4aa7fff6e1d

[35] U.S. EPA AirNow Wildfire website: https://www.airnow.gov/wildfires/

[36] CARB's Protecting Yourself from Wildfire Smoke website: https://ww2.arb.ca.gov/protecting-yourself-wildfire-smoke

[37] The Air District's Wildfire Safety website: https://www.baaqmd.gov/about-air-quality/wildfire-air-quality-response-program/wildfire-safety

[38] U.S. EPA AirNow Fire and Smoke Map for real-time $PM_{2.5}$ data: https://fire.airnow.gov/

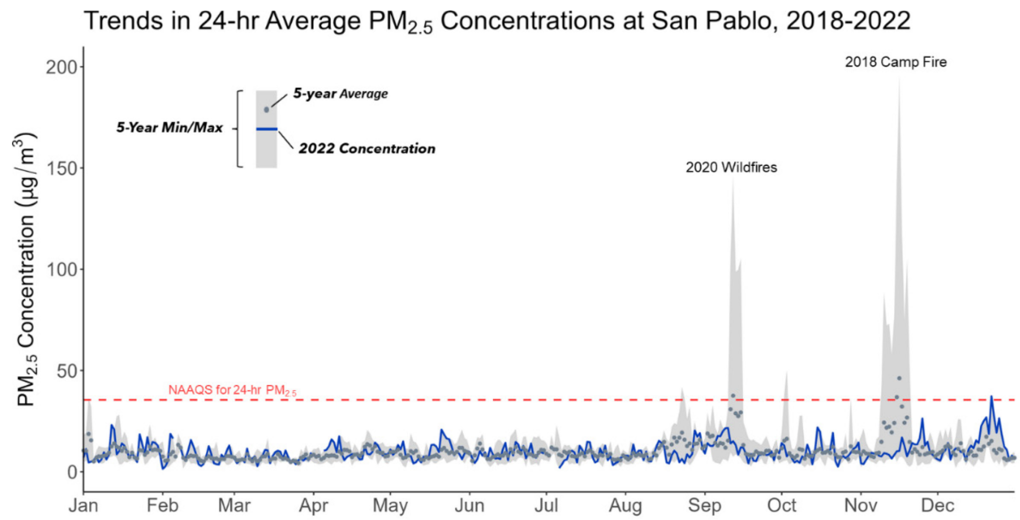

Figure 15. 24-hour average $PM_{2.5}$ concentrations at the San Pablo monitoring site, 2018-2022. $PM_{2.5}$ concentrations typically vary considerably over a year. Some of the highest concentrations occurred during periods of wildfire smoke.

Other factors can also cause periods of higher concentrations of $PM_{2.5}$ and other pollutants, such as during wintertime pollution episodes when weather conditions allow for pollution to build-up (stagnation) and bring pollution from other regions into the local area. In fact, the highest 24-hour average $PM_{2.5}$ concentrations measured in 2022 at the San Pablo monitoring site occurred in December during a wintertime pollution episode, when the NAAQS for 24-hour $PM_{2.5}$ was exceeded on one day. Smoke from fireplaces and wood stoves can be large contributors to $PM_{2.5}$ concentrations during these wintertime events (see *Health Strategy 2: Reduce Air Pollution at Home*), but $PM_{2.5}$ from all sources, including industries and traffic, also contribute and build-up during these events.

Real-time air quality data can help inform the public in making decisions about reducing exposure to unhealthy air quality, such as choosing to reschedule outdoor activities like exercise when air quality is or is expected to be unhealthy. The Air District's website provides real-time air quality monitoring data from Air District air monitoring sites on its website, and the air monitoring data reference guide for the PTCA area contains links to real-time air monitoring data from additional air monitoring programs and networks specific to the PTCA area, including refinery-related monitoring and sensor networks. Air quality meteorologists at the Air District also issue daily air quality forecasts for the Bay Area, as well as Spare the Air Alerts when air quality levels are expected to be unhealthy compared to the NAAQS. The public can view the daily air quality forecast and subscribe to receive forecasts and alerts by text and e-mail, and can download the Spare the Air mobile app, on the Spare the Air program website.[39] The Air District also issues Air Quality Advisories when air quality is expected to be poor in some areas for a short amount of time but not to the extent a health-based standard (based on a 24-hour average for $PM_{2.5}$) is exceeded. These Advisories are listed on a banner at the top of the Air District website and are posted on Air District social media pages. This information can support *Health Strategy 5: Pollution & Public Health Education, Outreach, Accountability, and Health Data Tracking*)

[39] Website for the Air District's Spare the Air program: https://www.sparetheair.org/